NEREUS

Núcleo de Economia Regional e Urbana
da Universidade de São Paulo

The University of São Paulo
Regional and Urban Economics Lab

Smart Specialization in Colombia: A Note on Miyazawa and Input-Output Linkages

"International Workshop on Interregional Economic Modeling: Applications for the Colombian Economy"

Banco de la República, Cartagena, Colombia
March 19-21, 2020

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Introduction

Economic base: Douglas North (1952)

Smart specialization/economic geography (McCann & Ortega-Argilés, 2013):

- **Embeddedness (input-output linkages)**
- Relatedness (knowledge spillovers)
- Connectivity (network, face-to-face contacts, and mobility of human capital)

Is the region specialized in activities with strong regional connections to certain industries, in terms of input-output linkages and labor force?

How integrated is the regional economic base with the rest of the economy (local and national)?

Miyazawa multipliers

Miyazawa (1966, 1968, 1971); Sonis e Hewings (1993, 1995, 1997)

Formulation of interregional income multipliers and alternative procedures for decomposing an economic system in order to reveal the specific contributions of output change to different regions

Miyazawa's application of internal and external multipliers

- Partition the Leontief inverse matrix
- Propagation of the internal activity and propagation of external activity

Economic base and Miyazawa multipliers

Two groups of sectors in each department of the Caribbean: economic base sectors and other sectors (non-economic base)

For a given Department, the partition of the Leontief inverse, considering the economic base criterion, allows to obtain three groups of analysis:

- G1 (sectors of the economic base within the region)
- G2 (non-economic base sectors within the region)
- G3 (rest of the country)

EB multipliers

Analysis will focus on the economic base backward and forward linkages:

$$(I-A)^{-1}=\begin{pmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{pmatrix}$$

EB forward linkages

EB backward linkages

Miyazawa decomposition

For a three-region scheme, the following pull-decomposition may be revealed:

$$A = \begin{pmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{pmatrix} = \begin{pmatrix} A_{11} & 0 & 0 \\ A_{21} & 0 & 0 \\ A_{31} & 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & A_{12} & 0 \\ 0 & A_{22} & 0 \\ 0 & A_{32} & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & A_{13} \\ 0 & 0 & A_{23} \\ 0 & 0 & A_{33} \end{pmatrix}$$

$$= A_1 + A_2 + A_3$$

Miyazawa decomposition (cont.)

$$(I-A)^{-1} = G_3 G_2 G_1 = \begin{pmatrix} I & 0 & A_{13}'\Delta_{33} \\ 0 & I & A_{23}'\Delta_{33} \\ 0 & 0 & \Delta_{33} \end{pmatrix} \begin{pmatrix} I & A_{12}'\Delta_{22} & 0 \\ 0 & \Delta_{22} & 0 \\ 0 & A_{32}'\Delta_{22} & I \end{pmatrix} \begin{pmatrix} \Delta_{11} & 0 & 0 \\ A_{21}\Delta_{11} & I & 0 \\ A_{31}\Delta_{11} & 0 & I \end{pmatrix}$$

where:

$\Delta_{11} = (I-A)^{-1}$

$\Delta_{22} = (I - A_{22} - A_{21}\Delta_{11}A_{12})^{-1}$

$\Delta_{33} = (I - A_{33} - A_{21}\Delta_{11}A_{13}) - [A_{32} + A_{21}\Delta_{11}A_{12}]\Delta_{22}[A_{23} + A_{21}\Delta_{11}A_{12}]^{-1}$

and

$A_{12}' = \Delta_{11}A_{12}$; $A_{32}' = A_{32} + A_{31}\Delta_{11}A_{12}$

$A_{23}' = A_{23} + A_{21}\Delta_{11}A_{12}$

$A_{13}' = \Delta_{11}A_{13} + \Delta_{11}A_{12}\Delta_{22} + (A_{23} + A_{21}\Delta_{11}A_{12})$

Definition of the economic base (EB)

Locational Quotient > 1 – share of the sector in the region is greater than in the total, the sector is said to be relatively concentrated

