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Interregional Input-Output Matrix for Colombia, 2012*

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Abstract:

This paper reports on the recent developments in the construction of an interregional input-output matrix for Colombia (IIOM-COL). As part of an ongoing project that aims to update an interregional CGE (ICGE) model for the country, the CEER model, 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. We conduct an analysis of the intraregional and interregional shares for the average total output multipliers. Furthermore, we also show detailed figures for the output decomposition, taking into account the structure of final demand.

Keywords: CEER Model, Interregional input-output matrix, Colombia.

JEL Code: R15

Matriz Insumo-Producto interregional para Colombia, 2012

Resumen:

El presente documento presenta un breve resumen de los principales aspectos asociados a la construcción de una matriz de insumo-producto interregional para Colombia. Como parte de un proyecto en curso que tiene como objetivo actualizar un modelo interregional CGE (ICGE) para el país, el modelo CEER, se construyó una base de datos para estimar un modelo de insumo-producto interregional completamente especificado, bajo condiciones de información limitada. Dicha base de datos se requiere para una futura calibración del modelo ICGE. Se lleva a cabo un análisis de las participaciones intra e interregionales de los multiplicadores medios de producto. Por otra parte, también se muestran algunas cifras detalladas sobre la descomposición del producto, teniendo en cuenta la estructura de la demanda final.

Código JEL: R15

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1. Introduction

Regional disparities have been documented for Colombian regions in several academic works. For this reason, the analysis of the economic growth and the sectoral composition in the country lacks the nuances of the different regions. To fill in this gap this work presents the results of the CEER Model, an interregional CGE model calibrated for the Colombian economy. 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 Centro de Estudios Económicos Regionales from the Banco de la República, in Colombia.

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 study. Given the renewed interest by economists on regional issues in Colombia, 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 should we wait until the data have improved sufficiently, or should we 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 IIOM-COL provides the opportunity to better understand the spatial linkage structure associated with the Colombian economy in the context of its 33 departments, and 7 different sectors/products (Figure 1).[1] Namely, agriculture (AGR), mining (MNE), manufacturing (IND), construction (CNT), transportation (TRN), public administration (ADP), and other services (OTS).

[1] See the Technical Appendix for the list of departamentos, sectors and commodities.

This report describes the process by which the IIOM-COL was constructed under the conditions of limited information that prevails in Colombia. In what follows, we will summarize the main tasks and working hypotheses involved in the treatment of the initial database that was used in the construction process of the system.

Figure 1. Schematic Structure of the IIOM-COL

			ABSORPTION MATRIX					
			1	2	3	4	5	6
			Producers	Investors	Household	Export	Regional Govt.	Central Govt.
		Size	J x Q	J x Q	Q	1	Q	Q
	Basic Flows	I x S	BAS1	BAS2	BAS3	BAS4	BAS5	BAS6
	Margins	I x S x R	MAR1	MAR2	MAR3	MAR4	MAR5	MAR6
	Taxes	I x S	TAX1	TAX2	TAX3	TAX4	TAX5	TAX6
	Labor	1	LABR					
	Capital	1	CPTL					
	Other	1	OCTS					

2. Initial Data Treatment

In this section we present the main hypotheses and procedures applied to estimate the interregional input-output matrix for Colombia (IIOM-COL). As mentioned before, the IIOM-COL was estimated under conditions of limited information. We used data of national and regional accounts provided by the Departamento Administrativo Nacional de Estadística (DANE) for the year 2012, which consist mainly in the Supply and Use Tables (SUT) at the national level, and data on gross output, value added, labor income and employment by sectors at the regional (departamentos) 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 and Sesso Filho (2005) for a similar exercise applied for Brazil. There are at least two main advantages of 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 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.

2. 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.

3. 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.

4. The structure of the Make Table was then used to transform the new Use Table from a commodity by sector into a sector by sector system of information.

5. Finally, the national structure of 61 sectors was aggregated into 7 sectors in order to match the structure of sectors at the departmental level, as we were constrained by availability of sectoral information at the regional level. Moreover, for computational constraints, we have decided to rely on a more aggregated version of the model at the sectoral level.

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

The second step was to disaggregate the national data into the 33 Departamentos of Colombia. The details of such procedure are described in the technical appendix. We focus the subsequent discussion on some of the relevant summary figures embedded in the IIOM-COL.

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 Colombia, the information provided by DANE at the regional level consists only of international exports, gross production and value added. The other components of the regional macroeconomic identity had to be estimated.

Figure 2. Structure of the National Input-Output System for Colombia: Summary Results, 2012 (in billion Pesos)

			Intermediate consumption	Investment demand	Household consumption	Exports	Government consumption	TOTAL
		Dim.	1 2 … 7	1 2 … 7	1	1	1	
Basic flows	Domestic	1 2 … 7	386.312	118.187	318.195	95.927	107.909	1.026.531
	Imported	1 2 … 7	58.765	29.036	32.656	0	1.146	121.602
Trade Margins	Domestic	1 2 … 7	23.572	2.531	26.669	4.124	503	57.398
	Imported	1 2 … 7	8.171	4.482	7.433	0	274	20.360
Transport Margins	Domestic	1 2 … 7	2.216	75	470	807	27	3.594
	Imported	1 2 … 7	565	165	183	0	17	930
Indirect taxes	Domestic	1 2 … 7	18.544	2.290	17.818	2.255	202	41.109
	Imported	1 2 … 7	4.281	2.409	3.244	0	49	9.983
	Labor payments		214.531	0	0	0	0	214.531
	Capital payments		378.742	0	0	0	0	378.742
	Other costs		13.115	0	0	0	0	13.115
	Total		1.108.814	159.176	406.667	103.112	110.127	1.887.896

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

where

C = household consumption

I = investment demand

G = government consumption

$(X - M)_{ROW}$ = international trade balance with the rest of the world

$(X - M)_{DOM}$ = interregional trade balance with the domestic economy

We used shares calculated from specific variables to estimate the departmental value of some components of equation (1): household consumption, investment demand and government consumption. The values for international exports were obtained directly from the Banco de la República's foregin data system "Serankua", and consolidated with the gross output data at the sectoral level. For each component, the variables used to calculate the shares were the following:

1. *Household consumption*: labor income ("ingreso laboral") estimated from DANE's national survey "Gran Encuesta Integrada de Hogares" - GEIH.

2. *Investment demand*: employment of the construction sector estimated using GEIH's sectoral results.

3. *Government consumption*: value added of the public administration sector obtained from the regional accounts published by DANE.

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 departamentos. Bogotá, together with Antioquia and Valle, concentrate almost half of the national household consumption and government demand, and near 42% of the investment demand. On the other hand, the departamentos of Meta, Casanare and Cesar present important participation in the total exports, mainly influenced by the sales of crude, refined oil and coal.

In order to regionalize the national IO table, we have relied on an adapted version of the Chenery-Moses approach (Chenery, 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 Colombia. 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 Colombian economy. In other 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 33 regions of the model and foreign imports).

Table 1. Shares used to Estimate the Components of the GRP of Colombia, 2012

	Investment demand	Household demand	Exports	Government demand
Antioquia	0,1364	0,1427	0,0951	0,0955
Atlántico	0,0645	0,0388	0,0197	0,0307
Bogotá D. C.	0,1975	0,2856	0,0997	0,3145
Bolívar	0,0483	0,0280	0,0633	0,0317
Boyacá	0,0267	0,0251	0,0281	0,0255
Caldas	0,0194	0,0186	0,0084	0,0161
Caquetá	0,0059	0,0090	0,0004	0,0156
Cauca	0,0216	0,0168	0,0051	0,0210
Cesar	0,0208	0,0174	0,0763	0,0171
Chocó	0,0098	0,0077	0,0001	0,0095
Córdoba	0,0300	0,0188	0,0027	0,0222
Cundinamarca	0,0568	0,0477	0,0362	0,0517
La Guajira	0,0164	0,0131	0,0561	0,0114
Huila	0,0200	0,0189	0,0187	0,0180
Magdalena	0,0229	0,0157	0,0095	0,0168
Meta	0,0231	0,0205	0,2195	0,0265
Nariño	0,0221	0,0223	0,0034	0,0268
Norte Santander	0,0279	0,0257	0,0112	0,0223
Quindío	0,0153	0,0130	0,0023	0,0103
Risaralda	0,0209	0,0202	0,0045	0,0145
Santander	0,0545	0,0592	0,0445	0,0352
Sucre	0,0163	0,0117	0,0010	0,0174
Tolima	0,0247	0,0226	0,0179	0,0306
Valle	0,0885	0,0894	0,0396	0,0814
Amazonas	0,0005	0,0006	0,0000	0,0024
Arauca	0,0021	0,0016	0,0312	0,0071
Casanare	0,0046	0,0040	0,0885	0,0084
Guainía	0,0003	0,0002	0,0000	0,0014
Guaviare	0,0006	0,0008	0,0000	0,0035
Putumayo	0,0009	0,0009	0,0167	0,0083
San Andrés y Providencia	0,0002	0,0028	0,0000	0,0032
Vaupés	0,0003	0,0003	0,0000	0,0008
Vichada	0,0003	0,0002	0,0000	0,0024
TOTAL	1,0000	1,0000	1,0000	1,0000

Source: calculations by the authors.

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

1. We have initially estimated total supply (output) of each sectoral 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 such that:

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

2. Next, we have estimated total demand, in each region, for each sector. 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 Colombian goods, were then adjusted so that, for each commodity, demand across regions equals supply across regions, i.e.:

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 (33x33) representing the transactions of each commodity between origin and destination, *SHIN(c,o,d)*. We have relied on the methodology described in Dixon and 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:

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

$$SHIN(c,o,d) = \left\{\frac{1}{Dist(o,d)} \cdot \frac{Supply(c,o)}{\sum_{k=1}^{33} Supply(c,k)}\right\} * \left\{\frac{1 - SHIN(c,d,d)}{\sum_{j=1, j\neq d}^{33}\left[\frac{1}{Dist(j,d)} \cdot \frac{Suply(c,j)}{\sum_{k=1}^{33} Suply(c,k)}\right]}\right\} \qquad (3)$$

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 values close to unity for *F(c)*, adopting a usual assumption –CNT and ADP = 0.95; and TRN and OTS = 0.80 –, while for tradables (AGR, MNE and IND), the value of *F(c)* was set to 0.5.[2]

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 out. This is done through a RAS procedure (for specific details of this method see Miller and Blair, 2009).

Tables 2 and 3 show the resulting structure of trade in the IIOM-COL (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-COL, 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.

[2] For AGR, MNE and IND, we have adopted a second step after generating the SHIN by assigning the structure of cargo flows from the Origin-Destination Matriz 2013 from the Ministry of Transportation to obtain a better fit to observed cargo flows for productos agrícolas, míneros and industrials.

