www.cepal.org/transporte

Issue No. 358 - Number 6 / 2017
English / Original: Spanish

BULLETIN FAL

FACILITATION OF TRANSPORT AND TRADE IN LATIN AMERICA AND THE CARIBBEAN

Estimating demand for transportation using the input-output model: Brazil, Chile, Ecuador and Nicaragua

Background

This document introduces an app for generating estimates of the demand for freight transport by using the input-output model or IOM.[1] The model entails analysing relations between economic sectors and projecting a desired rate of growth. The findings are then allocated and distributed among the input-output tables by using the "technical coefficients matrix" and a few quantitative techniques.

The outcomes are then converted into tons (*t*), based on import and export vectors. Transport demand estimates (in tons) are analysed for Brazil, Chile, Ecuador and Nicaragua. The estimates generated assume a rate of growth associated with a certain planned level of expenditure.

The challenges of generating fairly detailed and independent[2] transportation demand estimates are going to be directly related to the need to reduce economic inefficiencies in national and international logistics chains. Thus, increasing competitiveness will require a convergence of subnational economies brought about by insertion into global markets.[3]

[1] The IOM enables countries in the region to prepare infrastruture development plans and programmes. By using transportation network models and transportation engineering software, it provides an opportunity to allocate the demand for transport (demand approach) to supply, with a view to saturating existing multimodal networks, after identifying the most congested modes that need to be addressed.

[2] "Independent" in the sense that the estimation of demand for transportation is derived from each country's national accounts and not from case by case interviews with those generating freight and shippers.

[3] In 2002, Edgar Moncayo described what he called "winner" and "loser" territories in Latin America, pointing out that there are subnational regions that have become incorporated into the global economy and others that have not managed to connect with it. As a result, the region exhibits divergent trends.

This issue of the FAL Bulletin presents a tool for estimating demand for freight transport by using input-output tables. It shows how the method is applied in Brazil, Chile, Ecuador and Nicaragua. The estimates generated (in tons) are based on certain assumptions, such as growth associated with a certain planned level of expenditure, and provide an initial approximation to a model that should eventually include other techniques. The idea is to obtain a more accurate assessment of freight transport supply needs for strategic and operational purposes.

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The proposed methodology has to do with the following challenges listed by Jaimurzina, Pérez-Salas and Sánchez (2015):

1. The physical tightness or shortage in the provision of infrastructure and services which has led to acute stress and triggered a growing infrastructure gap.
2. The dispersal and multiplicity of public actions and decisions for infrastructure and its services, and the consequent absence of a comprehensive approach to the concept, design, implementation, monitoring, oversight and evaluation of policies.
3. The presence of institutional and regulatory failings and problems, both in the conduct of policies and in the organization of markets.
4. Lack of sustainability criteria in infrastructure service policies, especially in transport.

Ascertaining freight transport demands within the countries of the region will aid progress towards the establishment of development plans or programmes for rational infrastructure endowment, as part of a comprehensive and sustainable logistics policy aimed at increasing productivity and efficiency and reducing negative externalities.[4]

I. Background on the demand for transportation and infrastructure

The low rates of investment in transportation infrastructure in the region raise questions about the capacity of existing infrastructure to sustain economic expansion and a concomitant increase in demand for transportation services, above all bearing in mind the warning issued by Rozas and Sánchez about the congestion of installed capacity found in developing countries when investment in infrastructure dips below the rate of growth of GDP (Rozas and Sánchez, 2004).[5]

In general, the lack of (physical, logistic, and technological) infrastructure and the lack of operational security, in addition to the existence of obsolete technical and regulatory norms and the informality of ground transportation in much of the region are the main impediments to implementing combined or multimodal transportation systems at both the national and regional levels. This state of affairs impairs logistics flows within the territories of the countries in the region, including urban areas (Pérez, 2013).