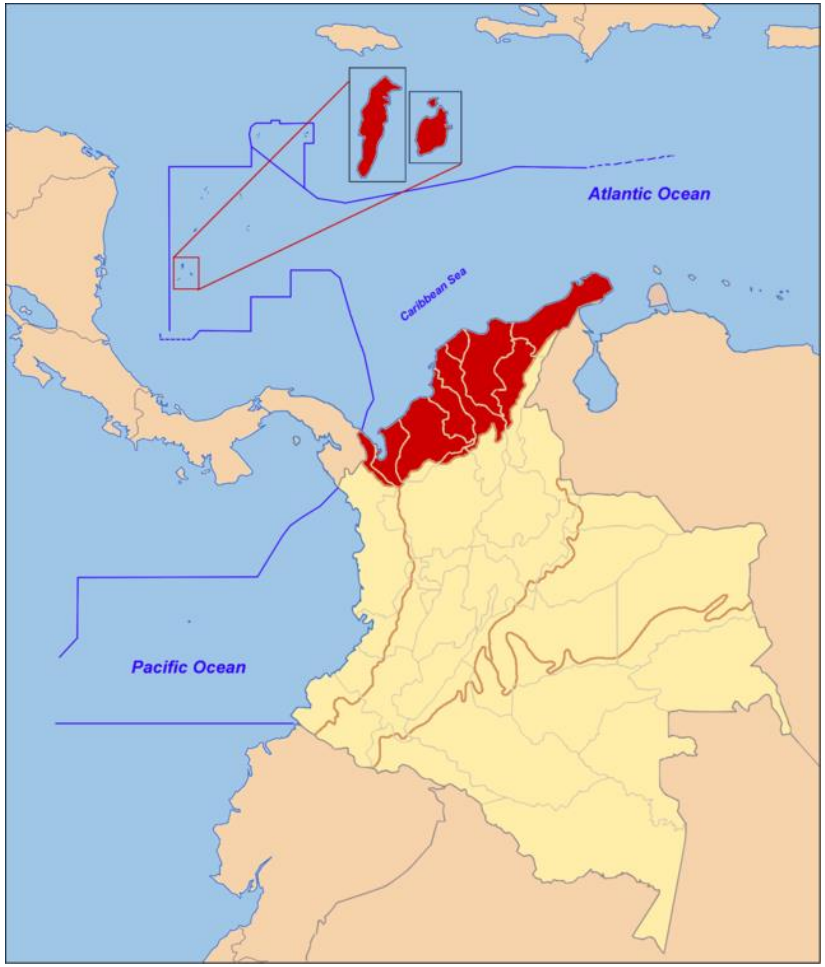
Relevant share of sectoral gross output – we use values greater than 1.85%, which represents the expected share of each sector (54 sectors), had they all had the same weight

Relevant export share in the sector's total sales – if this ratio is greater than 50%, the sector meets the third criterion (for services sectors, 30% share of total exports)