Table 2. Interregional Trade in Colombia: Purchases Shares, 2012

		DESTINATION																																
		D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_10	D_11	D_12	D_13	D_14	D_15	D_16	D_17	D_18	D_19	D_20	D_21	D_22	D_23	D_24	D_25	D_26	D_27	D_28	D_29	D_30	D_31	D_32	D_33
ORIGIN	D_1	0.000	0.059	0.037	0.157	0.023	0.044	0.043	0.033	0.047	0.145	0.736	0.012	0.085	0.034	0.043	0.044	0.050	0.043	0.027	0.033	0.086	0.243	0.024	0.060	0.098	0.052	0.031	0.082	0.046	0.046	0.118	0.083	0.099
	D_2	0.025	0.000	0.006	0.295	0.005	0.003	0.007	0.004	0.026	0.011	0.005	0.002	0.162	0.004	0.430	0.010	0.006	0.015	0.002	0.002	0.019	0.082	0.003	0.006	0.017	0.028	0.009	0.017	0.008	0.006	0.021	0.012	0.013
	D_3	0.061	0.022	0.000	0.023	0.397	0.176	0.237	0.091	0.087	0.161	0.007	0.570	0.069	0.340	0.022	0.397	0.102	0.125	0.153	0.120	0.224	0.037	0.355	0.148	0.068	0.184	0.247	0.211	0.373	0.092	0.074	0.181	0.171
	D_4	0.089	0.345	0.008	0.000	0.006	0.005	0.009	0.006	0.022	0.016	0.015	0.002	0.098	0.006	0.107	0.012	0.011	0.016	0.004	0.004	0.022	0.194	0.004	0.010	0.044	0.027	0.010	0.026	0.012	0.008	0.055	0.025	0.024
	D_5	0.008	0.004	0.065	0.006	0.000	0.006	0.010	0.005	0.013	0.012	0.001	0.033	0.009	0.012	0.004	0.020	0.007	0.022	0.007	0.004	0.033	0.005	0.009	0.011	0.012	0.046	0.201	0.017	0.018	0.008	0.015	0.018	0.023
	D_6	0.005	0.001	0.011	0.002	0.003	0.000	0.005	0.007	0.003	0.022	0.001	0.005	0.002	0.007	0.001	0.005	0.006	0.003	0.040	0.216	0.009	0.002	0.016	0.017	0.003	0.003	0.002	0.004	0.005	0.002	0.003	0.004	0.004
	D_7	0.001	0.001	0.003	0.001	0.001	0.001	0.000	0.010	0.001	0.003	0.000	0.002	0.001	0.010	0.001	0.002	0.021	0.001	0.001	0.001	0.002	0.001	0.002	0.006	0.002	0.001	0.001	0.002	0.001	0.014	0.002	0.002	0.001
	D_8	0.005	0.001	0.008	0.002	0.003	0.008	0.060	0.000	0.002	0.013	0.001	0.003	0.003	0.040	0.001	0.006	0.109	0.003	0.011	0.009	0.005	0.002	0.008	0.067	0.010	0.004	0.003	0.009	0.008	0.029	0.013	0.010	0.008
	D_9	0.005	0.011	0.004	0.010	0.004	0.002	0.003	0.002	0.000	0.005	0.002	0.002	0.020	0.002	0.010	0.003	0.001	0.030	0.001	0.001	0.072	0.015	0.002	0.003	0.004	0.005	0.005	0.004	0.002	0.001	0.004	0.003	0.003
	D_10	0.008	0.003	0.004	0.007	0.002	0.011	0.002	0.006	0.003	0.000	0.002	0.002	0.003	0.002	0.001	0.006	0.002	0.002	0.005	0.010	0.009	0.003	0.003	0.017	0.001	0.003	0.004	0.001	0.002	0.003	0.002	0.001	0.001
	D_11	0.188	0.006	0.002	0.017	0.001	0.001	0.001	0.001	0.003	0.004	0.000	0.001	0.005	0.001	0.003	0.002	0.001	0.002	0.001	0.001	0.003	0.028	0.001	0.002	0.001	0.002	0.001	0.002	0.002	0.001	0.002	0.001	0.001
	D_12	0.009	0.003	0.246	0.003	0.050	0.021	0.024	0.010	0.007	0.017	0.001	0.000	0.007	0.042	0.003	0.046	0.012	0.012	0.017	0.014	0.024	0.004	0.046	0.022	0.015	0.020	0.028	0.028	0.048	0.012	0.017	0.029	0.028
	D_13	0.002	0.013	0.002	0.010	0.001	0.000	0.001	0.001	0.005	0.001	0.001	0.000	0.000	0.001	0.025	0.002	0.001	0.002	0.000	0.000	0.004	0.004	0.001	0.001	0.001	0.003	0.001	0.002	0.001	0.001	0.002	0.001	0.002
	D_14	0.005	0.006	0.026	0.004	0.006	0.011	0.068	0.062	0.005	0.019	0.002	0.016	0.011	0.000	0.005	0.013	0.039	0.007	0.012	0.016	0.010	0.007	0.041	0.029	0.012	0.008	0.007	0.008	0.009	0.044	0.004	0.009	0.006
	D_15	0.004	0.124	0.003	0.027	0.001	0.001	0.002	0.001	0.008	0.002	0.001	0.001	0.089	0.001	0.000	0.003	0.001	0.004	0.001	0.000	0.006	0.010	0.001	0.001	0.002	0.007	0.002	0.004	0.003	0.001	0.004	0.002	0.003
	D_16	0.015	0.015	0.049	0.022	0.015	0.016	0.012	0.018	0.016	0.025	0.005	0.043	0.026	0.017	0.010	0.000	0.011	0.014	0.008	0.013	0.032	0.012	0.022	0.043	0.034	0.035	0.073	0.046	0.030	0.047	0.019	0.061	0.035
	D_17	0.004	0.002	0.006	0.003	0.002	0.004	0.070	0.064	0.001	0.007	0.001	0.003	0.003	0.014	0.001	0.005	0.000	0.003	0.004	0.004	0.005	0.002	0.005	0.029	0.005	0.004	0.003	0.006	0.006	0.307	0.008	0.005	0.005
	D_18	0.004	0.006	0.007	0.006	0.009	0.003	0.004	0.002	0.033	0.006	0.001	0.003	0.012	0.003	0.005	0.005	0.003	0.000	0.002	0.002	0.050	0.007	0.003	0.004	0.007	0.049	0.013	0.007	0.007	0.002	0.008	0.007	0.009
	D_19	0.002	0.001	0.005	0.001	0.002	0.022	0.003	0.006	0.001	0.010	0.000	0.003	0.001	0.005	0.000	0.002	0.003	0.001	0.000	0.088	0.003	0.001	0.034	0.018	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.001
	D_20	0.004	0.001	0.007	0.001	0.002	0.223	0.005	0.008	0.002	0.025	0.000	0.003	0.002	0.008	0.001	0.004	0.006	0.002	0.166	0.000	0.006	0.002	0.029	0.022	0.003	0.002	0.002	0.004	0.004	0.003	0.003	0.004	0.003
	D_21	0.099	0.078	0.092	0.049	0.091	0.071	0.064	0.037	0.482	0.145	0.015	0.038	0.174	0.077	0.081	0.070	0.061	0.409	0.036	0.051	0.000	0.109	0.067	0.083	0.155	0.193	0.084	0.116	0.098	0.035	0.159	0.140	0.142
	D_22	0.016	0.016	0.002	0.041	0.001	0.001	0.001	0.001	0.007	0.003	0.006	0.001	0.008	0.001	0.007	0.002	0.001	0.004	0.001	0.001	0.005	0.000	0.001	0.002	0.003	0.003	0.001	0.003	0.003	0.001	0.004	0.002	0.002
	D_23	0.005	0.002	0.039	0.002	0.006	0.027	0.015	0.011	0.004	0.010	0.001	0.020	0.004	0.037	0.002	0.011	0.009	0.005	0.096	0.047	0.015	0.003	0.000	0.030	0.004	0.006	0.006	0.007	0.010	0.007	0.005	0.007	0.006
	D_24	0.052	0.011	0.070	0.017	0.026	0.111	0.171	0.360	0.023	0.176	0.005	0.025	0.027	0.101	0.010	0.066	0.244	0.031	0.207	0.149	0.057	0.021	0.107	0.000	0.089	0.045	0.034	0.099	0.066	0.143	0.106	0.098	0.087
	D_25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.000	0.067	0.000	0.000
	D_26	0.003	0.004	0.005	0.007	0.008	0.001	0.001	0.002	0.003	0.002	0.001	0.004	0.005	0.002	0.003	0.008	0.001	0.014	0.001	0.001	0.017	0.002	0.002	0.004	0.002	0.000	0.026	0.002	0.003	0.002	0.004	0.002	0.003
	D_27	0.006	0.007	0.016	0.010	0.084	0.004	0.002	0.004	0.010	0.008	0.002	0.014	0.011	0.004	0.005	0.034	0.004	0.016	0.002	0.003	0.020	0.005	0.006	0.011	0.008	0.059	0.000	0.004	0.009	0.006	0.005	0.006	0.010
	D_28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	D_29	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000
	D_30	0.001	0.000	0.002	0.001	0.001	0.001	0.014	0.007	0.000	0.001	0.000	0.001	0.001	0.005	0.000	0.005	0.056	0.000	0.001	0.001	0.001	0.000	0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001
	D_31	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.064	0.003	0.001	0.007	0.001	0.001	0.000	0.002	0.002
	D_32	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	D_33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
	IMP	0.373	0.258	0.271	0.273	0.250	0.223	0.164	0.240	0.182	0.149	0.190	0.193	0.162	0.224	0.219	0.215	0.230	0.214	0.194	0.207	0.259	0.196	0.208	0.345	0.333	0.202	0.202	0.277	0.223	0.176	0.274	0.281	0.307
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	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: calculations by the authors.

Table 3. Interregional Trade in Colombia: Sales Shares, 2012

		DESTINATION																																TOTAL
		D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_10	D_11	D_12	D_13	D_14	D_15	D_16	D_17	D_18	D_19	D_20	D_21	D_22	D_23	D_24	D_25	D_26	D_27	D_28	D_29	D_30	D_31	D_32	D_33	
ORIGIN	D_1	0.000	0.042	0.125	0.106	0.010	0.013	0.006	0.010	0.016	0.021	0.287	0.014	0.020	0.011	0.012	0.018	0.015	0.016	0.006	0.011	0.105	0.051	0.010	0.064	0.001	0.003	0.004	0.000	0.001	0.002	0.002	0.000	0.000	1.000
	D_2	0.072	0.000	0.041	0.399	0.004	0.002	0.002	0.002	0.017	0.003	0.004	0.004	0.077	0.003	0.241	0.008	0.004	0.011	0.001	0.002	0.047	0.035	0.002	0.012	0.000	0.003	0.002	0.000	0.000	0.000	0.001	0.000	0.000	1.000
	D_3	0.040	0.007	0.000	0.007	0.078	0.024	0.015	0.012	0.013	0.011	0.001	0.301	0.007	0.049	0.003	0.074	0.014	0.021	0.015	0.018	0.124	0.004	0.065	0.073	0.000	0.004	0.014	0.000	0.002	0.001	0.001	0.000	0.000	1.000
	D_4	0.222	0.418	0.046	0.000	0.005	0.003	0.002	0.003	0.013	0.004	0.010	0.005	0.040	0.004	0.051	0.008	0.005	0.010	0.001	0.002	0.047	0.070	0.003	0.019	0.000	0.002	0.002	0.000	0.000	0.000	0.002	0.000	0.000	1.000
	D_5	0.028	0.008	0.546	0.010	0.000	0.005	0.004	0.004	0.011	0.004	0.001	0.096	0.005	0.010	0.003	0.020	0.005	0.021	0.004	0.004	0.101	0.003	0.009	0.030	0.000	0.006	0.062	0.000	0.001	0.001	0.001	0.000	0.000	1.000
	D_6	0.041	0.004	0.202	0.006	0.006	0.000	0.004	0.010	0.005	0.017	0.001	0.031	0.003	0.011	0.001	0.010	0.009	0.006	0.047	0.389	0.057	0.002	0.035	0.098	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	D_7	0.033	0.014	0.232	0.012	0.010	0.007	0.000	0.075	0.006	0.010	0.002	0.049	0.006	0.083	0.005	0.020	0.153	0.010	0.005	0.009	0.054	0.004	0.022	0.163	0.000	0.001	0.002	0.000	0.000	0.012	0.001	0.000	0.000	1.000
	D_8	0.037	0.005	0.137	0.007	0.006	0.012	0.042	0.000	0.004	0.010	0.001	0.017	0.003	0.066	0.002	0.013	0.166	0.006	0.013	0.016	0.034	0.002	0.017	0.373	0.000	0.001	0.002	0.000	0.001	0.005	0.001	0.000	0.000	1.000
	D_9	0.041	0.047	0.094	0.041	0.012	0.004	0.002	0.003	0.000	0.005	0.004	0.013	0.030	0.004	0.018	0.009	0.003	0.069	0.002	0.003	0.544	0.020	0.006	0.022	0.000	0.002	0.003	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	D_10	0.144	0.022	0.160	0.057	0.009	0.038	0.003	0.020	0.013	0.000	0.008	0.033	0.008	0.007	0.004	0.027	0.005	0.008	0.013	0.040	0.133	0.006	0.015	0.218	0.000	0.002	0.005	0.000	0.000	0.001	0.000	0.000	0.000	1.000
	D_11	0.865	0.013	0.021	0.037	0.001	0.001	0.001	0.001	0.003	0.002	0.000	0.002	0.004	0.001	0.003	0.002	0.001	0.002	0.000	0.001	0.011	0.019	0.001	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	D_12	0.013	0.002	0.815	0.002	0.021	0.006	0.003	0.003	0.002	0.002	0.000	0.000	0.002	0.013	0.001	0.019	0.004	0.004	0.004	0.005	0.029	0.001	0.018	0.024	0.000	0.001	0.003	0.000	0.001	0.000	0.000	0.000	0.000	1.000
	D_13	0.056	0.209	0.157	0.154	0.008	0.003	0.002	0.003	0.036	0.003	0.004	0.013	0.000	0.004	0.154	0.015	0.004	0.020	0.001	0.002	0.097	0.016	0.005	0.022	0.000	0.004	0.004	0.000	0.000	0.000	0.001	0.000	0.000	1.000
	D_14	0.028	0.016	0.344	0.009	0.010	0.013	0.037	0.071	0.007	0.011	0.003	0.072	0.010	0.000	0.005	0.021	0.045	0.011	0.010	0.021	0.049	0.006	0.065	0.124	0.000	0.002	0.003	0.000	0.000	0.006	0.000	0.000	0.000	1.000
	D_15	0.035	0.536	0.060	0.113	0.004	0.001	0.002	0.002	0.016	0.002	0.002	0.005	0.128	0.002	0.000	0.007	0.002	0.009	0.001	0.001	0.043	0.013	0.002	0.008	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	D_16	0.051	0.025	0.381	0.035	0.015	0.011	0.004	0.012	0.012	0.009	0.004	0.116	0.014	0.012	0.006	0.000	0.008	0.012	0.004	0.010	0.091	0.006	0.020	0.108	0.001	0.004	0.021	0.000	0.001	0.004	0.001	0.001	0.000	1.000
	D_17	0.047	0.010	0.166	0.017	0.008	0.009	0.076	0.146	0.004	0.008	0.002	0.029	0.005	0.034	0.003	0.015	0.000	0.008	0.007	0.010	0.051	0.004	0.015	0.241	0.000	0.002	0.003	0.000	0.001	0.080	0.001	0.000	0.000	1.000
	D_18	0.046	0.028	0.164	0.028	0.027	0.005	0.004	0.005	0.078	0.007	0.003	0.023	0.020	0.007	0.011	0.016	0.007	0.000	0.002	0.004	0.433	0.011	0.008	0.033	0.000	0.017	0.011	0.000	0.001	0.001	0.001	0.000	0.000	1.000
	D_19	0.023	0.003	0.163	0.005	0.007	0.064	0.004	0.015	0.003	0.014	0.001	0.029	0.002	0.014	0.001	0.008	0.010	0.004	0.000	0.281	0.032	0.002	0.132	0.181	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	D_20	0.029	0.003	0.127	0.004	0.004	0.336	0.004	0.012	0.003	0.019	0.001	0.017	0.002	0.013	0.001	0.008	0.010	0.004	0.184	0.000	0.035	0.002	0.059	0.122	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	D_21	0.108	0.041	0.231	0.025	0.029	0.016	0.007	0.008	0.120	0.016	0.004	0.033	0.031	0.019	0.017	0.022	0.014	0.115	0.006	0.013	0.000	0.017	0.020	0.068	0.001	0.007	0.008	0.000	0.001	0.001	0.002	0.000	0.000	1.000
	D_22	0.242	0.120	0.090	0.296	0.005	0.003	0.002	0.003	0.026	0.005	0.025	0.008	0.021	0.003	0.022	0.008	0.004	0.014	0.002	0.003	0.067	0.000	0.004	0.021	0.000	0.002	0.002	0.000	0.000	0.000	0.001	0.000	0.000	1.000
	D_23	0.024	0.004	0.444	0.006	0.009	0.027	0.007	0.011	0.005	0.005	0.001	0.078	0.003	0.041	0.002	0.015	0.009	0.006	0.072	0.054	0.060	0.002	0.000	0.111	0.000	0.001	0.002	0.000	0.000	0.001	0.000	0.000	0.000	1.000
	D_24	0.079	0.008	0.249	0.012	0.012	0.035	0.025	0.110	0.008	0.027	0.002	0.030	0.007	0.034	0.003	0.029	0.076	0.012	0.048	0.052	0.073	0.005	0.046	0.000	0.001	0.002	0.004	0.000	0.001	0.005	0.002	0.000	0.000	1.000
	D_25	0.058	0.015	0.167	0.029	0.011	0.004	0.009	0.013	0.008	0.007	0.003	0.024	0.009	0.006	0.005	0.059	0.019	0.011	0.003	0.003	0.059	0.004	0.007	0.057	0.000	0.011	0.008	0.002	0.001	0.003	0.384	0.000	0.001	1.000
	D_26	0.055	0.034	0.194	0.062	0.042	0.005	0.002	0.006	0.013	0.003	0.004	0.059	0.013	0.006	0.009	0.039	0.004	0.068	0.002	0.003	0.264	0.005	0.009	0.055	0.000	0.000	0.040	0.000	0.000	0.001	0.001	0.000	0.000	1.000
	D_27	0.039	0.023	0.265	0.032	0.177	0.006	0.002	0.006	0.017	0.006	0.003	0.080	0.013	0.007	0.006	0.068	0.005	0.030	0.002	0.005	0.118	0.006	0.011	0.056	0.000	0.014	0.000	0.000	0.001	0.001	0.000	0.000	0.000	1.000
	D_28	0.048	0.043	0.341	0.026	0.012	0.008	0.007	0.013	0.010	0.015	0.007	0.044	0.026	0.008	0.013	0.130	0.019	0.021	0.004	0.009	0.050	0.014	0.014	0.100	0.003	0.003	0.006	0.000	0.003	0.001	0.003	0.001	0.000	1.000
	D_29	0.037	0.034	0.408	0.013	0.015	0.011	0.002	0.015	0.007	0.016	0.006	0.082	0.016	0.011	0.010	0.042	0.024	0.028	0.005	0.015	0.055	0.015	0.021	0.099	0.001	0.003	0.007	0.000	0.000	0.001	0.000	0.000	0.000	1.000
	D_30	0.043	0.007	0.125	0.017	0.006	0.004	0.042	0.044	0.003	0.003	0.002	0.024	0.004	0.034	0.002	0.048	0.363	0.004	0.002	0.005	0.035	0.002	0.011	0.164	0.000	0.001	0.004	0.000	0.000	0.000	0.000	0.000	0.000	1.000
	D_31	0.073	0.017	0.211	0.016	0.015	0.007	0.021	0.028	0.017	0.019	0.004	0.021	0.025	0.011	0.005	0.127	0.047	0.024	0.005	0.007	0.084	0.008	0.011	0.074	0.060	0.025	0.019	0.004	0.002	0.007	0.000	0.001	0.001	1.000
	D_32	0.024	0.008	0.570	0.009	0.013	0.005	0.011	0.007	0.007	0.005	0.001	0.034	0.006	0.008	0.003	0.146	0.009	0.011	0.003	0.004	0.039	0.003	0.012	0.042	0.000	0.005	0.007	0.001	0.003	0.002	0.004	0.000	0.001	1.000
	D_33	0.076	0.047	0.305	0.027	0.022	0.008	0.005	0.014	0.009	0.013	0.007	0.054	0.026	0.010	0.014	0.064	0.022	0.034	0.004	0.010	0.077	0.014	0.014	0.106	0.002	0.004	0.009	0.000	0.001	0.001	0.001	0.001	0.000	1.000
	IMP	0.140	0.047	0.237	0.048	0.028	0.017	0.006	0.018	0.016	0.006	0.019	0.058	0.010	0.019	0.016	0.023	0.018	0.021	0.011	0.018	0.082	0.011	0.022	0.097	0.001	0.003	0.007	0.000	0.001	0.002	0.001	0.000	0.000	1.000