The end result tends to direct transportation actors (citizens, transportation operators, manufacturers) towards common goals, such as enhancing market participants' behaviour, for instance by buying more efficient vehicles, reducing energy consumption, optimizing freight transportation logistics, changes in the type of distribution through the establishment of a system of appropriate incentives and regulations (Kreuzer and Wilmsmeier, 2014).

With regard to traditional economic development and key economic actors in the transportation sector, it is worth pointing out that amid rising demand for distribution mechanisms that facilitate more frequent and speedier deliveries, logistics costs and transportation efficiency have key impacts on a region's local-global competitiveness and its integration into regional and global environments. Enhanced logistical efficiency based on appropriate infrastructure endowment is a key ingredient of public policy with respect to freight and passenger mobility and, therefore, the sustainability of economic growth. Increased efficiency in national and urban logistics and cost reduction are two of today's most pressing priorities (IDB, 2010).

II. The input-output table and its components

The input-output table method was developed by W. Leontief around 1930. Essentially, it is a set of matrices showing relations between economic sectors. Based on those relations, it is possible to determine which sectors boost and shape national economies by discerning strengths and/or weaknesses and degrees of diversification of countries' productive matrices.

For the input-output model, Leontief describes such matrices as: the total supply matrix; the intermediate demand matrix; the value-added matrix; the final demand matrix; and the technical coefficients matrix, which aims to show the distribution of probabilities of the relations established in the aforementioned matrices among the economic sectors recorded in intermediate demand. (Details of uses of the input-output table can be found in Schuschny, 2005).

The demand for transportation is construed as a demand derived from economic activity, that is to say, from the location of production and consumption. There are various stages in the production of goods, so that intermediate goods have to be relocated and transported in order to produce final goods, which in turn will be shipped to markets for final consumption.

The production of goods and services generates demand for transportation services at two stages: the transportation of inputs and raw materials and the transportation of intermediate and final products for consumption within

[4] In port cities, rational infrastructure endowment reduces the negative externalities associated with foreign trade.

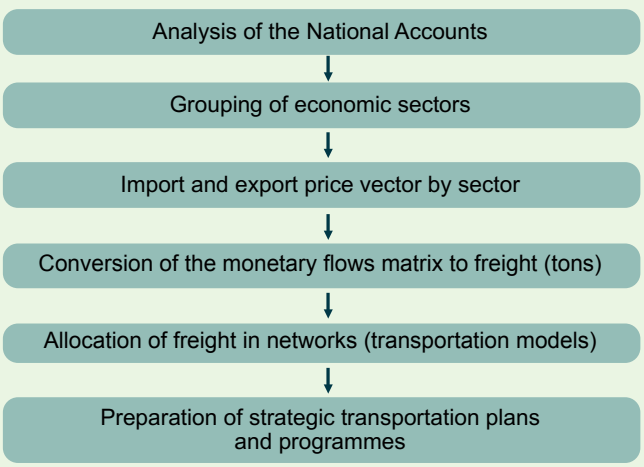
[5] "…In general, the high costs of infrastructure services in developing countries negatively affect their insertion in international trade. It has been estimated that the impact is similar to that of customs duties and barriers or exchange rate distortions. The high costs of transport, telecommunications, electricity and sanitation services, among other infrastructure services, as well as their quality, negatively affect factor productivity and business and export competitiveness" (Rozas and Sánchez, 2004).

and beyond national borders. That has to do with national and international logistics and supply chains, whereby products are imported for national production and consumption and production is generated for export.

III. Methodological description of the input-output model for estimating demand for transportation and infrastructure

To estimate national demand for transportation services, it is first necessary to estimate the future demand for freight and to plan the supply of multimodal transportat ion needed to satisfy that demand. Thus, if the supply does not suffice to satisfy potential demand, the result will be infrastructure congestion. That, in turn, will hamper other economic activities, raise their costs and result in a loss of competitiveness, which will discourage future investment and diminish the possibility of a new wave of economic growth. See diagram 1.

