

NEREUS

Núcleo de Economia Regional e Urbana
da Universidade de São Paulo



Regional Integration in Colombia: On Cournot's Problem and the New Economic Geography

Eduardo Haddad Ana Barufi Sílvia Costa

Outline

- ✓ Motivation

 - The B-MARIA-27 and the CEER models

 - Simulation results

 - Final remarks

Motivation

This paper provides a complementary analysis to an earlier exploration of the short-run implications of adopting a more realistic representation of transportation costs and considering the impact of increasing returns to scale (Haddad and Hewings, 2005)

The paper addresses the issues in a long-run equilibrium solution which adopts usual hypotheses on factor mobility in new economic geography (NEG) models

Motivation

Theoretical inconsistencies between competitive regimes conceptualized in space-less and spatial economies

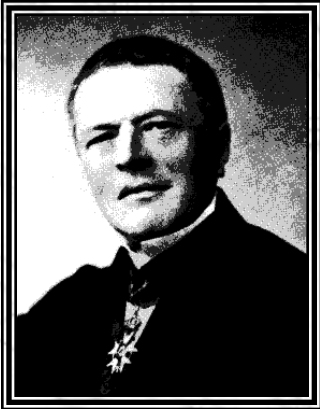
- Dominant result: spatial autarchy

New economic geography

- Role of increasing returns and transportation costs (Fujita *et al.*, 1999; Fujita and Thisse, 2002)
- Dominant result: core-periphery (**spatial heterogeneity**)

Notion of some intermediate form of space?

- High transportation costs would enable firms to exploit increasing returns to scale within less than complete national markets
- Asymmetries in competitive advantage between regions (central position)



Antoine Augustin **Cournot**, 1801-1877

“So far we have studied how, for each commodity by itself, the law of demand in connection with the conditions of production of that commodity, determines the price of it and regulates the incomes of its producers. We considered as given and invariable the prices of other commodities and the incomes of other producers; **but in reality the economic system is a whole of which all the parts are connected and react on each other.** An increase in the income of the producers of commodity *A* will affect the demand for commodities *B*, *C*, etc., and the incomes of their producers, and, by its reaction, will involve a change in the demand for commodity *A*. **It seems, therefore, as if, for a complete and rigorous solution of the problems relative to some parts of the economic system, it were indispensable to take the entire system into consideration. But this would surpass the powers of mathematical analysis and of our practical methods of calculation, even if the values of all the constants could be assigned to them numerically.”**

Cournot, Researches into the Mathematical Principles of the Theory of Wealth (1838), translated by Nathaniel T. Bacon (New York, 1929), p. 127.

Cournot's problem

Diagnostics:

(i) Development of economic analysis of **concrete problems** should pursue a “general equilibrium” framework

(ii) But existing mathematical, statistical and computational benchmarks, at the time of his writings, were far from sufficient for approaching the problem in a general equilibrium context

Solution:

Economics took different routes to (attempt) to solve the so-called Cournot's problem

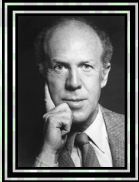
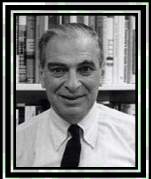
From pure theory to applied theory and **practice**

One route: development of Computable General Equilibrium models

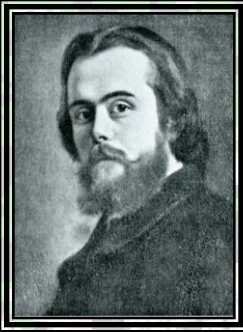
Regional Science

Norte-American School

Norwegian-Australian School



Marginalists



Proto-Marginalistas



Fisiocrats Classics

Cournot's problem in the context of the NEG

First pillar (pure theory):

It is relatively well acknowledged the intellectual background that influenced theorists of NEG

It is also recognized that the NEG approach deals properly with location and agglomeration: no other body of work explains agglomeration in a theoretical framework that is tractable, has solid micro foundations, and makes testable empirical predictions

It may be agreed that there are few major issues still to be resolved in the **realm of pure theory**.

Cournot's problem in the context of the NEG

Second pillar (applied theory):

As far as empirical relevance is concerned, we see a recent explosion of studies trying to test theoretical predictions of NEG models, which have been further developed to produce analytical insights to the policy debate

Thus, nowadays focus is on the **realm of applied theory**

Third pillar (practice):

Nonetheless, NEG applications have not reached the ground for fulfilling the policymakers' needs for analysis of **concrete** regional development policies

Krugman: development of "computable geographical equilibrium" models

Objectives

Develop a spatial CGE model that “mimics” NEG results

- Transportation costs
- (External) agglomeration economies – modeling “trick”
- Provide qualitatively similar results to displacements from the original equilibrium (Abdel-Rahman and Fujita, 1990)

Assess the role of transportation infrastructure to Colombian regions (illustrate analytical capability of the model)

- Equity and efficiency
- In this presentation: **the Colombian case**

Integration with a stylized transportation infrastructure model

- *Reach the planners*

Outline

Motivation

- ✓ The B-MARIA-27 and the CEER models

Simulation results

Final remarks

CEER MODEL

Spatial CGE Model of Colombia



Centro de Estudios Económicos Regionales - CEER
Banco de la República de Colombia

The CEER model

The first fully operational spatial CGE model for Colombia

Similar approach to Haddad and Hewings (2005) to incorporate recent theoretical developments in the new economic geography

Experimentation with the introduction of scale economies, market imperfections, and transportation costs provide innovative ways of dealing explicitly with theoretical issues related to integrated regional systems

Regarding the regional setting, the main innovation in the CEER model is the detailed treatment of interregional trade flows in the Colombian economy, in which the markets of regional flows are fully specified for each origin and destination. The model recognizes the economies of the 32 Colombian Departments and the capital city, Bogotá

General features of the CEER model

Interregional bottom-up CGE model for Colombia

- 33 regions
- 7 sectors/goods

Interregional flows of goods and services

Interregional factor mobility

Explicit modeling of transportation costs based on origin-destination pairs, considering a stylized transportation network

Regional and Central government

Regional labor markets

Non-constant returns to scale (agglomeration economies)

