

THE INTERREGIONAL AND INTERSECTORAL STRUCTURE OF MERCOSUR: AN APPLICATION OF INPUT-OUTPUT ANALYSIS¹

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ABSTRACT The emergence of strengthened and expanded free trade areas has created a need for careful analysis of the nature of internal and external dependence among nations. This paper uses the 1990 intercountry input-output tables for the four main countries that are integrated into Mercosur (Brazil, Argentina, Chile, and Uruguay) to analyze the economic structure of the countries when considered as a whole system. The analysis focuses on uncovering alternative views of the roles of linkages, multipliers, and key sectors in input-output systems in order to provide insight into the way in which the economies are integrated, the strength of the integration and the potential consequences of action in one economy on the rest of the system.

1. INTRODUCTION

As national economies undergo a process of internationalization and regionalisation, there is a lot of discussion about new tendencies in the international economic system.

On the positive side, the advantages of economic blocks, like MERCOSUR, are:

1. There are possibilities for the implementation of macroeconomic and sectoral policies, leading to harmonious development.
2. Economic blocks, such as Mercosur can promote new competition at regional level, which can lead to improvements in the quality and efficiency of the production process.

On the negative side, one can imagine that the integration process could be painful, mainly due to regional imbalances both within and between the countries involved. So far, in Mercosur, the process has not been painful but this could be because we do not yet know enough about the interindustrial relations that exist within the Mercosur countries.

¹ This article is based on the results of the Ph.D. dissertation elaborated by the first author and having the second author as advisor.

The basic goal of this article is to use input-output analysis to study the structure of the Mercosur countries' international transactions. In order to do so, the article analyses: a) the level of spatial integration in the markets; b) the power of the interindustrial linkages and key-sectors; and c) the induced aggregated production in one country due to the degree of influence of international trade.

The basic data sources for the analysis are a set of intercountry input-output tables for 1990 (Montoya, 1997), for the four main countries that are, or are going to be, integrated into Mercosur, i.e., Brazil, Argentina, Chile, and Uruguay.

2. THE STRUCTURE OF MERCOSUR

2.1 The Economic Dimension of the Market

Trade transactions in the international market are usually a result of competition in this market, taking into consideration, among other things, differences in the price of some goods. But, given that the process of openness in an economy can cause traumatic changes in the production structure of the economy, some measures to reduce and even to prohibit imports might be taken. The main reason for this policy is to protect national industries, even if in the medium and long term, the structure of the international market will prevail. Despite the fact that input-output analysis does not relate market structure to industrial structure, it is possible to study the process of integration in an indirect way. In the international input-output matrix, the import and industrial structures are linked through the technical coefficients of inputs, so it is possible to visualize: a) the market structure as a logical consequence of production activities; and b) the industrial structure as a determinant of trade flows. From this perspective, the 1990 industrial transactions between the Mercosur countries are summarized in Table 1. With this information it is possible to analyze the dimension of the markets and to determine the probable behavior of the economic agents.

The *economic dimension*, understood as the market capacity of a national economy, carries with it the macroeconomic idea that the size of a market allows for the use of production technologies proportionate to the size of the economy. So, depending on the economic dimension of the country or set of countries, the possibility of developing industrial and trade relations will be bigger or smaller. Following Salgado (1990, p. 164)², variables such as GDP; GDP per-capita; population; industrial structure; value added; market liberalization; and demand structure can be used as proxies to indicate the economic dimension of a country.

The economic integration of the Mercosur countries implies, in its elimination of tariffs and harmonization of the tax system, the equalization of legislation, taxes and trade practices. The market increases are potentially extremely unequal and as

² The author draws attention to some of the basic variables in the process of integration among developing countries, which are used to set, as a function of the economic dimension and the level of industrialization, which are the main economic reasons for economic union. In the integration process the countries do not necessarily pursue the same goals; this will depend on the level of economic development that each one presents.

Table 1. Mercosur Input-Output Matrix, 1990 (\$Millions US)

	Inputs to Production			Final Demand			Exp. and Stock Change	Total				
	Argentina	Brazil	Chile	Uruguay	Total	Argentina			Brazil	Chile	Uruguay	Total
Argentina	65177	830	224	140	66371	107925	214	89	72	108301	6679	181385
Brazil	1330	444835	489	203	446858	359	418038	286	139	418821	33364	899145
Chile	123	284	15650	13	16071	30	29	15837	4	15899	5421	37400
Uruguay	83	184	16	4395	4679	66	170	5	4627	4868	968	10449
Total of Domestic Inputs	66714	446133	16379	4752	533979	108379	418451	16216	4842	547889	46433	1128379
Insurance and Freight	201	169	96	51	517	59	54	49	28	190	0	707
Imports Rest of the World	2935	22572	3053	605	29166	1176	7683	1761	110	10730	0	39896
Intermediate Inputs	69851	468874	19528	5408	563661	109615	426187	18027	4980	558809	46433	1168982
Value Added	111534	430271	17872	5041	564718							
Total	181385	899145	37400	10449	1128379							

Source: Montoya (1997)

a consequence, the creation and implementation of such a common competitive base is likely to be very difficult. Table 1 shows the uneven size of the markets, where we can see that the value added of Argentina, Chile, and Uruguay are respectively, 19.75%, 3.16%, and 0.90% of Brazil. Taking each country's 1990³ figure, Mercosur would mean an increase in the population market size of around 5 times for Argentina; 23.87% for Brazil; 24 times for Chile; and, 63 times for Uruguay. Given these indicators and considering that the initial effect of economic integration is an increase in the number of consumers, one can see that demand opportunities related to demand size seems to benefit every country except Brazil. For example, for the Brazilian economy, capturing 90% of the Uruguayan consumer market would be the same as capturing only 1.87% of the Brazilian market. On the other hand, for Uruguay, capturing 90% of the Brazilian market would be the equivalent to increasing its economy 57 times. In a less dramatic example, if an Argentinian company could capture 10% of the Brazilian market, it would be the equivalent of 45.62% of the whole Argentinian market.

2.2 The Spatial Integration of the Markets

Using Table 1 it is possible to set some indices of spatial integration in Mercosur:

1. Exports of domestic production, i.e. assuming that the activities in the national market are proportional to the total production (row), the distribution of the production coefficients, as shown in Table 2, allow the identification of the degree of dependence of exports in each country.
2. Use of domestic and imported inputs, i.e., assuming that the national activities are proportional to the inputs (column), the results in Table 3 give the level of dependence on national and imported inputs.