Diagram 1
Procedure for estimating demand for freight transportation within the framework of a comprehensive and sustainable logistics policy



Source: Prepared by the author.

IOM uses countries' national accounts[6] to estimate demand for transportation services. The model establishes links in final demand for goods and services (private consumption, public expenditure, investments and exports), which in turn depends on growth of GDP. In other words, for a given rate of GDP growth, the idea is to establish the volume of freight that will need to be transported.

[6] For United Nations recommendations on national accounts, see The System of National Accounts (SNA) 1993, Michel Séruzier, 2003.
"Measure the economies of the countries according to the system of national accounts", Paris, ECLAC/ALFAOMEGA. See [online] http://repositorio.cepal.org/bitstream/handle/11362/1800/S3393S489_es.pdf?sequence=1.

IOM establishes the demand for additional goods and services (intermediate transactions) needed to satisfy final demand. Once total demand has been calculated, additional accounts for productive sectors can be estimated in terms of the imports they need in order to produce, the cost of workers' wages, corporate profits and taxes to be paid. These last three factors (wages, profits and taxes) constitute value added in the economy and are equivalent to GDP.

The production and consumption estimated using IOM can be regionalized within countries by assigning those values to the respective productive regions to which the logistics apply. Final consumption is assigned based on the national and regional population growth rate and the respective GDP. Using the technical coefficients matrix, projections can likewise be made for public expenditure, investment and exports.

A. Recommended Sources of Information for Developing the Methodology

Countries' national accounts are an essential source of information for analysing the economic sectors involved in the production and consumption of goods and services. The central banks in the countries of the region make this information available, based on IOM, i.e. the national accounts are presented as input-output tables. The data they contain are taken from a variety of sources, including:

- Imports and exports (data prepared by member states of the International Maritime Organization).
- Economic censuses (data prepared by ministries of economic affairs).
- Agricultural censuses (data prepared by ministries of agriculture and/or economic affairs).
- Population and housing censuses (data prepared by national institutes of statistics and ministries of housing and spatial planning).
- Household income and expenditure surveys (data prepared by ministries of economic affairs).

Table 1 shows the type of input-output table usually published by the countries in the region.

Table 1
Usual structure of an input-output table

Total supply matrix	Intermediate demand matrix	Final demand matrix
	Value-added matrix	

Source: Prepared by the author.

Other sources of information need to be consulted to obtain foreign-trade-related data, such as CIF and FOB prices for imports and exports. These then need to be applied to estimates of imports and exports in tons. That information is used to estimate price vectors of average

value per ton per economic sector. In the countries of the region, the above information is furnished by:

- Central banks.
- National institutes of statistics.
- Port and shipping authorities/agencies of member states of the International Maritime Organization.
- Public and private port information system networks.

Foreign trade data (for both imports and exports) tend to vary depending on the information sources used. To minimize discrepancies, it is best to check a variety of official sources for government agency data.

B. Grouping of economic sectors

The idea is to analyse economic sectors in terms of their capacity to generate freight. Thus, the economic sectors in the 12 x 12 tables are to be shown in 5 x 5 tables, in which the first three sector groups are assumed to be generators of demand for freight (in tons), while the last two generate freight, but to a lesser extent. See table 2.

Table 2
Grouping of economic sectors

Grouping of economic activities	
Activities grouped together	Economic activities in 12 x 12 economic sector tables
1.- Agriculture-fishing	Agriculture, livestock, forestry + extractive fishing
2.- Extractive	Mining
3.- Manufacturing	Manufacturing industry + electricity, gas and water + construction
4.- Commerce	Commerce, hotels and restaurants + transport and communications
5.- Services	Financial intermediation and business services + home ownership + social and personal services + public administration.

Source: Prepared by the author, on the basis of the 12 x 12 input-output table of Chile.

