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Interregional Interdependence among Ecuadorian Provinces: An Input-Output Analysis

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Abstract. In this paper, we explore the structural characteristics of the interregional input-output system developed for Ecuador for the year 2007. As part of an ongoing project that aims to develop an interregional CGE model for the country, this database was developed under conditions of limited information. It provides the opportunity to better understand the spatial linkage structure associated with the national economy in the context of its 22 provinces, 15 sectors and 60 different products. This exploratory analysis is based on the description of structural coefficients and the use of traditional input-output techniques. Finally, we further explore the spatial linkage structure by looking at the regional decomposition of final demand. It is hoped that this exercise might result in a better appreciation of a broader set of dimensions that might improve our understanding of the integrated interregional economic system in Ecuador.

1. Introduction

This paper reports on the recent developments in the construction of an interregional input-output matrix for Ecuador (IOM-EC). As part of an ongoing project that aims to develop an interregional CGE (ICGE) model for the country, a fully specified interregional input-output database was developed under conditions of limited information. Such database is needed for future calibration of the ICGE model. This research venture is part of a technical cooperation initiative involving researchers from the Regional and Urban Economics Lab at the University of São Paulo (Nereus), the Institute of Economic Research Foundation (Fipe), both in Brazil, and the Instituto de Investigaciones Económicas de la Universidad Técnica Particular de Loja, in Ecuador.

As claimed by Hulu and Hewings (1993, p. 135), analysts attempting to build regional models in developing countries are often confronted by the received wisdom that suggests that the task should be abandoned before it is initiated on two grounds. First, it is claimed that there is little interest in spatial development planning and spatial development issues in general. Secondly, the quality and quantity of data are such that the end product is likely to be of dubious value.

This wisdom is partially challenged in this paper. Given the renewed interest by economists on regional issues in Ecuador, there is a need for the development of regional and interregional models for bringing new insights into the process of regional planning in the country. We do recognize that, at this stage, there are still data limitations. But do you wait until the data have improved sufficiently, or do you start with existing data, no matter how imperfect, and improve the database gradually? In this project, we have opted for the second alternative, following the advice by Agenor et al. (2007).

The IOM-EC provides the opportunity to better understand the spatial linkage structure associated with the Ecuadorian economy in the context of its 22 provinces, 15 sectors and 60 different products (Figure 1).¹ This paper describes the process by which the IOM-EC was constructed under the conditions of limited information that prevails in Ecuador. The next section will describe the main tasks and working hypotheses involved in the treatment of the initial database that was used in the construction process of the system. Section 3 will explore the structural characteristics of the interregional input-output system developed for Ecuador for the year 2007. This exploratory analysis will be based on the description of structural coefficients and the use of traditional input-output techniques. We further explore the spatial linkage structure by looking at the decomposition of final demand components. It is hoped that this exercise might result in a better appreciation of a broader set of dimensions that might improve our understanding of the integrated interregional economic system in Ecuador. Final remarks follow.

¹ See the Technical Appendix for the list of provinces, sectors and commodities.

Figure 1. Schematic Structure of the IIOM-EC

Provinces		Intermediate consumption				Investment demand				Household consumption				Exports	Government consumption				Inventories	Total demand										
		1	2	...	22	1	2	...	22	1	2	...	22	1	1	2	...	22	1	1										
Dim.		15	15	15	15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1										
Domestic	1	60	1320 x 330				1320 x 22				1320 x 22				1320 x 1				1320 x 22				1320 x 1				1320 x 1			
	2	60																												
	...	60																												
	22	60																												
Imports		1	1 x 330				1 x 22				1 x 22				1	1 x 22				1	1									
Indirect taxes		1	1 x 330				1 x 22				1 x 22				1	1 x 22				1	1									
Value added		1	1 x 330																											
Gross output		1	1 x 330																											

Provinces		1	2	...	22
Dim.		60	60	60	60
1	15	330 x 1320			
2	15				
...	15				
22	15				

2. Initial Data Treatment

In this section we present the main hypotheses and procedures applied to estimate the interregional input-output matrix for Ecuador (IIOM-EC). As mentioned before, the IIOM-EC was estimated under conditions of limited information. We used data of national and regional accounts provided by Central Bank of Ecuador for the year 2007, which consist mainly in the Supply and Use Tables (SUT) at the national level and data about gross output and value added by sectors at the regional (provinces) level.

The first step was to estimate an input-output matrix for the whole country from the SUT. The main aspect in this procedure is to transform the economic flows of the SUT, which are valued at market prices, into economic flows valued at basic prices. We adapted the methodology developed by Guilhoto e Sesso Filho (2005) for a similar exercise applied for Brazil. There are at least two main advantages in this method: (i) first, it requires only data from the SUT; and (ii) second, the production multipliers are not significantly affected by these procedures when compared with the “real” input-output matrix. The procedure used in this work is described as follows.

1. The structure of 47 sectors was aggregated into 15 sectors in order to match the structure of sectors at the provincial level, as we were constrained by availability of sectoral information at the regional level.

2. The allocation of margins and indirect taxes for all users (intermediate consumption, investment demand, household consumption, government consumption, and exports) was estimated based on shares calculated from the sales structure of the Use Table. The underlying hypothesis is that margins coefficients and tax rates on products are the same for all users.

3. Similarly, the allocation of imports for all users (except exports) was also estimated based on shares calculated from the sales structure of the Use Table.

4. These values were then deducted from the Use Table originally evaluated at market prices to obtain a new Use Table now evaluated at basic prices.

All these economic flows can then be organized in the form of an Absorption (Use) Matrix, together with the Make Matrix, as presented in Figure 2.

**Figure 2. Structure of the National Input-Output System for Ecuador:
Summary Results, 2007 (in USD thousands)**

		Intermediate consumption				Investment demand				Household consumption	Exports	Government consumption	Inventories	TOTAL	
		Dim.	1	2	...	15	1	2	...	15	1	1	1	1	
Basic Flows	Domestic	1													
		2													
		...													
	Imported	1													
		2	18.067.831				6.961.864				20.317.434	14.918.979	5.195.881	138.051	65.600.040
		60													
Margins	Domestic	1													
		2													
		...													
	Imported	1													
		2	8.358.325				2.304.851				4.334.096	237.987	0	433.505	15.668.763
		60													
Indirect taxes	Domestic	1													
		2													
		...													
	Imported	1													
		2	2.146.926				143.318				2.204.404	960.186	0	40.036	5.494.870
		60													
Intermediate consumption			29.759.027				0				0	0	0	0	29.759.027
Value added			43.687.357				0				0	0	0	0	43.687.357
TOTAL			73.446.384				10.129.075				28.962.314	15.960.760	5.195.881	924.296	134.618.710

Dim.	1	2	...	60
1				
2	73.446.384			
...				
15				

The second step was to disaggregate the national data into the 22 provinces of Ecuador. The details of such procedure are described in a technical paper.² We focus the subsequent discussion on some of the relevant summary figures embedded in the IIOM-EC.

Given the regional macroeconomic identity, the components of Gross Regional Product (GRP) are the usual components of GDP (at the national level) plus the interregional trade balance. In the case of Ecuador, the information provided by Central Bank at the provincial level consists only of international exports, gross production and value added. The other components of the regional macroeconomic identity needed to be estimated.