Export shares of EB activities, by Department

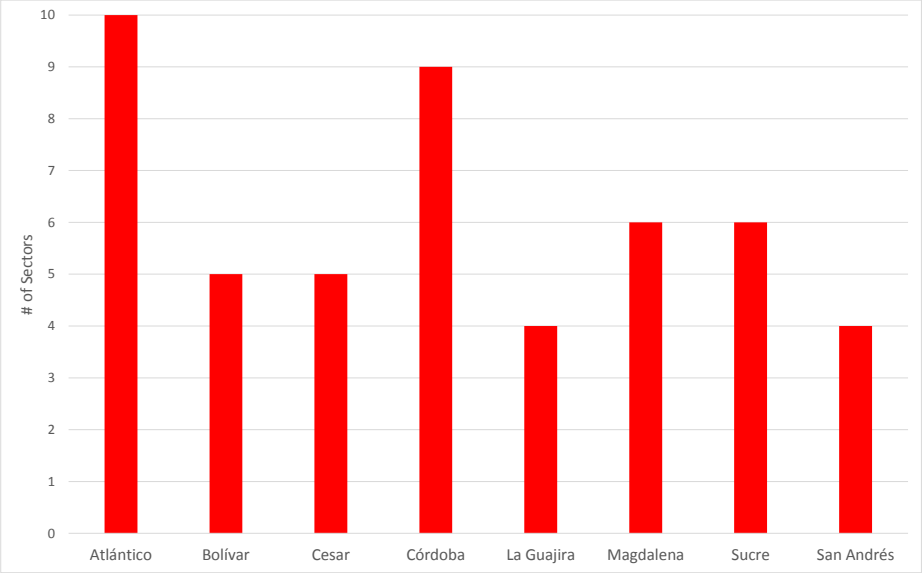
Code	Department	Intermediate Demand			Final Demand			Sales	Interregional Exports	International Exports	Total Exports
		EB	Non-EB	Rest of Colombia	Department	Rest of Colombia	Foreign Exports				
R1	Antioquia	8,102	12,099	13,347	6,628	8,822	6,554	**55,551**	39.9%	11.8%	51.7%
R2	Atlántico	4,558	2,104	5,621	5,246	5,211	3,916	**26,656**	40.6%	14.7%	55.3%
R3	Bogotá D.C.	19,920	15,771	21,902	50,183	30,848	2,929	**141,553**	37.3%	2.1%	39.3%
R4	Bolívar	3,701	1,533	8,761	3,059	3,877	290	**21,221**	59.6%	1.4%	60.9%
R5	Boyacá	2,363	1,475	7,861	1,073	3,314	33	**16,119**	69.3%	0.2%	69.5%
R6	Caldas	915	425	1,410	1,371	1,317	1,554	**6,991**	39.0%	22.2%	61.2%
R7	Caquetá	94	72	453	1,116	593	51	**2,378**	44.0%	2.2%	46.1%
R8	Cauca	1,528	1,303	3,839	2,773	2,495	860	**12,798**	49.5%	6.7%	56.2%
R9	Cesar	566	311	1,193	1,500	882	6,645	**11,096**	18.7%	59.9%	78.6%
R10	Córdoba	2,057	265	1,943	3,833	3,101	199	**11,398**	44.3%	1.7%	46.0%
R11	Cundinamarca	3,412	1,343	9,869	1,670	12,718	2,383	**31,395**	71.9%	7.6%	79.5%
R12	Chocó	107	43	1,819	670	760	56	**3,455**	74.6%	1.6%	76.3%
R13	Huila	1,021	637	3,474	799	1,204	913	**8,048**	58.1%	11.3%	69.5%
R14	La Guajira	447	80	645	843	553	4,710	**7,279**	16.5%	64.7%	81.2%
R15	Magdalena	805	167	1,344	2,522	1,778	1,203	**7,819**	39.9%	15.4%	55.3%
R16	Meta	2,614	238	9,538	265	2,616	18,084	**33,355**	36.4%	54.2%	90.7%
R17	Nariño	197	221	1,636	1,419	827	139	**4,439**	55.5%	3.1%	58.6%
R18	Norte de Santander	674	504	1,468	2,040	1,159	660	**6,505**	40.4%	10.1%	50.5%
R19	Quindío	189	109	827	666	463	305	**2,559**	50.4%	11.9%	62.3%
R20	Risaralda	466	946	732	1,375	1,106	1,868	**6,493**	28.3%	28.8%	57.1%
R21	Santander	3,580	3,766	10,986	2,310	3,676	4,930	**29,248**	50.1%	16.9%	67.0%
R22	Sucre	506	260	979	1,180	654	145	**3,723**	43.9%	3.9%	47.7%
R23	Tolima	687	523	2,991	1,724	2,217	178	**8,319**	62.6%	2.1%	64.7%
R24	Valle del Cauca	4,614	9,080	11,506	9,731	10,202	4,251	**49,384**	44.0%	8.6%	52.6%
R25	Arauca	410	40	957	551	961	2,828	**5,748**	33.4%	49.2%	82.6%
R26	Casanare	656	165	2,050	85	794	10,578	**14,327**	19.8%	73.8%	93.7%
R27	Putumayo	320	24	1,269	300	879	1,045	**3,836**	56.0%	27.2%	83.2%
R28	San Andrés...	117	19	257	295	730	193	**1,612**	61.2%	12.0%	73.2%
R29	Amazonas	67	14	122	125	270	41	**639**	61.3%	6.4%	67.7%
R30	Guainía	18	4	17	64	67	52	**222**	37.8%	23.4%	61.2%
R31	Guaviare	17	8	91	219	183	9	**527**	51.9%	1.7%	53.6%
R32	Vaupés	4	3	14	52	60	15	**149**	49.7%	10.2%	59.9%
R33	Vichada	41	8	110	93	178	5	**435**	66.2%	1.1%	67.4%