Note: The input-output tables of Brazil, Chile, Ecuador and Nicaragua are equivalent inasmuch as they list the same economic sectors in 12 x 12 or 14 x 14 tables.

In the case of Chile, the extended input-output tables are of 124 x 124 products or 73 x 73 economic subsectors. For Nicaragua, the recently updated 2006 input-output table is used.[7]

C. Conversion of economic transaction matrices into tonnage matrices

Information on exports and imports: To estimate demand for transportation, input-output tables need to be transformed into matrices containing the volume of economic transactions between sectors converted into tons of freight, by constructing two vectors for ton-equivalents of exports and imports, respectively. Thus, vectors are created for equivalent unit prices per ton of output in order to perform the aforementioned conversion, with the desired degree of regional disaggregation and depending on the available and reliable information it proves possible to compile.

It is recommended that the price per ton of output be calculated using the foreign trade (export and import) data generated by the member States of the International Maritime Organization (IMO). Brazil has been a member of IMO since 1963, Chile since 1972 and Nicaragua since 1982.[8] There are, however, countries that have not compiled such statistics.

D. Input data for analysing and calculating the technical coefficients matrix

Following are the input-output tables used as a case study. See table 3.

Table 3
Input-output table, country and year

Countries	Year and Source
Brazil	IOT 2005, Brazilian Institute of Geography and Statistics (IBGE)
Chile	IOT 2008, Central Bank of Chile
Ecuador	IOT 2012, Central Bank of Ecuador
Nicaragua	IOT 2006, Central Bank of Nicaragua

Source: Prepared by the author.

[7] *"At a meeting with economic actors on December 12, 2014, the Central Bank of Nicaragua (BCN) presented the new tool known as the 2006 Input-Output Table (IOT) of Nicaragua, which supplements the country's core System of National Accounts, in line with the methodological guidelines of the United Nations 2008 Manual of National Accounts (SNA 2008)." www.bcn.gob.ni/divulgacion_prensa/notas/2014/np121214.pdf.*

[8] International Maritime Organization, member States, http://www.imo.org/es/About/Membership/Paginas/MemberStates.aspx.

The input-output tables need to be reduced to 5 x 5 tables (or whatever is needed for the investigation) and technical coefficient matrices need to be generated for each of the matrices making up the input-output table.

The distribution of the various components of expenditure will need to be calculated (total household expenditure, government expenditure, investment and exports as percentages of gross domestic product).

Once the coefficient matrices have been worked out, the desired GDP needs to be distributed within the input-output table through iteration to make the GDP in the table converge with projected GDP. The matrices are then turned into freight flow matrices (in tons).

E. Vector for converting iot to tons

The input-output table reduced to 5 x 5 economic sectors and recording economic flows is converted into tons by using two vectors for price per ton of output, i.e.:

(i) Equivalent (dollar) value per ton of exports.[9] This vector divides the entire input-output table by the average price per ton calculated for each economic sector, with the exception of the imports sector in the table, thereby converting the monetary flows matrix into tons.

(ii) Equivalent (dollar) value per ton of imports.[10] The imports vector divides just the imports in the input-output table, thereby converting the monetary flows matrix into tons.

Both the input-output table analysed and the price per ton vectors for imports and exports need to be expressed in the same currency units.

In various data sources and publications, the countries analysed report the total amounts for financial and volume flows associated with foreign trade, for both imports and exports, in monetary values and in tons. Generally speaking, that information can be used to construct the vectors that this study refers to as "price per ton of output." Depending on the levels of disaggregation of the information obtained for the analyses, it is possible to identify the modal breakdown. Thus, for Chile, the Maritime Statistics Bulletin (BEM) differentiates between the following modes: maritime, overland, by air, by rail, pipelines, postal, and others.