Colombia: political division



Colombia: geography

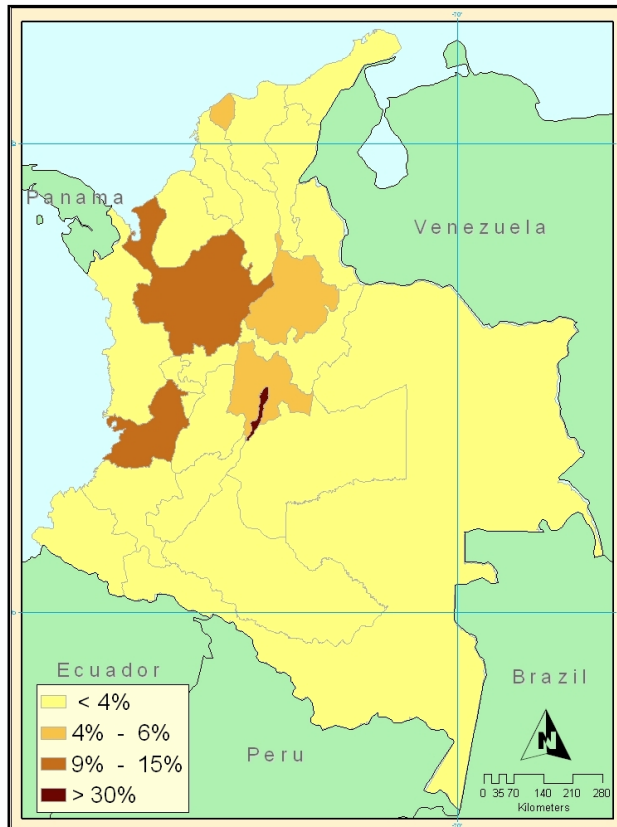


Aggregate domestic trade flows in Colombia

ORIGIN	DESTINATION																																	Total						
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33							
D1	0.6304	0.0409	0.0169	0.1059	0.0192	0.0554	0.0097	0.0346	0.0334	0.1107	0.0169	0.2930	0.0348	0.1149	0.0378	0.0197	0.0572	0.0257	0.0626	0.0703	0.0468	0.0837	0.0319	0.0499	-	-	0.0043	0.0109	-	0.0393	0.0385	0.0487	-	0.0549	0.1414					
D2	0.0318	0.6408	0.0157	0.0290	0.0213	0.0113	0.0125	0.0055	0.1011	0.0863	0.0090	0.0003	0.0431	0.0299	0.0116	0.0121	0.0099	0.0169	0.0043	0.0117	0.0503	0.0541	0.0119	0.0125	-	-	-	0.0485	-	-	-	0.0106	-	0.0783	0.0552					
D3	0.0779	0.1014	0.7815	0.1259	0.2459	0.0395	0.1501	0.0370	0.1227	0.0829	0.0619	0.0281	0.0906	0.1023	0.0891	0.2309	0.1034	0.1799	0.0681	0.0551	0.1251	0.1384	0.1538	0.1241	0.4484	0.3598	0.3747	-	0.4180	0.3179	0.1328	-	0.1489	0.2681						
D4	0.0374	0.0167	0.0169	0.5396	0.0253	0.0053	0.0101	0.0167	0.0350	0.0343	0.0017	0.0024	0.0298	0.0196	0.0077	0.0207	0.0061	0.0094	0.0203	0.0043	0.0178	0.0249	0.0116	0.0102	0.0053	-	0.0526	-	-	0.0073	0.0125	-	-	0.0419						
D5	0.0055	0.0095	0.0080	0.0117	0.4454	0.0018	0.0016	0.0051	0.0204	0.0054	0.0542	-	0.0060	0.0037	0.0033	0.0066	0.0031	0.0077	0.0074	0.0051	0.0095	0.0068	0.0043	0.0061	-	-	0.0112	0.0417	-	-	0.0006	0.0057	-	-	0.0026	0.0209				
D6	0.0053	0.0082	0.0134	0.0164	0.0037	0.6848	0.0021	0.0069	0.0017	0.0021	0.0053	0.0017	0.0137	0.0175	0.0020	0.0009	0.0058	0.0039	0.0142	0.0334	0.0019	0.0009	0.0176	0.0068	0.0128	0.0008	0.0051	-	-	0.0301	0.0068	-	-	-	0.0239					
D7	0.0006	0.0004	0.0026	0.0014	0.0025	0.0003	0.5176	0.0012	0.0034	-	0.0009	-	0.0079	-	-	-	-	-	0.0011	0.0006	0.0006	-	0.0050	0.0054	-	-	0.0029	-	0.0415	-	0.0001	-	-	-	0.0046					
D8	0.0024	0.0012	0.0021	0.0011	0.0002	0.0068	0.0133	0.6946	0.0018	0.0016	0.0031	-	0.0218	0.0111	0.0019	0.0022	0.0121	0.0009	0.0095	0.0039	0.0035	0.0035	0.0030	0.0150	-	-	-	0.0017	-	-	0.0005	0.0008	-	-	-	0.0179				
D9	0.0036	0.0166	0.0068	0.0076	0.0018	0.0035	0.0013	0.0001	0.4620	0.0013	0.0032	0.0007	0.0004	0.0236	0.0948	0.0001	0.0006	0.0061	0.0003	0.0044	0.0246	0.0328	0.0025	0.0016	-	0.0004	0.0033	-	-	-	-	0.0042	-	-	-	0.0141				
D10	0.0116	0.0093	0.0098	0.0367	0.0003	0.0023	0.0001	0.0037	0.0097	0.5737	0.0034	0.0007	0.0025	0.0119	0.0009	0.0002	0.0005	0.0015	0.0007	0.0017	0.0086	0.0167	0.0009	0.0045	-	-	0.0021	-	-	-	-	0.0058	-	-	-	0.0199				
D11	0.0124	0.0308	0.0060	0.0069	0.1426	0.0040	0.0101	0.0097	0.0007	0.0032	0.6985	-	0.0404	0.0025	0.0063	0.0198	0.0077	0.0131	0.0132	0.0009	0.0273	0.0058	0.0666	0.0211	-	0.0010	0.0407	0.0857	0.0115	-	-	0.0209	-	-	-	0.0430				
D12	0.0024	-	0.0001	0.0002	-	0.0010	0.0089	-	-	-	0.0024	0.5357	0.0001	-	-	-	-	0.0001	-	0.0048	0.0009	-	0.0003	0.0011	-	-	-	-	-	-	-	-	-	-	-	-	0.0033			
D13	0.0025	0.0032	0.0024	0.0042	0.0006	0.0025	0.1101	0.0184	0.0033	-	0.0032	-	0.5079	-	0.0001	0.0001	0.0082	0.0011	0.0081	0.0068	0.0022	0.0003	0.0100	0.0144	-	0.0137	0.0027	-	-	0.2129	0.0005	-	0.1773	0.0156						
D14	0.0051	0.0126	0.0019	0.0016	0.0002	0.0021	-	0.0001	0.0155	0.0021	0.0047	0.0007	0.0061	0.5496	0.0682	0.0002	0.0014	0.0007	-	0.0020	0.0024	0.0073	0.0027	0.0035	-	0.0002	0.0025	-	-	0.0029	0.0025	-	-	-	-	0.0078				
D15	0.0073	0.0061	0.0084	0.0019	0.0087	0.0011	-	-	0.0061	0.0016	0.0010	-	0.0002	0.0033	0.6102	0.0015	0.0004	0.0017	-	0.0002	0.0167	0.0009	0.0021	0.0021	0.0094	-	0.0068	-	-	-	0.0017	0.0009	-	-	-	0.0142				
D16	0.0033	0.0035	0.0165	0.0058	0.0055	0.0014	0.0024	0.0035	0.0016	0.0061	0.0037	-	0.0015	0.0057	0.0018	0.6039	0.0021	0.0007	-	0.0007	0.0014	0.0023	0.0061	0.0027	-	0.0019	0.0167	-	0.0073	0.0052	0.0009	0.5596	0.1832	0.0166						
D17	0.0062	0.0047	0.0067	0.0025	0.0010	0.0076	0.0122	0.0184	0.0004	0.0045	0.0030	-	0.0128	0.0083	0.0001	0.0004	0.5727	0.0046	0.0081	0.0076	0.0027	0.0001	0.0038	0.0176	-	-	-	-	-	-	0.0012	-	-	-	-	0.0171				
D18	0.0029	0.0159	0.0045	0.0028	0.0025	0.0011	0.0033	0.0018	0.0093	0.0006	0.0035	-	0.0028	0.0014	0.0031	0.0008	0.0007	0.5801	0.0020	0.0011	0.0117	0.0023	0.0024	0.0032	0.0025	0.0086	0.0058	-	-	0.0008	0.0039	-	-	-	-	0.0147				
D19	0.0023	0.0005	0.0023	0.0004	0.0009	0.0057	0.0071	0.0007	0.0021	-	0.0035	0.0034	0.0048	0.0010	0.0001	-	0.0055	0.0012	0.5994	0.0004	0.0009	0.0002	0.0056	0.0087	-	-	-	0.0001	-	0.0009	-	0.0002	-	-	-	0.0083				
D20	0.0094	0.0028	0.0013	0.0033	0.0030	0.0432	0.0008	0.0058	0.0026	0.0022	0.0006	0.0689	0.0019	0.0003	0.0014	0.0003	0.0064	0.0060	0.0022	0.6613	0.0015	-	0.0013	0.0135	-	-	0.0008	-	-	-	-	-	0.0019	-	-	-	0.0191			
D21	0.0168	0.0189	0.0097	0.0208	0.0244	0.0067	0.0240	0.0171	0.1201	0.0047	0.0259	-	0.0083	0.0409	0.0267	0.0094	0.0091	0.0460	0.0095	0.0080	0.5645	0.0112	0.0299	0.0136	-	0.0004	0.0041	-	-	0.0265	0.0119	-	-	-	-	0.0510				
D22	0.0060	0.0042	0.0010	0.0083	0.0002	0.0001	-	-	0.0019	0.0363	0.0034	-	0.0006	0.0012	0.0008	0.0001	-	0.0004	0.0013	0.0004	0.0001	0.5665	0.0001	0.0003	-	0.0006	0.0041	-	-	-	-	0.0001	0.0018	-	-	-	0.0074			
D23	0.0120	0.0082	0.0070	0.0075	0.0114	0.0345	0.0265	0.0046	0.0108	0.0028	0.0255	0.0012	0.0284	0.0127	0.0039	0.0054	0.0123	0.0018	0.0113	0.0036	0.0096	0.0032	0.5274	0.0056	-	0.0006	0.0050	0.4621	0.0166	0.0189	0.0031	-	-	-	-	0.0229				
D24	0.0987	0.0380	0.0386	0.0381	0.0137	0.0756	0.0723	0.1085	0.0288	0.0329	0.0289	0.0616	0.1188	0.0365	0.0256	0.0373	0.1708	0.0768	0.1516	0.1059	0.0531	0.0348	0.0780	0.6491	-	0.0025	0.0089	-	-	-	-	0.0533	0.0313	-	-	-	0.1274			
D25	-	-	-	-	-	-	-	0.0021	0.0003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0005	0.0002	0.5210	-	-	-	-	-	-	-	-	-	-	-	0.0007		
D26	0.0002	0.0001	0.0014	0.0004	0.0037	-	-	0.0002	-	-	-	0.0197	-	0.0002	-	-	0.0006	-	0.0110	0.0003	0.0013	0.0139	-	0.0001	-	-	-	0.3729	0.0108	-	-	-	-	-	-	-	0.0044			
D27	0.0029	0.0043	0.0129	0.0183	0.0133	0.0017	-	0.0020	0.0007	0.0021	0.0121	0.0011	0.0042	0.0003	0.0002	0.0219	0.0005	0.0016	0.0029	0.0032	0.0011	0.0019	0.0199	0.0064	-	0.0106	0.3300	-	-	-	-	-	0.0031	-	-	0.0115				
D28	-	-	-	0.0001	0.0001	0.0001	-	0.0001	0.0001	-	-	0.0001	-	0.0002	0.0001	-	0.0001	0.0001	0.0002	0.0001	-	-	-	-	-	0.0003	0.0001	-	-	-	-	0.4523	-	-	-	-	0.0003			
D29	-	-	0.0014	-	-	-	0.0034	-	-	-	-	-	-	-	-	0.0034	-	-	-	-	-	-	0.0003	-	-	-	-	-	-	-	-	-	0.3749	-	-	-	-	0.0011		
D30	0.0006	0.0002	0.0012	-	0.0003	-	-	0.0004	-	-	-	-	-	0.0085	0.0001	-	-	0.0029	-	0.0004	0.0001	0.0003	0.0001	0.0001	0.0004	-	-	-	-	-	-	-	-	-	-	-	0.0019			
D31	0.0024	0.0003	0.0012	0.0017	0.0018	0.0003	0.0005	0.0009	0.0041	0.0023	0.0007	-	0.0017	0.0004	0.0001	0.0006	0.0002	0.0005	0.0002	0.0002	0.0009	0.0008	0.0005	0.0004	0.0002	-	0.0043	-	-	-	0.0003	0.6862	-	-	0.0020	0.0025				
D32	0.0001	0.0002	-	0.0003	0.0004	0.0004	0.0001	0.0002	0.0003	0.0002	0.0002	0.0004	0.0001	0.0011	0.0003	0.0001	0.0003	0.0005	0.0006	0.0006	0.0001	0.0002	0.0002	0.0001	0.0001	0.0001	0.0002	0.0002	-	0.0001	0.0003	0.0013	0.4404	0.0001	-	-	0.0004			
D33	-	-	0.0021	-	0.0001	-	-	-	-	-	-	-	-	-	-	0.0020	0.0004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3526	0.0010
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	