Source: calculations by the authors.

3. Structural Analysis

In this section, some of the main structural features of the economy of Colombia are revealed through the use of indicators derived from the IIOM-COL. 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 the departamentos in Colombia. Bogotá, Antioquia and Valle dominate the national production, with shares of 23.8%, 13.4% and 9.6% in total output, respectively.

The regional output shares by sectors in Colombia reveal some evidence of spatial concentration of specific activities: agriculture in Antioquia, Cundinamarca, Valle, Boyacá and Santander (44.7% of total output); mining in Meta, Casanare and Cesar (58.0%); and manufacturing in Bogotá, Santander, Antioquia and Valle (62.4%). Services, in general, are concentrated in Bogotá, Antioquia and Valle.

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 and hydrocarbon activities in Casanare (62.9% of total regional output), Meta (60.7%) and Arauca (55.4%); the relevance of the other services sector in San Andrés y Providencia (62.6%) and Bogotá (58.2%).

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).

Table 4. Regional Structure of Sectoral Output: Colombia, 2012

		AGR	MNE	IND	CNT	TRN	ADP	OTS	TOTAL
D_1	Antioquia	0.126	0.044	0.146	0.143	0.130	0.101	0.151	0.134
D_2	Atlántico	0.014	0.001	0.045	0.040	0.061	0.033	0.046	0.040
D_3	Bogotá D. C.	0.000	0.006	0.194	0.206	0.252	0.257	0.340	0.238
D_4	Bolívar	0.033	0.016	0.085	0.050	0.054	0.036	0.029	0.045
D_5	Boyacá	0.068	0.039	0.031	0.027	0.034	0.029	0.022	0.030
D_6	Caldas	0.024	0.002	0.015	0.017	0.015	0.017	0.015	0.015
D_7	Caquetá	0.011	0.000	0.001	0.008	0.003	0.015	0.004	0.005
D_8	Cauca	0.022	0.004	0.020	0.018	0.007	0.025	0.014	0.016
D_9	Cesar	0.031	0.089	0.005	0.014	0.018	0.019	0.012	0.019
D_10	Chocó	0.010	0.020	0.000	0.003	0.001	0.011	0.003	0.005
D_11	Córdoba	0.044	0.022	0.005	0.020	0.016	0.027	0.018	0.018
D_12	Cundinamarca	0.109	0.006	0.086	0.047	0.044	0.051	0.044	0.055
D_13	La Guajira	0.008	0.069	0.001	0.005	0.006	0.014	0.006	0.011
D_14	Huila	0.035	0.029	0.006	0.042	0.032	0.023	0.013	0.018
D_15	Magdalena	0.034	0.000	0.006	0.017	0.019	0.021	0.014	0.013
D_16	Meta	0.058	0.350	0.010	0.042	0.026	0.025	0.014	0.047
D_17	Nariño	0.036	0.003	0.006	0.016	0.012	0.030	0.016	0.015
D_18	Norte Santander	0.027	0.008	0.010	0.013	0.020	0.025	0.018	0.016
D_19	Quindío	0.019	0.001	0.004	0.016	0.007	0.011	0.008	0.008
D_20	Risaralda	0.020	0.001	0.015	0.015	0.017	0.016	0.015	0.014
D_21	Santander	0.067	0.044	0.161	0.126	0.062	0.039	0.044	0.081
D_22	Sucre	0.018	0.001	0.005	0.007	0.007	0.020	0.008	0.008
D_23	Tolima	0.047	0.026	0.016	0.021	0.020	0.032	0.019	0.022
D_24	Valle	0.078	0.002	0.123	0.067	0.113	0.085	0.108	0.096
D_25	Amazonas	0.001	0.000	0.000	0.000	0.001	0.003	0.001	0.001
D_26	Arauca	0.022	0.049	0.001	0.003	0.002	0.007	0.002	0.007
D_27	Casanare	0.032	0.141	0.003	0.012	0.011	0.009	0.005	0.018
D_28	Guainía	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
D_29	Guaviare	0.001	0.000	0.000	0.001	0.001	0.003	0.001	0.001
D_30	Putumayo	0.003	0.027	0.001	0.001	0.001	0.009	0.003	0.004
D_31	San Andrés y Providencia	0.000	0.000	0.000	0.000	0.005	0.003	0.002	0.002
D_32	Vaupés	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
D_33	Vichada	0.001	0.000	0.000	0.001	0.000	0.002	0.001	0.001
	TOTAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Source: calculations by the authors.

Table 5. Sectoral Structure of Regional Output: Colombia, 2012

		AGR	MNE	IND	CNT	TRN	ADP	OTS	TOTAL
D_1	Antioquia	0.048	0.027	0.249	0.102	0.052	0.063	0.459	1.000
D_2	Atlántico	0.018	0.002	0.261	0.096	0.082	0.069	0.473	1.000
D_3	Bogotá D. C.	0.000	0.002	0.187	0.083	0.057	0.090	0.582	1.000
D_4	Bolívar	0.037	0.028	0.433	0.106	0.064	0.066	0.265	1.000
D_5	Boyacá	0.117	0.108	0.242	0.086	0.062	0.081	0.304	1.000
D_6	Caldas	0.083	0.009	0.227	0.112	0.052	0.098	0.418	1.000
D_7	Caquetá	0.125	0.004	0.062	0.173	0.030	0.267	0.338	1.000
D_8	Cauca	0.072	0.019	0.287	0.109	0.023	0.133	0.358	1.000
D_9	Cesar	0.084	0.382	0.064	0.072	0.052	0.085	0.260	1.000
D_10	Chocó	0.105	0.353	0.024	0.053	0.015	0.205	0.246	1.000
D_11	Córdoba	0.128	0.101	0.060	0.111	0.049	0.129	0.421	1.000
D_12	Cundinamarca	0.102	0.009	0.362	0.081	0.043	0.077	0.327	1.000
D_13	La Guajira	0.040	0.521	0.020	0.045	0.030	0.109	0.235	1.000
D_14	Huila	0.097	0.127	0.071	0.220	0.094	0.104	0.287	1.000
D_15	Magdalena	0.132	0.003	0.099	0.124	0.078	0.129	0.435	1.000
D_16	Meta	0.063	0.607	0.047	0.085	0.030	0.045	0.122	1.000
D_17	Nariño	0.123	0.019	0.091	0.105	0.044	0.169	0.448	1.000
D_18	Norte Santander	0.087	0.039	0.139	0.075	0.068	0.128	0.463	1.000
D_19	Quindío	0.120	0.005	0.118	0.193	0.049	0.112	0.403	1.000
D_20	Risaralda	0.071	0.004	0.234	0.096	0.065	0.094	0.436	1.000
D_21	Santander	0.043	0.045	0.458	0.150	0.041	0.040	0.224	1.000
D_22	Sucre	0.111	0.007	0.137	0.079	0.048	0.201	0.418	1.000
D_23	Tolima	0.110	0.098	0.168	0.092	0.048	0.121	0.363	1.000
D_24	Valle	0.041	0.002	0.295	0.067	0.063	0.074	0.458	1.000
D_25	Amazonas	0.097	0.002	0.037	0.037	0.085	0.303	0.439	1.000
D_26	Arauca	0.158	0.554	0.031	0.039	0.012	0.080	0.127	1.000
D_27	Casanare	0.090	0.629	0.040	0.063	0.032	0.039	0.106	1.000
D_28	Guainía	0.040	0.026	0.034	0.123	0.017	0.372	0.386	1.000
D_29	Guaviare	0.049	0.003	0.039	0.153	0.035	0.318	0.404	1.000
D_30	Putumayo	0.039	0.489	0.028	0.024	0.017	0.162	0.242	1.000
D_31	San Andrés y Providencia	0.010	0.001	0.022	0.030	0.157	0.154	0.626	1.000
D_32	Vaupés	0.029	0.004	0.011	0.098	0.054	0.332	0.473	1.000
D_33	Vichada	0.071	0.002	0.020	0.119	0.028	0.361	0.398	1.000
	TOTAL	0.051	0.081	0.229	0.095	0.053	0.083	0.406	1.000

Source: calculations by the authors.

Table 6. Location Quotients: Colombia, 2012

		AGR	MNE	IND	CNT	TRN	ADP	OTS
D_1	Antioquia	0.939	0.330	1.088	1.065	0.974	0.755	1.130
D_2	Atlántico	0.343	0.028	1.137	1.012	1.525	0.828	1.163
D_3	Bogotá D. C.	0.001	0.024	0.816	0.866	1.062	1.079	1.431
D_4	Bolívar	0.733	0.349	1.889	1.110	1.191	0.796	0.653
D_5	Boyacá	2.289	1.334	1.054	0.906	1.165	0.969	0.747
D_6	Caldas	1.634	0.116	0.990	1.175	0.977	1.176	1.028
D_7	Caquetá	2.456	0.047	0.271	1.814	0.570	3.208	0.833
D_8	Cauca	1.407	0.231	1.250	1.141	0.431	1.602	0.880
D_9	Cesar	1.637	4.711	0.280	0.758	0.975	1.024	0.641
D_10	Chocó	2.054	4.348	0.106	0.551	0.281	2.466	0.604
D_11	Córdoba	2.513	1.240	0.264	1.161	0.920	1.557	1.036
D_12	Cundinamarca	1.989	0.107	1.576	0.851	0.811	0.924	0.804
D_13	La Guajira	0.778	6.422	0.087	0.476	0.567	1.308	0.578
D_14	Huila	1.904	1.563	0.308	2.303	1.766	1.247	0.707
D_15	Magdalena	2.583	0.037	0.432	1.305	1.450	1.548	1.071
D_16	Meta	1.243	7.488	0.205	0.892	0.566	0.540	0.300
D_17	Nariño	2.413	0.229	0.399	1.104	0.831	2.038	1.101
D_18	Norte Santander	1.695	0.483	0.608	0.790	1.268	1.543	1.140
D_19	Quindío	2.345	0.064	0.513	2.022	0.914	1.350	0.992
D_20	Risaralda	1.394	0.044	1.021	1.008	1.214	1.131	1.073
D_21	Santander	0.835	0.550	1.997	1.569	0.767	0.483	0.551
D_22	Sucre	2.166	0.081	0.597	0.826	0.904	2.421	1.027
D_23	Tolima	2.157	1.212	0.730	0.959	0.905	1.458	0.893
D_24	Valle	0.810	0.026	1.287	0.700	1.176	0.891	1.126
D_25	Amazonas	1.903	0.020	0.160	0.387	1.598	3.647	1.080
D_26	Arauca	3.086	6.826	0.135	0.414	0.220	0.960	0.312
D_27	Casanare	1.765	7.759	0.174	0.658	0.602	0.473	0.261
D_28	Guainía	0.782	0.326	0.150	1.293	0.321	4.481	0.950
D_29	Guaviare	0.959	0.032	0.168	1.602	0.650	3.825	0.995
D_30	Putumayo	0.766	6.027	0.120	0.253	0.313	1.946	0.595
D_31	San Andrés y Providencia	0.203	0.009	0.094	0.315	2.943	1.856	1.539
D_32	Vaupés	0.563	0.054	0.047	1.026	1.003	3.994	1.163
D_33	Vichada	1.391	0.026	0.089	1.250	0.530	4.341	0.979

Source: calculations by the authors.