[9] The price per ton is a generalization, in the sense that it derives from a grouping of economic sectors. Nevertheless, for more disaggregated studies, it would be best to obtain separate prices per ton for each economic sector. In order to analyse logistics chains and their modal distribution, it would also be best to study extended product-based input-output tables. For instance, Nicaragua's 2006 input-output table can be used to analyse the 39 x 39 products table and Ecuador's 2012 input-output tables can be used to analyse the 71 x 71 products table.

[10] The price per ton for imports behaves in the same way as the export vector, with respect to the desired level of disagregation.

Prices per ton for exports and imports are taken from the foreign trade maritime statistics bulletins. Table 4 lists the bulletins[11] used for the Brazil, Chile, Ecuador and Nicaragua case studies.

Table 4
Foreign trade information for the case study countries

Country	Source generating the information/ publication
Brazil	Instituto Brasileiro de Geografía y Estadística http://seriesestatisticas.ibge.gov.br/ *Several publications*
Chile	Dirección General del Territorio Marítimo y Marina Mercante DIRECTEMAR http://web.directemar.cl/estadisticas/maritimo/*Boletín Estadístico Marítimo BEM*
Ecuador	Cámara Marítima del Ecuador CAMAE http://www.camae.org/ *Informativo Estadístico Portuario INFORMAR, as well as a range of other publications.*
Nicaragua	Comisión Centro Americana de Transporte Marítimo COCATRAM http://www.cocatram.org.ni/redmarport.html *Sistema de Información Estadística Portuaria de Centroamérica*

Source: Prepared by the author.

IV. Findings of four country case studies: Brazil, Chile, Ecuador and Nicaragua

Following are the findings obtained by applying the input-output table method (IOM) to Brazil, Chile, Ecuador and Nicaragua. The cases studies show first the country's input-output table and then an analysis thereof.

- Time series analyses of changes in GDP with a view to establishing criteria for projecting economic growth so as to be able to project the countries' demand for freight, based on three scenarios: optimistic growth projections, expected growth and pessimistic growth expectations.
- Freight estimates (in tons) by five-year periods, starting with the current year, and taking as their basis the base year of the original input-output table.

A. Brazil: input-output table, base year 2005, and freight projection matrices

Source of information regarding the input-output table

GDP is projected on the basis of the 2005 input-output table reduced to 5 x 5 sectors and published by IBGE of Brazil.

[11] Brazil, Chile, Ecuador and Nicaragua are all member States of the International Maritime Organization http://www.imo.org/es/Paginas/Default.aspx.

Average prices per ton of both exports and imports for projecting transportation demand (measured in tons) were projected on the basis of a GDP growth rate of 4.53% from 2008 through 2015, 2020, 2025, and 2030.

Following is the future demand for transportation (in tons), using GDP projections for 2015, 2020, 2025 and 2030, and taking 2005 GDP and the 2005 IOT as the starting point.

Estimates of freight tonnage for five-year periods

Table 5
Brazil: freight estimates at 2015
(Thousands of tons)

Year 2015	Agriculture-fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	655 040	522 372	4 575 023			5 752 435
Final demand	225 083	94 762	3 577 698			3 897 543
Imports	10 669	2 260	243 273	12 639		268 841
Total Freight						**9 918 820**

Source: Prepared by the author using Brazil's IOT for 2005.

Table 6
Brazil: Freight estimates at 2020
(Thousands of tons)

Year 2020	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	718 038	572 612	5 015 029			6 305 680
Final demand	246 730	103 876	3 921 786			4 272 392
Imports	11 688	2 476	266 518	13 847		294 530
Total freight						**10 872 602**

Source: Prepared by the author using the input-output table of Brazil for 2005.

Table 7
Brazil: freight estimates at 2025
(Thousands of tons)

Year 2025	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	746 537	595 339	5 214 075			6 555 952
Final demand	256 523	107 999	4 077 441			4 441 963
Imports	12 159	2 576	277 265	14 405		306 406
Total freight						**11 304 321**

Source: Prepared by the author using the input-output table of Brazil for 2005.