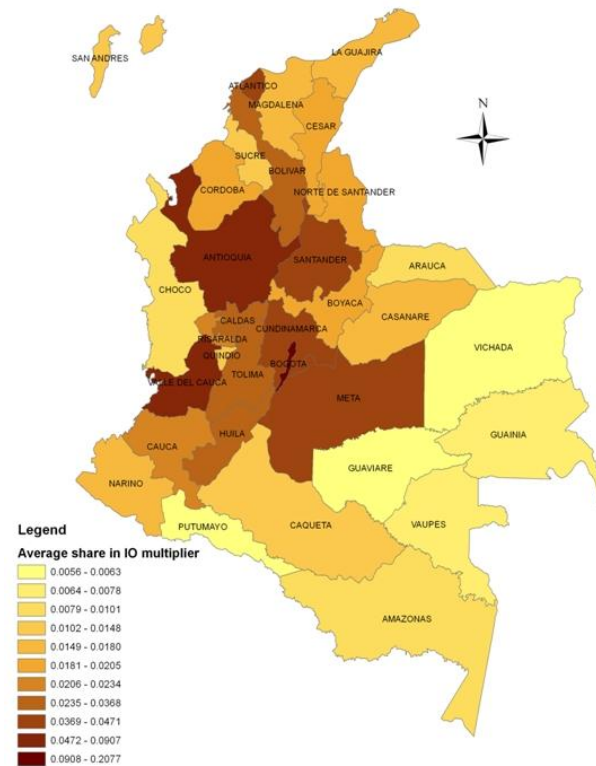
Regional setting

Departmental share in GNI, 2000

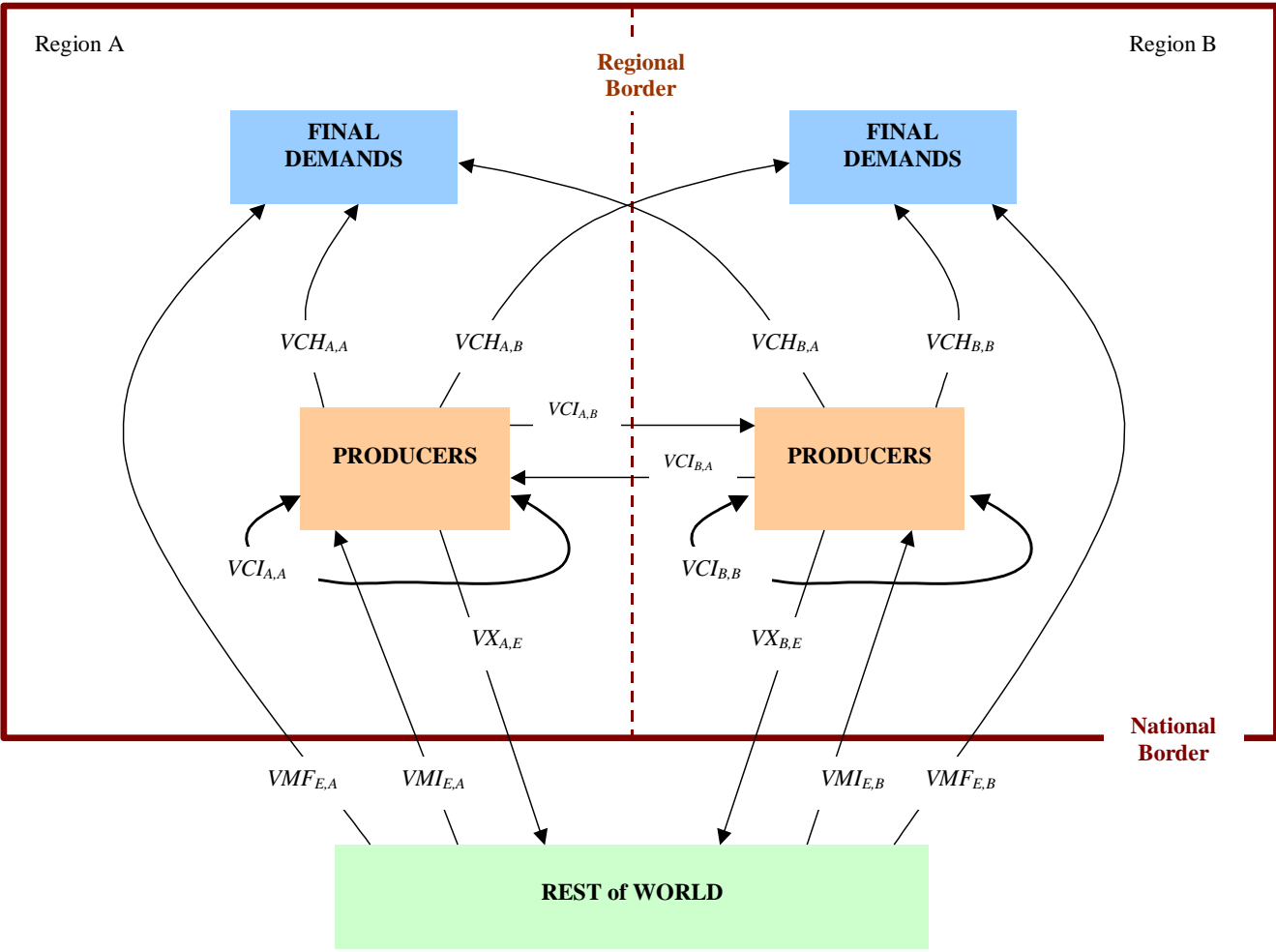


Source: Bonet and Meisel (2006)

Linkages in Colombia
(Average % share in net I-O output multipliers)



Stylized flows



Increasing returns

More generic specification of demand for primary factors

$$X1PRIM(j, q) = A1(j, q) * A1PRIM(j, q) * [\alpha(j, q)Z(j, q)]^{MRP(j, q)}$$

$MRP(j, q) < 1 \rightarrow$ increasing returns

Manufacturing sector in Bogotá = 0.8

Transportation cost

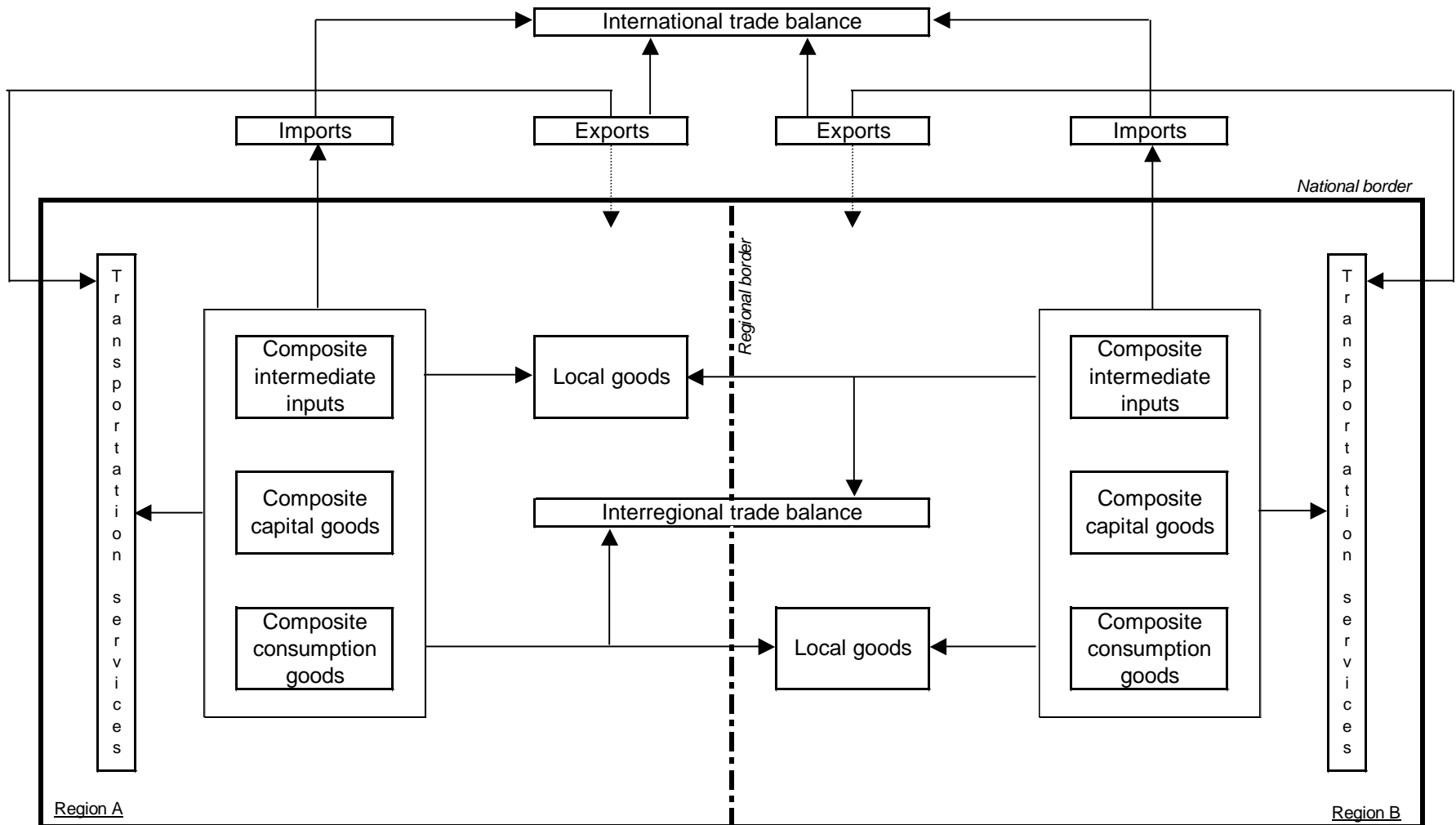
Prices paid for commodity i from region s in region q by each user equate to the sum of its basic value and the costs of the relevant taxes and **transportation services**

Transportation services facilitate flows of goods from points of production or points of entry to either domestic users or ports of exit

$$XMARG(i, s, q, r) = AMARG_{-I}(s, q, r) * [\eta(i, s, q, r) * X(i, s, q, r)^{\theta(i, s, q, r)}]$$



The role of transportation services in the CEER model



Calibration

The calibration strategy adopted takes into account explicitly, for each origin-destination pair, key elements of the Colombian integrated interregional economic system, namely:

- Type of trade involved (transportation services vary according to specific commodity flows)
- Transportation network (distance matters!)
- Scale effects in transportation, in the form of long-haul economies
- Increasing returns to transportation

Outline

Motivation

The B-MARIA-27 and the CEER models

✓ Simulation results

Final remarks

Simulations

The CEER model is used to simulate the impacts of regional integration in Colombia

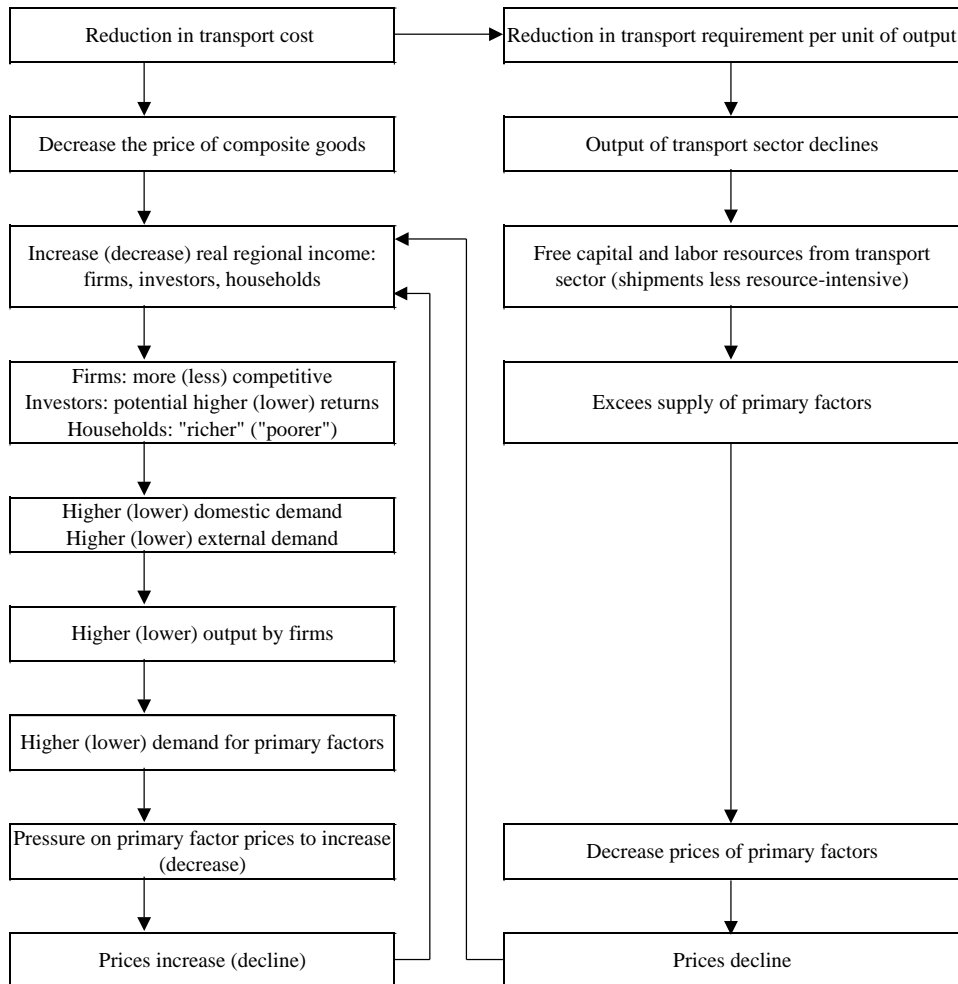
The model is applied to analyze the effects of an overall 1% reduction in transportation cost **within** the country. All exogenous variables are set equal to zero, except the changes in transport costs between each origin-destination pair