² Haddad et al. (2011). Interregional Input-Output System for Ecuador: Methodology and Results. TD Nereus 03-2011, available at www.usp.br/nereus.

$$\text{GRP} = C + I + G + (X - M)_{\text{ROW}} + (X - M)_{\text{DOM}} \quad (1)$$

where

C = household consumption

I = investment demand

G = government consumption

$(X - M)_{\text{ROW}}$ = international trade balance

$(X - M)_{\text{DOM}}$ = interregional trade balance

We used shares calculated from specific variables to estimate the provincial value of some components of equation (1): household consumption, investment demand and government consumption. The values for international exports were obtained directly from the Central Bank. For each component, the variable used to calculate the shares were the following:

1. *Household consumption*: wages and salaries obtained from the Employment and Unemployment Survey published by National Institute of Statistics and Census (INEC).
2. *Investment demand*: value added of the construction sector obtained from the regional accounts published by the Central Bank of Ecuador.
3. *Government consumption*: value added of the public administration sector obtained from the regional accounts published by the Central Bank of Ecuador.

Table 1 presents these shares, including those for international exports. A general result is the spatial concentration of aggregate demand, which is very likely influenced by the distribution of economic activity and population over the provinces. The provinces of Pichincha and Guayas concentrate more than half of the national household consumption and investment and approximately 46% of the government consumption. On the other hand, the provinces of Francisco de Orellana, Sucumbíos and Esmeraldas present important participation in the total exports, mainly influenced by the sales of crude and refined petroleum.

Table 1. Shares used to Estimate the Components of the GRP of Ecuador, 2007

	Investment demand	Household consumption	Government consumption	Exports
R1 Azuay	0,104	0,098	0,051	0,022
R2 Bolivar	0,007	0,010	0,015	0,003
R3 Cañar	0,021	0,008	0,016	0,007
R4 Carchi	0,007	0,008	0,012	0,004
R5 Cotopaxi	0,022	0,009	0,026	0,020
R6 Chimborazo	0,016	0,018	0,032	0,008
R7 El Oro	0,043	0,087	0,045	0,021
R8 Esmeraldas	0,013	0,022	0,033	0,066
R9 Guayas	0,256	0,238	0,266	0,153
R10 Imbabura	0,028	0,021	0,028	0,008
R11 Loja	0,050	0,015	0,037	0,007
R12 Los Rios	0,024	0,029	0,049	0,026
R13 Manabi	0,063	0,044	0,096	0,039
R14 Morona Santiago	0,009	0,010	0,012	0,002
R15 Napo	0,005	0,015	0,010	0,001
R16 Pastaza	0,005	0,019	0,007	0,044
R17 Pichincha	0,268	0,275	0,193	0,122
R18 Tungurahua	0,041	0,028	0,036	0,014
R19 Zamora Chinchipe	0,006	0,010	0,008	0,002
R20 Galapagos	0,004	0,006	0,004	0,001
R21 Sucumbios	0,005	0,020	0,013	0,203
R22 Francisco de Orellana	0,005	0,010	0,007	0,227
TOTAL	1,000	1,000	1,000	1,000

In order to regionalize the national IO table, we have relied on an adapted version of the Chenery-Moses approach (Chenrey, 1956; Moses, 1955), which assumes, in each region, the same commodity mixes for different users (producers, investors, households and government) as those presented in the national input-output tables for Ecuador. For sectoral cost structures, value added generation may be different across regions. Trade matrices for each commodity are used to disaggregate the origin of each commodity in order to capture the structure of the spatial interaction in the Ecuadorian economy. In order words, for a given user, say agriculture sector, the mix of intermediate inputs will be the same in terms of its composition, but it will differ from the regional sources of supply (considering the 22 regions of the model and foreign imports).

The strategy for estimating the 60 trade matrices (one for each commodity in the system) included the following steps.

1. We have initially estimated total supply (output) of each commodity by region, excluding exports to other countries. Thus, for each region, we obtained information for the total sales of each commodity for the domestic markets.

$Supply(c,s)$ = supply for the domestic markets of commodity c by region s

2. Following that, we have estimated total demand, in each region, for the aforementioned 60 commodities. To do that, we have assumed the respective users' structure of demand followed the national pattern. With the regional levels of sectoral production, investment demand, household demand and government demand, we have estimated the initial values of total demand for each commodity in each region, from which the demand for imported commodities were deducted. The resulting estimates, which represent the regional total demand for Ecuadorian goods, were then adjusted so that, for each commodity, demand across regions equals supply across regions.

$Demand(c,d)$ = demand of commodity c by region d

3. With the information for $Supply(c,s)$ and $Demand(c,d)$, the next step was to estimate, for each commodity c , matrices of trade (22x22) representing the transactions of each

commodity between Ecuatorian regions. We have fully relied on the methodology described in Dixon e Rimmer (2004). The procedure considered the following steps:

a) For the diagonal cells, equation (2) was implemented, while for the off-diagonal elements, equation (3) is the relevant one:

$$SHIN(c,d,d) = Min\left\{\frac{Supply(c,d)}{Demand(c,d)}, 1\right\} * F(c) \quad (2)$$

$$SHIN(c,o,d) = \left\{ \frac{1}{Dist(o,d)} \cdot \frac{Supply(c,o)}{\sum_{k=1}^{22} Supply(c,k)} \right\} * \left\{ \frac{1 - SHIN(c,d,d)}{\sum_{j=1, j \neq d}^{22} \left[\frac{1}{Dist(j,d)} \cdot \frac{Supply(c,j)}{\sum_{k=1}^{22} Supply(c,k)} \right]} \right\} \quad (3)$$

where c refers to a given commodity, and o and d represent, respectively, origin and destination regions.

The variable $Dist(o,d)$ refers to the distance between two trading regions. The factor $F(c)$ gives the extent of tradability of a given commodity. For the non-tradables (usually services), typically assumed to be locally provided goods, we have used the value of 0.9 for $F(c)$, adopting a usual assumption, while for tradables, the value of $F(c)$ was set to 0.5.

It can be shown that the column sums in the resulting matrices add to one. What these matrices show are the supply-adjusted shares of each region in the specific commodity demand by each region of destination.

Once these share coefficients are calculated, we then distribute the demand of commodity c by region d ($Demand(c,d)$) across the corresponding columns of the SHIN matrices. Once we adopt this procedure, we have to further adjust the matrices to make sure that supply and demand balance. This is done through a RAS procedure.

Tables 2 and 3 show the resulting structure of trade in the IIOM-EC (aggregated across commodities). We have also included regional demand for imported commodities (last row), estimated considering the structure of demand according to the national pattern.

In the next section, we continue to evaluate the general structure of the IIOM-EC, described in terms of summary indicators. An evaluation of the production linkages follows, based on the intermediate consumption flows, providing a brief comparative analysis of the economic structure of the regions. Traditional input-output methods are used in an attempt to uncover similarities and differences in the structure of the regional economies.

