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Trade and Infrastructure: Evidences From the Andean Community*

Gina E. Acosta Rojas**

Germán G. Calfat**

Renato G. Flôres Jr***

* Part of this work was made while Renato Flôres was a visiting scholar at IDPM, University of Antwerp.

** Institute of Development Policy and Management (IDPM), University of Antwerp, Antwerp

*** EPGE / Fundação Getulio Vargas, Rio de Janeiro

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ABSTRACT

This paper analyses the role of infrastructure on the Andean Community trade patterns. Three distinct but related gravity models of bilateral trade are used. The first model aims at identifying the importance of the Preferential Trade Agreement and adjacency within the Andean Community trade, while also checking the traditional roles of economic size and distance. The second and third models assess the evolution of the Trade Agreement and the importance of sharing a common border, but their main goal is to analyze the relevance of including infrastructure in the augmented gravity equation, testing the theoretical assumption that infrastructure endowments reduce trade and transport costs and therefore reduce "distance" between bilateral partners. Indeed, if one accepts distance as a proxy for transportation costs, infrastructure development and improvement drastically modify it. As evidenced by the results, trade liberalization eliminates most of the distortions that a protectionist tariff system imposes on international business; hence transportation costs represent nowadays a considerably larger barrier to trade than in past decades. As new trade pacts are being negotiated in the Americas, agreements and borders will lose significance as most countries will be able to trade among themselves without exchange restrictions, and bilateral trade will be defined in terms of costs and competitiveness. Competitiveness, however, will only be achieved by an improvement in infrastructure services at all points in the production-distribution chain and the reduction in costs triggered by a more modern type of regional integration.

1. INTRODUCTION

This paper adds further evidence to the argument that infrastructure development is a source of integration and competitiveness. It shows the dynamic role played by infrastructure in explaining as well as determining the trade flows within and outside the Andean Community.

The work is organized as follows. The next section briefly reviews the evolution of the Andean Community since its formation in 1969, focusing on the consolidation of the internal market and its trade pattern. An augmented gravity model of bilateral trade flows, with cross section data for the period 1993 to 1999, is applied to determine whether the Andean Pact did in fact increase trade within the region, and to capture the effect of adjacency on trade among its members. Section 3 discusses infrastructure in the bilateral trade model, showing theoretical and statistical evidences that location and endowments play a decisive role in determining whether two countries will decide to enhance their trading opportunities by developing (transport-cost reducing) infrastructure.

Section 4, where the effect of infrastructure is fully assessed, is the core of the paper. Going beyond a traditional gravity model, we consider that transportation costs are not only a function of distance but also of the availability of infrastructure, such as roads, energy and telecommunications networks. These variables are summarized in an index measuring the level of infrastructure in the countries used as reporters and their respective partners, modifying the distance variable. The analysis sheds light on the role played by infrastructure and its impact on the relevance of other explanatory variables. We then link the results to the new concept of infrastructure development in the region, where its interaction with geographical space is regarded as a key integration and competitiveness tool. The final section concludes.

2. THE ANDEAN COMMUNITY: TRADE FLOWS AND REGIONAL INTEGRATION

2.1 Evolution of the Andean Community Pact.

The beginnings of the Andean Community date back to 1969, when a group of countries signed the Cartagena Agreement, also known as the Andean Pact, for establishing a customs union within a period of ten years. Since then, Andean integration has passed through a series of different stages where an initial inward-

looking project, based on the import substitution model, gradually gave way to a more open-regionalism initiative. In June 1997, the group became the Andean Community, with the Cartagena Agreement being modified by the Trujillo Protocol. The Protocol created a Presidential Council and a Council of Foreign Ministers, giving to both a critical role in the decision making process. It also strengthened the internal cohesion of the integration process, by placing all its institutions and mechanisms under a new umbrella, the Andean Integration System. The Andean Community is, nowadays, a regional organization endowed with international legal status and five members: Venezuela, Colombia, Ecuador, Peru and Bolivia.

Since 1987, members began to design a new strategy to keep up with the liberalization process that was taking place in Latin America. The formation of a Free Trade Area (FTA) in 1992 evolved into an imperfect Customs Union. Colombia and Venezuela, already in February 1992, eliminated tariffs and other restrictions to their reciprocal trade. Bolivia joined them in September 1992 and Ecuador in January 1993, when the FTA entered into full operation among these four countries. Peru temporarily suspended its obligations under the liberalization program; instead, from 1992, it negotiated bilateral trade agreements with each of its Andean partners and, in some cases, partially liberalized the reciprocal trade flows. These bilateral agreements were effective until 1997, when a compromise was reached for Peru's gradual incorporation into the Andean FTA (Decision 414). Most products were liberalized until 2000 and the remaining *sensitive* products, including agricultural goods, will be totally liberalized by 2005.