Results of the simulation computed via a four-step Euler procedure with extrapolation, under a **long-run closure**

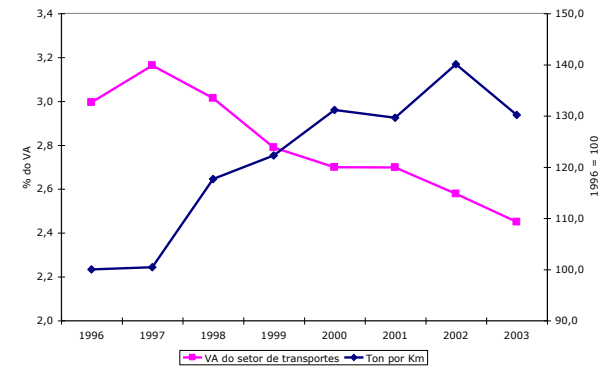
Analytically important transportation links

Role of increasing returns

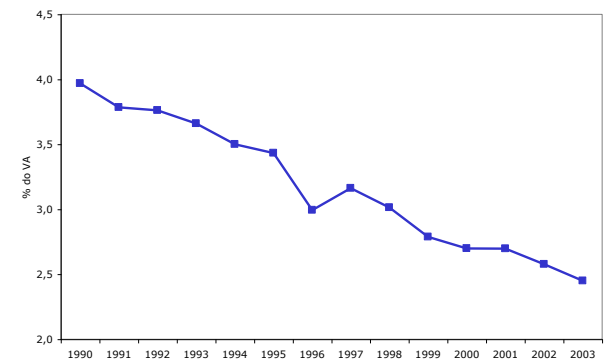
Functioning mechanisms of the simulations



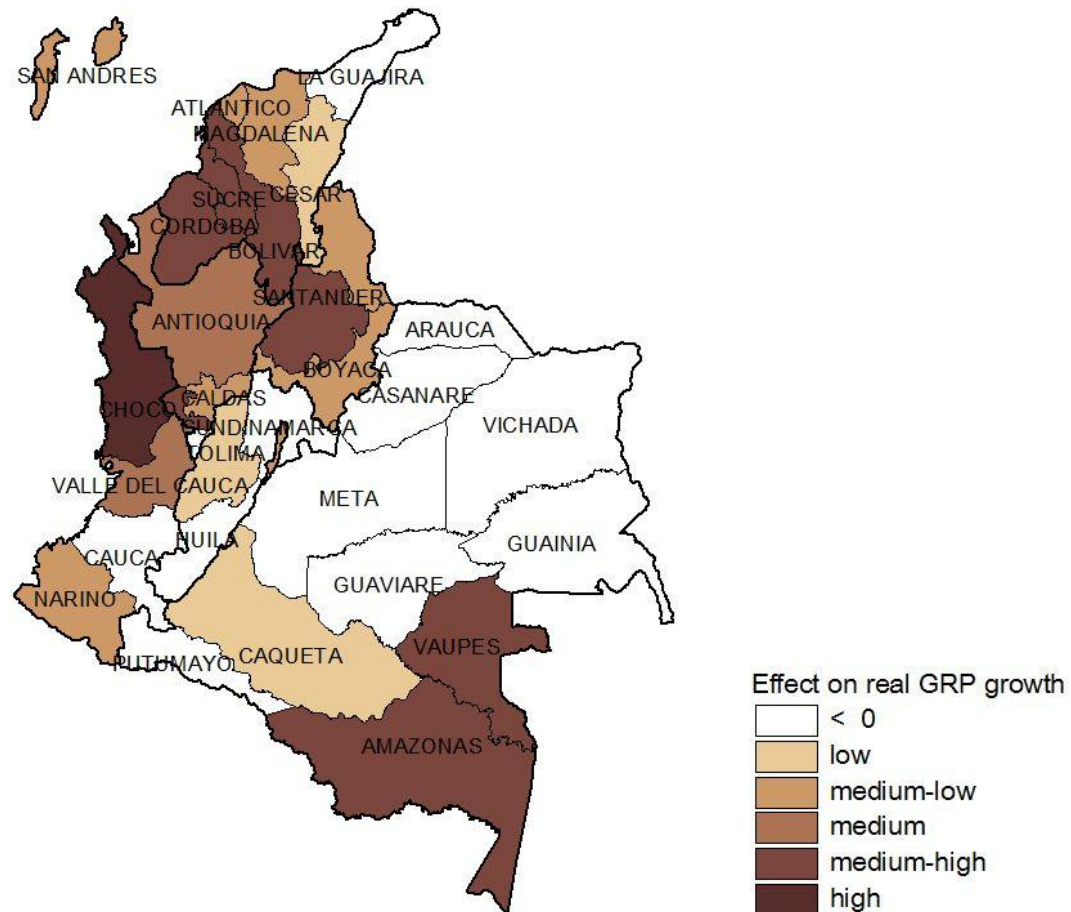
Recent evolution of transport sector



Share of transport sector in VA



Spatial effects of regional integration on GRP growth



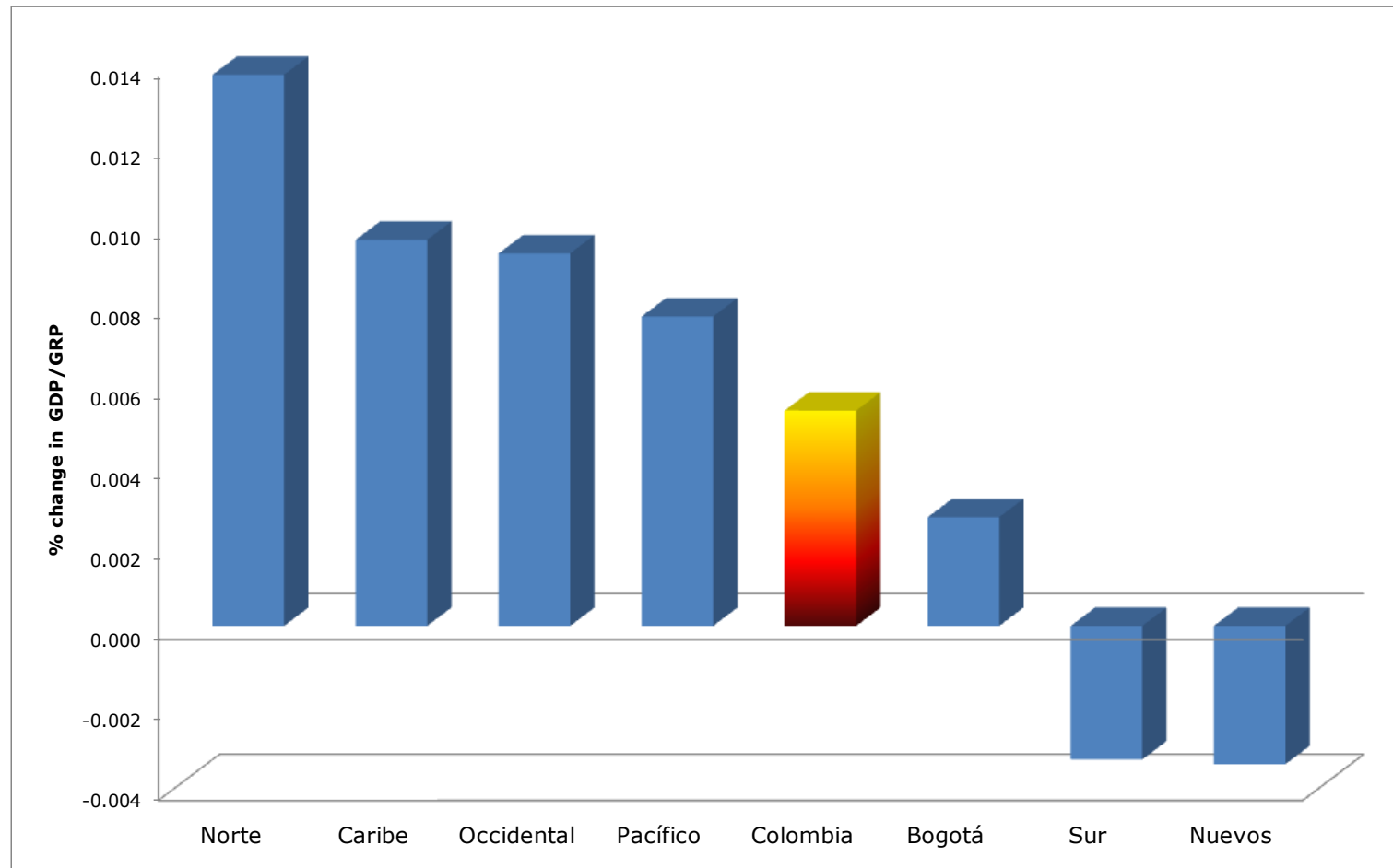
Colombian Regions



Colombian Departments



Macro-regional effects of regional integration



Model pre-selection and NEG

Pre-selection shapes the policy analysis in a way that one would expect the model to reproduce empirical regularities evidenced from tests of equilibrium equations derived from structural NEG models

We used the model results to capture the embedded relationship between regional wages and market access and supplier access in a context of regional integration

Wage equation considering displacements from the original equilibrium

Structural analysis of regional wages results

Dependent variable: Regional wage

<i>Variable</i>	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-Statistic</i>	<i>P-value</i>
<i>Constant</i>	-0.0098	0.0004	-24.3539	0.0000
<i>Interregional exports</i>	0.1940	0.0425	4.5646	0.0001
<i>International exports</i>	0.2535	0.0207	12.2192	0.0000
<i>Interregional imports</i>	-0.1176	0.0321	-3.6591	0.0010
<i>International imports</i>	0.1636	0.0372	4.4013	0.0001

Obs.: Variables in percentage-change form

R-squared = 0.9613

Analytically important transportation links

For each transportation link, we can calculate its contribution to specific outcomes, considering different dimensions of regional policy

To obtain a finer perspective on the analytically most important transportation links for optimizing a given policy target (regional/national growth), we can decompose the results into region-to-region links

Key links based on their influence on each policy strategy are highlighted

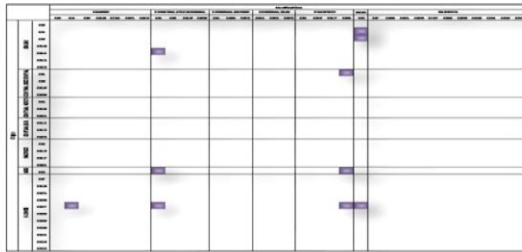
Row = market access

Column = supplier access

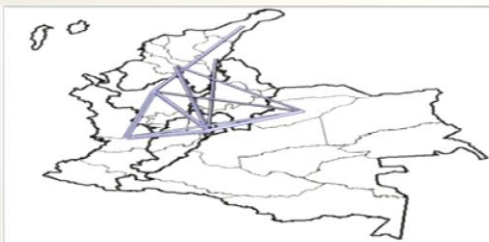
How do we read the following slides?