Caribbean departments

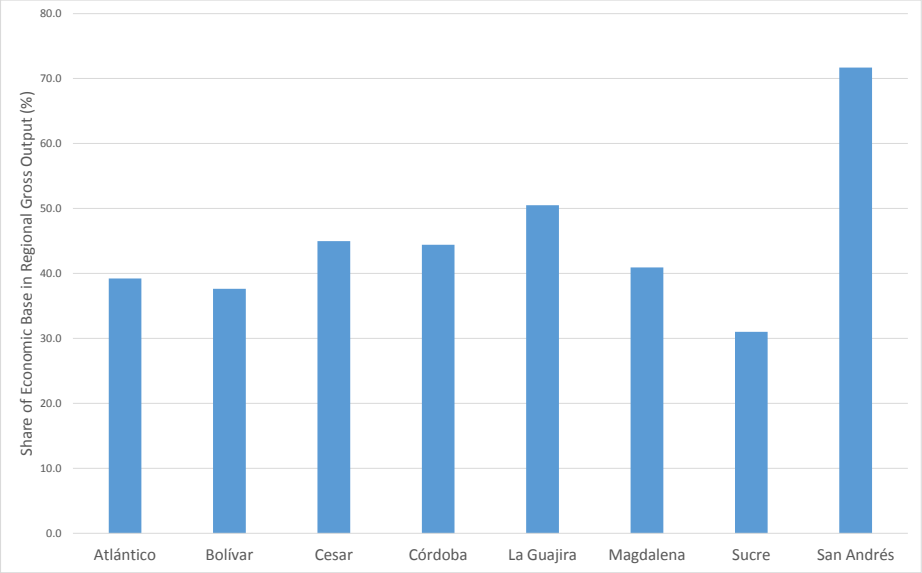


Identification of the economic base (EB)

Number of Sectors: EB

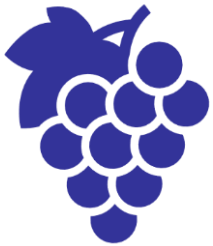


Share in Gross Output: EB Sectors



Economic base: Atlántico

10 sectors of the EB represent 39.2% of total GO

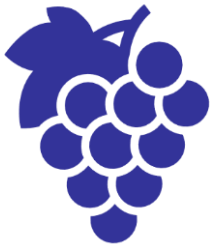


Meat processing (S10); Elaboration of vegetable and animal oils (S11); Preparation of beverages and tobacco products (S18); Coke and petroleum refining (S23); Manufacture of basic chemical substances (S24); Non-metallic mineral products (S26)

Energy (S33); Land transport (40); Accommodation and food services (S45); Human health and social services activities (52)

Economic base: Bolívar

5 sectors of the EB represent 37.6% of total GO

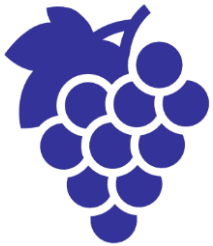


Coke and petroleum refining (S23); Non-metallic mineral products (S26)

Land transport (40); Accommodation and food services (S45); Human health and social services activities (52)

Economic base: Cesar

5 sectors of the EB represent 45.0% of total GO

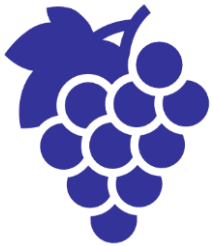


Agriculture (S1); Livestock (S3); Extraction of stone and lignite coal (S6)

Accommodation and food services (S45); Human health and social services activities (52)

Economic base: Córdoba

9 sectors of the EB represent 44.4% of total GO

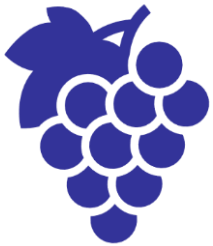


Agriculture (S1); Livestock (S3); Meat processing (S10); Dairy products (S12); Starch, bakery and pasta grinding (S13)

Energy (S33); Accommodation and food services (S45); Education (51); Human health and social services activities (52)