As shown in Figure 1, Chile shows the greatest dependence on exports, with 15.79% of its domestic production going directly to export, of which 91.83% is exported to the rest of the world (mainly the United States and the European Union), and only 8.17% to the Mercosur countries. Uruguay has the second largest proportion of dependence on exports, 14.28%, of which 64.92% goes to the rest of the world. Brazilian (4.02%) and Argentinian (4.55%) exports are low compared to the other economies in the group, with their respective exports to the rest of the world standing at 92.23% and 80.58% respectively. From these figures, we can see the low dependence on exports. This means that in 1990 there was an extremely limited spatial integration into the world economy, that is even worse when related to Mercosur.

The Mercosur countries' low dependence on exports can be explained by:

1. The policy of import substitution industrialization in the past, directed to an industrial production structure based on domestic markets (Prebisch, 1950, and

³ From the CEPAL 1991 *Statistical Yearbook of Latin America and Caribbean*, the population of the Mercosur countries are as follow: Argentina, 32.55 millions; Brazil, 148.48 millions; Chile, 13.17 millions; and Uruguay, 3.09 millions.

Table 2. Spatial Integration of the Markets From the Exports Perspective

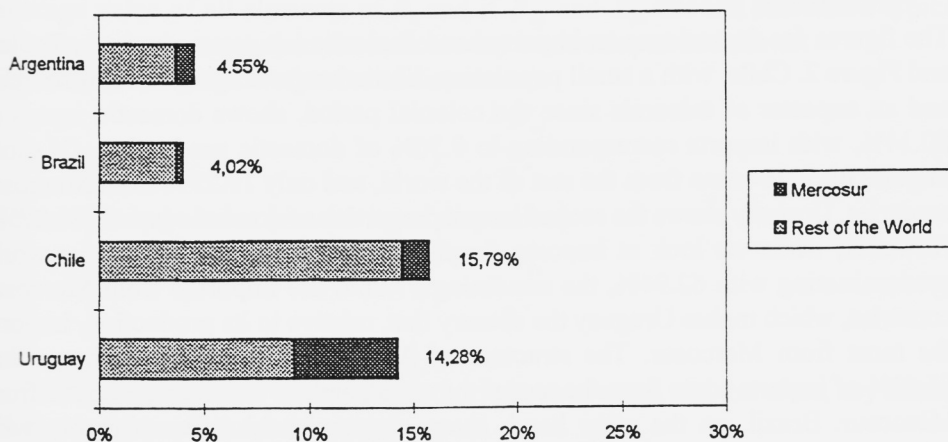
	Inputs to Production			Final Demand			Exp. and Stock Change	Total				
	Argentina	Brazil	Chile	Uruguay	Total	Argentina			Brazil	Chile	Uruguay	Total
Argentina	0.3593	0.0046	0.0012	0.0008	0.3659	0.5950	0.0012	0.0005	0.0004	0.5971	0.0368	1.0000
Brazil	0.0015	0.4947	0.0005	0.0002	0.4970	0.0004	0.4649	0.0003	0.0002	0.4658	0.0371	1.0000
Chile	0.0033	0.0076	0.4184	0.0004	0.4297	0.0008	0.0008	0.4234	0.0001	0.4251	0.1450	1.0000
Uruguay	0.0080	0.0176	0.0015	0.4206	0.4478	0.0063	0.0162	0.0004	0.4429	0.4659	0.0927	1.0000
Total of Domestic Inputs	0.0591	0.3954	0.0145	0.0042	0.4732	0.0960	0.3708	0.0144	0.0043	0.4856	0.0412	1.0000
Insurance and Freight	0.2847	0.2388	0.1356	0.0719	0.7311	0.0836	0.0759	0.0699	0.0395	0.2689	0.0000	1.0000
Imports Rest of the World	0.0736	0.5658	0.0765	0.0152	0.7310	0.0295	0.1926	0.0441	0.0028	0.2690	0.0000	1.0000
Intermediate Inputs	0.0598	0.4011	0.0167	0.0046	0.4822	0.0938	0.3646	0.0154	0.0043	0.4780	0.0397	1.0000
Value Added	0.1975	0.7619	0.0316	0.0089	1.0000							

Source: Table 1

Table 3. Spatial Integration of the Markets From the Imports Perspective

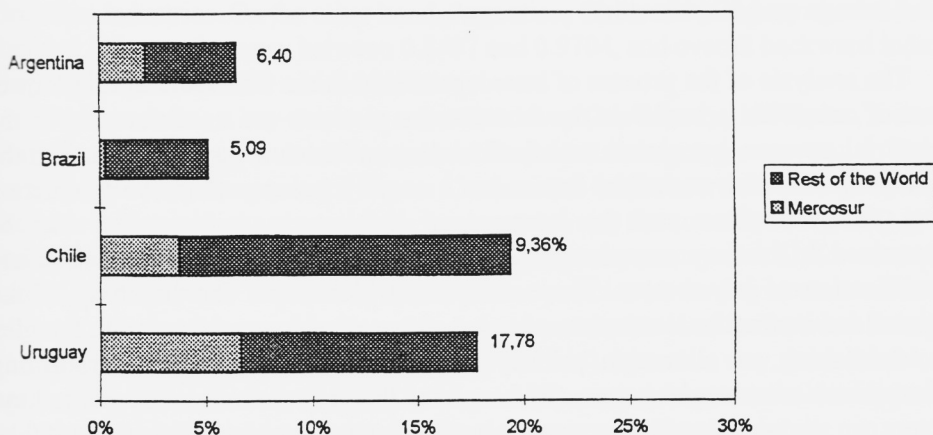
	Inputs to Production				Final Demand				Exp. and Stock Change	Total		
	Argentina	Brazil	Chile	Uruguay	Total	Argentina	Brazil	Chile			Uruguay	Total
Argentina	0.9331	0.0018	0.0115	0.0259	0.1178	0.9846	0.0005	0.0050	0.0145	0.1938	0.1438	0.1552
Brazil	0.0190	0.9487	0.0251	0.0376	0.7928	0.0033	0.9809	0.0158	0.0279	0.7495	0.7185	0.7692
Chile	0.0018	0.0006	0.8014	0.0025	0.0285	0.0003	0.0001	0.8785	0.0008	0.0285	0.1168	0.0320
Uruguay	0.0012	0.0004	0.0008	0.8127	0.0083	0.0006	0.0004	0.0003	0.9291	0.0087	0.0209	0.0089
Total of Domestic Inputs	0.9551	0.9515	0.8388	0.8787	0.9473	0.9887	0.9818	0.8996	0.9723	0.9805	1.0000	0.9653
Insurance and Freight	0.0029	0.0004	0.0049	0.0094	0.0009	0.0005	0.0001	0.0027	0.0056	0.0003	0.0000	0.0006
Imports Rest of the World	0.0420	0.0481	0.1563	0.1119	0.0517	0.0107	0.0180	0.0977	0.0221	0.0192	0.0000	0.0341
Intermediate Inputs	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Source: Table 1



Source: Table 2

Figure 1. Share of Exports to Mercosur and the Rest of the World in Total Production



Source: Table 3

Figure 2. Share of Imports from Mercosur and the Rest of the World in Total Inputs

CEPAL, 1951).