3.2. Interregional linkages

The indicators described above are based on interdependence ratios of the IIOM-COL, 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:

$$x = Ax + f \tag{4}$$

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

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,…, 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:

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

and

$$\begin{aligned} x^1 &= B^{11}f^1 + \cdots + B^{1R}f^R \\ &\vdots \\ x^R &= B^{R1}f^1 + \cdots + B^{RR}f^R \end{aligned} \tag{7}$$

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

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

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

$$x^1 = B^{11}(v^{11} + \cdots + v^{R1} + e^1) + \cdots + B^{1R}(v^{1R} + \cdots + v^{RR} + e^R)$$
$$\vdots$$
$$x^R = B^{R1}(v^{11} + \cdots + v^{R1} + e^1) + \cdots + B^{RR}(v^{1R} + \cdots + v^{RR} + e^R) \qquad (8)$$

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 originating 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 33 regions in Colombia 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. Amazonas, Antioquia, Valle and Bogotá D.C. are the most self-sufficient regions; the average flow-on effects from a unit change in sectoral final demand is in excess of 83%. The average net effect exceeds 50% for these same regions. For some regions, such as Chocó, Caquetá, Quindío, La Guajira, Córdoba and Cundinamarca, 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: Colombia, 2012

		Total output multiplier		Net output multiplier	
		Intra-regional share	Interregional share	Intra-regional share	Interregional share
D_1	Antioquia	87.9	12.1	64.5	35.5
D_2	Atlántico	82.4	17.6	47.6	52.4
D_3	Bogotá D.C.	83.6	16.4	52.0	48.0
D_4	Bolívar	82.7	17.3	48.6	51.4
D_5	Boyacá	81.4	18.6	45.4	54.6
D_6	Caldas	78.8	21.2	37.7	62.3
D_7	Caquetá	73.8	26.2	23.6	76.4
D_8	Caucá	80.1	19.9	41.2	58.8
D_9	Cesar	76.3	23.7	30.0	70.0
D_10	Chocó	73.2	26.8	20.4	79.6
D_11	Córdoba	75.9	24.1	28.3	71.7
D_12	Cundinamarca	76.6	23.4	31.4	68.6
D_13	La Guajira	75.1	24.9	26.0	74.0
D_14	Huila	77.9	22.1	35.1	64.9
D_15	Magdalena	78.3	21.7	35.4	64.6
D_16	Meta	79.8	20.2	40.8	59.2
D_17	Nariño	79.7	20.3	40.3	59.7
D_18	Norte Santander	79.2	20.8	38.5	61.5
D_19	Quindío	74.7	25.3	25.3	74.7
D_20	Risaralda	77.9	22.1	35.0	65.0
D_21	Santander	82.1	17.9	47.6	52.4
D_22	Sucre	77.4	22.6	32.7	67.3
D_23	Tolima	78.2	21.8	35.8	64.2
D_24	Valle	87.2	12.8	62.3	37.7
D_25	Amazonas	84.9	15.1	55.7	44.3
D_26	Arauca	79.5	20.5	40.0	60.0
D_27	Casanare	79.5	20.5	40.0	60.0
D_28	Guanía	81.7	18.3	46.1	53.9
D_29	Guaviare	78.7	21.3	37.8	62.2
D_30	Putumayo	78.2	21.8	36.0	64.0
D_31	San Andrés y Providencia	81.2	18.8	46.0	54.0
D_32	Vaupés	81.5	18.5	45.4	54.6
D_33	Vichada	82.1	17.9	47.4	52.6

Source: calculations by the authors.

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 33 domestic and the foreign regions (Sonis et al., 1996).

According to equation (8), regional output (for each region) was decomposed, and the contributions of the components of final demand from different areas were calculated. The results are presented in Table 8. On 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 those Departamentos that present higher dependency upon the rest of the world. The demand for foreign exports is very relevant not only for the oil exporters but also for other resource-based economies. Its contribution to the regional outuput is frequently above 40% (13.6% for the country as a whole), as is the case of Cesar (44.5%), La Guajira (55.8%), Meta (54.2%), Arauca (51.1%), and Casanare (57.3%). There are also some cases of stronger depenceny upon the rest of the country, as it is the case of the dependency of Cundinamarca on Bogotá's demand.

A more systematic approach to look at the influence of final demand from different areas is to map the column original estimates that generated 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 Colombia. The maps are in standard deviation from the mean.

Moreover, one can also look at the data that originated Table 8 from a row perspective. That is, one may be interested in evaluating the main sources of domestic demand that affect the output of a specific region. The results are illustrated in Figure 4.

Table 8. Components of Decomposition of Regional Output Based on the Sources of Final Demand: Colombia, 2012 (in %)

REGIONAL OUTPUT	ORIGIN OF FINAL DEMAND																																	
	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_10	D_11	D_12	D_13	D_14	D_15	D_16	D_17	D_18	D_19	D_20	D_21	D_22	D_23	D_24	D_25	D_26	D_27	D_28	D_29	D_30	D_31	D_32	D_33	ROW
D_1	63.6	1.4	4.1	2.0	0.3	0.4	0.2	0.3	0.5	0.6	7.0	0.5	0.7	0.3	0.4	0.5	0.5	0.6	0.2	0.4	2.0	1.5	0.3	1.7	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	9.7
D_2	4.2	51.2	2.7	11.3	0.2	0.1	0.1	0.2	0.8	0.2	0.4	0.3	3.5	0.2	9.6	0.3	0.3	0.7	0.1	0.1	1.7	1.8	0.2	0.7	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	9.0
D_3	1.5	0.3	64.6	0.2	2.1	0.8	0.6	0.4	0.5	0.4	0.1	7.3	0.3	1.4	0.1	1.9	0.6	0.9	0.6	0.7	2.8	0.2	2.0	2.3	0.0	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	6.8
D_4	9.6	15.2	3.0	38.0	0.3	0.2	0.1	0.2	0.6	0.3	0.9	0.3	2.1	0.2	3.0	0.3	0.4	0.7	0.1	0.2	1.6	3.2	0.2	1.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	17.9
D_5	1.8	0.5	24.7	0.3	41.2	0.4	0.3	0.3	0.6	0.3	0.2	3.5	0.4	0.7	0.2	1.0	0.4	1.3	0.3	0.3	2.9	0.2	0.7	1.7	0.0	0.2	1.3	0.0	0.0	0.0	0.1	0.0	0.0	14.1
D_6	1.9	0.3	9.2	0.2	0.3	51.9	0.2	0.5	0.3	0.8	0.1	1.2	0.2	0.6	0.1	0.5	0.6	0.4	2.4	13.5	1.6	0.2	1.5	3.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	7.5
D_7	1.1	0.5	7.0	0.2	0.3	0.3	71.2	1.8	0.2	0.3	0.1	1.1	0.2	1.9	0.2	0.5	4.2	0.4	0.2	0.3	0.9	0.1	0.7	3.9	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	1.9
D_8	1.9	0.3	7.3	0.3	0.3	0.6	1.9	52.8	0.2	0.6	0.2	0.8	0.2	2.4	0.1	0.6	7.1	0.4	0.7	0.9	1.1	0.2	0.9	12.7	0.0	0.0	0.1	0.0	0.0	0.2	0.1	0.0	0.0	5.2
D_9	1.8	1.4	4.2	0.7	0.4	0.2	0.1	0.2	31.1	0.2	0.2	0.5	0.9	0.2	0.6	0.3	0.2	2.3	0.1	0.2	7.5	0.6	0.3	0.9	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	44.5
D_10	6.7	1.5	11.9	1.4	0.6	1.7	0.4	1.1	0.8	42.9	0.9	1.6	0.5	0.7	0.5	0.8	1.0	1.0	1.1	1.9	2.9	0.6	1.0	7.4	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	8.3
D_11	37.9	1.2	2.8	1.6	0.2	0.2	0.1	0.2	0.3	0.3	43.4	0.3	0.4	0.2	0.4	0.3	0.3	0.3	0.1	0.2	1.0	1.4	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7
D_12	1.2	0.3	43.1	0.2	1.4	0.5	0.3	0.3	0.3	0.3	0.1	33.3	0.2	1.0	0.1	1.2	0.4	0.5	0.4	0.5	1.6	0.1	1.4	1.9	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.0	0.0	9.0
D_13	0.9	2.2	2.5	1.0	0.1	0.1	0.0	0.1	0.4	0.1	0.1	0.2	32.5	0.1	1.7	0.2	0.1	0.3	0.0	0.1	0.8	0.3	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.8
D_14	1.5	0.8	15.5	0.3	0.5	0.7	1.7	2.9	0.4	0.6	0.2	2.7	0.5	42.4	0.3	0.7	2.3	0.7	0.6	1.1	1.4	0.3	2.7	5.4	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	13.6
D_15	2.2	17.5	3.4	3.6	0.2	0.1	0.1	0.1	0.7	0.1	0.2	0.3	5.0	0.1	52.2	0.3	0.2	0.5	0.1	0.1	1.4	0.8	0.1	0.5	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	10.1
D_16	1.7	0.8	10.4	0.5	0.5	0.4	0.2	0.4	0.3	0.3	0.2	2.2	0.4	0.5	0.3	20.0	0.5	0.6	0.3	0.4	1.2	0.3	0.7	2.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	54.2
D_17	1.5	0.4	5.9	0.3	0.3	0.4	2.3	3.3	0.2	0.3	0.1	0.7	0.2	1.0	0.1	0.5	68.4	0.3	0.3	0.4	1.0	0.2	0.5	5.5	0.0	0.0	0.1	0.0	0.0	1.5	0.1	0.0	0.0	4.3
D_18	1.9	1.0	6.5	0.6	0.8	0.3	0.2	0.2	2.3	0.3	0.2	0.8	0.8	0.3	0.4	0.5	0.3	62.5	0.1	0.2	7.3	0.4	0.4	1.3	0.0	0.3	0.2	0.0	0.0	0.0	0.1	0.0	0.0	9.5
D_19	1.2	0.2	7.9	0.2	0.3	2.8	0.3	0.7	0.2	0.7	0.1	1.1	0.1	0.7	0.1	0.4	0.6	0.3	55.7	9.9	1.0	0.1	4.6	6.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	4.4
D_20	1.5	0.2	7.1	0.2	0.3	12.7	0.3	0.6	0.2	0.9	0.1	0.9	0.2	0.6	0.1	0.4	0.6	0.3	7.6	50.9	1.2	0.1	2.6	5.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	5.0
D_21	6.2	2.7	14.2	1.2	1.5	1.0	0.5	0.6	5.9	1.1	0.5	2.0	2.0	1.1	1.1	1.1	1.0	6.7	0.5	0.9	31.8	1.2	1.3	3.9	0.0	0.3	0.3	0.0	0.1	0.0	0.2	0.0	0.0	9.2
D_22	8.9	4.8	4.4	6.3	0.3	0.2	0.1	0.2	1.0	0.3	1.2	0.4	1.1	0.2	1.2	0.3	0.3	0.7	0.1	0.2	1.8	60.8	0.2	1.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	4.1
D_23	1.4	0.3	19.2	0.2	0.6	1.3	0.4	0.6	0.3	0.3	0.1	2.7	0.2	1.6	0.1	0.7	0.6	0.5	2.9	2.3	1.8	0.2	45.7	4.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	11.3
D_24	3.0	0.4	10.0	0.4	0.5	1.3	1.0	3.5	0.4	1.1	0.2	1.2	0.3	1.2	0.2	0.9	3.1	0.6	1.8	1.9	1.9	0.2	1.7	55.9	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	6.7
D_25	1.0	0.3	3.4	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.4	0.2	0.1	0.1	0.5	0.4	0.3	0.1	0.1	0.7	0.1	0.2	0.9	80.8	0.1	0.1	0.0	0.0	0.0	7.2	0.0	0.0	1.6
D_26	2.6	1.3	8.5	1.0	1.1	0.3	0.2	0.3	0.7	0.2	0.3	1.5	0.5	0.4	0.5	0.6	0.4	2.4	0.2	0.3	3.4	0.4	0.5	1.8	0.0	18.9	0.3	0.0	0.0	0.0	0.1	0.0	0.0	51.1
D_27	1.8	1.0	10.5	0.6	3.5	0.3	0.2	0.3	0.5	0.3	0.2	2.0	0.5	0.4	0.4	0.8	0.4	1.3	0.2	0.3	1.8	0.3	0.6	1.9	0.0	0.1	12.2	0.0	0.0	0.0	0.0	0.0	0.0	57.3
D_28	0.9	0.8	6.8	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.7	0.5	0.2	0.3	1.5	0.4	0.4	0.1	0.2	0.5	0.3	0.3	1.7	0.0	0.0	0.1	80.9	0.1	0.0	0.1	0.0	0.0	1.6
D_29	1.0	0.9	9.9	0.3	0.4	0.3	0.1	0.4	0.2	0.4	0.2	1.8	0.4	0.3	0.3	0.8	0.6	0.8	0.2	0.4	0.9	0.4	0.6	2.5	0.0	0.0	0.1	0.0	74.6	0.0	0.0	0.0	0.0	1.2
D_30	1.4	0.3	5.3	0.3	0.2	0.3	1.5	1.1	0.2	0.2	0.2	0.7	0.1	0.8	0.1	0.6	10.6	0.3	0.2	0.3	0.7	0.1	0.4	3.5	0.0	0.0	0.0	0.0	0.0	26.8	0.0	0.0	0.0	43.5
D_31	1.2	0.3	3.6	0.2	0.2	0.2	0.4	0.4	0.3	0.3	0.1	0.4	0.4	0.2	0.1	0.9	0.8	0.4	0.1	0.1	1.0	0.1	0.2	1.1	1.0	0.1	0.1	0.1	0.0	0.0	83.3	0.0	0.0	2.3
D_32	0.4	0.1	10.8	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.0	0.6	0.1	0.1	0.1	2.2	0.2	0.2	0.1	0.1	0.5	0.1	0.2	0.7	0.0	0.1	0.1	0.0	0.1	0.0	0.1	81.3	0.0	0.8
D_33	1.8	1.2	7.9	0.5	0.5	0.2	0.2	0.3	0.3	0.4	0.2	1.1	0.7	0.3	0.4	1.3	0.6	0.9	0.1	0.3	1.1	0.4	0.4	2.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	75.1	1.3
COLOMBIA	11.4	3.7	23.4	2.9	2.2	1.6	0.8	1.6	1.6	0.7	1.9	4.4	1.2	1.6	1.5	1.9	2.0	2.2	1.1	1.7	4.6	1.2	2.1	7.6	0.1	0.2	0.4	0.0	0.1	0.2	0.2	0.0	0.1	13.6

Source: calculations by the authors.