Economic base: La Guajira

4 sectors of the EB represent 50.5% of total GO

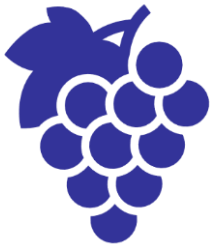


Livestock (S3); Extraction of stone and lignite coal (S6)

Energy (S33); Accommodation and food services (S45)

Economic base: Magdalena

6 sectors of the EB represent 40.9% of total GO

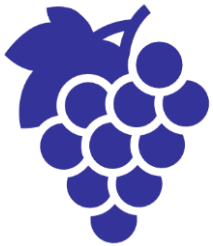


Agriculture (S1); Livestock (S3); Elaboration of vegetable and animal oils (S11)

Accommodation and food services (S45); Education (51); Human health and social services activities (52)

Economic base: Sucre

6 sectors of the EB represent 31.0% of total GO

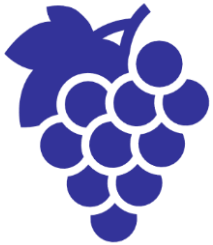


Agriculture (S1); Livestock (S3); Non-metallic mineral products (S26)

Storage and activities complementary to transport (S43); Accommodation and food services (S45); Human health and social services activities (52)

Economic base: San Andrés

4 sectors of the EB represent
71.7% of total GO



Trade (S38); Air transport (S42);
Accommodation and food services
(S45); Public Administration(50)

Backward and forward linkages

Backward linkages:

How strong are the intra-regional linkages among EB activities and other activities in the region?

Forward linkages:

How important is the demand from other sectors/regions in the country to the EB activities?

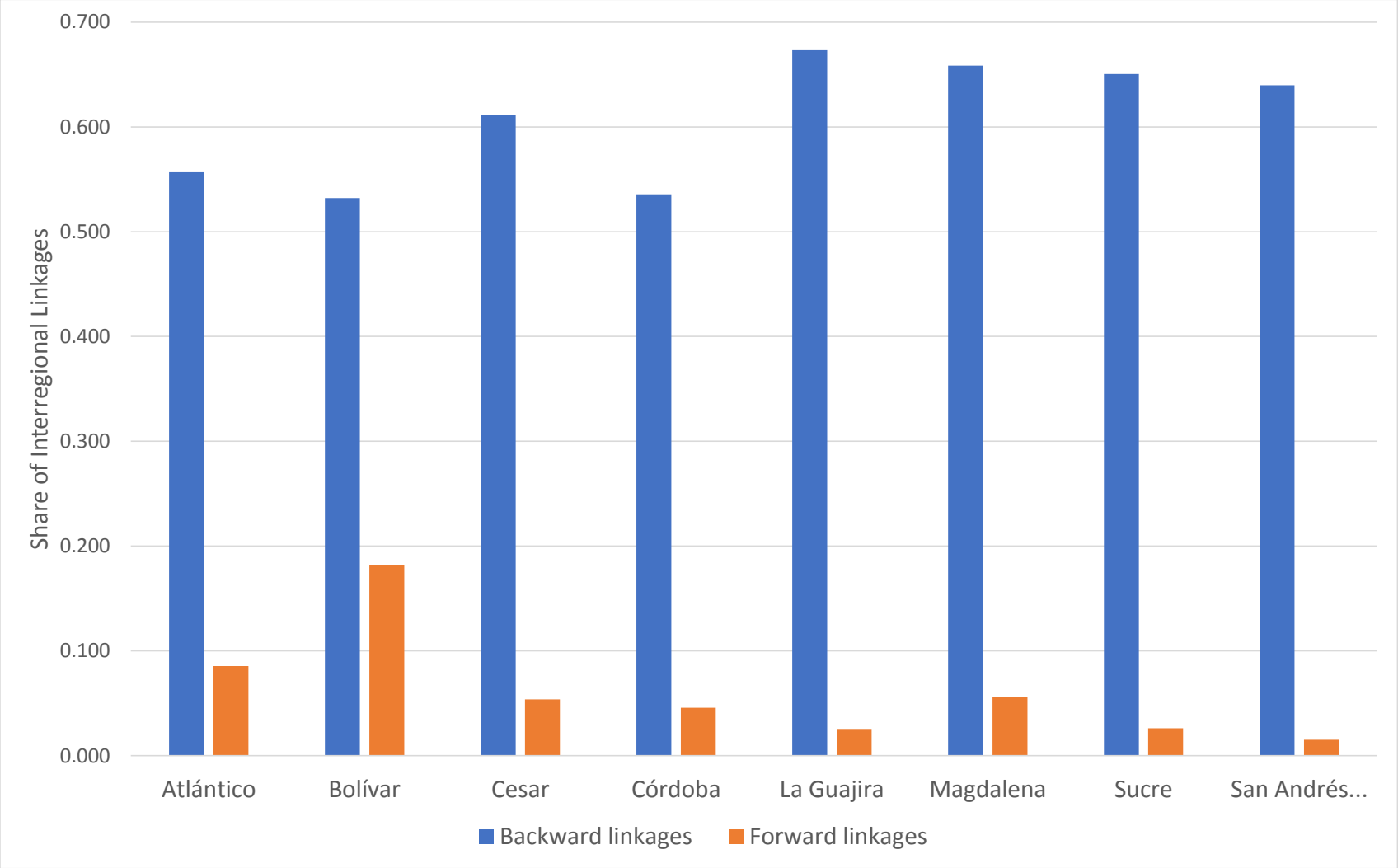
Decomposition of backward and forward linkages