2. The lack of international competition in domestic markets due to long term protectionist policies.

The figures for dependence on imported and domestic inputs are shown in Table 3 and Figure 2. Chile, with a small population, limited natural agricultural resources, and an exporter of minerals since the colonial period, shows domestic inputs of 80.14%, with imports corresponding to 9.36% of domestic production. Of those imports 80.73% come from the rest of the world, and only 19.27% from Mercosur countries. Uruguay shows the second lowest proportion of domestic inputs (81.27%). However, when we look at imports, despite imports from the rest of the world predominating with 62.94%, the remaining 37.06% are imported from Mercosur countries, which makes Uruguay the country that, relative to its production, imports the most from Mercosur. The structure of Argentinian dependence shows that 65.62% of imports come from the rest of the world, and the remaining 34.38% from Mercosur. Brazil, on the other hand, shows a completely different result, with 94.50% of its imports coming from the rest of the world and only 5.50% from Mercosur. This shows that all of the Mercosur economies have limited spatial integration both worldwide and in the Mercosur context. In addition, a lot of the exports from the Mercosur countries are natural resources and processed agricultural products, which, with similar products being produced throughout the region, explains the low trade dependence compared to the rest of the world.

Concerning the domestic share in the structure of the final demand, the proportions are high in all of the countries and their levels are slightly higher than the proportions of the domestic inputs discussed above.

2.3 Linkage and Key-Sectors

The analysis of the process of interdependence in the intersectoral relations of a set of countries is based on the fact that the products are used not only in the industrial process, but also to satisfy final demand. In that way, given that in the input-output model, each final demand of a country is exogenous, the production level, the multipliers and the intersectoral linkages in each country can be determined. In this way, complementary methods can be used for the estimation and identification of key-sectors. These methods, which allow for the study of the national and international structure of transactions are also associated with the idea of establishing an allocation priority of resources, as well as in promoting industrialization strategies because it is expected that the resources allocated to key-sectors can stimulate production growth, employment, wages, etc., faster than if they were directed to other sectors.

The Rasmussen-Hirschman Approach

Considering the internal structure of the economy based on the input-output model (Leontief, 1951), the work of Rasmussen (1956) and Hirschman (1958) led to the development of indices of linkage. These indices have now become part of the

generally accepted procedures for identifying key sectors in an economy.

Define b_{ij} as a typical element of the Leontief inverse matrix, B ; B^* as the average value of all elements of B , and if B_{*j} and B_{i*} are the associated typical column and row sums, then the indices may be developed as follows:

Backward linkage index (power of dispersion):

$$U_j = \frac{\frac{1}{n} B_{*j}}{B^*} \quad (1)$$

Forward linkage index (sensitivity of dispersion):

$$U_i = \frac{\frac{1}{n} B_{i*}}{B^*} \quad (2)$$

Indices greater than one refer to sectors above average, and therefore, key sectors in the development of the economy.

The backward and forward linkages for the 31 sectors from the 4 Mercosur countries are shown in Table 4. Figures 3 and 4 show the indices for each sector in each country, while the overall forward and backward index is shown in Figure 5. In Figure 5 it is possible to see two standards: a) Brazil with its more consolidated industrial structure; and b) Argentina, Chile, and Uruguay all of which are still trying to consolidate their industrial structures.

In general, Brazil shows greater values for forward and backward linkages than the other countries, which is an indication that the Brazilian economy is probably much more integrated than the other economies. However, this does not mean stronger international relations rather it is a result of the strong linkages among Brazilian industries. On the other hand, Argentina, Chile and Uruguay show overall forward linkages that vary between 0.8407 and 0.9704, and overall backward indices varying between 0.9373 and 0.9819.

One can define a key-sector in a restricted way (McGilvray, 1977), i.e., a sector that simultaneously presents forward and backward linkages greater than 1. Based on this definition, the results of Figure 5, associated with a more detailed analysis of the interindustrial linkages and how they vary among the countries (Table 4) gives indications for the design of industrial policies in each country. Brazil, for example, would be advised to implement development policies in the key-sectors with the highest values of forward indices this is because the level of its forward linkages (1.2688) is superior to its backward linkage (1.1346). In such a way, from the 8 key-sectors identified (5, 6, 9, 11, 12, 14, 15, and 17) one could stress the development of exports and of the Metallurgy, Mechanic, Paper, and Textile sectors.

One can also use a more relaxed concept of key-sector, i.e., define a key-sector as the one that presents either backward or forward indices greater than one. Using this less restricted definition of a key-sector, Brazil has 29 key sectors, from which we can conclude that:

1. Brazil has a diversified and integrated industry.
2. With its high number of sectors with a backward linkage greater than one, it should be possible to increase production through demand for Brazilian products