Real GDP– Colombia

- Policy target (real GDP, real GRP by region)



- Long-run analytically important transportation links (top 10)
- Highlighted cells indicate transportation links that contribute most for achieving the policy goal
- Rows (origin) represent forward linkages, and columns (destination) backward linkages



- Cartographical representation of the table, highlighting the desire lines related to the “top 10” links

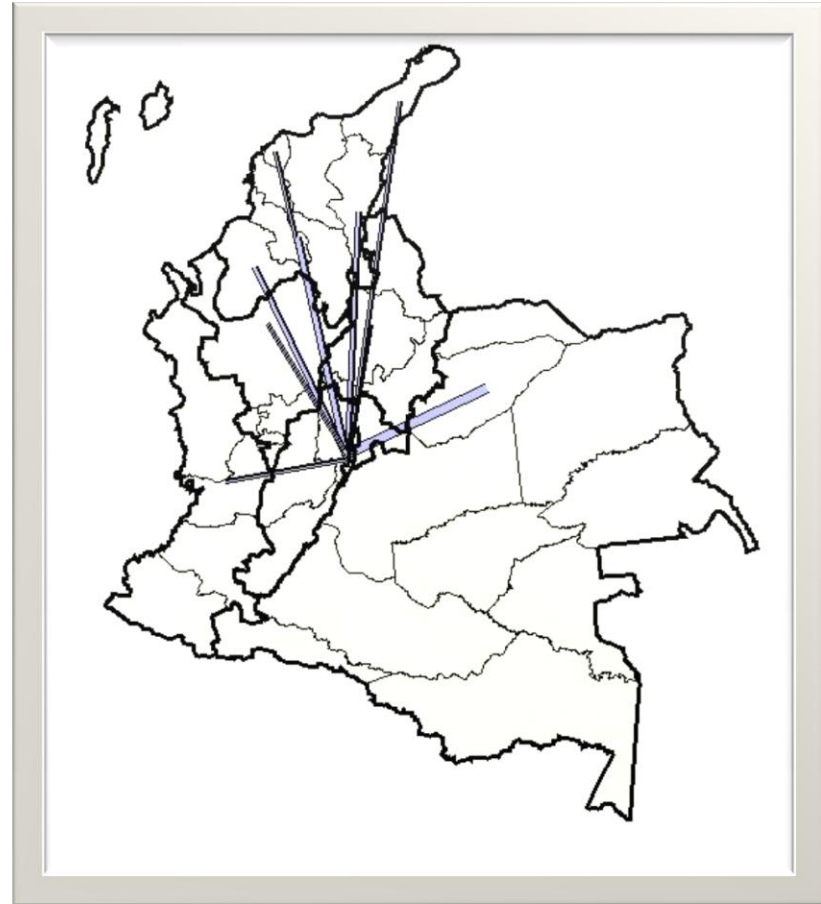
Real GDP- Colombia

		Destination																																																															
		CARIBE						CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO				BOG	NUEVOS																																										
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33																															
Origin CARIBE	D2																																																																
	D4																																																																
	D9																																																																
	D10																																																																
	D14																																																																
	D15																																																																
	D22																																																																
Origin CENTRAL OCCIDENTAL	D1																																																																
	D6																																																																
	D19																																																																
	D20																																																																
Origin CENTRAL NORTE	D5																																																																
	D18																																																																
	D21																																																																
Origin CENTRAL SUR	D11																																																																
	D13																																																																
	D23																																																																
Origin PACIFICO	D8																																																																
	D12																																																																
	D17																																																																
	D24																																																																
Origin BOG	D3																																																																
	D7																																																																
Origin NUEVOS	D16																																																																
	D25																																																																
	D26																																																																
	D27																																																																
	D28																																																																
	D29																																																																
	D30																																																																
	D31																																																																
	D32																																																																
	D33																																																																



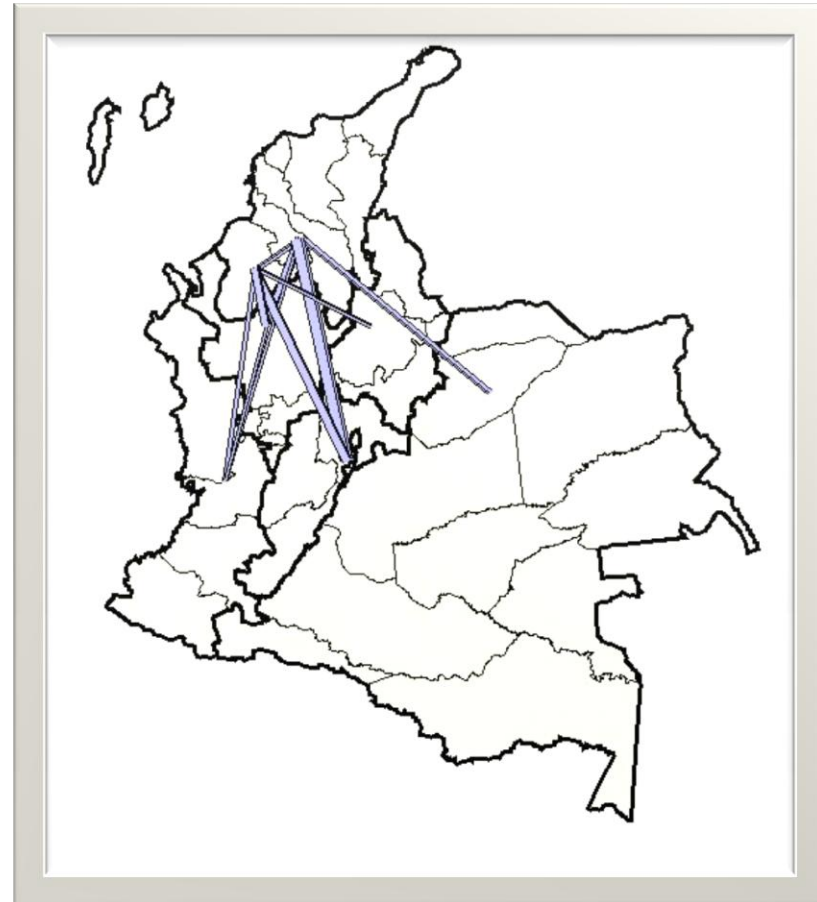
Real GRP – Bogotá

		Destination																																																		
		CARIBE						CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO				BOG	NUEVOS																													
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33																		
Origin	CARIBE																																																			
	CENTRAL OCCIDENTAL																																																			
CENTRAL NORTE																																																				
CENTRAL SUR																																																				
PACIFICO																																																				
BOG																																																				
NUEVOS																																																				



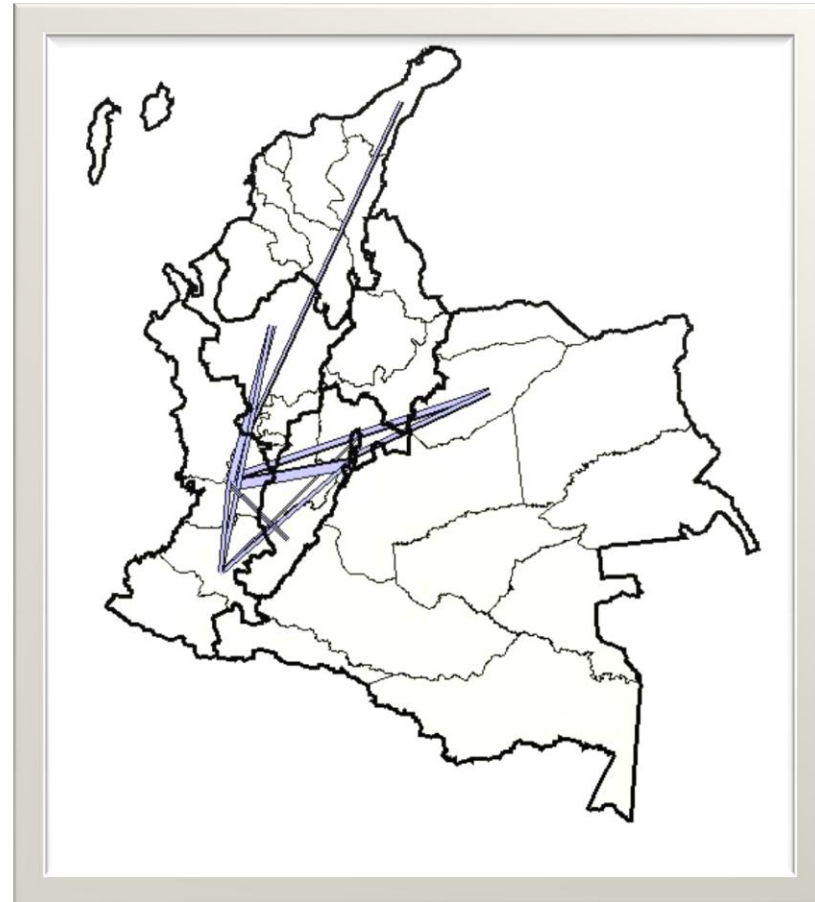
Real GRP – Caribe

Origin		Destination																																				
		CARIBE					CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO				BOG	NUEVOS																
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33				
CARIBE	D2																																					
	D4																																					
	D9																																					
	D10																																					
	D14																																					
	D15																																					
	D22																																					
CENTRAL OCCIDENTAL	D1																																					
	D6																																					
	D19																																					
	D20																																					
CENTRAL NORTE	D5																																					
	D18																																					
	D21																																					
CENTRAL SUR	D11																																					
	D13																																					
	D23																																					
PACIFICO	D8																																					
	D12																																					
	D17																																					
	D24																																					
BOG	D3																																					
NUEVOS	D7																																					
	D16																																					
	D25																																					
	D26																																					
	D27																																					
	D28																																					
	D29																																					
	D30																																					
	D31																																					
	D32																																					
	D33																																					