Code	Department	Gross Output (COP billions)			# of sectors	*Linkages*					
						Backward Linkages			*Forward Linkages*		
		Total	Economic Base	EB (%)		*EB*	*Non-EB*	*Rest of Colombia*	*EB*	*Non-EB*	*Rest of Colombia*
R1	Antioquia	214,750	55,551	25.87	8	0.2359	0.2826	0.4815	0.2182	0.6150	0.1667
R2	Atlántico	67,968	26,656	39.22	10	0.2476	0.1957	0.5567	0.3895	0.5249	0.0856
R3	Bogotá D.C.	344,379	141,553	41.10	6	0.3717	0.3290	0.2993	0.1428	0.5781	0.2791
R4	Bolívar	56,380	21,221	37.64	5	0.2609	0.2071	0.5321	0.2345	0.5841	0.1814
R5	Boyacá	41,046	16,119	39.27	8	0.2564	0.1606	0.5830	0.2412	0.6457	0.1131
R6	Caldas	24,042	6,991	29.08	7	0.1745	0.1785	0.6470	0.3639	0.5818	0.0543
R7	Caquetá	6,165	2,378	38.58	4	0.0748	0.1404	0.7848	0.1148	0.8619	0.0233
R8	Cauca	26,536	12,798	48.23	10	0.2202	0.1496	0.6302	0.2358	0.7109	0.0533
R9	Cesar	24,669	11,096	44.98	5	0.1814	0.2074	0.6112	0.2694	0.6768	0.0538
R10	Córdoba	25,660	11,398	44.42	9	0.3018	0.1624	0.5358	0.5325	0.4218	0.0457
R11	Cundinamarca	87,944	31,395	35.70	7	0.1763	0.1610	0.6627	0.2892	0.4826	0.2282
R12	Chocó	5,979	3,455	57.78	6	0.0983	0.0829	0.8188	0.1306	0.7903	0.0791
R13	Huila	25,506	8,048	31.55	6	0.2770	0.1426	0.5804	0.2032	0.7297	0.0671
R14	La Guajira	14,410	7,279	50.51	4	0.2305	0.0963	0.6732	0.2923	0.6822	0.0255
R15	Magdalena	19,102	7,819	40.93	6	0.1798	0.1617	0.6585	0.3708	0.5729	0.0562
R16	Meta	56,352	33,355	59.19	2	0.1330	0.1723	0.6948	0.0514	0.5722	0.3764
R17	Nariño	21,107	4,439	21.03	4	0.0863	0.1802	0.7335	0.0934	0.8347	0.0718
R18	Norte de Santander	23,088	6,505	28.18	5	0.1772	0.1654	0.6574	0.1805	0.7762	0.0432
R19	Quindío	11,430	2,559	22.39	5	0.1449	0.1493	0.7058	0.2834	0.6704	0.0461
R20	Risaralda	24,183	6,493	26.85	6	0.1093	0.2075	0.6832	0.1744	0.8055	0.0200
R21	Santander	91,388	29,248	32.00	7	0.1774	0.1730	0.6496	0.1661	0.6764	0.1575
R22	Sucre	12,007	3,723	31.01	6	0.1882	0.1613	0.6504	0.2692	0.7047	0.0260
R23	Tolima	31,524	8,319	26.39	7	0.1587	0.1844	0.6569	0.3063	0.5849	0.1088
R24	Valle del Cauca	139,437	49,384	35.42	9	0.1816	0.2940	0.5243	0.1550	0.7009	0.1440
R25	Arauca	8,628	5,748	66.61	6	0.1705	0.1313	0.6982	0.4032	0.5504	0.0464
R26	Casanare	24,610	14,327	58.22	4	0.0932	0.2509	0.6559	0.1343	0.7594	0.1064
R27	Putumayo	6,262	3,836	61.26	4	0.2058	0.1748	0.6195	0.4248	0.4849	0.0903
R28	San Andrés, Providencia	2,249	1,612	71.68	4	0.1059	0.2544	0.6396	0.2257	0.7591	0.0153
R29	Amazonas	1,050	639	60.82	7	0.2332	0.1603	0.6065	0.3574	0.6370	0.0055
R30	Guainía	564	222	39.29	5	0.1875	0.1441	0.6684	0.5207	0.4778	0.0014
R31	Guaviare	1,209	527	43.62	4	0.0915	0.1405	0.7680	0.1474	0.8464	0.0062
R32	Vaupés	421	149	35.25	3	0.0562	0.1144	0.8294	0.2775	0.7201	0.0024
R33	Vichada	895	435	48.65	6	0.2426	0.1724	0.5851	0.4378	0.5544	0.0078