Table 4. Hirschman/Rasmussen Linkages for Mercosur, 1990

	Sectors	H/R Forward Linkages					H/R Backward Linkages											
		Argentina Rank	Brazil Rank	Chile Rank	Uruguay Rank	Rank	Argentina Rank	Brazil Rank	Chile Rank	Uruguay Rank	Rank							
1	Agriculture	2.6188	5	2.9523	3	2.3323	7	2.1644	9		0.7047	117	0.9137	88	0.8577	104	0.8131	110
2	Mining (excluding energy source products)	0.7436	68	0.8331	52	1.0804	32	0.5741	104		0.6897	118	1.0504	47	0.8795	96	0.9928	66
3	Crude Petroleum, Natural Gas, and Coal	1.5698	17	0.9666	42	1.3426	26	0.5119	122		0.6232	120	0.9374	80	0.8014	111	0.5119	124
4	Non-Metallic Minerals	0.7598	65	0.9889	37	0.6757	85	0.7267	70		0.9143	87	1.1286	29	0.8936	93	0.8922	95
5	Metal Products	1.6839	16	3.6273	1	1.0395	34	0.7079	75		1.0207	56	1.3159	5	0.9666	72	1.0020	63
6	Machinery	0.9790	39	1.4201	22	0.7965	57	0.8823	47		1.0322	53	1.1100	33	1.0920	35	0.9350	82
7	Electrical Equipment	0.7651	61	0.8240	54	0.5769	102	0.5878	101		1.0072	58	1.2197	20	1.0023	62	0.9721	71
8	Electronic Equipment	0.5681	106	0.7163	73	0.5177	120	0.5119	121		1.0387	50	1.0213	55	0.9029	91	0.5119	123
9	Transport Equipment	0.8290	53	1.2954	29	0.5667	107	0.5451	113		1.2135	21	1.3223	3	1.0346	52	1.0850	38
10	Wood and Wood Products	0.7646	62	0.7622	63	0.6709	87	0.6760	84		0.9995	64	1.1441	27	0.9434	78	1.0065	59
11	Pulp, Paper, Paper Products, and Printing	1.0518	33	1.3322	27	0.9773	40	0.8593	49		1.0585	42	1.2320	12	0.9645	73	1.0904	36
12	Rubber	0.6140	94	1.0027	36	0.5982	99	0.6077	96		0.9797	68	1.2034	22	0.8691	101	0.8377	107
13	Basic Chemicals	1.2995	28	0.9419	44	0.7550	66	0.6189	93		0.9493	75	1.1313	28	0.8416	106	0.8984	92
14	Petroleum Refining	1.3826	23	2.7836	4	1.0303	35	1.3473	24		1.0148	57	1.0513	46	1.0575	44	0.6097	121
15	Other Chemicals/ Pharmaceutical/ Cosmetics	1.8101	11	1.5039	18	0.8053	56	0.7862	59		1.0767	39	1.0760	40	0.8614	103	0.9104	89
16	Plastics	0.8426	51	0.9206	46	0.7620	64	0.6303	92		0.9725	70	1.0659	41	0.8703	100	0.8258	108
17	Textile	1.3457	25	1.7815	13	0.9678	41	0.8557	50		1.0034	60	1.2354	11	0.8785	97	1.0571	45
18	Clothing	0.5667	108	0.5425	114	0.5398	115	0.5374	116		1.1476	26	1.2021	23	1.0449	48	1.2203	17
19	Footwear	0.6760	83	0.6954	79	0.7550	67	0.6393	91		1.1821	25	1.2883	6	1.2374	10	1.2486	9
20	Vegetal Products	0.5937	100	0.7259	71	0.6675	88	0.6055	97		0.9068	90	1.2211	16	1.2233	15	1.0226	54
21	Meat Products	0.7963	58	0.6715	86	0.6843	82	0.7689	60		1.1194	31	1.3186	4	1.2317	13	1.0901	37
22	Dairy Products	0.5761	103	0.6872	81	0.5588	109	0.5297	118		1.0031	61	1.3814	2	1.1216	30	1.1910	24
23	Sugar Products	0.6094	95	0.6994	77	0.5690	105	0.5488	110		0.8141	109	1.2779	8	1.2253	14	0.9595	74
24	Vegetal Oil	0.7422	69	0.8599	48	0.6006	98	0.5539	112		1.1110	32	1.3955	1	1.2198	19	1.2199	18
25	Other Food Products	0.6996	76	0.7081	74	0.6991	78	0.6913	80		1.0415	49	1.2842	7	1.0973	34	0.9978	65
26	Other Industrial Products	0.5359	117	0.8124	55	0.5281	119	0.5504	111		0.9915	67	1.0374	51	0.9366	81	0.9479	76
27	Public Utilities	0.9470	43	1.4495	20	1.2270	30	0.9821	38		0.7379	114	0.9217	83	0.9193	84	0.7278	115
28	Construction	0.5119	124	0.6432	89	0.7224	72	0.6423	90		0.9153	86	0.9786	69	0.9437	77	1.0584	43
29	Trade	0.5119	124	0.6432	89	0.7224	72	0.6423	90		0.9153	86	0.9786	69	0.9437	77	1.0584	43
30	Transport	0.9327	45	1.4641	19	1.4337	21	1.1406	31		0.7439	113	0.9174	85	0.8782	98	0.8922	94
31	Services	1.7564	15	2.9578	2	2.2530	8	1.9368	10		0.6028	122	0.9428	79	0.8622	102	0.8723	99
	Overall linkages	0.9704		1.2688		0.9201		0.8407			0.9462		1.1346		0.9819		0.9373	

Source: Montoya (1997)