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

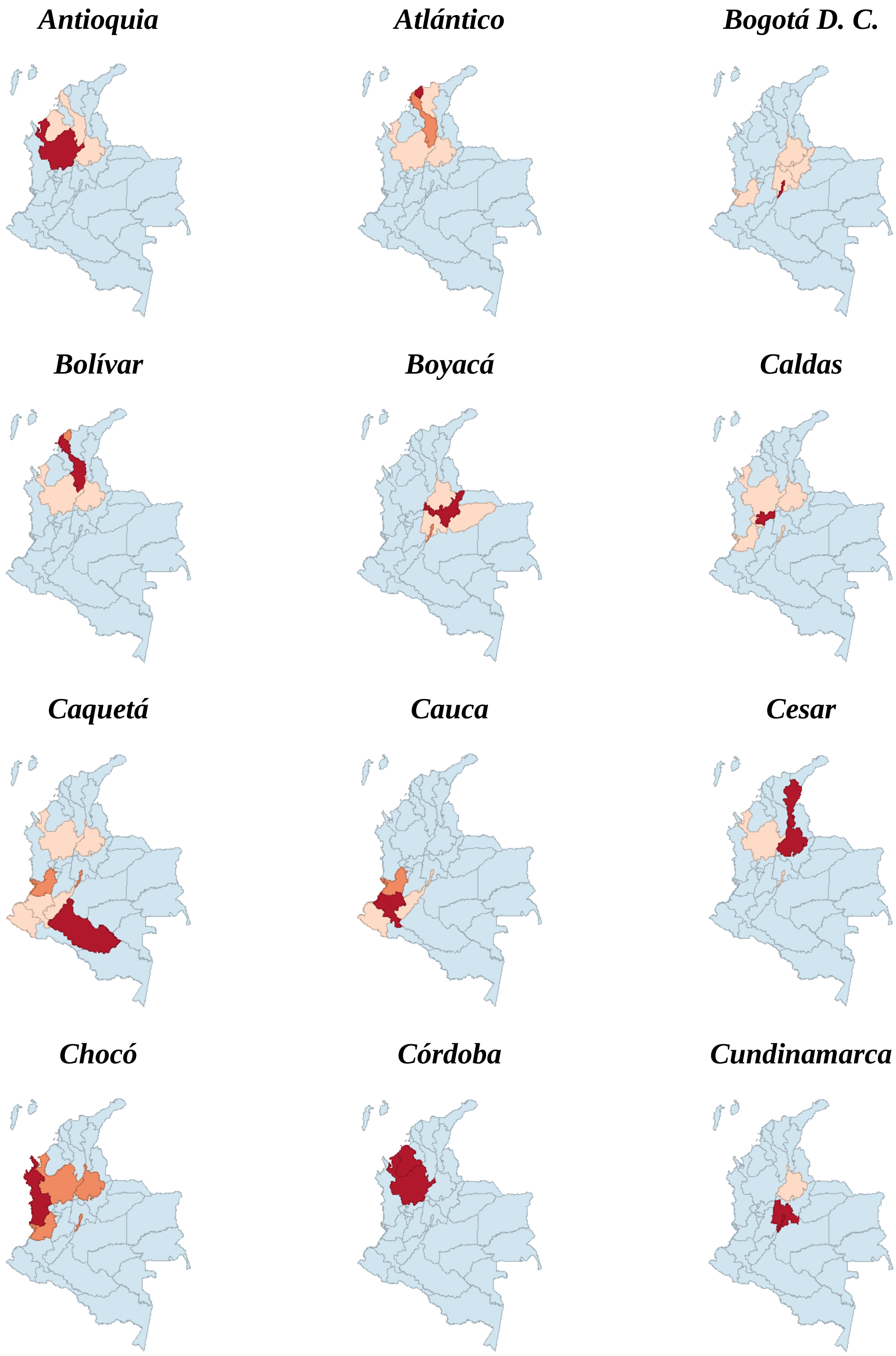


Figure 3. Identification of Regions Relatively More Affected by a Specific Regional Demand, by Origin of Final Demand (cont.)

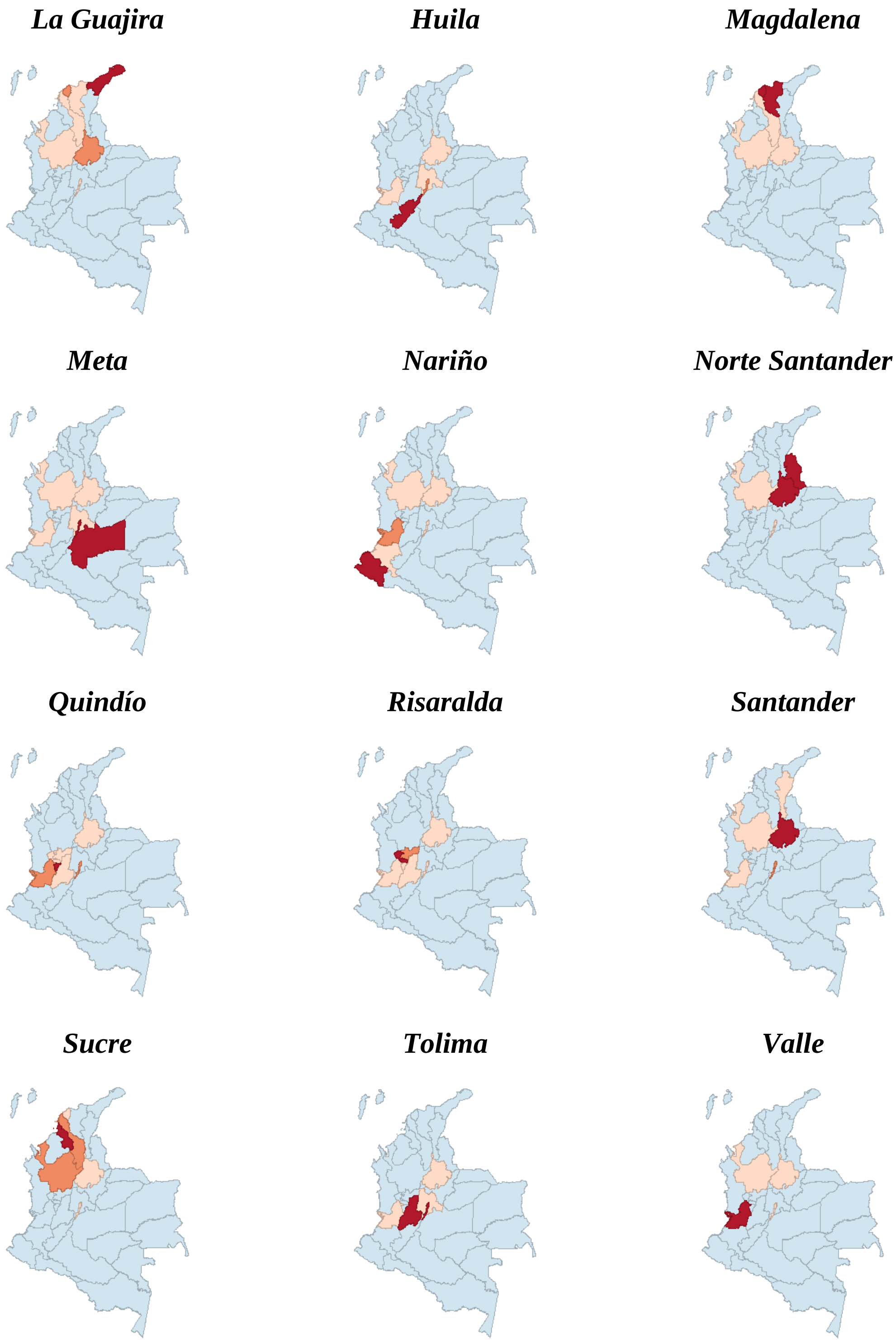


Figure 3. Identification of Regions Relatively More Affected by a Specific Regional Demand, by Origin of Final Demand (cont.)

Amazonas

Arauca

Casanare

Guainía

Guaviare

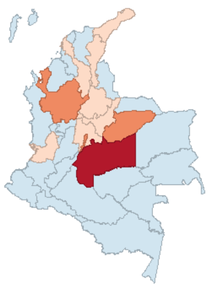
Putumayo

San Andrés y Providencia

Vaupés

Vichada

Rest of the World



Source: calculations by the authors.

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

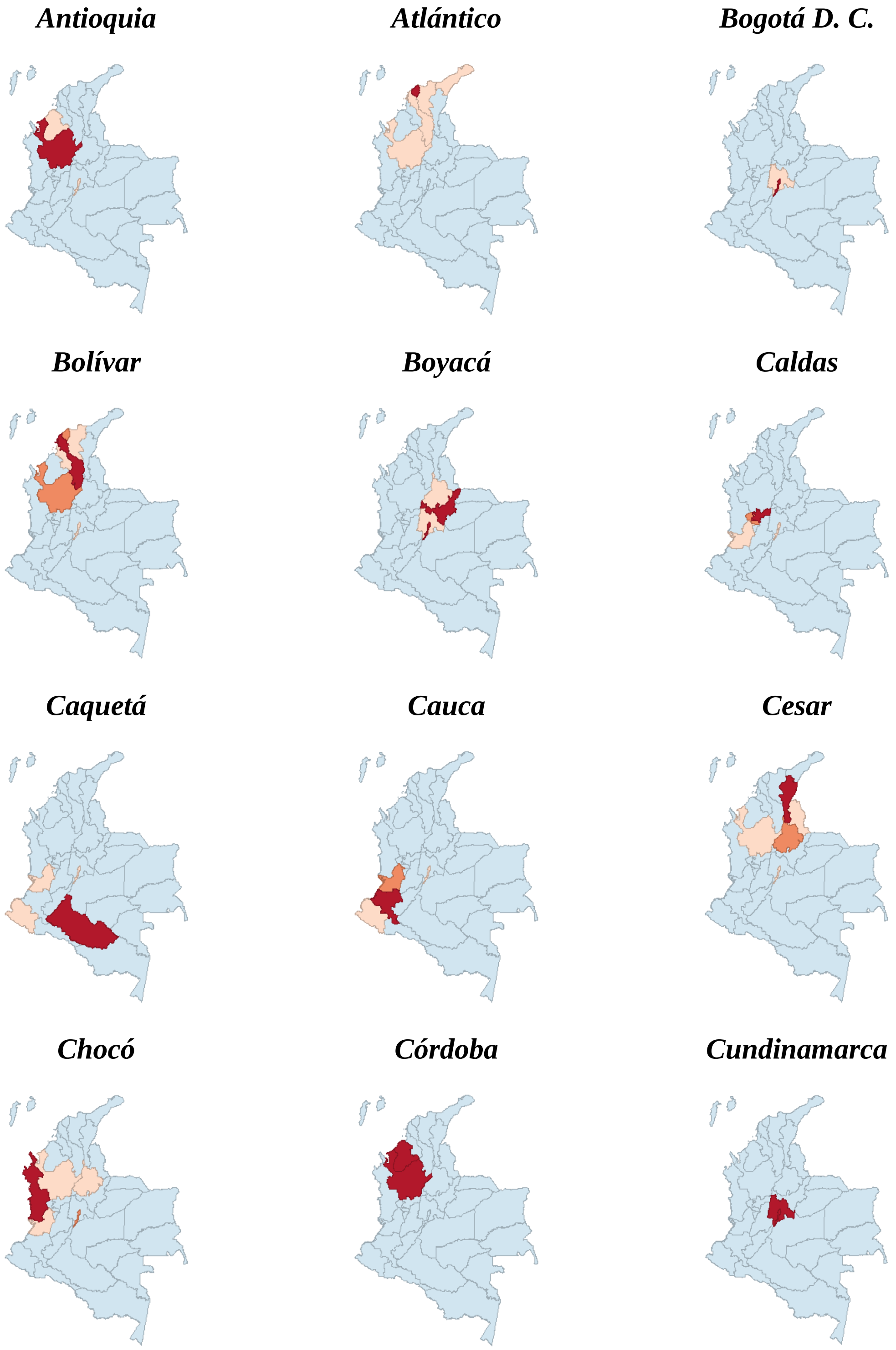


Figure 4. Identification of Regions whose Demands Affect Relatively More a Specific Regional Output, by Regional Output (cont.)

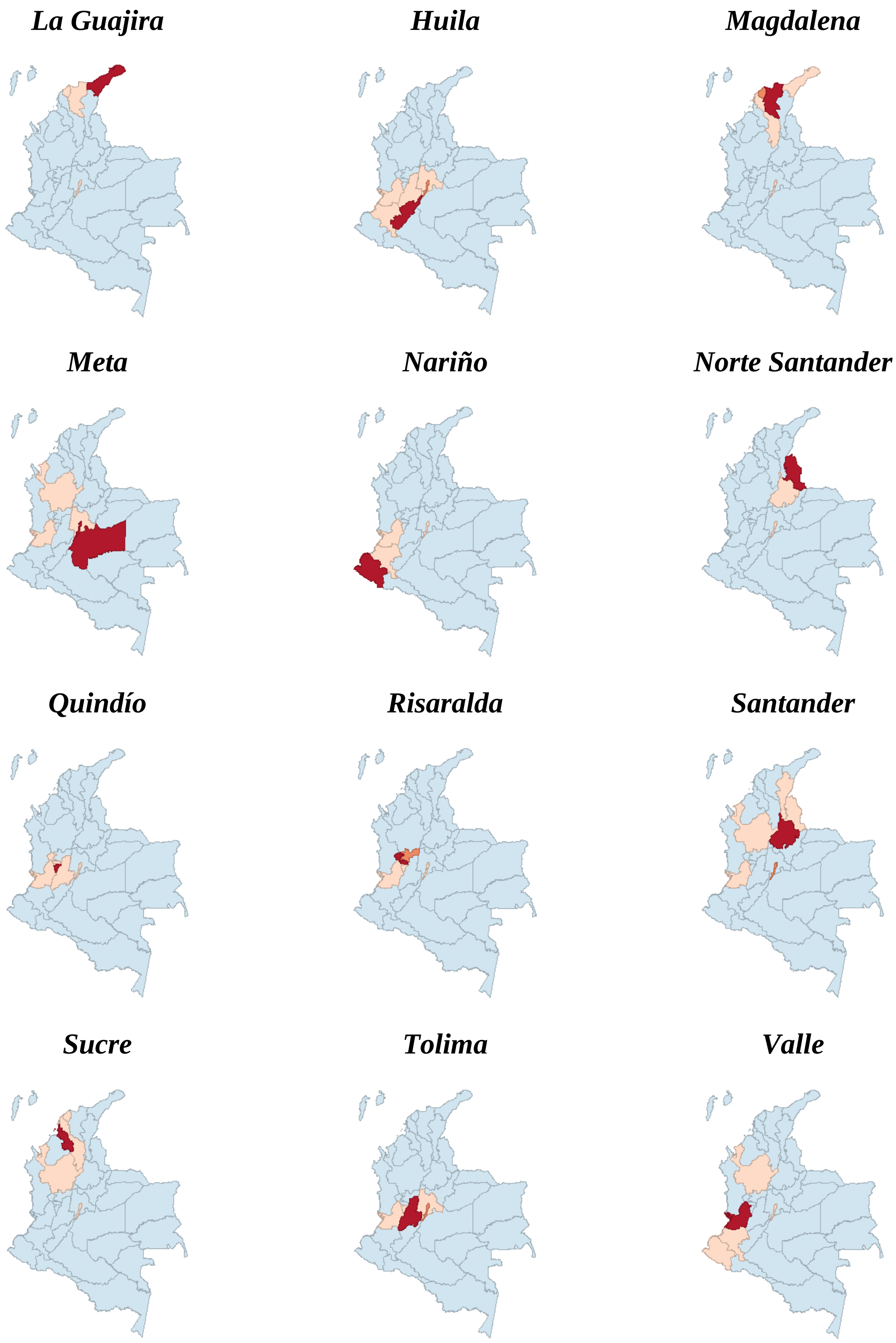
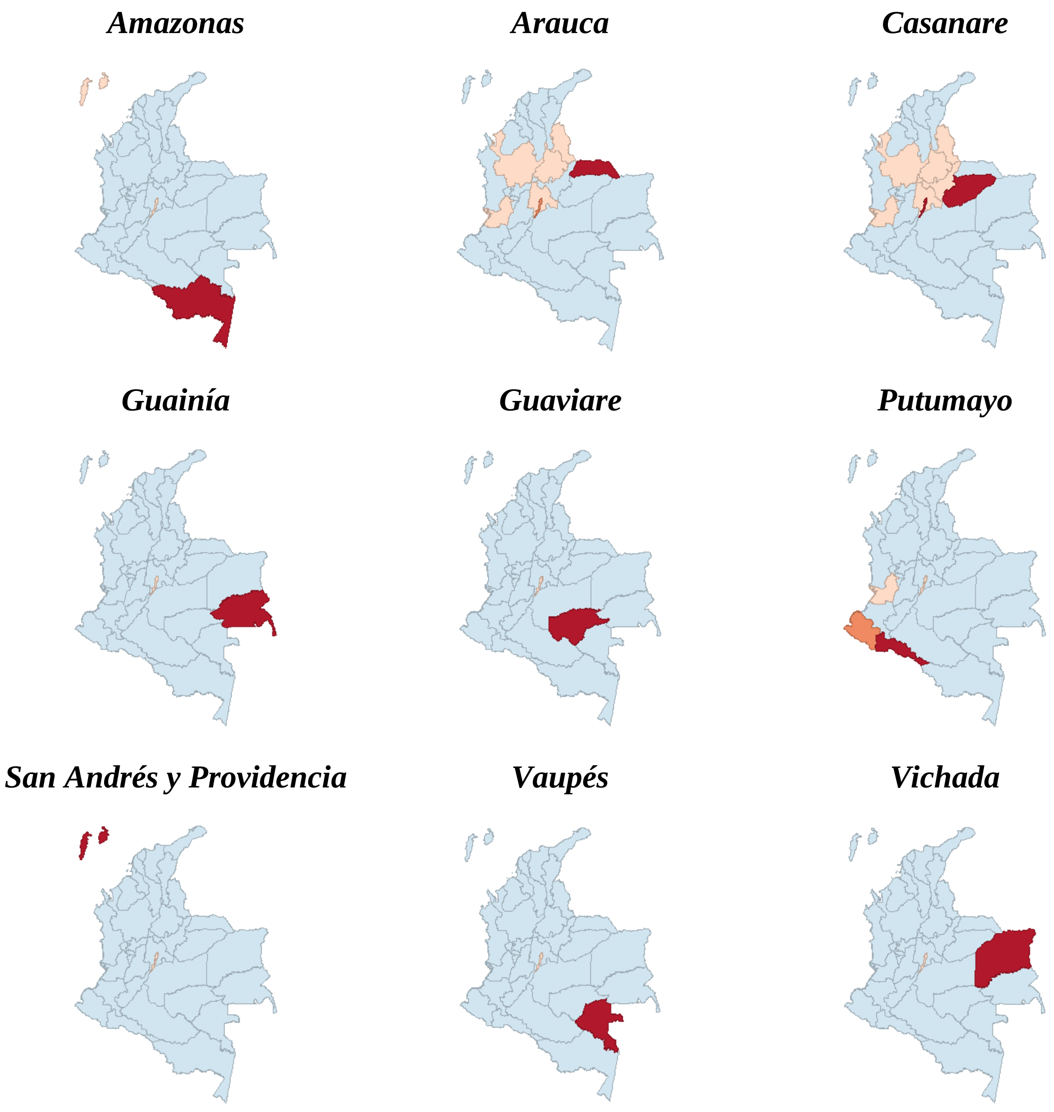