Table 2. Interregional Trade in Ecuador: Purchases Shares, 2007

		Destination																						TOTAL
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	
Origin	R1 Azuay	0,461	0,008	0,186	0,004	0,003	0,008	0,048	0,005	0,023	0,003	0,032	0,003	0,006	0,030	0,009	0,012	0,007	0,008	0,036	0,006	0,007	0,011	0,053
	R2 Bolívar	0,001	0,480	0,001	0,000	0,002	0,010	0,001	0,000	0,001	0,000	0,000	0,002	0,001	0,004	0,003	0,007	0,003	0,003	0,000	0,001	0,002	0,003	0,005
	R3 Cañar	0,049	0,001	0,480	0,000	0,000	0,001	0,004	0,000	0,001	0,000	0,002	0,001	0,000	0,003	0,001	0,001	0,001	0,000	0,003	0,001	0,001	0,001	0,011
	R4 Carchi	0,001	0,001	0,000	0,596	0,001	0,000	0,001	0,001	0,000	0,009	0,000	0,000	0,000	0,002	0,004	0,003	0,006	0,001	0,001	0,001	0,020	0,010	0,007
	R5 Cotopaxi	0,002	0,008	0,001	0,002	0,452	0,007	0,002	0,002	0,001	0,002	0,001	0,001	0,001	0,007	0,009	0,018	0,034	0,032	0,002	0,001	0,005	0,004	0,020
	R6 Chimborazo	0,003	0,043	0,002	0,001	0,005	0,584	0,002	0,001	0,002	0,001	0,001	0,002	0,001	0,017	0,015	0,040	0,008	0,022	0,002	0,002	0,005	0,009	0,016
	R7 El Oro	0,025	0,004	0,010	0,002	0,003	0,002	0,375	0,002	0,017	0,002	0,013	0,005	0,004	0,008	0,004	0,005	0,004	0,003	0,016	0,004	0,004	0,005	0,031
	R8 Esmeraldas	0,009	0,007	0,008	0,014	0,015	0,011	0,010	0,407	0,018	0,018	0,007	0,004	0,013	0,010	0,014	0,012	0,026	0,015	0,007	0,023	0,014	0,010	0,033
	R9 Guayas	0,176	0,111	0,069	0,021	0,023	0,050	0,278	0,042	0,602	0,016	0,070	0,288	0,121	0,113	0,068	0,103	0,045	0,036	0,086	0,148	0,063	0,100	0,231
	R10 Imbabura	0,001	0,002	0,000	0,016	0,001	0,001	0,001	0,003	0,001	0,551	0,001	0,000	0,001	0,003	0,007	0,004	0,016	0,001	0,001	0,001	0,007	0,008	0,017
	R11 Loja	0,011	0,001	0,004	0,001	0,001	0,001	0,012	0,001	0,002	0,001	0,617	0,001	0,001	0,006	0,003	0,004	0,002	0,001	0,232	0,004	0,004	0,006	0,018
	R12 Los Rios	0,005	0,011	0,003	0,001	0,002	0,004	0,013	0,002	0,040	0,001	0,001	0,477	0,004	0,007	0,006	0,011	0,004	0,002	0,002	0,003	0,005	0,009	0,028
	R13 Manabí	0,015	0,010	0,006	0,007	0,007	0,005	0,024	0,011	0,037	0,006	0,009	0,008	0,598	0,017	0,018	0,024	0,022	0,005	0,013	0,017	0,025	0,024	0,057
	R14 Morona Santiago	0,001	0,001	0,001	0,000	0,001	0,001	0,001	0,000	0,001	0,000	0,001	0,000	0,000	0,434	0,004	0,009	0,001	0,001	0,002	0,001	0,001	0,002	0,004
	R15 Napo	0,000	0,001	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,303	0,014	0,001	0,001	0,000	0,000	0,002	0,005	0,003
	R16 Pastaza	0,001	0,002	0,001	0,000	0,002	0,003	0,000	0,005	0,001	0,000	0,001	0,000	0,000	0,009	0,021	0,254	0,001	0,003	0,001	0,000	0,002	0,004	0,004
	R17 Pichincha	0,030	0,110	0,014	0,129	0,211	0,080	0,039	0,098	0,025	0,189	0,026	0,017	0,042	0,129	0,306	0,222	0,575	0,110	0,047	0,123	0,257	0,250	0,196
	R18 Tungurahua	0,003	0,032	0,001	0,003	0,043	0,043	0,004	0,004	0,003	0,003	0,002	0,002	0,002	0,017	0,023	0,062	0,022	0,542	0,004	0,002	0,008	0,010	0,028
	R19 Zamora Chinchipe	0,001	0,000	0,001	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,020	0,000	0,000	0,002	0,001	0,001	0,000	0,000	0,374	0,001	0,001	0,001	0,003
	R20 Galapagos	0,001	0,001	0,000	0,001	0,000	0,000	0,003	0,002	0,002	0,000	0,001	0,000	0,001	0,004	0,003	0,003	0,004	0,000	0,005	0,460	0,004	0,004	0,004
	R21 Sucumbios	0,003	0,002	0,003	0,017	0,006	0,004	0,001	0,054	0,006	0,005	0,003	0,001	0,003	0,005	0,011	0,009	0,009	0,006	0,003	0,006	0,261	0,084	0,015
	R22 Francisco de Orellana	0,003	0,001	0,002	0,003	0,002	0,002	0,001	0,073	0,007	0,002	0,002	0,001	0,002	0,003	0,009	0,007	0,004	0,003	0,002	0,002	0,067	0,208	0,012
	ROW Foreign	0,196	0,165	0,208	0,179	0,221	0,182	0,177	0,286	0,209	0,188	0,189	0,187	0,198	0,168	0,158	0,176	0,203	0,203	0,162	0,194	0,236	0,232	0,204
TOTAL	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	