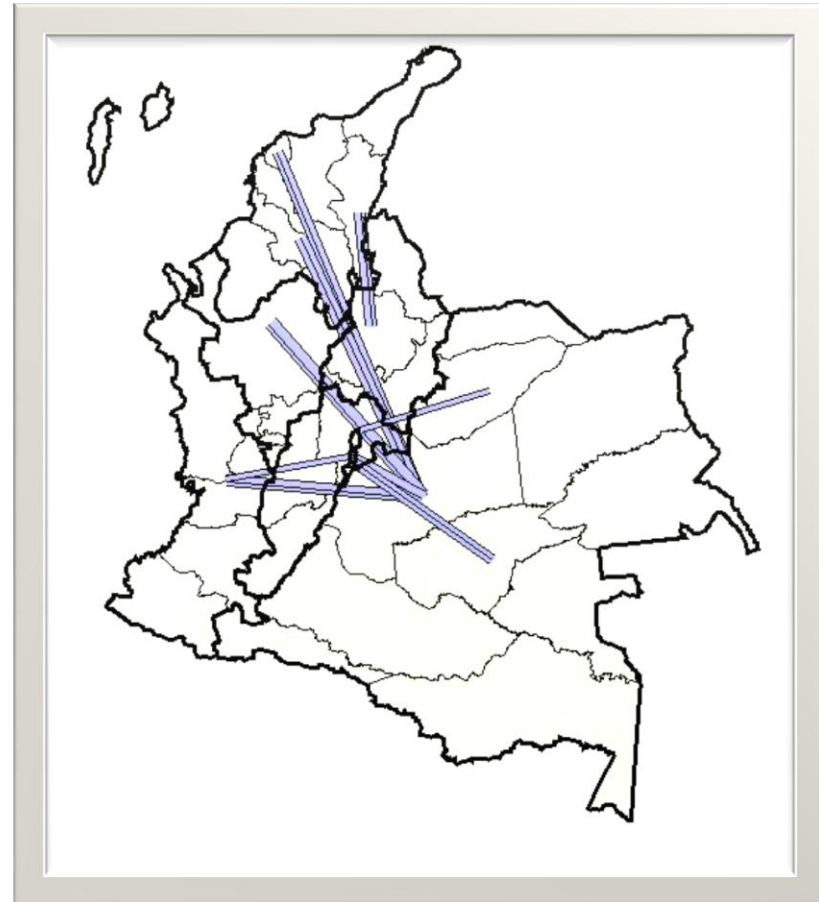
Real GRP – Pacífico

		Destination																																					
		CARIBE						CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO				BOG	NUEVOS																
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33					
Origin	CARIBE	D2																																					
		D4																																					
		D9																																					
		D10																																					
		D14																																					
		D15																																					
	D22																																						
	CENTRAL OCCIDENTAL	D1																																					
		D6																																					
		D19																																					
		D20																																					
	CENTRAL NORTE	D5																																					
		D18																																					
		D21																																					
	CENTRAL SUR	D11																																					
		D13																																					
		D23																																					
	PACIFICO	D8																																					
		D12																																					
		D17																																					
		D24																																					
	BOG	D3																																					
NUEVOS	D7																																						
	D16																																						
	D25																																						
	D26																																						
	D27																																						
	D28																																						
	D29																																						
	D30																																						
	D31																																						
	D32																																						
	D33																																						



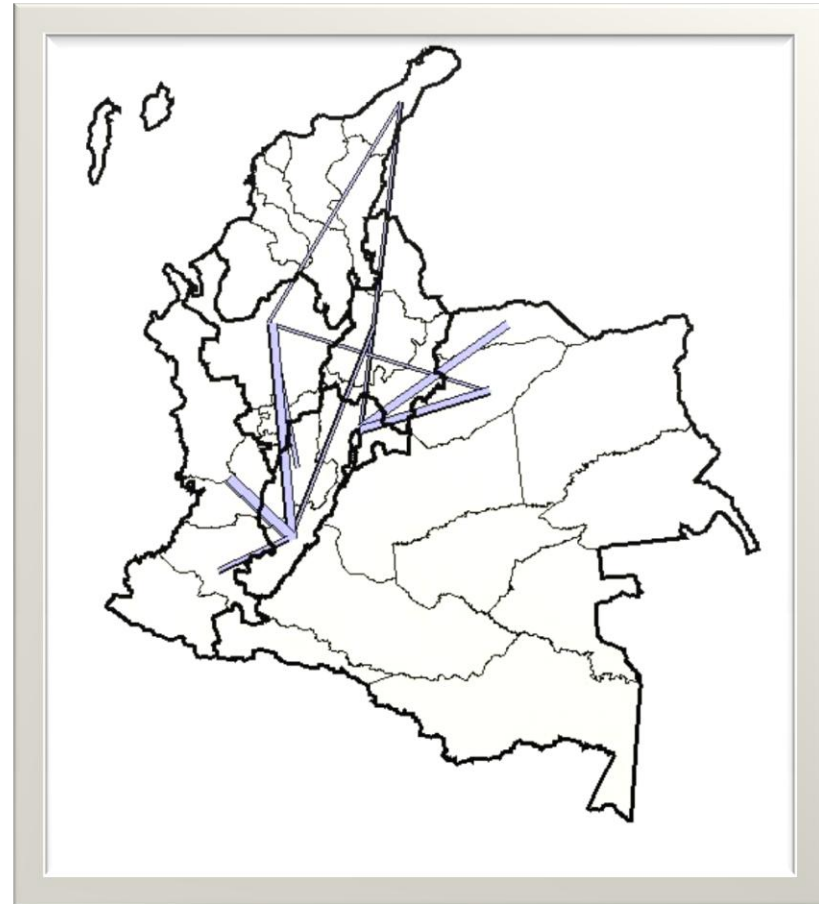
Real GRP – Nuevos

		Destination																																
		CARIBE					CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO				BOG	NUEVOS												
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33
Origin	CARIBE	D2																																
		D4																																
		D9																																
		D10																																
		D14																																
		D15																																
	CENTRAL OCCIDENTAL	D22																																
		D1																																
		D6																																
		D19																																
	CENTRAL NORTE	D20																																
		D5																																
		D18																																
	CENTRAL SUR	D21																																
		D11																																
		D13																																
	PACIFICO	D23																																
D8																																		
D12																																		
D17																																		
BOG	D24																																	
	D3																																	
	D7																																	
NUEVOS	D16																																	
	D25																																	
	D26																																	
	D27																																	
	D28																																	
	D29																																	
	D30																																	
	D31																																	
	D32																																	
	D33																																	



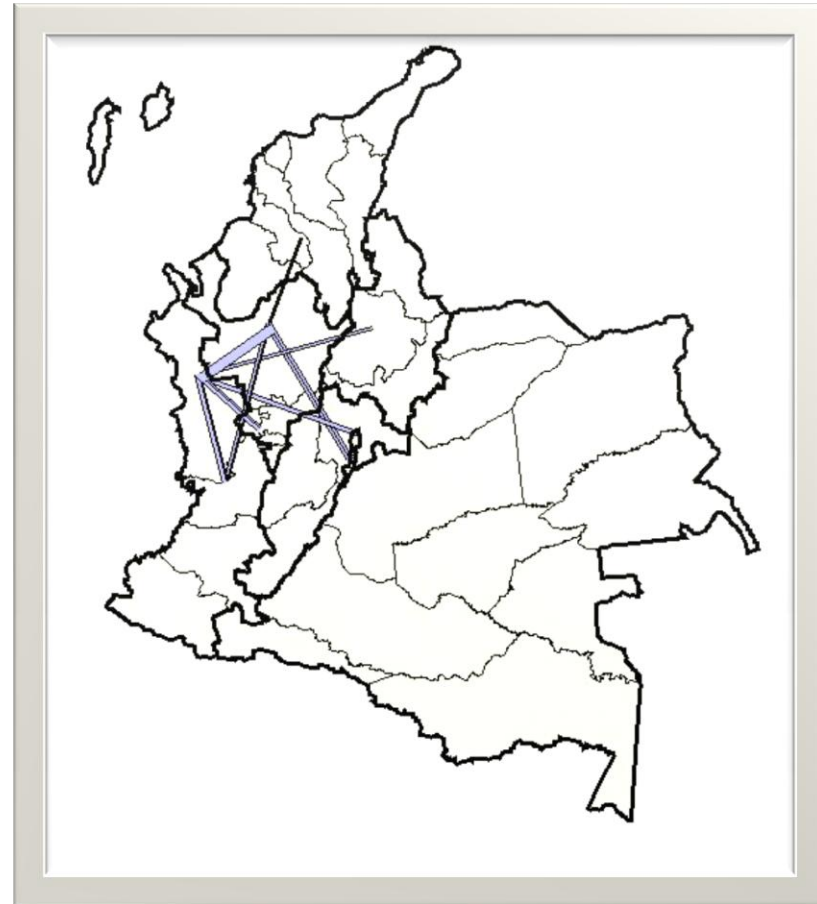
Real GRP – Central Sur

		Destination																																					
		CARIBE					CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO				BOG	NUEVOS																	
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33					
Origin	CARIBE																																						
	CENTRAL OCCIDENTAL																																						
	CENTRAL NORTE																																						
	CENTRAL SUR																																						
	PACIFICO																																						
	BOG																																						
NUEVOS	D7																																						
	D16																																						
	D25																																						
	D26																																						
	D27																																						
	D28																																						
	D33																																						



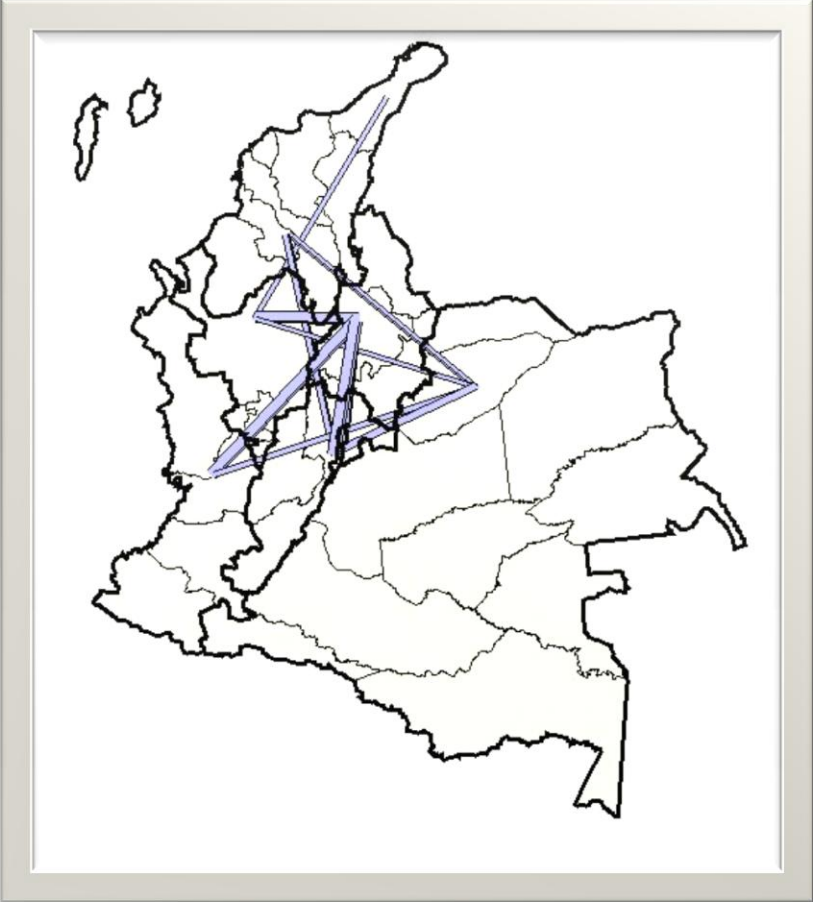
Real GRP – Central Occidental

		Destination																																			
		CARIBE					CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO				BOG	NUEVOS															
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33			
Origin	CARIBE	D2																																			
		D4							■																												
		D9																																			
		D10																																			
		D14																																			
		D15																																			
	D22																																				
	CENTRAL OCCIDENTAL	D1	■																																		
		D6																																			
		D19																																			
		D20																																			
	CENTRAL NORTE	D5																																			
		D18																																			
		D21																																			
	CENTRAL SUR	D11																																			
		D13																																			
		D23																																			
	PACIFICO	D8																																			
		D12								■		■		■	■																						
		D17																																			
		D24																																			
	BOG	D3								■																											
NUEVOS	D7																																				
	D16																																				
	D25																																				
	D26																																				
	D27																																				
	D28																																				
	D29																																				
	D30																																				
	D31																																				
	D32																																				
	D33																																				