Figure 4. Identification of Regions whose Demands Affect Relatively More a Specific Regional Output, by Regional Output (cont.)



Source: calculations by the authors.

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 Colombia (IIOM-COL). The understanding of the functioning of the Colombian regional economies within an integrated system is one of the main goals of the joint project involving NEREUS and Fipe, in Brazil, and he Centro de Estudios Económicos Regionales from the Banco de la República, in Colombia. 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 similirarities that exist among the departamentos in Colombia.

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

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Technical Appendix

In this appendix, the methodology used to generate the interregional input-output system for Colombia is provided. The description is organized around the TABLO Input file, used for data manipulation in GEMPACK.[3] As the final goal of the project is to re-calibrate an interregional CGE model for the country – the CEER model – to be impleneted using GEMPACK, the choice of the language for the code for generating the IIOM-COL matrix was straightforward. Attention is directed to the different steps undertaken and their underlying assumptions. We present the complete text of the TABLO Input file divided into a sequence of excerpts and supplemented by tables and explanatory text. The presentation draws on the document "ORANI-G: A Generic Single-Country Computable General Equilibrium Model", by **Mark Horridge**, March 2006.

A1. Dimensions of the IIOM-COL

Excerpt 1 of the TABLO Input file begins by defining logical names for input and output files. Initial data are stored in the BDATA input file. The RIODATA output file is used to store results for the manipulation of the initial information. Note that BDATA and RIODATA are logical names. The actual locations of these files (disk, folder, filename) are chosen by the user.

The rest of Excerpt 1 defines sets: lists of descriptors for the components of vector coefficients. Set names appear in upper-case characters. For example, the first Set statement is to be read as defining a set named 'COM' which contains commodity descriptors. The elements of COM (a list of commodity names) are read from the input file REGSETS (this allows the model to use databases with different numbers of sectors). By contrast the two elements of the set SRC – dom and imp – are listed explicitly.

```
! Excerpt 1 of TABLO input file: !
! Files and sets !
```

[3] The TABLO language is essentially conventional algebra, with names for variables and coefficients chosen to be suggestive of their economic interpretations. It is no more complex than alternative means of setting out a CGE model and undertaking calculations from an original set of data.

```
FILE BDATA # Data File #;
FILE(NEW) RIODATA # Regional IO data #;
FILE REGSETS # Sets file #;

SET
COM # Commodities #
READ ELEMENTS FROM FILE REGSETS HEADER "COM";
MARGCOM # Margin Commodities #
READ ELEMENTS FROM FILE REGSETS HEADER "MAR";
SUBSET MARGCOM IS SUBSET OF COM;
SET
MARGCOM1 # Margin Commodity 1 #
READ ELEMENTS FROM FILE REGSETS HEADER "MAR1";
MARGCOM2 # Margin Commodity 2 #
READ ELEMENTS FROM FILE REGSETS HEADER "MAR2";
SUBSET MARGCOM1 IS SUBSET OF COM;
SUBSET MARGCOM2 IS SUBSET OF COM;
SUBSET MARGCOM1 IS SUBSET OF MARGCOM;
SUBSET MARGCOM2 IS SUBSET OF MARGCOM;
SET
NONMARGCOM # NonMargin Commodities #
READ ELEMENTS FROM FILE REGSETS HEADER "NMAR";
SUBSET NONMARGCOM IS SUBSET OF COM;
SET
SRC # Source of Commodities # (dom,imp);
IND # Industries #
READ ELEMENTS FROM FILE REGSETS HEADER "IND";
REGDEST # Regional destinations #
READ ELEMENTS FROM FILE REGSETS HEADER "REG";
ALLSOURCE # Origin of goods #
READ ELEMENTS FROM FILE REGSETS HEADER "ASRC";
REGSOURCE # Domestic origin of goods #
READ ELEMENTS FROM FILE REGSETS HEADER "REG";
SUBSET REGSOURCE IS SUBSET OF ALLSOURCE;
SUBSET REGSOURCE IS SUBSET OF REGDEST;
SUBSET REGDEST IS SUBSET OF REGSOURCE;
```

The commodity and industry classifications of the IIOM-COL described here are based on aggregates of the classifications used in the national IO tables published by DANE, which considers 61 industries and 61 commodities. We were constrained by availability of regional information at the sectoral level, ending up with 7 sectors/commodities. Multiproduction is not considered in the 33 domestic regions of the system, since we have built the national absorption matrix based on the sector by sector approach.

Table A1 lists the elements of the set COM which are read from file. GEMPACK uses the element names to label the rows and columns of results and data tables. The element names cannot be more than 12 letters long, nor contain spaces. The IND elements are presented in Table A2 and the ALLSOURCE elements in Table A3.

Elements of the set MARGCOM are margins commodities, i.e., they are required to facilitate the flows of other commodities from producers (or importers) to users. Hence, the costs of margins services, together with indirect taxes, account for differences between basic prices (received by producers or importers) and purchasers' prices (paid by users). In the IIOM-COL system, we considered two commodities as margin, namely "TRN" and "OTS".

TABLO does not prevent elements of two sets from sharing the same name; nor, in such a case, does it automatically infer any connection between the corresponding elements. The Subset statement which follows the definition of the set MARGCOM is required for TABLO to realize that the two elements of MARGCOM, "TRN" and "OTS", are the same as the elements of the set COM.

The statement for NONMARGCOM defines that set as a complement. That is, NONMARGCOM consists of all those elements of COM which are not in MARGCOM. In this case TABLO is able to deduce that NONMARGCOM must be a subset of COM.

Table A1. Commodity Classification

Elements of Set COM	Description	Commodities from DANE
AGR	Agriculture	
MNE	Mining	
IND	Manufaturing	
CNT	Construction	
TRN	Transportation	
ADP	Public Administration	
OTS	Other Services	

Table A2. Industry Classification

Elements of Set IND	Description	Sectors from DANE
AGR	Agriculture	
MNE	Mining	
IND	Manufaturing	
CNT	Construction	
TRN	Transportation	
ADP	Public Administration	
OTS	Other Services	

Table A3. Regional Classification

Elements of Set ALLSOURCE	Description
D_1	Antioquia
D_2	Atlántico
D_3	Bogotá D. C.
D_4	Bolívar
D_5	Boyacá
D_6	Caldas
D_7	Caquetá
D_8	Cauca
D_9	Cesar
D_10	Chocó
D_11	Córdoba
D_12	Cundinamarca
D_13	La Guajira
D_14	Huila
D_15	Magdalena
D_16	Meta
D_17	Nariño
D_18	Norte Santander
D_19	Quindío
D_20	Risaralda
D_21	Santander
D_22	Sucre
D_23	Tolima
D_24	Valle
D_25	Amazonas
D_26	Arauca
D_27	Casanare
D_28	Guainía
D_29	Guaviare
D_30	Putumayo
D_31	San Andrés y Providencia
D_32	Vaupés
D_33	Vichada
Foreign	Imports

A2. Initial Data

The next excerpts of the TABLO file contains statements indicating data to be read from file. The data items defined in these statements appear as coefficients in the initial database. The statements define coefficient names (which all appear in upper-case characters), and the locations from which the data are to be read.

A2.1. National input-output data

This excerpt groups the data according to the information contained in the national input-output system organized as illustrated in Figure A1. Thus, Excerpt 2 begins by defining coefficients representing the basic commodity flows corresponding to the flows of Figure A1 for each user except exports and inventories, i.e., the basic flow matrices for intermediate consumption, investment demand, household consumption and government consumption, and the associatred margins and indirect taxes flows. Preceding the coefficient names are their dimensions, indicated using the "all" qualifier, and the sets defined in Excerpt 1. For example, the first 'COEFFICIENT' statement defines a data item LABAS(c,i) which is the basic value of a flow of intermediate inputs of commodity c to user industry i, aggregated by source (domestic and imported). The first 'READ' statement indicates that this data item is stored on file BDATA with header 'ABAS'. (A GEMPACK data file consists of a number of data items such as arrays of real numbers. Each data item is identified by a unique key or 'header').

Figure A1. Structure of the National Flows Database

			Intermediate consumption	Investment demand	Household consumption	Exports	Government consumption
		Dim.	1 2 … 7	1 2 … 7	1	1	1
Basic flows	Domestic	1 2 … 7	LABAS (DOM)	LIBAS (DOM)	LCBAS (DOM)	LXBAS (DOM)	LGBAS (DOM)
	Imported	1 2 … 7	LABAS (IMP)	LIBAS (IMP)	LCBAS (IMP)	LXBAS (IMP)	LGBAS (IMP)
Trade Margins	Domestic	1 2 … 7	LAMR1 (DOM)	LIMR1 (DOM)	LCMR1 (DOM)	LXMR1 (DOM)	LGMR1 (DOM)
	Imported	1 2 … 7	LAMR1 (IMP)	LIMR1 (IMP)	LCMR1 (IMP)	LXMR1 (IMP)	LGMR1 (IMP)
Transport Margins	Domestic	1 2 … 7	LAMR2 (DOM)	LIMR2 (DOM)	LCMR2 (DOM)	LXMR2 (DOM)	LGMR2 (DOM)
	Imported	1 2 … 7	LAMR2 (IMP)	LIMR2 (IMP)	LCMR2 (IMP)	LXMR2 (IMP)	LGMR2 (IMP)
Indirect taxes	Domestic	1 2 … 7	LATX1 (DOM)	LITX1 (DOM)	LCTX1 (DOM)	LXTX1 (DOM)	LGTX1 (DOM)
	Imported	1 2 … 7	LATX1 (IMP)	LITX1 (IMP)	LCTX1 (IMP)	LXTX1 (IMP)	LGTX1 (IMP)
	Labor payments		LABR	0	0	0	0
	Capital payments		CPTL	0	0	0	0
	Other costs		OCTS	0	0	0	0
	Total		MAKE_I	ITOT	CTOT	XTOT	GTOT

```
! Excerpt 2 of TABLO input file: !
! Initial data !


COEFFICIENT
(all,c,COM)(all,i,IND)
LABAS(c,i) # Technical level matrix - national #;
(all,c,COM)(all,i,IND)
LIBAS(c,i) # Investnent level matrix - national #;
(all,c,COM)
LCBAS(c) # Consumption level matrix - national #;
(all,c,COM)
LGBAS(c) # Government level matrix - national #;
(all,c,COM)(all,i,IND)
LAMR1(c,i) # MAR1 1 level matrix - national #;
(all,c,COM)(all,i,IND)
LIMR1(c,i) # MAR2 1 level matrix - national #;
(all,c,COM)
LCMR1(c) # MAR3 1 level matrix - national #;
```

```
(all,c,COM)
LGMR1(c) # MAR5 1 level matrix - national #;
(all,c,COM)(all,i,IND)
LAMR2(c,i) # MAR1 2 level matrix - national #;
(all,c,COM)(all,i,IND)
LIMR2(c,i) # MAR2 2 level matrix - national #;
(all,c,COM)
LCMR2(c) # MAR3 2 level matrix - national #;
(all,c,COM)
LGMR2(c) # MAR5 2 level matrix - national #;
(all,c,COM)(all,i,IND)
LATX1(c,i) # TAX1 1 level matrix - national #;
(all,c,COM)(all,i,IND)
LITX1(c,i) # TAX2 1 level matrix - national #;
(all,c,COM)
LCTX1(c) # TAX3 1 level matrix - national #;
(all,c,COM)
LGTX1(c) # TAX5 1 level matrix - national #;
(all,i,IND)
CITO(i) # Total intermediate consumption - national #;
CTOT # Total household consumption - national #;
ITOT # Total investment demand - national #;
GTOT # Total government demand - national #;

READ
LABAS FROM FILE BDATA HEADER "ABAS";
LIBAS FROM FILE BDATA HEADER "IBAS";
LCBAS FROM FILE BDATA HEADER "CBAS";
LGBAS FROM FILE BDATA HEADER "GBAS";
LAMR1 FROM FILE BDATA HEADER "AMR1";
LIMR1 FROM FILE BDATA HEADER "IMR1";
LCMR1 FROM FILE BDATA HEADER "CMR1";
LGMR1 FROM FILE BDATA HEADER "GMR1";
LAMR2 FROM FILE BDATA HEADER "AMR2";
LIMR2 FROM FILE BDATA HEADER "IMR2";
LCMR2 FROM FILE BDATA HEADER "CMR2";
LGMR2 FROM FILE BDATA HEADER "GMR2";
LATX1 FROM FILE BDATA HEADER "ATX1";
LITX1 FROM FILE BDATA HEADER "ITX1";
LCTX1 FROM FILE BDATA HEADER "CTX1";
```

```
LGTX1 FROM FILE BDATA HEADER "GTX1";
CITO FROM FILE BDATA HEADER "CITO";
CTOT FROM FILE BDATA HEADER "CTOT";
ITOT FROM FILE BDATA HEADER "ITOT";
GTOT FROM FILE BDATA HEADER "GTOT";
```