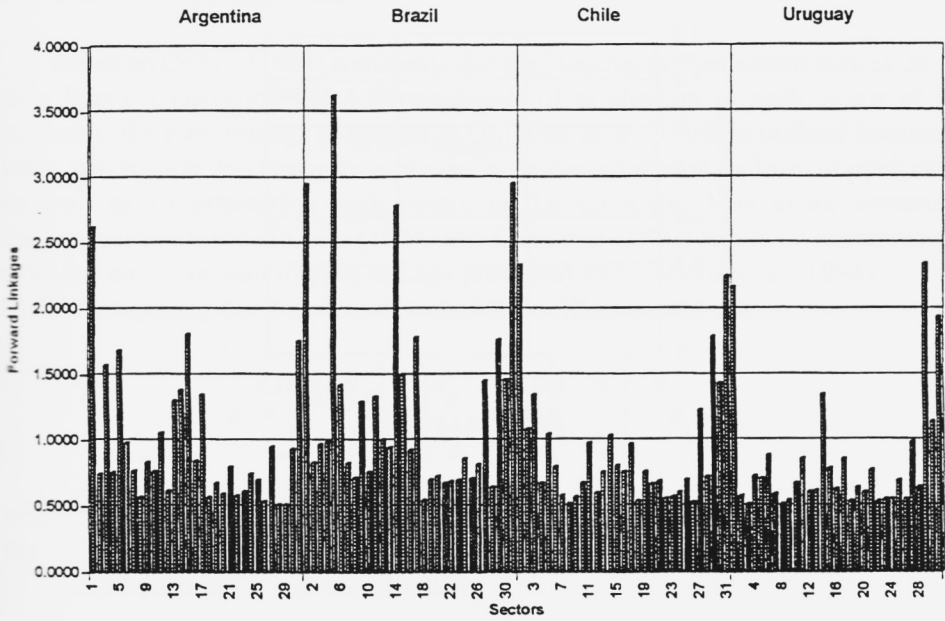


Figure 3. Hirschman/Rasmussen Forward Linkages for the Mercosur, 1990

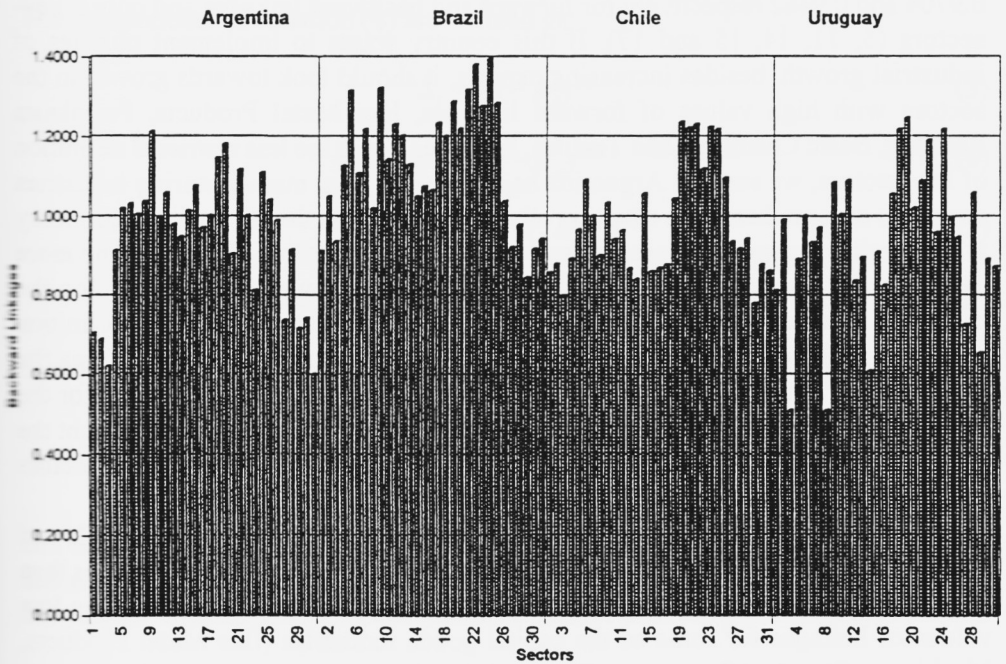


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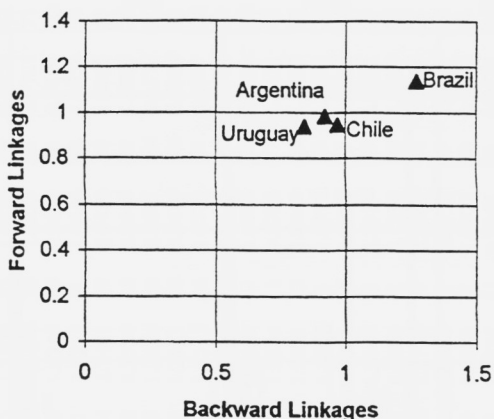


Figure 5. Hirschman/Rasmussen Linkages for the Mercosur Interregional System, 1990

in either the national or the Mercosur market.

Argentina, Chile, and Uruguay show low interindustry linkages; however, from Table 4 it is clear that there are differences between the countries.

According to the more restricted definition, Argentina has average values of 0.9704 and 0.9462 respectively for forward and backward linkages and only 5 key-sectors (5, 11, 14, 15 and 17). If this country wants to implement policies of industrial growth, besides increasing exports, it should look towards growth in the sectors with high values of forward linkages, like Metal Products, Petroleum Refining, Basic Chemicals and Textiles. However, using the less restricted definition of key-sectors, we see that Argentina has 19 key sectors, manufacturing industries dominant amongst them; this situation allows us to say that the Argentinian economy is a diversified economy, closer in type to that of the Brazilian economy. The more export oriented economies of Chile and Uruguay show higher values for the backward linkages than for the forward linkages. Using the more restricted definition of a key sector, we can only identify one for Chile and none for Uruguay. Using the less restricted definition, the number of sectors with values greater than one for the forward linkages are 9 for both Argentina and Chile. For Chile, one can highlight the sectors of Mining, Services, Trade, and Transport; while for Argentina the sectors include Paper, Basic Chemicals, Other Chemicals, and Textiles.

Argentina has 15 sectors with backward linkages greater than one, and Chile and Uruguay have 12 each. We can also see that Chile has a higher value of linkages than Argentina and Uruguay and that each country has different key sectors. The low values of linkages for some of the capital goods industries (like Metal Products, Machinery, Electrical Equipment, Electronic Equipment, and Transport Equipment) for Argentina, Chile, and Uruguay point to problems that could face these economies in the process of increasing industrialization.

The Pure Linkage Approach

Based on Cella's (1984) comments that the Hirschman/Rasmussen indices do not take into consideration the different levels of production in each sector of the economy, the pure linkage presented in Guilhoto *et al.* (1996) is utilized because it takes into account the importance of a given sector in terms of its level of production as well as its interaction with others in the economy. This index corrects a decomposition error of Cella (1984) and Clements (1990) and is an improvement over the initial version of pure linkage presented by Guilhoto *et al.* (1994).

Decomposing the A matrix of technical coefficients one has:

$$A = \begin{bmatrix} A_{jj} & A_{jr} \\ A_{rj} & A_{rr} \end{bmatrix} = \begin{bmatrix} A_{jj} & A_{jr} \\ A_{rj} & 0 \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & A_{rr} \end{bmatrix} = A_j + A_r \tag{3}$$

where the matrix A_j represents the sector j isolated from the rest of the economy, and the A_r matrix represents the rest of the economy.

From equation (3) one can arrive at :

$$B = (I - A)^{-1} = \begin{bmatrix} B_{jj} & B_{jr} \\ B_{rj} & B_{rr} \end{bmatrix} = \begin{bmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{bmatrix} \begin{bmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{bmatrix} \begin{bmatrix} I & A_{jr}\Delta_r \\ A_{rj}\Delta_j & I \end{bmatrix} \tag{4}$$

The components of equation (4) are defined as:

$$\Delta_j = (I - A_{jj})^{-1} \tag{5}$$

$$\Delta_r = (I - A_{rr})^{-1} \tag{6}$$

$$\Delta_{jj} = (I - \Delta_j A_{jr} \Delta_r A_{rj})^{-1} \tag{7}$$

$$\Delta_{rr} = (I - \Delta_r A_{rj} \Delta_j A_{jr})^{-1} \tag{8}$$

In that way, from equation (4) it is possible to derive the pure linkages.