Real GRP – Norte

		Destination																																
		CARIBE					CENTRAL OCCIDENTAL				CENTRAL NORTE			CENTRAL SUR			PACIFICO			BOG	NUEVOS													
		D2	D4	D9	D10	D14	D15	D22	D1	D6	D19	D20	D5	D18	D21	D11	D13	D23	D8	D12	D17	D24	D3	D7	D16	D25	D26	D27	D28	D29	D30	D31	D32	D33
Origin	CARIBE																																	
	CENTRAL OCCIDENTAL																																	
	CENTRAL NORTE																																	
	CENTRAL SUR																																	
	PACIFICO																																	
	BOG																																	
NUEVOS																																		



Implications of regional integration for regional growth

We present a visualization technique that provides an opportunity to explore regional characteristics of the Colombian economy, reflecting the spatial economic phenomena of backward and forward linkages specifications in a fully integrated interregional system

The results are presented in a way that helps identifying the different patterns of spatial integration from a **region's own perspective**

HBC figure

Basic information

The basic information used to build the HBC figure is drawn from matrices of results that contain, for each Departamento, the GRP effect of reductions in transportation costs for every origin-destination pair in the Colombian system.

A typical element of this matrix is the percentage change in GRP in region r , associated with a 1% reduction in transport costs from s to q

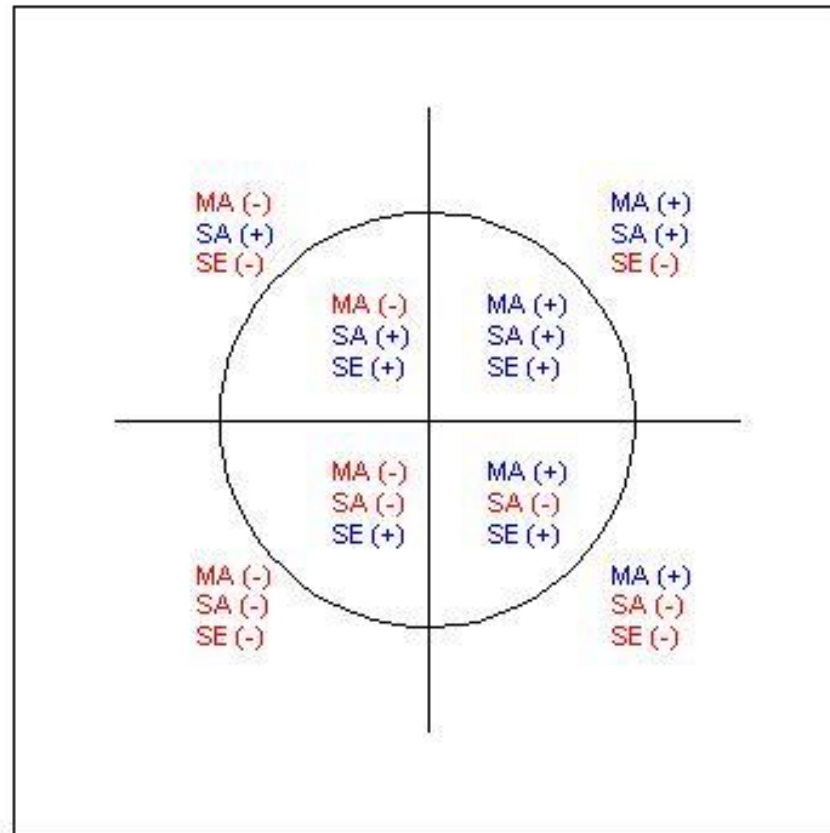
It is possible to aggregate this information in such a way that we obtain three summary measures reflecting the isolated effects of increasing the region's direct access to markets (MA_r); increasing direct access to suppliers (SA_r); as well as the indirect effects associated with transportation costs reductions outside the region (SE_r)

Summary matrix of results for GRP effects

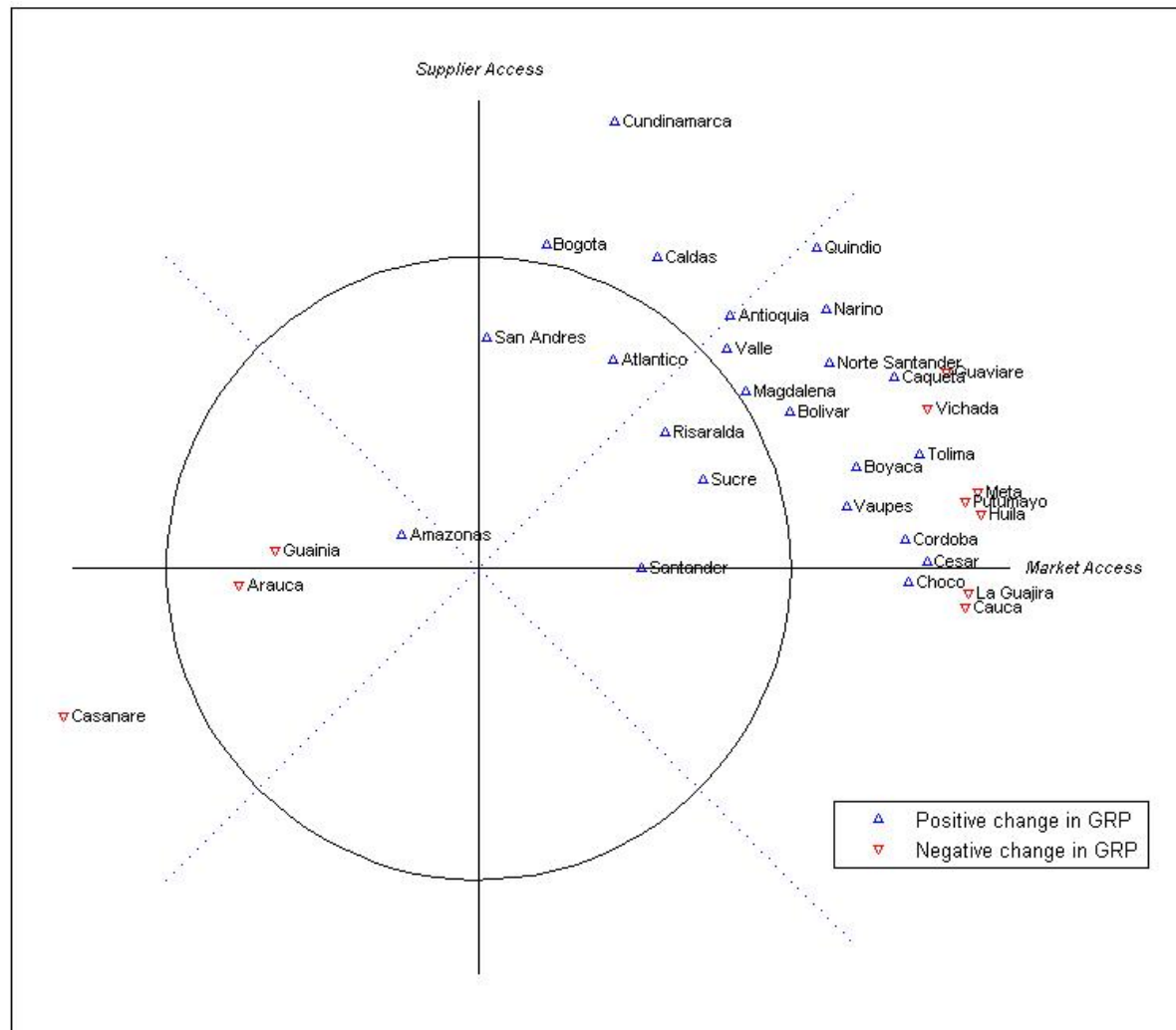
		<i>Destination</i>	
		<i>r</i>	<i>R</i>
<i>Origin</i>	<i>r</i>	0	$MA_r = \sum_q y_{sq}^r = y_{s\bullet}^r, \text{ for } s = r$
	<i>R</i>	$SA_r = \sum_s y_{sq}^r = y_{\bullet q}^r, \text{ for } q = r$	$SE_r = \sum_s \sum_q y_{sq}^r = y_{\bullet\bullet}^r, \text{ for } s, q \neq r$

r = study region; *R* = rest of the country

Schematic representation of the HBC figure



Typology of regions according to their growth-orientation with increasing integration