Table 3. Interregional Trade in Ecuador: Sales Shares, 2007

	Destination																						TOTAL		
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22			
Origin	R1	Azuay	0,704	0,001	0,043	0,001	0,001	0,003	0,051	0,004	0,112	0,001	0,013	0,002	0,007	0,004	0,001	0,002	0,035	0,005	0,004	0,000	0,003	0,003	1,000
	R2	Bolivar	0,014	0,673	0,001	0,000	0,007	0,031	0,013	0,002	0,060	0,002	0,001	0,009	0,006	0,005	0,005	0,013	0,122	0,020	0,001	0,001	0,006	0,008	1,000
	R3	Cañar	0,370	0,001	0,541	0,000	0,001	0,001	0,019	0,001	0,033	0,000	0,004	0,002	0,003	0,002	0,001	0,001	0,014	0,001	0,001	0,000	0,002	0,002	1,000
	R4	Carchi	0,007	0,001	0,001	0,614	0,002	0,001	0,006	0,008	0,011	0,025	0,001	0,001	0,004	0,002	0,005	0,004	0,222	0,003	0,000	0,001	0,061	0,022	1,000
	R5	Cotopaxi	0,007	0,003	0,001	0,001	0,434	0,007	0,005	0,004	0,018	0,002	0,001	0,001	0,004	0,003	0,004	0,010	0,435	0,051	0,001	0,000	0,005	0,003	1,000
	R6	Chimborazo	0,018	0,021	0,001	0,001	0,007	0,653	0,008	0,003	0,035	0,002	0,002	0,004	0,003	0,009	0,008	0,028	0,135	0,045	0,001	0,001	0,008	0,009	1,000
	R7	El Oro	0,068	0,001	0,004	0,001	0,002	0,001	0,694	0,003	0,151	0,001	0,010	0,005	0,009	0,002	0,001	0,002	0,034	0,003	0,003	0,001	0,003	0,003	1,000
	R8	Esmeraldas	0,021	0,002	0,003	0,003	0,009	0,006	0,017	0,502	0,146	0,012	0,005	0,004	0,023	0,002	0,004	0,004	0,204	0,015	0,001	0,003	0,010	0,005	1,000
	R9	Guayas	0,062	0,004	0,004	0,001	0,002	0,004	0,068	0,007	0,688	0,001	0,007	0,037	0,031	0,004	0,002	0,005	0,049	0,005	0,002	0,003	0,006	0,007	1,000
	R10	Imbabura	0,004	0,001	0,000	0,007	0,001	0,001	0,004	0,007	0,008	0,687	0,001	0,001	0,003	0,001	0,004	0,003	0,247	0,002	0,000	0,000	0,010	0,007	1,000
	R11	Loja	0,050	0,000	0,003	0,000	0,001	0,001	0,036	0,002	0,029	0,001	0,750	0,001	0,004	0,003	0,001	0,002	0,022	0,001	0,082	0,001	0,005	0,006	1,000
	R12	Los Rios	0,015	0,003	0,001	0,000	0,001	0,002	0,026	0,002	0,376	0,001	0,001	0,506	0,009	0,002	0,002	0,004	0,035	0,003	0,001	0,000	0,004	0,005	1,000
	R13	Manabi	0,022	0,001	0,001	0,001	0,002	0,001	0,024	0,008	0,174	0,002	0,003	0,004	0,626	0,002	0,003	0,005	0,098	0,003	0,002	0,001	0,010	0,007	1,000
	R14	Morona Santiago	0,027	0,002	0,002	0,001	0,003	0,006	0,010	0,002	0,033	0,001	0,004	0,002	0,005	0,783	0,008	0,024	0,063	0,006	0,002	0,001	0,007	0,009	1,000
	R15	Napo	0,006	0,001	0,000	0,001	0,002	0,003	0,004	0,003	0,012	0,003	0,001	0,001	0,002	0,006	0,752	0,047	0,111	0,006	0,001	0,000	0,015	0,023	1,000
	R16	Pastaza	0,016	0,003	0,001	0,001	0,007	0,010	0,006	0,043	0,086	0,002	0,002	0,003	0,005	0,016	0,039	0,628	0,083	0,025	0,001	0,000	0,010	0,013	1,000
	R17	Pichincha	0,012	0,004	0,001	0,005	0,021	0,007	0,011	0,020	0,034	0,020	0,003	0,003	0,013	0,005	0,013	0,013	0,744	0,018	0,002	0,003	0,029	0,020	1,000
	R18	Tungurahua	0,010	0,009	0,001	0,001	0,030	0,027	0,008	0,006	0,026	0,002	0,001	0,002	0,005	0,005	0,007	0,024	0,202	0,620	0,001	0,000	0,006	0,006	1,000
	R19	Zamora Chinchipe	0,036	0,000	0,002	0,000	0,001	0,001	0,024	0,001	0,020	0,001	0,137	0,001	0,003	0,005	0,002	0,004	0,025	0,001	0,729	0,001	0,004	0,004	1,000
	R20	Galapagos	0,026	0,002	0,001	0,001	0,001	0,001	0,042	0,014	0,113	0,001	0,004	0,002	0,009	0,007	0,005	0,007	0,222	0,001	0,007	0,497	0,020	0,015	1,000
	R21	Sucumbios	0,018	0,001	0,002	0,009	0,007	0,005	0,006	0,148	0,101	0,007	0,004	0,002	0,012	0,002	0,006	0,007	0,158	0,012	0,001	0,002	0,399	0,090	1,000
	R22	Francisco de Orellana	0,023	0,001	0,002	0,002	0,004	0,003	0,006	0,256	0,169	0,004	0,003	0,002	0,008	0,002	0,007	0,007	0,078	0,009	0,001	0,001	0,129	0,283	1,000
	ROW	Foreign	0,078	0,006	0,012	0,007	0,021	0,016	0,049	0,056	0,270	0,019	0,020	0,028	0,058	0,006	0,007	0,010	0,252	0,032	0,005	0,004	0,026	0,018	1,000
	TOTAL		0,082	0,008	0,012	0,008	0,019	0,018	0,056	0,040	0,264	0,021	0,022	0,030	0,059	0,008	0,008	0,011	0,253	0,032	0,006	0,005	0,022	0,016	1,000

3. Structural Analysis

In this section, some of the main structural features of the economy of Ecuador are revealed through the use of indicators derived from the IOM-EC. An analysis of output composition, and sales and purchases shares is presented, considering intermediate demand, final demand, and value added transactions.

3.1. Output Composition

Table 4 presents the regional output shares for provinces in Ecuador. Guayas and Pichincha provinces dominate the national production, with shares of 26.0% and 21.8% in total output, respectively.

The regional output shares by sectors in Ecuador reveal some evidence of spatial concentration of specific activities: fishing in Guayas (56.6% of total output), El Oro (23.6%) and Manabi (15.5%); mining in Francisco de Orellana (47.7%) and Sucumbíos (40.6%); oil refining in Esmeraldas (57.3%), Guayas (25.3%) and Sucumbíos (13.1%); and financial institutions in Pichincha (47.1%) and Guayas (25.9%).

Table 5 shows the sectoral shares in regional output, revealing the important role of some activities in relatively specialized regions: the dominant role of mining activities in Francisco de Orellana (91.8% of total regional output), Sucumbíos (80.6%) and Pastaza (76.8%); the relevance of the oil refining sector in Esmeraldas (54.0%).

Relative regional specialization can also be assessed by the calculation of the sectoral location quotients, as presented in Table 6. The highlighted cells identify sectors relatively concentrated in specific regions, i.e. sectors for which their share in total regional output is greater than the respective shares in national output (location quotient greater than unit).

3.2. Interregional linkages

The indicators described above are based on interdependence ratios of the IIOM-EC, which only measure the direct linkages among agents in the economy. In this section, a comparative analysis of regional economic structure is carried out. Production linkages between sectors are considered through the analysis of the intermediate inputs portion of the interregional input-output database. Both the direct and indirect production linkage effects of the economy are captured by the adoption of different methods based on the evaluation of the Leontief inverse matrix. The purpose remains the comparison of economic structures rather than an evaluation of the methods of analysis themselves.

The conventional input-output model is given by the system of matrix equations:

$$x = Ax + f \quad (4)$$

$$x = (I - A)^{-1}f = Bf \quad (5)$$

where x and f are respectively the vectors of gross output and final demand; A consists of input coefficients a_{ij} defined as the amount of product i required per unit of product j (in monetary terms), for $i, j = 1, \dots, n$; and B is known as the Leontief inverse.

Let us consider systems (4) and (5) in an interregional context, with R different regions, so that:

$$x = \begin{bmatrix} x^1 \\ \vdots \\ x^R \end{bmatrix}; A = \begin{bmatrix} A^{11} & \dots & A^{1R} \\ \vdots & \ddots & \vdots \\ A^{R1} & \dots & A^{RR} \end{bmatrix}; f = \begin{bmatrix} f^1 \\ \vdots \\ f^R \end{bmatrix}; \text{ and } B = \begin{bmatrix} B^{11} & \dots & B^{1R} \\ \vdots & \ddots & \vdots \\ B^{R1} & \dots & B^{RR} \end{bmatrix} \quad (6)$$

and

$$\begin{aligned} x^1 &= B^{11}f^1 + \dots + B^{1R}f^R \\ &\vdots \\ x^R &= B^{R1}f^1 + \dots + B^{RR}f^R \end{aligned} \quad (7)$$

Let us also consider different components of f , which include demands originating in the specific regions, v^{rs} , $s = 1, \dots, R$, and abroad, e . We obtain information of final demand from origin s in the IOM-EC, allowing us to treat v as a matrix which provides the monetary values of final demand expenditures from the domestic regions in Ecuador and from the foreign region.

$$v = \begin{bmatrix} v^{11} & \dots & v^{1R} \\ \vdots & \ddots & \vdots \\ v^{R1} & \dots & v^{RR} \end{bmatrix}; e = \begin{bmatrix} e^1 \\ \vdots \\ e^R \end{bmatrix}$$

Thus, we can re-write (7) as:

$$\begin{aligned} x^1 &= B^{11}(v^{11} + \dots + v^{R1} + e^1) + \dots + B^{1R}(v^{1R} + \dots + v^{RR} + e^R) \\ &\vdots \\ x^R &= B^{R1}(v^{11} + \dots + v^{R1} + e^1) + \dots + B^{RR}(v^{1R} + \dots + v^{RR} + e^R) \end{aligned} \quad (8)$$

With (8), we can then compute the contribution of final demand from different origins on regional output. It is clear from (8) that regional output depends, among others, on demand originated in the region, and, depending on the degree of interregional integration, also on demand from outside the region.