From the Leontief formulation:

$$X = (I - A)^{-1} Y \tag{9}$$

and using the information contained in equation (4) one can derive a set of indices that can be used to rank a region in terms of its importance to the economy and to see how the production process occurs in the economy. One can get these indices from:

$$\begin{bmatrix} X_j \\ X_r \end{bmatrix} = \begin{bmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{bmatrix} \begin{bmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{bmatrix} \begin{bmatrix} I & A_{jr}\Delta_r \\ A_{rj}\Delta_j & I \end{bmatrix} \begin{bmatrix} Y_j \\ Y_r \end{bmatrix} \tag{10}$$

From the multiplication of the three terms on the right side of equation (10), one can derive:

$$\begin{bmatrix} X_j \\ X_r \end{bmatrix} = \begin{bmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{bmatrix} \begin{bmatrix} \Delta_j Y_j + \Delta_j A_{jr} \Delta_r Y_r \\ \Delta_r A_{rj} \Delta_j Y_j + \Delta_r Y_r \end{bmatrix} \quad (11)$$

where $A_{jr} \Delta_r Y_r$ is the direct impact of the rest of the economy final demand on region j , i.e., the level of exports in region j that are needed to satisfy the production necessities of the rest of the economy for a level of final demand given by Y_r ; and $A_{rj} \Delta_j Y_j$ is the direct impact of region j final demand on the rest of the economy, i.e., it gives the level of exports in the rest of the economy that are needed to satisfy the production necessities of region j for a level of final demand given by Y_j .

Thus, one has a new definition for the Pure Backward Linkage (*PBL*) and for the Pure Forward Linkage (*PFL*), i.e.,

$$\begin{aligned} PBL &= \Delta_r A_{rj} \Delta_j Y_j \\ PFL &= \Delta_j A_{jr} \Delta_r Y_r \end{aligned} \quad (12)$$

where the *PBL* will give the pure impact of the value of the total production in region j , ($\Delta_j Y_j$) on the rest of the economy; i.e., the impact that is free from the demand inputs that region j makes from region j , and the feedback from the rest of the economy to region j and vice-versa. The *PFL* will give the pure impact of the total production in the rest of the economy ($\Delta_r Y_r$) on region j . If one wants to know what the pure total linkage (*PTL*) of each sector is in the economy, for example, to rank them, it is possible to add the *PBL* to the *PFL*, as these indices, as defined above, are expressed in actual values rather than as indicants. Hence:

$$PTL = PBL + PFL \quad (13)$$

The results for the pure linkages are shown in Tables 5 and 6 and Figures 6 and 7. From these results one can see that the countries can be ranked according to their importance to the Mercosur economy.

At the sectoral level, the highest forward linkage values are found in the Brazilian economy with the most important being Agriculture, Metal Products, Petroleum Refining, Trade, Transport, Services, Textile, and Public Utilities. Considering the importance of the Brazilian economy, the values for Argentina, Chile, and Uruguay are rather small.

The Argentinian sectors with high forward linkages are Agriculture, Metal Products, Other Chemicals, Textiles, and Services. For Chile the sectors are Agriculture, Trade, and Services. In Uruguay the most important sectors are Trade, Services, and Agriculture.

The Brazilian economy shows the highest values for backward linkages too, mainly in the Service, Construction, Trade, Meat Products, Vegetable Products, and

Table 5. Pure Forward and Backward Linkages for Mercosur, 1990 (US\$ Millions)

Sectors	Pure Forward Linkages						Pure Backward Linkages									
	Argentina Rank	Brazil Rank	Chile Rank	Uruguay Rank	Uruguay Rank	Rank	Argentina Rank	Brazil Rank	Chile Rank	Uruguay Rank	Uruguay Rank	Rank				
1 Agriculture	13365.38	14	76040.53	1	4759.65	33	3451.69	40	620.72	60	17448.01	9	519.89	63	307.61	72
2 Mining (excluding energy source products)	1083.78	68	6123.90	25	1680.01	54	179.86	103	-119.27	119	-404.44	123	33.26	102	1.66	115
3 Crude Petroleum, Natural Gas, and Coal	4259.86	35	3030.97	42	855.82	75	0.00	122	-213.32	121	623.09	58	45.13	98	0.00	117
4 Non-Metallic Minerals	2709.61	46	18405.98	12	583.29	84	831.89	77	122.70	87	1617.83	42	27.28	106	5.78	112
5 Metal Products	8180.24	20	65086.81	2	2536.07	47	478.20	85	-1161.67	124	1939.31	39	28.31	105	2.39	114
6 Machinery	3511.85	39	25667.82	8	1126.12	65	835.87	76	4602.35	28	14686.66	12	284.47	73	30.47	103
7 Electrical Equipment	1510.69	58	8905.49	19	215.31	101	237.01	99	1415.29	47	9835.00	18	101.31	90	116.30	88
8 Electronic Equipment	107.63	109	2329.86	49	21.09	120	0.00	121	145.34	83	9931.64	17	10.95	109	0.00	116
9 Transport Equipment	2783.93	45	10012.55	15	107.36	110	53.60	117	4371.35	30	25242.68	6	135.50	85	62.65	95
10 Wood and Wood Products	1049.65	69	6344.39	23	440.76	86	355.55	90	660.35	56	11498.68	14	209.74	80	29.53	104
11 Pulp, Paper, Paper Products, and Printing	3299.35	41	20809.89	10	1549.08	57	622.73	82	850.58	53	4621.20	27	190.83	82	76.06	93
12 Rubber	1101.37	67	9472.48	16	168.52	105	339.57	92	467.36	67	280.13	75	35.57	100	18.16	108
13 Basic Chemicals	2945.73	44	9351.27	17	624.37	81	307.01	94	-277.48	122	6058.23	21	-0.87	118	6.59	111
14 Petroleum Refining	4942.61	31	56666.00	3	1184.73	61	1760.06	53	4481.77	29	1482.38	46	-164.32	120	60.50	96
15 Other Chemicals/ Pharmaceutical/ Cosmetics	6169.99	24	20807.12	11	1001.56	71	876.69	74	1876.32	40	10451.84	15	330.06	70	212.46	79
16 Plastics	2044.10	52	15078.60	13	681.84	78	387.72	89	620.98	59	1130.28	50	67.54	94	18.81	107
17 Textile	5187.65	29	29817.02	7	1614.35	56	1007.08	70	977.82	51	5865.79	23	243.37	76	108.52	89
18 Clothing	302.91	95	956.20	73	87.37	112	29.50	119	4048.43	31	17540.56	8	501.53	65	217.22	78
19 Footwear	679.52	79	1414.21	59	243.94	97	330.00	93	1163.13	49	5010.57	26	197.61	81	77.54	92
20 Vegetal Products	341.50	91	8978.05	18	185.57	102	61.94	115	6057.60	22	27780.92	5	1737.04	41	795.54	54
21 Meat Products	2064.52	51	5052.46	30	412.21	88	1137.05	64	10055.66	16	32724.50	4	1570.28	45	696.15	55
22 Dairy Products	102.24	111	1178.42	62	118.15	107	62.54	114	3086.11	34	13682.86	13	519.43	64	323.94	71
23 Sugar Products	983.80	72	4326.02	34	240.27	98	84.83	113	1960.61	38	4028.13	32	374.31	69	92.14	91
24 Vegetal Oil	1301.09	60	6114.90	26	149.35	106	37.45	118	587.36	61	5571.18	24	236.27	77	34.64	101
25 Other Food Products	634.75	80	4854.53	32	429.82	87	234.54	100	5163.48	25	21627.03	7	900.08	52	400.66	68
26 Other Industrial Products	172.48	104	8175.88	21	58.79	116	116.04	108	123.62	86	2457.19	36	9.20	110	2.85	113
27 Public Utilities	2958.34	43	25372.83	9	1622.49	55	1121.45	66	1605.55	43	6421.79	20	143.19	84	53.95	97
28 Construction	0.00	124	5400.97	28	613.98	83	249.10	96	7274.56	19	80006.76	2	2018.21	37	560.87	62
29 Trade	0.00	123	43882.01	4	4226.55	36	7231.59	22	14728.59	11	53868.45	3	1579.43	44	42.24	99
30 Transport	2471.89	48	30924.37	6	2192.05	50	1167.61	63	1349.02	48	16349.01	10	654.46	57	284.01	74
31 Services	5512.37	27	31099.70	5	3816.53	37	3583.57	38	3983.44	33	82160.90	1	2625.34	35	475.58	66