Table 8
Brazil: freight estimates at 2030
(Thousands of tons)

Year 2030	Agriculture-fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	748 158	596 632	5 225 397			6 570 187
Final demand	257 080	108 234	4 086 295			4 451 608
Imports	12 186	2 582	277 867	14 437		307 071
Total freight						**11 328 867**

Source: Prepared by the author using the input-output table of Brazil for 2005.

B. Chile: input-output table, base year 2008, and freight projection matrices

Source of information regarding the input-output table

GDP is projected using the 2008 input-output table reduced to 5 x 5 sectors, published by the Central Bank of Chile, and GDP through 2014 published by the same institution.

The rate of growth of GDP in 1996-2014 was approximately 7% per year and the rates of growth for the projected scenarios were 3.55% (pessimistic scenario), 5.32% (expected scenario) and 7.08% (optimistic scenario).

The GDPs used to estimate the input-output table of freight (in tons), whose coefficients correspond to the 2008 IOT, are as follows: (GDP in millions of dollars): 2008 GDP =182,888; GDP 2015 = 299,262; GDP 2020 = 404,323; GDP 2025 = 521,979 and GDP 2030 = 650,845.

Estimates of freight tonnage for five-year periods

Table 9
Chile: freight estimates at 2015
(Tons)

Year 2015	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	10 339 510	10 568 316	70 430 343	--	--	91 338 168
Final demand	5 717 052	52 312 626	140 724 083	--	--	198 753 761
Imports	15 914 887	19 172 335	40 854 662	32 194 399	--	108 136 283
Total freight						**398 228 212**

Source: Prepared by the author using the input-output table of Chile for 2008.

Table 10
Chile: freight estimates at 2020
(Tons)

Year 2020	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	19 049 596	7 876 938	99 094 020	--	--	126 020 554
Final demand	10 534 737	38 993 320	198 018 678		--	247 546 735
Imports	16 835 171	16 479 002	47 141 284	34 681 274	--	115 136 731
Total Freight						**488 704 020**

Source: Prepared by the author using the input-output table of Chile for 2008.

Table 11
Chile: Freight estimates at 2025
(Tons)

Year 2025	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	22 412 161	9 267 346	116 585 729	--	--	148 265 236
Final demand	12 394 290	45 876 276	232 972 201		--	291 242 767
Imports	13 712 371	13 422 270	38 396 926	28 248 155	--	93 779 723
Total Freight						**533 287 726**

Source: Prepared by the author using the input-output table of Chile for 2008.

Table 12
Chile: freight estimates at 2030
(Tons)

Year 2030	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	25 443 373	10 520 742	132 353 781	--	--	168 317 896
Final demand	14 070 599	52 080 977	264 481 356		--	330 632 932
Imports	13 007 913	12 732 715	36 424 325	26 796 936	--	88 961 888
Total Freight						**587 912 716**

Source: Prepared by the author using the input-output table of Chile for 2008.

C. Ecuador: input-output table, base year 2012, and freight projection matrices

The analysis looks at Ecuador's IOT,[12] published by the Central Bank of Ecuador in 2012, i.e. the expanded 2012 input-output table, product x product table, 71 x 71.

Annual GDP growth rates in 2000–2014 averaged 4% and the projected rates for the various scenarios are: 2.71% (pessimistic), 3.32% (expected) and 4.01% (optimistic).

The GDPs used to estimate the input-output table of freight (in tons), whose coefficients correspond to the 2012 IOT, are as follows: (GDP in millions of dollars): 2012 = 83,555; GDP 2015 = 92,870; GDP 2020 = 110,990; GDP 2025 = 130,579 and GDP 2030 = 151,545.

Estimates of freight tonnage for five-year periods

Table 13
Ecuador: freight estimates at 2015
(Tons)

Year 2015	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	6 334 591	3 518 356	16 513 540	--	--	26 366 487
Final demand	7 319 324	16 546 496	29 878 141		--	53 743 961
Imports	463 793	250 005	5 737 117	2 238 041	--	8 688 957
Total Freight						**88 799 405**

Source: Prepared by the author using the input-output table of Ecuador for 2012.