In what follows, interdependence among sectors in different regions is considered through the analysis of the complete intermediate input portion of the interregional input-output table. The Leontief inverse matrix, based on the system (7), will be considered, and some summary interpretations of the structure of the economy derived from it will be provided.

3.2.1. Multiplier Analysis

The column multipliers derived from B were computed (see Miller and Blair, 2009). An output multiplier is defined for each sector j , in each region r , as the total value of production in all sectors and in all regions of the economy that is necessary in order to satisfy a dollar's worth of final demand for sector j 's output. The multiplier effect can be decomposed into intraregional (internal multiplier) and interregional (external

multiplier) effects, the former representing the impacts on the outputs of sectors within the region where the final demand change was generated, and the latter showing the impacts on the other regions of the system (interregional spillover effects).

Table 7 shows the intraregional and interregional shares for the average total output multipliers in the 22 regions in Ecuador as well as the equivalent shares for the direct and indirect effects of a unit change in final demand in each sector in each region net of the initial injection, i.e., the total output multiplier effect net of the initial change. The entries are shown in percentage terms, providing insights into the degree of dependence of each region on the other regions. Guayas and Pichincha are by far the most self-sufficient regions; the average flow-on effects from a unit change in sectoral final demand is in excess of 85%. The average net effect exceeds 50% for Guayas and is a little above 48% for Pichincha. For the peripheral provinces, there is a lower degree of intraregional self-sufficiency. Specially in the Sierra region, where the Amazon jungle provinces are located (Morona Santiago, Napo, Francisco de Orellana, Pastaza, Sucumbíos, and Zamora-Chinchipe), the degree of regional self-sufficiency is lower, and the intraregional flow-on effects, on the average, are much lower than the total interregional effects.

Table 7. Regional Percentage Distribution of the Average Total and Net Output Multipliers: Ecuador, 2007

	Total output multiplier		Net output multiplier	
	Intra-regional share	Interregional share	Intra-regional share	Interregional share
R1 Azuay	81,7	18,3	37,2	62,8
R2 Bolivar	76,4	23,6	18,9	81,1
R3 Cañar	79,9	20,1	30,9	69,1
R4 Carchi	80,2	19,8	31,8	68,2
R5 Cotopaxi	78,2	21,8	24,9	75,1
R6 Chimborazo	80,4	19,6	32,5	67,5
R7 El Oro	79,9	20,1	31,1	68,9
R8 Esmeraldas	82,3	17,7	42,6	57,4
R9 Guayas	86,1	13,9	55,1	44,9
R10 Imbabura	79,6	20,4	29,9	70,1
R11 Loja	81,4	18,6	36,1	63,9
R12 Los Rios	77,2	22,8	21,6	78,4
R13 Manabi	82,3	17,7	39,3	60,7
R14 Morona Santiago	77,7	22,3	23,4	76,6
R15 Napo	76,2	23,8	18,2	81,8
R16 Pastaza	76,0	24,0	17,5	82,5
R17 Pichincha	84,9	15,1	48,1	51,9
R18 Tungurahua	81,4	18,6	36,0	64,0
R19 Zamora Chinchipe	76,1	23,9	17,6	82,4
R20 Galapagos	79,1	20,9	28,2	71,8
R21 Sucumbios	76,2	23,8	22,7	77,3
R22 Francisco de Orellana	75,7	24,3	21,2	78,8

3.2.2. Output Decomposition

A complementary analysis to the multiplier approach is presented in this section. Regional output is decomposed, by taking into account not only the multiplier structure, but also the structure of final demand in the 22 domestic and the foreign regions (Sonis et al., 1996).

According to equation (8), regional output (for each regions) was decomposed, and the contributions of the components of final demand from different areas were calculated. The results are presented in Table 8. On the average, the self-generated component of output in each region, i.e., the share of output generated by demand within the region, is lower in the Sierra provinces, reinforcing the previous conjecture of the higher dependency of this area upon the rest of the country and, especially for the oil producing provinces, upon the demand from the rest of the world.

The demand for foreign exports is very relevant not only for the oil exportes but also for most of the provinces. Their contribution to regional output is frequently above 20% (around 38% for the country as a whole).

Noteworthy is the prominent role played by the demand originating in the more dynamic areas of Pichincha and Guayas, with a contribution to national output of 16.20% and 15.13%, respectively. Other provinces with considerable contributions to national output are Azuay (5.60%), El Oro (4.86%) and Manabi (3.33%).

It is worthwhile examining Table 8 in more detail in order to unravel spatial patterns of interactions in Ecuador. A first visual inspection of the results in the columns suggests strong influence of regions at higher hierarchical levels on their immediate neighbours. For instance, 14.52% of the output of Manabi depends on final demand from Guayas; or 31.55% of the output in Cotopaxi depends on demand originated in the neighboring more developed province of Pichincha.

A more systematic approach to look at the influence of final demand from different areas is to map the column estimates from Table 8. The results illustrated in Figure 3 provide an attempt to reveal the spatial patterns of output dependence upon specific sources of final demand. Figure 3 presents for each demanding region, the distribution of their influence on output of all other regions in Ecuador. It is clear that the demand originating in the main provinces of the country (Pichincha, Guayas and Azuay) tend to have an influence on output of a more spread area. The maps are in standard deviation from the mean.

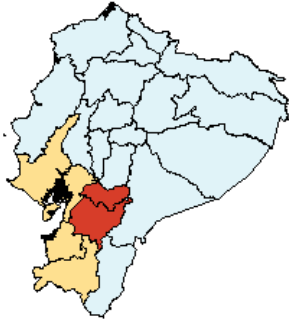
Moreover, one can also look at the results from Table 8 from a row perspective. That is, one may be interested in evaluating the main sources of demand that affect the output of a specific region. For instance, 18.57% of the ouput of Cotopaxi are associated with final demand originated within the province and 31.55% with final demand from Pichincha. Figure 4 illustrates the pattern of dependence of output in each region upon final demand from all regions in the system. Considering the domestic regions, the relevant role played by demand from the core regions of the country is again noticeable (Pichincha is highlighted in 19 out of 22 maps, and Guayas in 15 of them).