Source: Montoya (1997)

Table 6. Pure Total Linkages for Mercosur, 1990 (US\$ Millions)

Sectors	Pure Total Linkages							
	Argentina	Rank	Brazil	Rank	Chile	Rank	Uruguay	Rank
1 Agriculture	13986.09	25	93488.54	3	5279.54	47	3759.30	54
2 Mining (excluding energy source products)	964.51	85	5719.46	46	1713.27	74	181.53	116
3 Crude Petroleum, Natural Gas, and Coal	4046.54	52	3654.05	55	900.95	86	0.00	124
4 Non-Metallic Minerals	2832.31	60	20023.81	17	610.57	98	837.67	89
5 Metal Products	7018.56	39	67026.11	5	2564.37	64	480.59	100
6 Machinery	8114.20	34	40354.48	8	1410.59	78	866.34	87
7 Electrical Equipment	2925.98	58	18740.49	18	316.62	109	353.31	108
8 Electronic Equipment	252.97	112	12261.50	26	32.04	122	0.00	123
9 Transport Equipment	7155.28	38	35255.23	12	242.87	114	116.25	119
10 Wood and Wood Products	1709.99	75	18043.06	20	650.50	93	385.08	106
11 Pulp, Paper, Paper Products, and Printing	4149.93	50	25431.08	16	1739.91	73	698.79	92
12 Rubber	1568.73	76	9752.61	30	204.09	115	357.74	107
13 Basic Chemicals	2668.26	61	15409.50	22	623.50	96	313.60	110
14 Petroleum Refining	9424.38	32	58148.38	6	1020.41	84	1820.56	71
15 Other Chemicals/ Pharmaceutical/ Cosmetics	8046.32	35	31258.96	14	1331.62	79	1089.15	83
16 Plastics	2665.09	62	16208.88	21	749.38	91	406.53	103
17 Textile	6165.47	43	35682.80	11	1857.72	68	1115.60	82
18 Clothing	4351.34	49	18496.76	19	588.90	99	246.73	113
19 Footwear	1842.64	69	6424.77	41	441.55	101	407.54	102
20 Vegetal Products	6399.10	42	36758.97	10	1922.61	66	857.48	88
21 Meat Products	12120.18	27	37776.96	9	1982.49	65	1833.21	70
22 Dairy Products	3188.35	56	14861.28	23	637.58	94	386.48	104
23 Sugar Products	2944.41	57	8354.15	33	614.58	97	176.98	117
24 Vegetal Oil	1888.46	67	11686.08	28	385.61	105	72.08	120
25 Other Food Products	5798.23	45	26481.56	15	1329.90	80	635.20	95
26 Other Industrial Products	296.11	111	10633.07	29	67.99	121	118.89	118
27 Public Utilities	4563.89	48	31794.62	13	1765.67	72	1175.41	81
28 Construction	7274.56	36	85407.72	4	2632.19	63	809.97	90
29 Trade	14728.59	24	97750.46	2	5805.98	44	7273.83	37
30 Transport	3820.91	53	47273.38	7	2846.51	59	1451.63	77
31 Services	9495.82	31	113260.59	1	6441.87	40	4059.15	51

Source: Montoya (1997)