A2.2. National input-output shares

The use of the national aggregates presente in Excerpt 2, disregarding domestic and foreign sources, will allow us to assume the same national technolology of production, and the same composition of investment demand and household expenditures in each region (similarly for government demand). However, the associated regional compositions will be region-specific, including the share of foreign imports. Excerpt 3 presents the coefficients that make explicit the national structures.

```
! Excerpt 3 of TABLO input file: !
! Initial data !

COEFFICIENT
(all,c,COM)(all,i,IND)
ABAS(c,i) # Technical coefficient matrix - national #;
(all,c,COM)(all,i,IND)
IBAS(c,i) # Investnent coefficient matrix - national #;
(all,c,COM)
CBAS(c) # Consumption coefficient matrix - national #;
(all,c,COM)
GBAS(c) # Government coefficient matrix - national #;
(all,c,COM)(all,i,IND)
AMR1(c,i) # MAR1 1 coefficient matrix - national #;
(all,c,COM)(all,i,IND)
IMR1(c,i) # MAR2 1 coefficient matrix - national #;
(all,c,COM)
CMR1(c) # MAR3 1 coefficient matrix - national #;
(all,c,COM)
GMR1(c) # MAR5 1 coefficient matrix - national #;
(all,c,COM)(all,i,IND)
AMR2(c,i) # MAR1 2 coefficient matrix - national #;
```

```
(all,c,COM)(all,i,IND)
IMR2(c,i) # MAR2 2 coefficient matrix - national #;
(all,c,COM)
CMR2(c) # MAR3 2 coefficient matrix - national #;
(all,c,COM)
GMR2(c) # MAR5 2 coefficient matrix - national #;
(all,c,COM)(all,i,IND)
ATX1(c,i) # TAX1 1 coefficient matrix - national #;
(all,c,COM)(all,i,IND)
ITX1(c,i) # TAX2 1 coefficient matrix - national #;
(all,c,COM)
CTX1(c) # TAX3 1 coefficient matrix - national #;
(all,c,COM)
GTX1(c) # TAX5 1 coefficient matrix - national #;
TINY # A very small number #;

FORMULA
(all,c,COM)(all,i,IND)
ABAS(c,i)=LABAS(c,i)/CITO(i);
(all,c,COM)(all,i,IND)
IBAS(c,i)=LIBAS(c,i)/ITOT;
(all,c,COM)
CBAS(c)=LCBAS(c)/CTOT;
(all,c,COM)
GBAS(c)=LGBAS(c)/GTOT;
(all,c,COM)(all,i,IND)
AMR1(c,i)=LAMR1(c,i)/CITO(i);
(all,c,COM)(all,i,IND)
IMR1(c,i)=LIMR1(c,i)/ITOT;
(all,c,COM)
CMR1(c)=LCMR1(c)/CTOT;
(all,c,COM)
GMR1(c)=LGMR1(c)/GTOT;
(all,c,COM)(all,i,IND)
AMR2(c,i)=LAMR2(c,i)/CITO(i);
(all,c,COM)(all,i,IND)
IMR2(c,i)=LIMR2(c,i)/ITOT;
(all,c,COM)
CMR2(c)=LCMR2(c)/CTOT;
```

```
(all,c,COM)
GMR2(c)=LGMR2(c)/GTOT;
(all,c,COM)(all,i,IND)
ATX1(c,i)=LATX1(c,i)/CITO(i);
(all,c,COM)(all,i,IND)
ITX1(c,i)=LITX1(c,i)/ITOT;
(all,c,COM)
CTX1(c)=LCTX1(c)/CTOT;
(all,c,COM)
GTX1(c)=LGTX1(c)/GTOT;
TINY = 0.00000000000000001;
```

A2.3. Commodity trade matrices

The coefficients of excerpt 4 are associated with commodity trade matrices, i.e., the intra-regional and the interregional flows, for each commodity, from every possible origin-destination pair (including foreign origin). Tables 2 and 3 in the main text present a synthesis of the aggregate flows for Colombia in 2012.

```
! Excerpt 4 of TABLO input file: !
! Initial data !

COEFFICIENT
(all,s,ALLSOURCE)(all,q,REGDEST)
P1(s,q) # Trade matrix - flows #;
(all,s,ALLSOURCE)(all,q,REGDEST)
P2(s,q) # Trade matrix - flows #;
(all,s,ALLSOURCE)(all,q,REGDEST)
P3(s,q) # Trade matrix - flows #;
(all,s,ALLSOURCE)(all,q,REGDEST)
P4(s,q) # Trade matrix - flows #;
(all,s,ALLSOURCE)(all,q,REGDEST)
P5(s,q) # Trade matrix - flows #;
(all,s,ALLSOURCE)(all,q,REGDEST)
P6(s,q) # Trade matrix - flows #;
(all,s,ALLSOURCE)(all,q,REGDEST)
P7(s,q) # Trade matrix - flows #;
```

```
READ
P1 FROM FILE BDATA HEADER "P1";
P2 FROM FILE BDATA HEADER "P2";
P3 FROM FILE BDATA HEADER "P3";
P4 FROM FILE BDATA HEADER "P4";
P5 FROM FILE BDATA HEADER "P5";
P6 FROM FILE BDATA HEADER "P6";
P7 FROM FILE BDATA HEADER "P7";
```

A2.4. Mapping commodity trade matrices

The bi-dimensional coefficients from the initial database related to the original commodity trade matrices (excerpt 4) are mapped into tri-dimensional coefficients. This is necessary only because of the way the initial data were prepared in order to make the calculations more efficient.

```
! Excerpt 5 of TABLO input file: !
! Initial data !

COEFFICIENT
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TRADE(c,s,q) # Trade matrices, by commodity, regional #;
(all,s,ALLSOURCE)(all,q,REGDEST)
TRADE_C(s,q) # Trade matrices, regional #;

FORMULA
(all,s,ALLSOURCE)(all,q,REGDEST)  TRADE("AGR",s,q)=P1(s,q);
(all,s,ALLSOURCE)(all,q,REGDEST)  TRADE("MNE",s,q)=P2(s,q);
(all,s,ALLSOURCE)(all,q,REGDEST) TRADE("IND",s,q)=  P3(s,q);
(all,s,ALLSOURCE)(all,q,REGDEST) TRADE("CNT",s,q)=P4(s,q);
(all,s,ALLSOURCE)(all,q,REGDEST) TRADE("TRN",s,q)=P4(s,q);
 (all,s,ALLSOURCE)(all,q,REGDEST) TRADE("ADP",s,q)=P6(s,q);
(all,s,ALLSOURCE)(all,q,REGDEST) TRADE("CNS",s,q)=P7(s,q);
```

A2.5. Regional information

The last piece of information from the initial database is related to regional aggregates. Regional information on sectoral intermediate consumption and value added, as well as on regional aggregates on total investment, total household consumption and total government consumption is also part of the initial database. Finally, the regional distribution of exports by commodities was made available by the official statistics agency in Colombia.

```
! Excerpt 6 of TABLO input file: !
! Initial data !

COEFFICIENT
(all,i,IND)(all,q,REGDEST)
CINT(i,q) # Total regional intermediate consumption, by sector #;
(all,q,REGDEST)
INV(q) # Total investment demand - regional #;
(all,q,REGDEST)
CONS(q) # Total household demand - regional #;
(all,q,REGDEST)
GOV(q) # Total government demand - regional #;
(all,c,COM)(all,q,REGDEST)
BAS4_S(c,q) # Total export demand - regional #;
(all,s,ALLSOURCE)(all,q,REGDEST)
SHIND(s,q) # Diagonal trade share matrix #;
(all,i,IND)(all,q,REGDEST)
CPTL(i,q) # Total regional capital payments, by sector #;

READ
CINT from file BDATA header "CINT";
INV from file BDATA header "INV";
CONS from file BDATA header "CONS";
GOV from file BDATA header "GOV";
BAS4_S from file BDATA header "EXP";
SHIND from file BDATA header "SHND";
CPTL from file BDATA header "CPTL";
```

A3. The Chenery-Moses Approach

A3.1. Interregional coefficients

As the basic data are prepared, we can proceed with the application of the adaptation of the Chenery-Moses approach to generate the IIO coefficients for Colombia. The *SHIN(c,s,q)* coefficient corresponds to showing the proportions of a commodity *c* in region *q* that come from within the region and from each one of the other regions (including the rest of the world – *s* is an element of the set ALLSOURCE). It is assumed that all users in each region share the same importing pattern for a given commodity.

The SHIN coefficients are applied to the national aggregate coefficients for the following users: intermediate consumption, investment demand, household consumption and government consumption. The treatment adopted for exports and changes in inventories are explained later.

```
! Excerpt 7 of TABLO input file: !
! Regionalization of the national coefficients !

COEFFICIENT
(all,c,COM)(all,q,REGDEST)
TOTDEM(c,q) # Total regional demand, by commodity #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
SHIN(c,s,q) # Import trade share matrices, by commodity, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RABAS(c,s,i,q) # Technical coefficient, commodity usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RIBAS(c,s,i,q) # Investment coefficient, commodity usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCBAS(c,s,q) # Consumption coefficient, commodity usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGBAS(c,s,q) # Government coefficient, commodity usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RAMR1(c,s,i,q) # Technical coefficient, margin 1 usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RIMR1(c,s,i,q) # Investment coefficient, margin 1 usage, regional #;
```

```
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCMR1(c,s,q) # Consumption coefficient, margin 1 usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGMR1(c,s,q) # Government coefficient, margin 1 usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RAMR2(c,s,i,q) # Technical coefficient, margin 2 usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RIMR2(c,s,i,q) # Investment coefficient, margin 2 usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCMR2(c,s,q) # Consumption coefficient, margin 2 usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGMR2(c,s,q) # Government coefficient, margin 2 usage, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RATX1(c,s,i,q) # Technical coefficient, tax 1, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RITX1(c,s,i,q) # Investment coefficient, tax 1, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCTX1(c,s,q) # Consumption coefficient, tax 1, regional #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGTX1(c,s,q) # Government coefficient, tax 1, regional #;

Formula
(all,s,ALLSOURCE)(all,q,REGDEST)
TRADE_C(s,q)=sum(c,COM,TRADE(c,s,q));
(all,c,COM)(all,q,REGDEST)
TOTDEM(c,q)=sum(s,ALLSOURCE,TRADE(c,s,q));
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
SHIN(c,s,q)=TRADE(c,s,q)/(TINY+TOTDEM(c,q));
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RABAS(c,s,i,q)=SHIN(c,s,q)*ABAS(c,i);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RIBAS(c,s,i,q)=SHIN(c,s,q)*IBAS(c,i);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCBAS(c,s,q)=SHIN(c,s,q)*CBAS(c);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGBAS(c,s,q)=SHIN(c,s,q)*GBAS(c);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RAMR1(c,s,i,q)=SHIN(c,s,q)*AMR1(c,i);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RIMR1(c,s,i,q)=SHIN(c,s,q)*IMR1(c,i);
```

```
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCMR1(c,s,q)=SHIN(c,s,q)*CMR1(c);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGMR1(c,s,q)=SHIN(c,s,q)*GMR1(c);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RAMR2(c,s,i,q)=SHIN(c,s,q)*AMR2(c,i);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RIMR2(c,s,i,q)=SHIN(c,s,q)*IMR2(c,i);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCMR2(c,s,q)=SHIN(c,s,q)*CMR2(c);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGMR2(c,s,q)=SHIN(c,s,q)*GMR2(c);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RATX1(c,s,i,q)=SHIN(c,s,q)*ATX1(c,i);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
RITX1(c,s,i,q)=SHIN(c,s,q)*ITX1(c,i);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RCTX1(c,s,q)=SHIN(c,s,q)*CTX1(c);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
RGTX1(c,s,q)=SHIN(c,s,q)*GTX1(c);
```

A3.2. Structural flows

A3.2.1. Basic flows

In exerpt 8, the basic flows are calculated for the various users in the system. For producers, investors, households and government, the interregional coefficients described above are transformed into monetary values according to the relevant levels provided by the information on regional aggregates (excerpt 6). Exports are organized in a bi-dimensional matrix according to the COM and ALLSOURCE sets.