Table 8. Components of Decomposition of Regional Output Based on the Sources of Final Demand: Ecuador, 2007

		Origin of final demand																						ROW
		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	
Regional output	R1 Azuay	49,51	0,24	2,48	0,11	0,12	0,38	6,76	0,32	9,62	0,28	1,27	0,57	0,95	0,58	0,29	0,40	4,65	0,44	0,71	0,11	0,28	0,17	19,79
	R2 Bolívar	1,61	49,64	0,10	0,08	0,26	2,29	1,71	0,22	4,86	0,27	0,16	0,69	0,50	0,51	0,55	1,07	7,54	1,31	0,11	0,10	0,36	0,22	25,88
	R3 Cañar	32,44	0,10	30,70	0,03	0,04	0,15	2,89	0,11	3,63	0,08	0,49	0,23	0,31	0,29	0,13	0,19	1,61	0,14	0,28	0,05	0,13	0,08	25,89
	R4 Carchi	0,82	0,13	0,04	48,77	0,16	0,21	0,82	0,64	1,51	1,90	0,13	0,13	0,40	0,22	0,56	0,44	11,36	0,35	0,10	0,16	3,24	0,84	27,10
	R5 Cotopaxi	1,00	0,40	0,06	0,18	18,57	0,75	0,87	0,44	2,23	0,57	0,17	0,18	0,46	0,36	0,68	1,26	31,55	3,62	0,12	0,10	0,72	0,33	35,39
	R6 Chimborazo	2,01	2,21	0,11	0,09	0,34	47,48	1,21	0,29	3,44	0,26	0,19	0,37	0,35	0,91	0,97	2,66	10,14	3,25	0,14	0,09	0,50	0,32	22,65
	R7 El Oro	6,46	0,21	0,32	0,11	0,12	0,26	45,54	0,31	9,85	0,28	0,89	0,73	0,83	0,31	0,26	0,33	4,14	0,38	0,53	0,12	0,31	0,18	27,53
	R8 Esmeraldas	2,11	0,26	0,17	0,27	0,35	0,52	2,31	18,22	7,48	0,90	0,42	0,57	1,48	0,33	0,51	0,53	11,77	0,86	0,25	0,23	0,62	0,28	49,55
	R9 Guayas	5,94	0,46	0,28	0,10	0,12	0,43	7,44	0,44	43,77	0,24	0,62	2,96	2,18	0,45	0,36	0,54	4,61	0,45	0,39	0,33	0,38	0,24	27,29
	R10 Imbabura	0,67	0,14	0,03	0,68	0,17	0,20	0,70	0,60	1,29	51,15	0,11	0,11	0,35	0,21	0,60	0,44	19,39	0,33	0,09	0,09	0,83	0,39	21,43
	R11 Loja	5,40	0,08	0,22	0,04	0,05	0,12	4,79	0,14	2,78	0,10	51,67	0,20	0,39	0,32	0,20	0,27	1,99	0,14	11,23	0,14	0,22	0,14	19,36
	R12 Los Rios	2,47	0,36	0,13	0,05	0,07	0,27	3,85	0,24	23,29	0,12	0,27	29,27	0,96	0,25	0,24	0,38	2,83	0,26	0,16	0,12	0,22	0,14	34,05
	R13 Manabí	2,84	0,23	0,12	0,13	0,14	0,25	3,29	0,59	14,52	0,31	0,38	0,67	37,37	0,31	0,39	0,53	7,41	0,37	0,26	0,20	0,58	0,26	28,87
	R14 Morona Santiago	2,66	0,25	0,17	0,08	0,13	0,52	1,37	0,21	2,81	0,23	0,33	0,26	0,38	57,46	0,94	2,35	4,89	0,46	0,31	0,12	0,46	0,31	23,31
	R15 Napo	0,76	0,17	0,04	0,11	0,16	0,35	0,60	0,23	1,39	0,39	0,11	0,14	0,27	0,63	63,55	4,61	8,71	0,53	0,11	0,08	1,03	0,96	15,05
	R16 Pastaza	0,50	0,11	0,04	0,03	0,09	0,29	0,39	0,08	1,05	0,10	0,09	0,13	0,19	0,47	1,19	14,03	2,29	0,42	0,07	0,03	0,19	0,15	78,05
	R17 Pichincha	1,55	0,49	0,08	0,45	0,88	0,73	1,59	1,15	3,45	1,73	0,27	0,30	1,01	0,59	1,58	1,42	51,00	1,43	0,21	0,32	1,92	0,91	26,95
	R18 Tungurahua	1,37	1,03	0,07	0,15	1,36	2,60	1,35	0,52	3,02	0,45	0,18	0,30	0,53	0,64	1,01	2,88	17,52	40,03	0,16	0,08	0,66	0,39	23,68
	R19 Zamora Chinchipe	2,65	0,05	0,13	0,03	0,03	0,08	2,27	0,09	1,74	0,08	8,96	0,13	0,25	0,30	0,17	0,23	1,43	0,10	53,73	0,11	0,17	0,10	27,15
	R20 Galapagos	3,80	0,32	0,10	0,13	0,06	0,14	7,37	1,53	15,16	0,14	0,53	0,47	1,21	1,05	0,71	0,84	8,27	0,15	1,28	43,48	2,01	1,09	10,16
	R21 Sucumbios	0,57	0,08	0,05	0,19	0,11	0,16	0,48	0,22	1,50	0,25	0,13	0,14	0,30	0,12	0,25	0,23	3,57	0,26	0,08	0,05	5,24	0,55	85,47
	R22 Francisco de Orellana	0,51	0,06	0,05	0,07	0,06	0,12	0,43	0,14	1,27	0,14	0,10	0,14	0,24	0,08	0,18	0,15	1,90	0,18	0,06	0,03	0,56	2,68	90,85
ECUADOR		5,60	0,65	0,62	0,52	0,78	1,26	4,86	1,44	15,13	1,40	1,24	2,00	3,33	0,66	0,86	1,01	16,20	1,84	0,60	0,33	1,14	0,60	37,94

Figure 3. Identification of Regions Relatively More Affected by a Specific Regional Demand, by Origin of Final Demand

R1 Azuay



R2 Bolívar



R3 Cañar



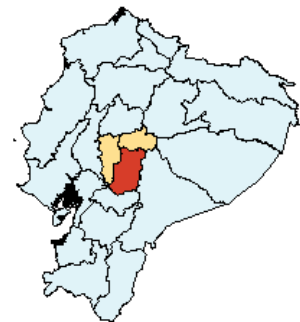
R4 Carchi



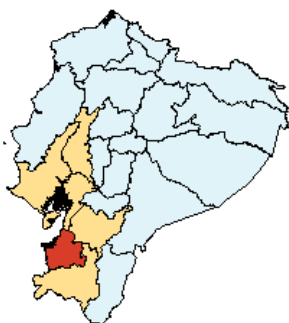
R5 Cotopaxi



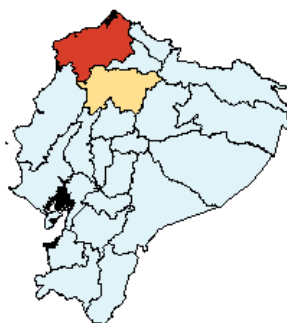
R6 Chimborazo



R7 El Oro



R8 Esmeraldas



R9 Guayas

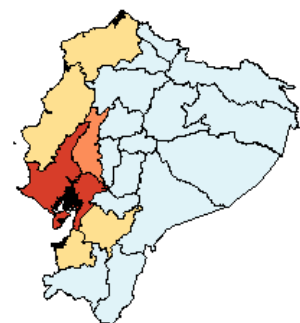


Figure 3. Identification of Regions Relatively More Affected by a Specific Regional Demand, by Origin of Final Demand