Table 14
Ecuador: freight estimates at 2020
(Tons)

Year 2020	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	6 795 260	3 774 183	17 714 353			28 283 795
Final demand	7 851 435	17 749 418	32 050 268			57 651 120
Imports	455 901	245 751	5 639 485	2 199 955		8 541 092
Total Freight						**94 476 007**

Source: Prepared by the author using the input-output table of Ecuador for 2012.

Table 15
Ecuador: freight estimates at 2025
(Tons)

Year 2025	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	6 869 602	3 815 512	17 908 252			28 593 366
Final demand	7 937 505	17 943 991	32 401 610			58 283 106
Imports	577 826	311 474	7 147 697	2 788 307		10 825 304
Total Freight						**97 701 776**

Source: Prepared by the author using the input-output table of Ecuador for 2012.

Table 16
Ecuador: freight estimates at 2030
(Tons)

Year 2030	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	7 141 802	3 966 657	18 617 744			29 726 203
Final demand	8 251 840	18 654 597	33 684 757			60 591 194
Imports	628 666	338 879	7 776 595	3 033 639		11 777 779
Total Freight						**102 095 177**

Source: Prepared by the author using the input-output table of Ecuador for 2012.

12 See[online]http://www.bce.fin.ec/index.php/boletines-de-prensa-archivo/item/787-el-banco-central-del-ecuadorpresenta-la-matriz-insumo-producto-del-año-2012-que-describe-la-dinámica-de-los-sectores-productivos-conun-nivel-de-detalle-de-245-actividades-económicas and http://contenido.bce.fin.ec/documentos/PublicacionesNotas/Catalogo/CuentasNacionales/Anuales/Dolares/MenuMatrizInsumoProducto.htm.

D. Nicaragua: input-output table, base year 2006, and freight projection matrices

Source of information regarding the input-output table

The analysis uses the input-output table of Nicaragua[13] prepared by the Central Bank and published in 2006. It presents both disaggregated and group data, i.e.:

(i) Industry x industry table, 14 x 14.
(ii) Product x product table, 24 x 24 and 39 x 39.

Annual GDP growth rates in 1994–2011 averaged 5% and the projected rates for the various scenarios are: 3% (pessimistic), 4% (expected) and 5% (optimistic).

The GDPs used to estimate the input-output table of freight (in tons), whose coefficients correspond to the 2006 IOT, are as follows: (GDP in millions of dollars): 2006 = 6,786; GDP 2015 = 10,632; GDP 2020 = 13,161; GDP 2025 = 15,950 and GDP 2030 = 18,974/.

Estimates of freight tonnage for five-year periods

The following tables (17 to 20), based on the 2006 IOT, contain a summary of the IOT estimated in tons for five-year periods starting in 2015.

Table 17
Nicaragua: freight estimates at 2015
(Tons)

Year 2015	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	850 846	68 905	1 280 193			2 199 943
Final demand	1 044 994	84 842	4 209 112			5 338 949
Imports	190 454	33 685	1 337 586	308 832		1 870 556
Total Freight						**9 409 448**

Source: Prepared by the author using the input-output table of Nicaragua for 2006.

Table 18
Nicaragua: freight estimates at 2020
(Tons)

Year 2020	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	908 194	73 549	1 366 481			2 348 225
Final demand	1 115 440	90 561	4 492 859			5 698 860
Imports	197 42	34 918	1 386 540	320 135		1 939 017
Total Freight						**9 986 102**

Source: Prepared by the author using the input-output table of Nicaragua for 2006.