Decomposition of backward and forward linkages

Code	Department	*Linkages*					
		Backward Linkages			*Forward Linkages*		
		EB	*Non-EB*	*Rest of Colombia*	*EB*	*Non-EB*	*Rest of Colombia*
R2	Atlántico	0.248	0.196	0.557	0.390	0.525	0.086
R4	Bolívar	0.261	0.207	0.532	0.234	0.584	0.181
R9	Cesar	0.181	0.207	0.611	0.269	0.677	0.054
R10	Córdoba	0.302	0.162	0.536	0.533	0.422	0.046
R14	La Guajira	0.231	0.096	0.673	0.292	0.682	0.026
R15	Magdalena	0.180	0.162	0.659	0.371	0.573	0.056
R22	Sucre	0.188	0.161	0.650	0.269	0.705	0.026
R28	San Andrés...	0.106	0.254	0.640	0.226	0.759	0.015

Decomposition of backward and forward linkages



Economic base and local labor markets

How strong is the capacity of the EB to create additional jobs in the local economy?

How many jobs in the economy are related to jobs in the EB?

- **EB (employment) multipliers**

How does the composition of jobs associated with the EB compare to the overall labor composition in the region?

Does the EB favor higher-skill jobs?

- **Location quotient of EB-related jobs**
- Implications for relatedness and connectivity

Does the EB enhance the quality of jobs?