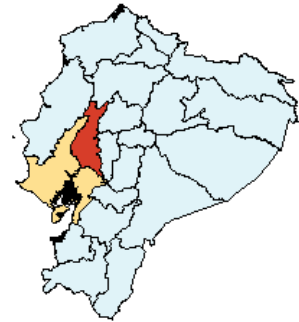
R10 Imbabura



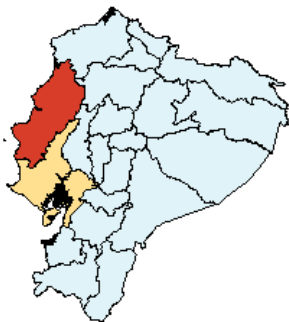
R11 Loja



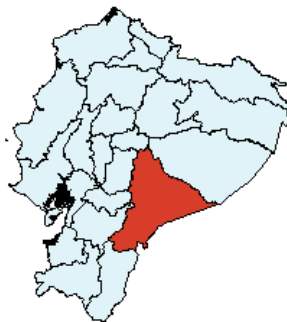
R12 Los Rios



R13 Manabi



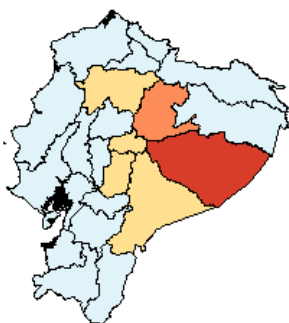
R14 Morona Santiago



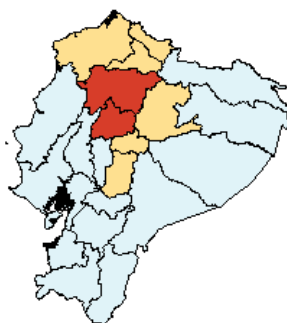
R15 Napo



R16 Pastaza



R17 Pichincha



R18 Tungurahua

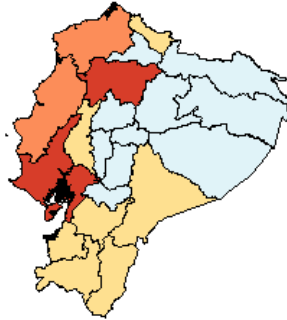


Figure 3. Identification of Regions Relatively More Affected by a Specific Regional Demand, by Origin of Final Demand

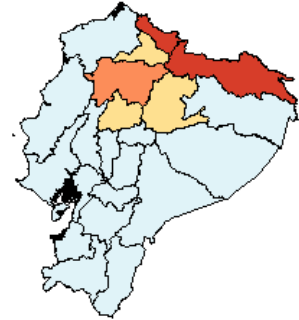
R19 Zamora Chinchipe



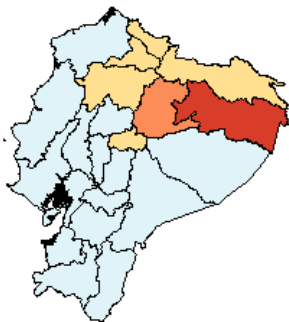
R20 Galapagos



R21 Sucumbios



R22 Francisco de Orellana



ROW Rest of the World

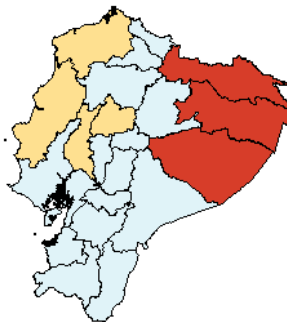
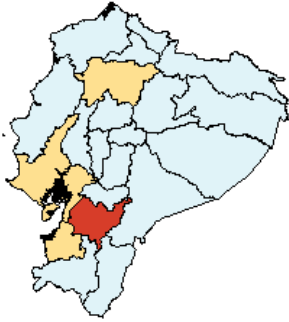
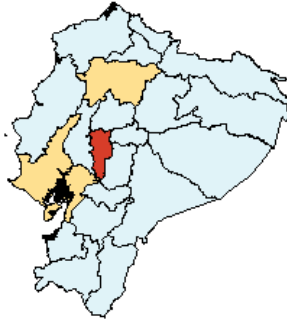


Figure 4. Identification of Regions whose Demands Affect Relatively More a Specific Regional Output, by Regional Output

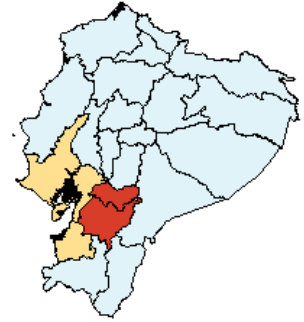
R1 Azuay



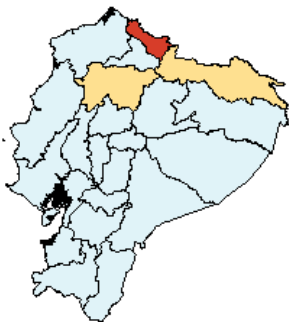
R2 Bolívar



R3 Cañar



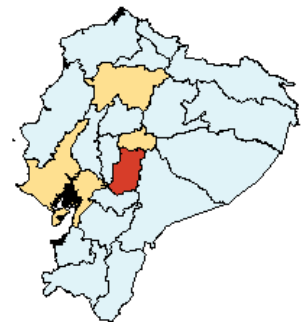
R4 Carchi



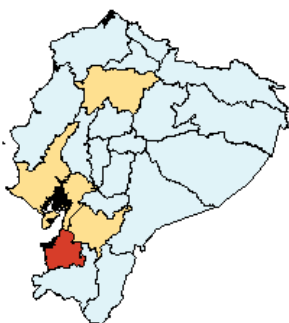
R5 Cotopaxi



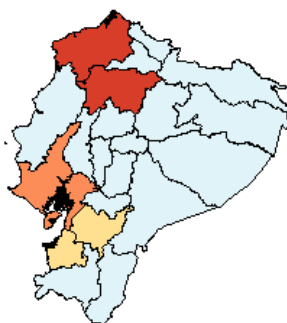
R6 Chimborazo



R7 El Oro



R8 Esmeraldas



R9 Guayas

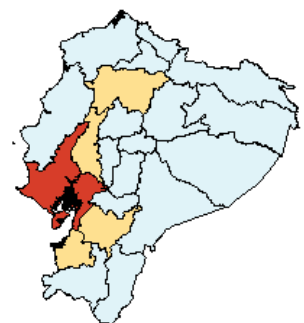
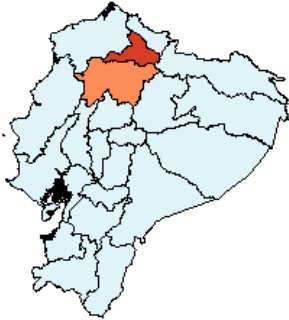
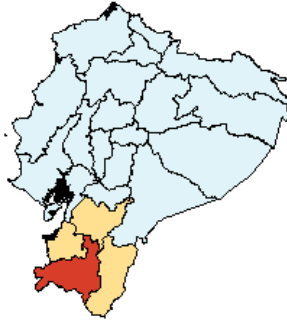


Figure 4. Identification of Regions whose Demands Affect Relatively More a Specific Regional Output, by Regional Output