Role of increasing returns

Qualitative sensitivity analysis

$$X1PRIM(j, q) = A1(j, q) * A1PRIM(j, q) * [\alpha(j, q)Z(j, q)]^{MRP(j, q)}$$

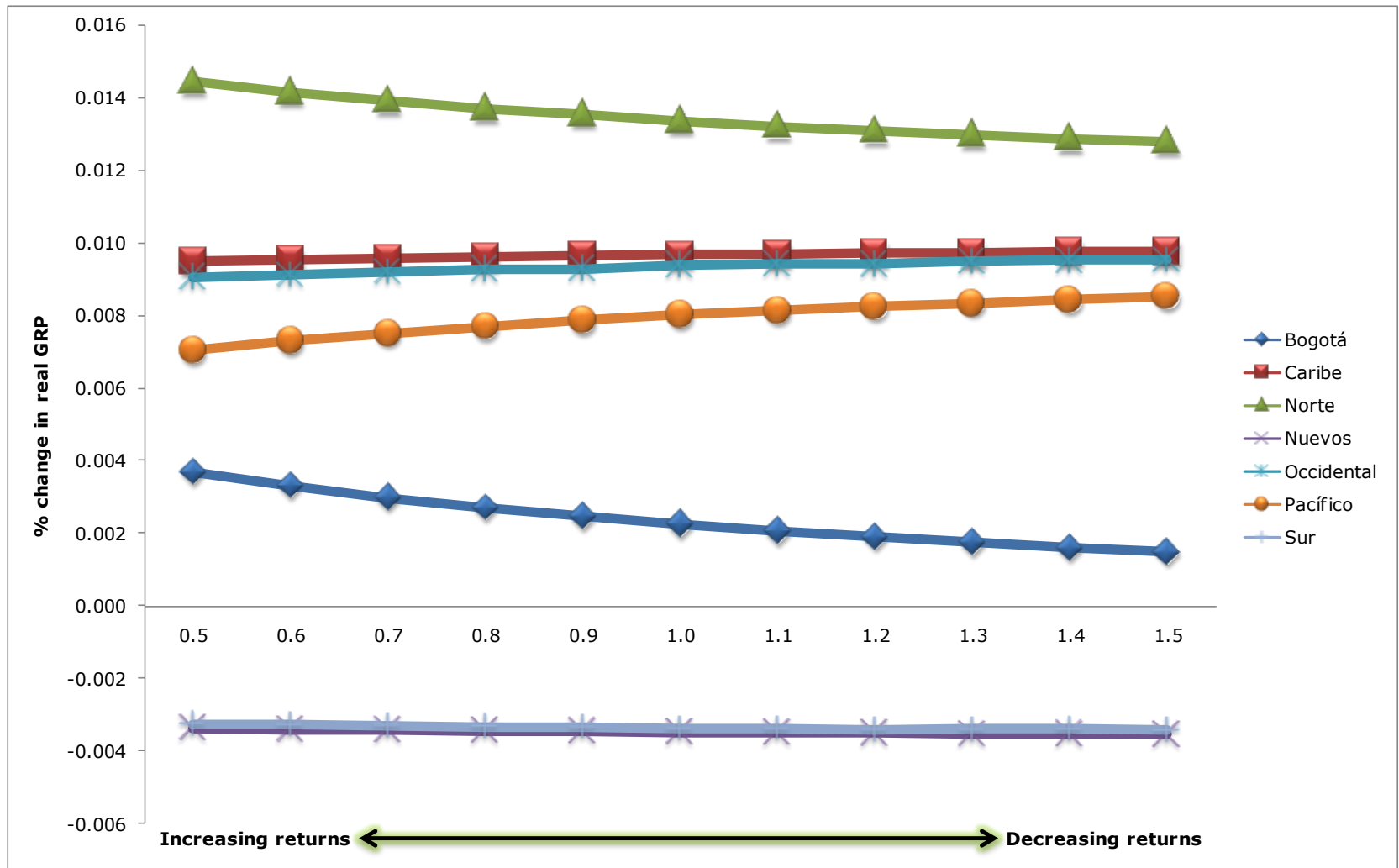
$$MRP \in [0.5, 1.5]$$

Increasing returns in manufacturing sector in Bogotá

- 31.5% of VA and 23.1 % of employment (2002-2005)

Working hypothesis: Bogotá (core region) could potentially further benefit from improvements in the transportation sector by exploiting scale economies

Effects of regional integration under different levels of agglomeration economies in Bogotá



Systematic Sensitivity Analysis

The scenarios related to the regional integration experiment discussed above were employed using the Gaussian quadrature approach to establish confidence intervals for the main results

The range for the parameters in the first group of sensitivity analyses was set to $\pm 25\%$ around the default values, with independent, symmetric, triangular distributions for the set of parameters related to the **trade elasticities**

The second group of sensitivity analyses was carried out in the **scale economies parameters** in the regional manufacturing sectors ($\pm 25\%$)

Systematic Sensitivity Analysis: GDP/GRP changes (%)

	Trade elasticities		Scale economies parameters	
	Lower bound	Upper bound	Lower bound	Upper bound
D1	0.0041	0.0123	0.0092	0.0094
D2	0.0061	0.0071	0.0064	0.0066
D3	0.0012	0.0019	0.0011	0.0019
D4	0.0198	0.0284	0.0237	0.0240
D5	0.0023	0.0071	0.0039	0.0044
D6	0.0028	0.0039	0.0035	0.0036
D7	-0.0026	0.0049	-0.0001	0.0004
D8	-0.0517	0.0265	-0.0244	-0.0218
D9	0.0001	0.0016	0.0007	0.0007
D10	0.0145	0.0197	0.0165	0.0166
D11	-0.0009	0.0023	0.0002	0.0002
D12	-0.1257	0.2372	0.1024	0.1048
D13	-0.0289	-0.0045	-0.0205	-0.0202
D14	-0.0014	-0.0004	-0.0011	-0.0009
D15	0.0039	0.0059	0.0046	0.0048
D16	-0.0082	-0.0048	-0.0072	-0.0068
D17	0.0008	0.0070	0.0030	0.0031
D18	0.0011	0.0056	0.0027	0.0030
D19	-0.0012	0.0025	0.0002	0.0002
D20	-0.0051	0.0407	0.0236	0.0239
D21	0.0190	0.0266	0.0215	0.0221
D22	0.0125	0.0197	0.0157	0.0161
D23	-0.0019	0.0064	0.0011	0.0013
D24	0.0103	0.0119	0.0108	0.0112
D25	0.0060	0.0307	0.0210	0.0214
D26	-0.0050	-0.0035	-0.0047	-0.0044
D27	-0.0024	-0.0013	-0.0021	-0.0019
D28	-0.1390	0.1005	-0.0338	-0.0315
D29	-0.0201	-0.0102	-0.0181	-0.0142
D30	-0.0064	-0.0013	-0.0048	-0.0044
D31	0.0029	0.0053	0.0039	0.0039
D32	0.0120	0.0180	0.0155	0.0155
D33	-0.0047	-0.0006	-0.0037	-0.0025
Colombia	0.0051	0.0054	0.0051	0.0052

Outline

Motivation

The B-MARIA-27 and the CEER models

Simulation results

✓ Final remarks

Final remarks

We depart from Haddad and Hewings (2005) modeling approach, which offers some preliminary steps in the marriage of some of the theoretical foundations of NEG with spatial CGE models

Potential modeling strategy to be pursued in order to reinforce policy relevance of NEG-based models

Its ability to handle increasing returns to scale and transportation costs in an integrated spatial economic system with explicit forward and backward linkages places spatial CGE models as strong candidates for bridging the gap between theory and practice

Final remarks

Potential applications:

Impact analysis of transportation projects

- Road improvements, tolls, paving, ...

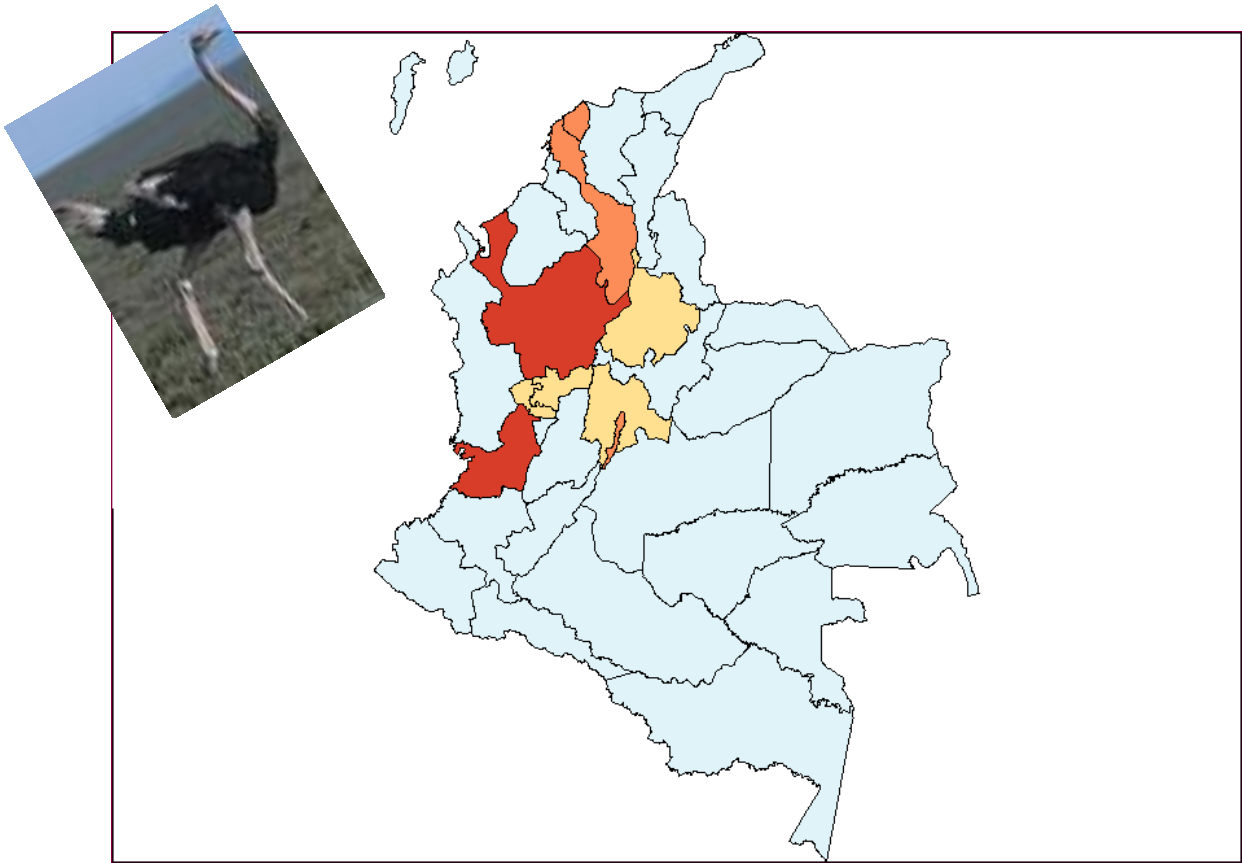
Adapt extraction method (I-O):

- Value of existence
- Unscheduled events

Treatment of spatial information and multimodal systems

(...)

What do you see in this picture?



Things about ostriches...

In Ancient Egypt mythology, usually, the feather was a symbol of Maat, the goddess of truth and order. The goddess was always shown wearing an **ostrich feather** in her hair. The feather by itself was her emblem.

In popular mythology, the Ostrich is famous for hiding its head in the sand at the first sign of danger.

Why the “Running Ostrich”?

Things to think about the “Colombian Running Ostrich”:

- It is interesting to link the shape of such spatial cluster, very dynamic in economic terms, to the goddess of truth and justice – it gives a flavor of *efficiency*;
- The ostrich is running towards the north (Europe, USA): it is well known that Colombia has stronger economic ties with these areas – one may think also about *catch-up* (convergence);
- The cluster seems to be self-contained; spatial competition does not play a relevant role outside the cluster – “hiding the head” may be associated with *self-sufficiency*;
- The fact that the female ostrich may leave the nest unattended (because the eggs are too thick-shelled to be easily broken open by predators) was mentioned in the Bible as the reason why the bird was chastised as a bad parent in the Book of Job (Job 39:13-18); ostriches as proverbial examples of poor parenting may be a metaphor for the low HDI in the region.