Code	Department	EB Multiplier					QL			
			Education				Education			
		Employment	Elementary school	Middle school	High school	University education	Elementary school	Middle school	High school	University education
R1	Antioquia	2.80	18.00	3.85	2.24	1.99	1.436	1.161	1.012	0.747
R2	Atlántico	2.13	3.62	2.54	1.87	1.89	1.403	1.185	0.905	0.866
R3	*Bogotá D.C.*	*3.89*	*3.61*	*3.65*	*3.43*	*4.61*	*0.994*	*1.001*	*0.966*	*1.026*
R4	**Bolívar**	**1.73**	**1.81**	**1.80**	**1.64**	**1.72**	**0.786**	**0.926**	**1.089**	**1.092**
R5	Boyacá	1.40	1.40	1.27	1.54	2.87	1.590	1.250	0.944	0.414
R6	Caldas	4.36	7.55	4.99	3.03	3.16	1.963	1.427	0.699	0.374
R7	*Caquetá*	*1.56*	*1.37*	*1.46*	*1.76*	*1.83*	*1.138*	*0.976*	*0.973*	*1.069*
R8	*Cauca*	*1.68*	*1.82*	*1.73*	*1.82*	*1.44*	*1.133*	*0.929*	*0.941*	*1.231*
R9	**Cesar**	**1.95**	**1.53**	**1.91**	**2.13**	**2.10**	**0.984**	**0.981**	**1.020**	**1.021**
R10	*Córdoba*	*1.69*	*1.49*	*1.78*	*1.83*	*1.53*	*1.067*	*0.997*	*0.867*	*1.156*
R11	Cundinamarca	2.34	2.76	1.98	2.96	3.88	1.911	1.153	0.892	0.626
R12	*Chocó*	*1.43*	*1.23*	*1.47*	*1.66*	*1.37*	*1.138*	*0.966*	*0.799*	*1.249*
R13	Huila	1.51	1.29	1.32	1.89	3.67	1.566	1.251	0.804	0.497
R14	La Guajira	2.47	2.05	2.59	2.71	2.26	0.733	1.027	1.227	0.920
R15	*Magdalena*	*1.55*	*1.30*	*1.61*	*1.62*	*1.50*	*1.044*	*0.964*	*0.873*	*1.324*
R16	**Meta**	**7.23**	**3.05**	**4.64**	**13.17**	**25.33**	**0.785**	**0.948**	**1.006**	**1.168**
R17	Nariño	1.30	1.24	1.23	1.47	1.98	1.386	1.237	0.787	0.374
R18	Norte de Santander	1.49	1.28	1.39	1.69	2.25	1.532	1.183	0.842	0.571
R19	Quindío	1.80	1.99	1.83	1.70	1.72	1.761	1.261	0.821	0.502
R20	Risaralda	3.90	19.45	5.01	2.43	2.42	2.207	1.310	0.767	0.470
R21	Santander	1.68	1.38	1.47	1.96	2.97	1.972	1.292	0.913	0.518
R22	Sucre	1.49	1.27	1.41	1.62	1.73	1.201	1.020	0.919	0.940
R23	Tolima	1.59	1.55	1.51	1.69	2.00	1.544	1.195	0.908	0.521
R24	Valle del Cauca	2.82	11.77	3.87	2.08	2.18	1.574	1.173	0.928	0.752
R25	Arauca	8.26	14.23	13.09	8.54	5.10	1.245	1.097	1.059	0.826
R26	Casanare	45.98	186.16	143.08	61.31	20.38	2.405	1.111	1.106	0.777
R27	Putumayo	6.76	19.28	9.81	9.02	4.03	1.631	1.100	1.195	0.771
R28	San Andrés...	2.16	14.15	2.63	1.92	1.87	3.230	1.065	1.001	0.884
R29	Amazonas	1.90	3.25	2.24	1.78	1.68	1.364	1.121	1.014	0.879
R30	Guainía	2.96	2.64	2.91	3.75	2.64	1.212	1.041	1.191	0.819
R31	**Guaviare**	**1.91**	**2.25**	**2.09**	**1.97**	**1.70**	**0.895**	**0.888**	**1.180**	**1.050**
R32	Vaupés	2.25	4.01	2.52	2.46	1.82	2.419	1.107	1.033	0.834
R33	Vichada	2.44	2.27	2.40	3.58	2.10	0.972	1.000	1.163	0.925

Final remarks

Linkages:

Structure and relative concentration of the economic base influences interregional connections

Regional integration: Atlántico, Bolívar and Córdoba – stronger connections between economic base and the rest of the region

Regions with greater relative share of the mining industries in their EB presented weaker intra-regional connections

Final remarks

Employment:

Employment multipliers: Atlántico, Cesar, La Guajira and San Andres – greater capacity of EB to create local additional jobs (larger share of EB in GO)

EB favors higher-skill jobs in Cesar (relative concentration of high education)

Employment multipliers for higher-skill jobs: attractiveness for industries with a higher degree of technology (**connectivity**)

Next steps (room for collaboration)

Explore further elements of Miwazawa decomposition

Look at occupational composition of EB-related jobs

- Can we speculate on relatedness and connectivity in the context of smart specialization?

Explore the definition of EB

- Disentangle sectorial domestic and foreign exports in each Department (see Inácio's presentation later today…)

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