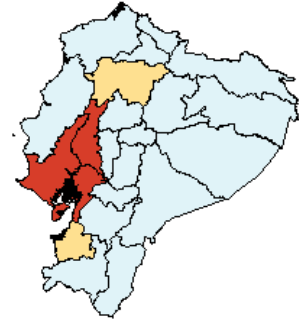
R10 Imbabura



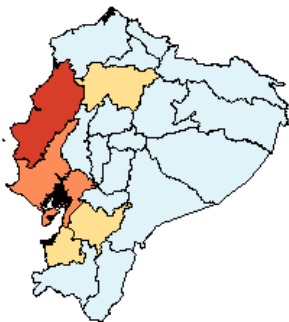
R11 Loja



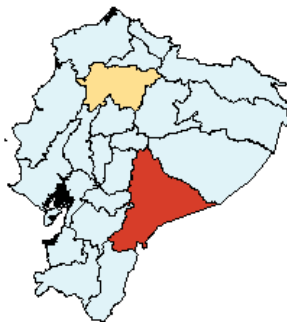
R12 Los Rios



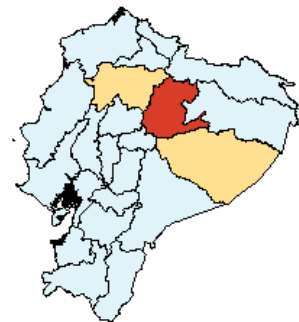
R13 Manabi



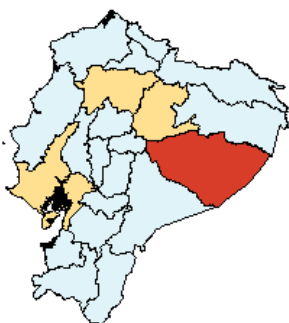
R14 Morona Santiago



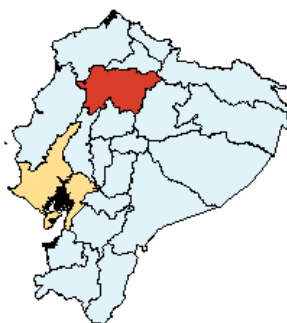
R15 Napo



R16 Pastaza



R17 Pichincha



R18 Tungurahua

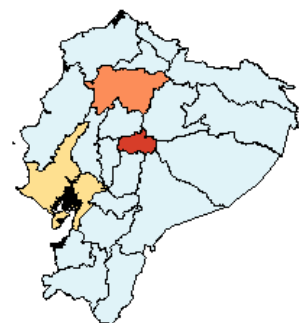
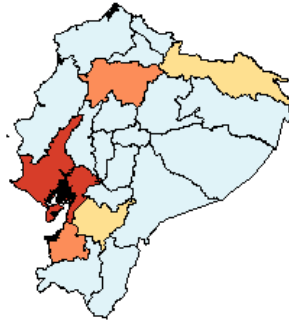


Figure 4. Identification of Regions whose Demands Affect Relatively More a Specific Regional Output, by Regional Output

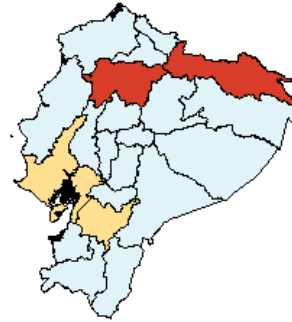
R19 Zamora Chinchipe



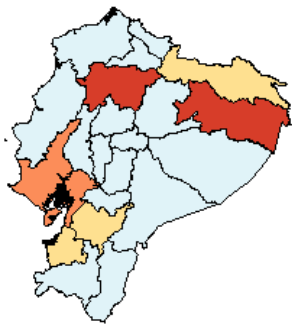
R20 Galapagos



R21 Sucumbios



R22 Francisco de Orellana



4. Final Remarks

The main goal of this paper was to present the recent developments in the construction of an interregional input-output matrix for Ecuador (IOM-EC). The understanding of the functioning of the Ecuadorian regional economies within an integrated system is one of the main goals of the joint project involving Nereus, in Brazil, and UTPL, in Ecuador. By exploring different methods of comparative structure analysis, it is hoped that this initial exercise benefited from the complementarity among them, resulting in a better appreciation of the full dimensions of differences and similarities that exist among the provinces in Ecuador.

The analysis suggests that there are some important differences in the internal structure of the regional economies in Ecuador and the external interactions among their different agents. As the absorption matrix used throughout the structural analysis will serve as the basis for the calibration of the ICGE model, understanding of the relationships underlying it is fundamental for a better understanding of the model's results.

It is clear from the preceding analysis that the role of international exports in generating domestic output in Ecuador is very relevant. The output decomposition analysis has shown that foreign exports are responsible for over one-third of gross output in the country. For some regions, especially those reliant upon exports of crude oil, the international exports generate over 80% of total regional output.

Even in this context, the role of interregional trade to the province economies should not be relegated to a secondary place. One should consider interregional interactions for a better understanding of how the province economies are affected, both in the international and in the domestic markets, once for the smaller economies, the performance of the more developed regions plays a crucial role. As Anderson and Hewings (1999) observe, the usual region versus the rest of the world characterization of spatial interaction provides a convenient mechanism to generate demand-driven models, but it provides little insights into two properties associated with spatial interaction that have not featured prominently in regional models, namely, feedbacks and hierarchy. On one hand, interregional trade might generate the potential for the propagation of feedback effects that, in quantitative terms, could be larger than the

effects generated by international trade. On the other hand, the impact of feedback effects will be determined, partly, by the hierarchical structure of the interregional system under consideration. Thus, in the Ecuadorian case, it is expected that the impacts of interregional trade related to the Guayas and Pichincha economies will differ from those from the other peripheral economies.

Inspection of Table 9 reveals some important characteristics of the Ecuadorian interregional system. It presents estimates of the interregional and international export coefficients for the 22 provinces in the country. It is noteworthy that, for almost every province, interregional exports are higher than international exports. In general, interregional flows have higher relative importance to the less developed economies, except those specialized in oil production/exports. These estimates, based on the information from the IIOM-EC, reveal, at first, the relevance of interregional trade for the regional economies. A further analysis of the trade among the Ecuadorian provinces, including the way of generalizations about the type of trade involved, its changing composition over time as an economy evolves and the implications for these structural differences in the articulation and implementation of development policies, would enhance the understanding of the economic system.

Finally, one could reach the conclusion that, for some of the province economies under consideration, the future is not only tied with its ability to compete in the international export market, but also with its articulation with other domestic markets. Again, more room for public policy might be advocated, through actions towards the modernization of the transportation infrastructure of the country to generate a more efficient integration of producers and consumers, and, thus, maximize the effects of the different strategies of trade policy: not only the mechanisms of propagation of feedback effects would be enhanced, but also the competitiveness of Ecuadorian products in international markets would increase.

Table 9. Interregional and International Export Coefficients: Ecuadorian Provinces, 2007 (in %)

	Interregional exports/VA	International exports/VA	Total exports/VA
R1 Azuay	0,504	0,150	0,655
R2 Bolívar	0,438	0,173	0,611
R3 Cañar	0,697	0,225	0,922
R4 Carchi	0,549	0,157	0,707
R5 Cotopaxi	0,881	0,343	1,224
R6 Chimborazo	0,498	0,163	0,661
R7 El Oro	0,463	0,226	0,689
R8 Esmeraldas	0,742	0,651	1,394
R9 Guayas	0,505	0,234	0,739
R10 Imbabura	0,465	0,147	0,612
R11 Loja	0,363	0,119	0,482
R12 Los Rios	0,677	0,277	0,954
R13 Manabi	0,578	0,230	0,808
R14 Morona Santiago	0,302	0,170	0,472
R15 Napo	0,355	0,097	0,452
R16 Pastaza	0,149	0,847	0,996
R17 Pichincha	0,415	0,219	0,634
R18 Tungurahua	0,608	0,172	0,780
R19 Zamora Chinchipe	0,360	0,195	0,555
R20 Galapagos	0,800	0,044	0,844
R21 Sucumbios	0,189	0,949	1,138
R22 Francisco de Orellana	0,163	0,973	1,135
TOTAL	0,452	0,365	0,818

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