Note that the coefficient S_CPTL(i,q) is calculated based on information for total capital payments by sector (excerpt 6). The coefficient is then used for disaggregating investors demand by sector.

```
! Excerpt 8 of TABLO input file: !
! Basic flows !
```

```
COEFFICIENT
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
BAS1(c,s,i,q) # Intermdiate consumption - basic values #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
BAS2(c,s,i,q) # Investment demand - basic values #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
BAS3(c,s,q) # Household demand - basic values #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
BAS4(c,s,q) # Export demand - basic values #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
BAS5(c,s,q) # Government demand - basic values #;
(all,i,IND)(all,q,REGDEST)
S_CPTL(i,q) # Sectoral share in regional capital payments #;

FORMULA
(all,i,IND)(all,q,REGDEST)
S_CPTL(i,q)=CPTL(i,q)/(sum(j,IND,CPTL(j,q)));
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
BAS1(c,s,i,q)=RABAS(c,s,i,q)*CINT(i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
BAS2(c,s,i,q)=RIBAS(c,s,i,q)*INV(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
BAS3(c,s,q)=RCBAS(c,s,q)*CONS(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
BAS4(c,s,q)=SHIND(s,q)*BAS4_S(c,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
BAS5(c,s,q)=RGBAS(c,s,q)*GOV(q);
```

A3.2.2. Margin flows

Margin demands in monetary terms are calculated here. For each basic flow, there is a corresponding margin demand in the system. The distribution of margins follows the same pattern as in the country.

```
! Excerpt 9 of TABLO input file: !
! Margin flows !
```

```
COEFFICIENT
(all,c,COM)
XMR1(c) # Exports - margin 1 #;
(all,c,COM)
XMR2(c) # Exports - margin 2 #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR11(c,s,i,q) # Intermdiate consumption - margin 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR12(c,s,i,q) # Investment demand - margin 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR13(c,s,q) # Household demand - margin 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR14(c,s,q) # Export - margin 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR15(c,s,q) # Government demand - margin 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR21(c,s,i,q) # Intermdiate consumption - margin 2 #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR22(c,s,i,q) # Investment demand - margin 2 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR23(c,s,q) # Household demand - margin 2 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR25(c,s,q) # Government demand - margin 2 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
X_SH(c,s,q) # Export share #;

READ
XMR1 FROM FILE BDATA HEADER "XMR1";
XMR2 from file BDATA header "XMR2";

FORMULA
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
X_SH(c,s,q)=BAS4(c,s,q)/(TINY+sum(r,ALLSOURCE,sum(t,REGDEST,BAS4(c,r,t))));
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR11(c,s,i,q)=RAMR1(c,s,i,q)*CINT(i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR12(c,s,i,q)=RIMR1(c,s,i,q)*INV(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR13(c,s,q)=RCMR1(c,s,q)*CONS(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
```

```
MR14(c,s,q)=X_SH(c,s,q)*XMR1(c);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR15(c,s,q)=RGMR1(c,s,q)*GOV(q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR21(c,s,i,q)=RAMR2(c,s,i,q)*CINT(i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
MR22(c,s,i,q)=RIMR2(c,s,i,q)*INV(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR23(c,s,q)=RCMR2(c,s,q)*CONS(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR24(c,s,q)=X_SH(c,s,q)*XMR2(c);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
MR25(c,s,q)=RGMR2(c,s,q)*GOV(q);
```

A3.2.3. Indirect tax flows

Tax values associated with the basic flow are calculated here. For each basic flow, the corresponding national tax rate is applied.

```
! Excerpt 10 of TABLO input file: !
! Tax flows !

COEFFICIENT
(all,c,COM)
XTX1(c) # Exports - tax 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TX11(c,s,i,q) # Intermdiate consumption - tax 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TX12(c,s,i,q) # Investment demand - tax 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TX13(c,s,q) # Household demand - tax 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TX14(c,s,q) # Export - tax 1 #;
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TX15(c,s,q) # Government demand - tax 1 #;

READ
XTX1 FROM FILE BDATA HEADER "XTX1";
```

```
FORMULA
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TX11(c,s,i,q)=RATX1(c,s,i,q)*CINT(i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TX12(c,s,i,q)=RITX1(c,s,i,q)*INV(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TX13(c,s,q)=RCTX1(c,s,q)*CONS(q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TX14(c,s,q)=X_SH(c,s,q)*XTX1(c);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TX15(c,s,q)=RGTX1(c,s,q)*GOV(q);
```

A3.2.4. Disaggregation of sectoral value added

This excerpt shows the procedure for the disaggregation of the sectoral value added. Since there is no information available for the regional sectoral aggregates, the specification below is kept only for the purpose of future development of the IIO-COL.

In our case, we have implemented the system according to the code as shown here. The shortcut was to set the values for the coefficients *LABR(i,q)* and *CPTL(i,q)* using the national sectoral shares and using *OCTS(i,q)* as the residual.

```
! Excerpt 11 of TABLO input file: !
! Value added !

COEFFICIENT
(all,i,IND)(all,q,REGDEST)
LABR(i,q) # Total regional labor payments, by sector #;
(all,i,IND)(all,q,REGDEST)
OCTS(i,q) # Other costs, by sector #;
(all,i,IND)(all,q,REGDEST)
VA(i,q) # Total regional value added, by sector #;

READ
LABR from file BDATA header "LABR";
OCTS from file BDATA header "OCTS";
```

```
FORMULA
(all,i,IND)(all,q,REGDEST)
VA(i,q)=LABR(i,q)+CPTL(i,q)+OCTS(i,q);
```

A3.2.5. Production aggregates

The coefficient *MAKE(i,c,s)* refers to the 33 regional make matrices. Given the transformation of the datrabase into a sector by sector framework, the make matrix for each regional is a diagonal matrix. The code is general enough to be adapted for the commodity by sector framework.

This excerpt shows also specific aggregations of the make matriz to be used for balance checking purposes.

```
! Excerpt 12 of TABLO input file: !
! Gross output !

COEFFICIENT
(all,i,IND)(all,q,REGDEST)
MAKE_I(i,q) # Total regional output, by sector #;
(all,i,IND)(all,q,REGDEST)
MAKE_I2(i,q) # Total regional output, by sector, make version #;
(all,c,COM)(all,s,REGSOURCE)
MAKE_C(c,s) # Total regional output, by commodity #;
(all,i,IND)(all,c,COM)(all,s,REGSOURCE)
MAKE(i,c,s) # Make matrix, by region #;

READ
MAKE from file BDATA header "MAKE";

FORMULA
(all,i,IND)(all,q,REGDEST)
MAKE_I(i,q)=VA(i,q)+CINT(i,q);
(all,i,IND)(all,q,REGDEST)
MAKE_I2(i,q)=sum(c,COM,MAKE(i,c,q));
(all,c,COM)(all,s,REGSOURCE)
```

```
MAKE_C(c,s)=sum(i,IND,MAKE(i,c,s));
```

A3.2.6. Balancing checks

The first check was undertaken to assure that the information provided in the make matrix was consistent with the information on the absorption (use) matrix, i.e. *MAKE_I(i,q) = MAKE_I2(i,q)*, for every *i* and *q*.

The second check refers to the commodity balance check. Changes in inventories are introduced and defined as the discrepancy needed to be inserted in the system for commodity balancing purposes between the use and make tables.

Finally, the third check confirms that total sectoral costs equal total sectoral output.

```
! Excerpt 13 of TABLO input file: !

! Check 1 - Sector output balance check !

COEFFICIENT
(all,i,IND)(all,q,REGDEST)
CHECKA(i,q) # Check MAKE_I = MAKE_I2 #;

FORMULA
(all,i,IND)(all,q,REGDEST)
CHECKA(i,q)=MAKE_I(i,q)-MAKE_I2(i,q);

! Check 2 – Commodity balance check !

COEFFICIENT
(all,c,COM)(all,s,REGSOURCE)
DIRSALES(c,s) # Direct usage #;
(all,r,MARGCOM)(all,s,REGSOURCE)
MARSALES1(r,s) # Margin 1 usage #;
(all,r,MARGCOM2)(all,s,REGSOURCE)
MARSALES2(r,s) # Margin 2 usage #;
(all,c,COM)(all,s,REGSOURCE)
SALES(c,s) # All usage #;
```

```
(all,c,COM)(all,s,REGSOURCE)
LOSTGOODS(c,s) # Discrepancy #;
(all,c,COM)(all,s,REGSOURCE)
BAS7(c,s) # Change in stocks - for balancing purposes #;

FORMULA
(all,c,COM)(all,s,REGSOURCE)
DIRSALES(c,s)=sum(i,IND,sum(q,REGDEST,BAS1(c,s,i,q)))
+sum(i,IND,sum(q,REGDEST,BAS2(c,s,i,q)))
+sum(q,REGDEST,BAS3(c,s,q))
+sum(q,REGDEST,BAS4(c,s,q))
+sum(q,REGDEST,BAS5(c,s,q));
(all,r,MARGCOM)(all,s,REGSOURCE)
MARSALES1(r,s)=sum(i,IND,sum(c,COM,sum(ss,ALLSOURCE,MR11(c,ss,i,s))))
+sum(i,IND,sum(c,COM,sum(ss,ALLSOURCE,MR12(c,ss,i,s))))
+sum(c,COM,sum(ss,ALLSOURCE,MR13(c,ss,s)))
+sum(c,COM,sum(ss,ALLSOURCE,MR14(c,ss,s)))
+sum(c,COM,sum(ss,ALLSOURCE,MR15(c,ss,s)));
(all,r,MARGCOM2)(all,s,REGSOURCE)
MARSALES2(r,s)=sum(i,IND,sum(c,COM,sum(ss,ALLSOURCE,MR21(c,ss,i,s))))
+sum(i,IND,sum(c,COM,sum(ss,ALLSOURCE,MR22(c,ss,i,s))))
+sum(c,COM,sum(ss,ALLSOURCE,MR23(c,ss,s)))
+sum(c,COM,sum(ss,ALLSOURCE,MR24(c,ss,s)))
+sum(c,COM,sum(ss,ALLSOURCE,MR25(c,ss,s)));
(all,c,NONMARGCOM)(all,s,REGSOURCE)
SALES(c,s)=DIRSALES(c,s);
(all,c,MARGCOM)(all,s,REGSOURCE)
SALES(c,s)=DIRSALES(c,s)+MARSALES1(c,s);
(all,c,MARGCOM2)(all,s,REGSOURCE)
SALES(c,s)=DIRSALES(c,s)+MARSALES2(c,s);
(all,c,COM)(all,s,REGSOURCE)
LOSTGOODS(c,s)=SALES(c,s)-MAKE_C(c,s);
(all,c,COM)(all,s,REGSOURCE)
BAS7(c,s)=-LOSTGOODS(c,s);

! Sector output balance !

COEFFICIENT
(all,i,IND)(all,q,REGDEST)
V1TOT(i,q) # Total cost by sector #;
```

```
(all,i,IND)(all,q,REGDEST)
STOK(i,q) # Total cost adjustment by sector #;
(all,i,IND)(all,q,REGDEST)
CHECKB(i,q) # Check MAKE_I = MAKE_I2 #;

FORMULA
(all,i,IND)(all,q,REGDEST)
STOK(i,q)=CHECKA(i,q);
(all,i,IND)(all,q,REGDEST)
V1TOT(i,q)=VA(i,q)+CINT(i,q)-STOK(i,q);
(all,i,IND)(all,q,REGDEST)
CHECKB(i,q)=V1TOT(i,q)-MAKE_I2(i,q);
Assertion # V1TOT = MAKE_I2 for sectors #
(all,i,IND)(all,q,REGDEST)
ABS(CHECKB(i,q))<SMALL;
```

A3.2.7. Renaming arrays

This excerpt renames some of the arrays in order to be consistent with the notation adopted in the model code, as presented in Figure A2.

```
COEFFICIENT
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)(all,r,MARGCOM)
MAR1(c,s,i,q,r);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)(all,r,MARGCOM)
MAR2(c,s,i,q,r);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM)
MAR3(c,s,q,r);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM)
MAR4(c,s,q,r);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM)
MAR5(c,s,q,r);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TAX1(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TAX2(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TAX3(c,s,q);
```

```
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TAX4(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TAX5(c,s,q);

FORMULA
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)(all,r,MARGCOM)
MAR1(c,s,i,q,r)=MR11(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)(all,r,MARGCOM)
MAR2(c,s,i,q,r)=MR12(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM)
MAR3(c,s,q,r)=MR13(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM)
MAR4(c,s,q,r)=MR14(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM)
MAR5(c,s,q,r)=MR15(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)(all,r,MARGCOM2)
MAR1(c,s,i,q,r)=MR21(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)(all,r,MARGCOM2)
MAR2(c,s,i,q,r)=MR22(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM2)
MAR3(c,s,q,r)=MR23(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM2)
MAR4(c,s,q,r)=MR24(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)(all,r,MARGCOM2)
MAR5(c,s,q,r)=MR25(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TAX1(c,s,i,q)=TX11(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,i,IND)(all,q,REGDEST)
TAX2(c,s,i,q)=TX12(c,s,i,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TAX3(c,s,q)=TX13(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TAX4(c,s,q)=TX14(c,s,q);
(all,c,COM)(all,s,ALLSOURCE)(all,q,REGDEST)
TAX5(c,s,q)=TX15(c,s,q);
```

A3.2.8. Writing the results to the output file

The final step is to write the relevant results for the output file RIODATA, which can then be used to prepare the consolidated IIOM-COL in Excel format.

```
WRITE BAS1 TO FILE RIODATA HEADER "BAS1";
WRITE BAS2 TO FILE RIODATA HEADER "BAS2";
WRITE BAS3 TO FILE RIODATA HEADER "BAS3";
WRITE BAS4 TO FILE RIODATA HEADER "BAS4";
WRITE BAS5 TO FILE RIODATA HEADER "BAS5";
WRITE BAS7 TO FILE RIODATA HEADER "BAS7";
WRITE MAR1 TO FILE RIODATA HEADER "MAR1";
WRITE MAR2 TO FILE RIODATA HEADER "MAR2";
WRITE MAR3 TO FILE RIODATA HEADER "MAR3";
WRITE MAR4 TO FILE RIODATA HEADER "MAR4";
WRITE MAR5 TO FILE RIODATA HEADER "MAR5";
WRITE TAX1 TO FILE RIODATA HEADER "TAX1";
WRITE TAX2 TO FILE RIODATA HEADER "TAX2";
WRITE TAX3 TO FILE RIODATA HEADER "TAX3";
WRITE TAX4 TO FILE RIODATA HEADER "TAX4";
WRITE TAX5 TO FILE RIODATA HEADER "TAX5";
WRITE LABR TO FILE RIODATA HEADER "LABR";
WRITE CPTL TO FILE RIODATA HEADER "CPTL";
WRITE OCTS TO FILE RIODATA HEADER "OCTS";
WRITE MAKE TO FILE RIODATA HEADER "MAKE";
WRITE CHECKA TO FILE RIODATA HEADER "CHKA";
WRITE CHECKB TO FILE RIODATA HEADER "CHKB";
WRITE STOK TO FILE RIODATA HEADER "STOK";
```

Figure A2. Structure of the Interregional Flows Database: The Absorption (Use) Matrix

			User 1			User 2			User 3			User 4	User 5			User 7
			Producers			Investors			Household			Export	Regional Govt.			Inventories
		Size	7	7	7	7	7	7	1	1	1	1	1	1	1	1
	Size	Source/ Destination	R1	…	R33	R1	…	R33	R1	…	R33		R1	…	R33	
Basic Flows	7	R1	BAS1			BAS2			BAS3			BAS4	BAS5			BAS7
	7	…														
	7	R33														
	7	ROW														
Margins	7	R1	MAR1			MAR2			MAR3			MAR4	MAR5			0
	7	…														
	7	R33														
	7	ROW														
Taxes	7	R1	TAX1			TAX2			TAX3			TAX4	TAX5			0
	7	…														
	7	R33														
	7	ROW														
Labor	1		LABR													
Capital	1		CPTL													
Other Costs	1		OCTS													


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