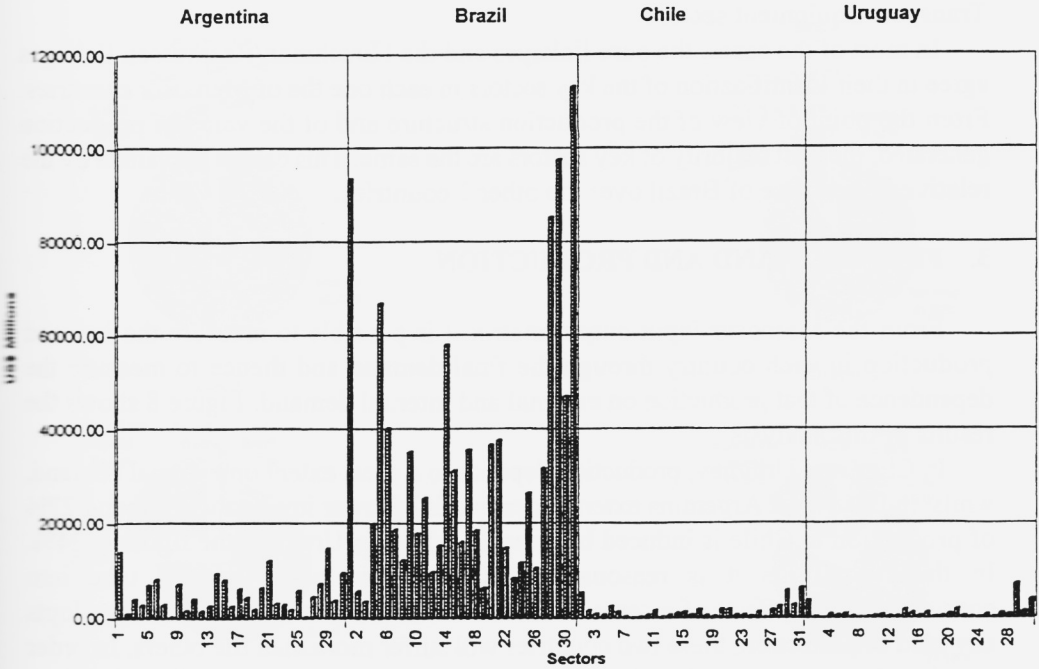


Figure 6. Pure Total Linkages for Mercosur, 1990

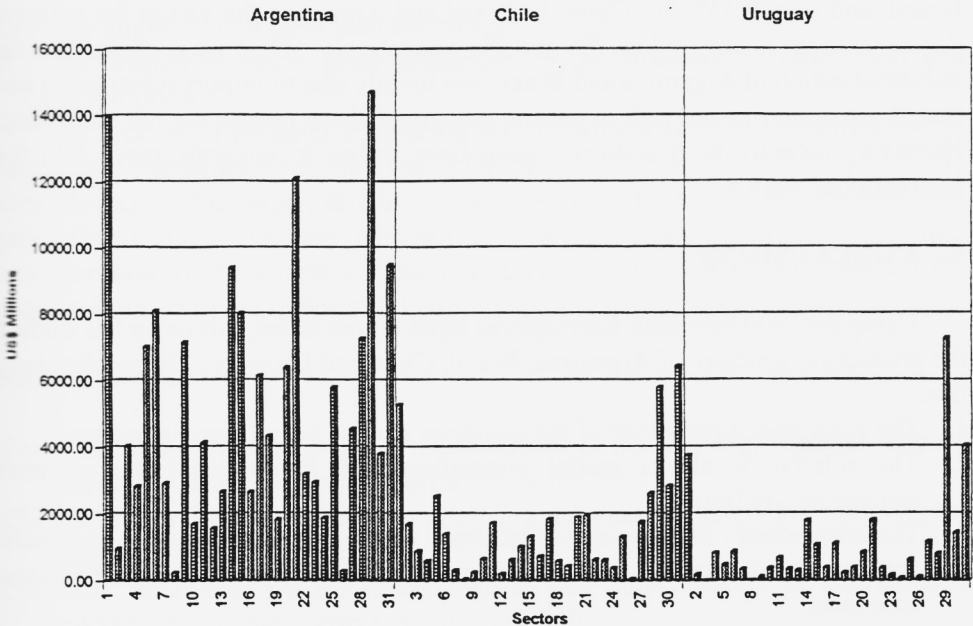


Figure 7. Pure Total Linkages for Mercosur, Select Countries, 1990

Transport Equipment sectors.

In most of the cases, the pure linkages and the Hirschman/Rasmussen linkages agree in their identification of the key sectors in each one of the Mercosur countries. From the point of view of the production structure and of the value of production generated, the vast majority of key sectors are the same. This can be explained by the relative importance of Brazil over the other 3 countries.

3. FINAL DEMAND AND PRODUCTION

From the Mercosur input-output matrix it is possible to measure the induced production in each country through the final demand and thence to measure the dependence of that production on external and internal demand. Figure 8 shows the results of this analysis.

In Chile and Uruguay, production depends to a great extent on external demand, whilst in Brazil and Argentina external demand is of lower importance. Around 27% of production in Chile is induced by exports, whilst in Uruguay the figure is 24%. In these countries it is reasonable that economic policy should take into consideration the effects of external markets - when the international market adopts any kind of protection, these two countries will suffer more than the others. In order to minimize international trade problems, these countries should diversify their patterns of industry as well as increase their competitiveness in internal and external markets.

1.15% of production in Chile is induced by Brazil, 0.68% by Argentina, and 0.07% by Uruguay. For Uruguay the values are 2.52% for Argentina, 5.61% for Brazil, and only 0.34% for Chile. In Brazil and Argentina the values for external dependence are relatively low, 9% and 8% respectively. When we consider that the industrialization of Argentina and Brazil was mainly due to import substitution and that these countries are rich in natural resources, these results are not surprising. However, recently both countries have been trying to integrate more into the international market.

4. CONCLUSIONS

Using the 1990 Mercosur interregional input-output tables, this paper has studied the production structure of Argentina, Brazil, Chile and Uruguay. The results show that:

1. The economic dimensions of the countries studied are extremely uneven.
2. The relative levels of spatial integration with international and regional economies are limited.
3. The interindustry linkages show that Brazil has the highest values for backward and forward linkages in both the Rasmussen/Hirschman and the pure linkage approach.
4. All of the countries showed a stronger dependence on induced production than is inferred from their spatial integration levels.
5. In general the economies which make up Mercosur, are closed, with Chile and

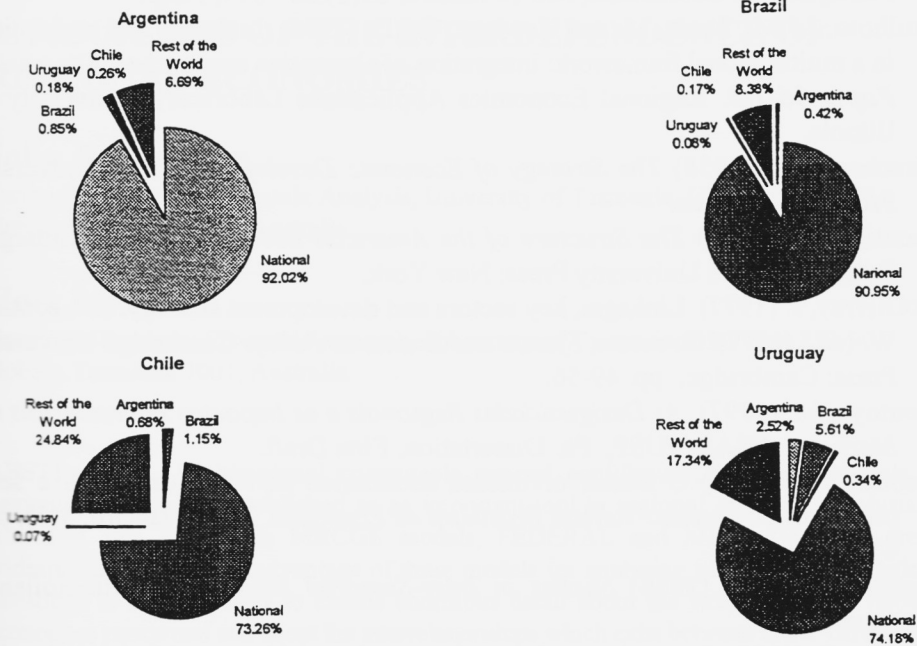


Figure 8. Relative Share of Aggregated Production, Induced by the Final Demand in Each Country

Uruguay slightly more open than the others.

6. The economies show great disparities in the structure of production and consumption.

The process of regional integration should bring about the intensification of industrial interdependence for the Mercosur countries. However, given the conclusions of this paper, this industrial interdependence will be achieved less painfully if the interaction between the various sectors is fully taken into consideration. If this course of action is taken should be possible to conduct the economic union of the region in a harmonious way.

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