Table 19
Nicaragua: freight estimates at 2025
(Tons)

Year 2025	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	968 317	78 418	1 456 942			2 503 677
Final demand	1 189 282	96 556	4 790 286			6 076 124
Imports	205 769	36 394	1 445 147	333 666		2 020 977
Total Freight						**10 600 778**

Source: Prepared by the author using the input-output table of Nicaragua for 2006.

Table 20
Nicaragua: freight estimates at 2030
(Tons)

Year 2030	Agriculture-Fishing	Extractive	Manufacturing	Commerce	Services	Total
Intermediate demand	1 028 246	83 271	1 547 112			2 658 629
Final demand	1 262 886	102 532	5 086 755			6 452 173
Imports	214 719	37 977	1 508 006	348 179		2 108 882
Total Freight						**11 219 684**

Source: Prepared by the author using the input-output table of Nicaragua for 2006.

13 http://www.bcn.gob.ni/estadisticas/cuentas_nacionales/anual/index.php.

V. Conclusions

The IOT is an instrument[14] that the countries of the region can use to draw up infrastructure development plans. Using transportation network models and transportation engineering software, estimated freight can be allocated among existing carriers (transportation supply) organized in multimodal networks, thereby identifying those that are congested and need adjusting.

Estimating potential demand for freight makes it easier to plan supply and optimize it through effective and efficient allocation of resources, thereby satisfying that demand and contributing to the countries' development at the pace they set in their objectives. In other words, infrastructure endowment helps to make the expected GDP growth rate possible. The next step is to recommend the development of transportation plans and programmes for the countries of the region (such as Chile's 1997 Master Plans for Transportation, or MEPLAN,[15] for instance) as instruments for a comprehensive and sustainable logistics policy. They should address the following:

(i) Investment to boost the capacity of multimodal (road, maritime, riverine, air, rail and pipeline) networks, as well as cargo and travel transfer stations (connections, ports, airports, stations, deposits and warehousing).
(ii) Regulations for optimizing network capacity and security.
(iii) Prices for internalizing the externalities of the different modes of transportation through taxes and subsidization of network operations, thereby optimizing the use of modal networks.

To replicate use of the methodology and achieve more disaggregated data, it is best to use the information published by the central banks of the countries in the region on the input-output table and to compare at least two such tables for different years. It is also worth checking the export and import data shown in the input-output tables against the export and import volumes reported by customs offices or maritime agencies, so as to obtain more precise information and narrow discrepancies.

Estimating the demand for freight transportation by using the input-output table makes it possible to conduct regional, subregional, and even local analyses. The input-output table extended by product can also be used to achieve a more detailed analysis for a 5 x 5 matrix (as an initial approximation) and a 12 x 12 sectoral matrix, that is, analysis by 70 X 70 matrices, such as those used in the case studies. The analytical challenge is to obtain a ton price vector for converting the matrix.

The average value per ton for each economic sector — needed to convert the economic transactions matrix into the tonnages matrix— requires careful analysis. Nevertheless, the method described here allows assumptions to be adjusted depending on different priorities, such as final demand (private consumption, public expenditure, investment, etc.).

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[14] Using IOTs, it is posible to measure inefficiencies in national logistics systems. For that, a baseline needs to be established showing the current state of the transportation industry within the countries of the región. It should focus in particular on:
1. Subsidies and other State incentives to truck drivers that distort market prices and, hence, resource allocation.
2. The existence or non-existence of a logistics and mobility policy that provides for the evaluation of other land transportation modes (by rail, for example).
3. Liberalization of, or restrictions on, cabotage traffic for fleets not flying the national flag.

These three factors have to do with types of financing for infrastructure endowment within the countries analysed and others: i.e. direct financing by the State, private financing via concessions or mixed financing models.

[15] Modelo Nacional para el Análisis de Estrategias de Inversión, Precios y Regulación. MEPLAN CHILE 1997. Ministry of Public Works, Planning Directorate, prepared by MECSA-ME&P-INECOM Consultores. (MEPLAN: used for projections of road, port and airport infrastructure needs through 2020).