In 1994, the Common External Tariff (CET) was approved by Decision 370. Implementing the CET, as usual, proved to be difficult. At the time Decision 370 was made, Bolivia was exempt from it and Peru, as mentioned, did not play a part in the process. It was again Colombia and Venezuela the two to firstly adopt the CET, in 1994, joined by Ecuador in 1995. The Andean CET is determined by the level of processing, with a 5% rate applied to raw materials and industrial inputs; 10 and 15% to intermediate inputs and capital goods, respectively, and 20% to final goods. The CET average is 13.6%, and it has a 20% ceiling. The customs union, effective for Venezuela, Colombia and Ecuador, is being gradually applied for Bolivia and Peru. Full adoption is expected also in 2005.

The Andean Community has addressed most of the newer trade issues, such as investment, competition policy, services and intellectual property rights and adopted

common policies in most of these areas[1]. The development of a common foreign policy is also a main objective, and involves the joint participation of all members in the World Trade Organization (WTO) as well as in the negotiations concerning regional agreements.

The Andean countries form a market with over 115 million people living in an area of 4,700,000 square kilometers. Their joint GDP in 2001 reached US$ 283 billion. The most important markets for their exports, as shown in Table 1, are the United States, the European Union (EU) and the Community itself.

Liberalization of the internal market has had an important effect on trade among its member countries. Trade flows have reached unprecedented levels, with intra-regional trade growing faster than trade with the rest of the world, as Table 1 shows. After a decade of flat or declining growth in the '80s, intra-Andean trade picked up in 1989 and grew steadily after 1990. At the end of 2001, intra-Andean exports amounted to US$ 5.6 billion, more than double the 1992 level. Equally important, Andean trade with the rest of the world has also risen; imports and exports from and to countries outside the Community have consistently increased since the agreement was reactivated in the early '90s (Table 1).

Though there is a commitment to establish a Common Market by 2005, at the latest, nowadays, as mentioned above, the Community is an incomplete customs union, as both the CET and the FTA are still subject to a number of exceptions.

[1] As a few examples, Decision 291 replaced Decision 24, which restricted foreign direct investment activities, granting national treatment to foreign investors and eliminating all restrictions on capital and profit remittances, Decision 344 granted patent rights to pharmaceutical products, and Decision 351 dealt with copyrights.

Table 1: Andean Community 1992-2001
(Millions of U$ dollars)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Exports (FOB)										
TOTAL	28378	29740	34252	37903	45500	47677	38896	43208	57423	50173
ANDEAN COMMUNITY	2225	2868	3428	4801	4693	5628	5411	3939	5167	5631
Bolivia	91	120	196	218	260	251	320	293	311	367
Colombia	1014	1139	1110	1937	1839	2115	2130	1634	2161	2741
Ecuador	178	295	386	359	428	636	540	445	662	760
Perú	276	269	310	405	418	515	468	347	446	523
Venezuela	666	1045	1426	1882	1748	2111	1953	1220	1586	1240
MERCOSUR	861	921	1216	1479	1642	1979	1516	1685	2299	1807
EUROPEAN UNION-15	5093	4834	6403	7183	7211	6981	6238	5589	5605	5949
NAFTA	13446	14410	15379	16205	22433	22800	17567	21337	29149	23200
ASEAN	136	117	180	195	230	254	125	172	306	274
MCCA	536	565	623	631	774	911	750	942	1262	1109
CARICOM	664	679	1217	609	579	392	374	512	1098	1016
Imports (CIF)										
TOTAL	27162	29401	30731	38324	37026	43982	45709	35423	39754	44778
ANDEAN COMMUNITY	2108	2646	3279	4880	4907	5907	5209	4098	5477	5872
Bolivia	40	77	103	116	141	166	175	157	168	179
Colombia	694	1292	1542	1845	1848	2232	1900	1438	1612	1400
Ecuador	160	181	494	706	653	918	965	578	859	1170
Perú	596	522	646	1190	1433	1564	1175	980	1399	1147
Venezuela	618	573	494	1023	832	1027	994	945	1439	1977
MERCOSUR	2233	2337	2408	2961	2676	3258	3461	2626	3344	3947
EUROPEAN UNION-15	5607	5721	5855	6892	6946	7562	8380	6421	6508	6971
NAFTA	11988	12616	12246	15671	15620	18546	18552	14796	15404	16893
ASEAN	149	152	221	277	313	327	358	292	429	509
MCCA	66	72	93	153	118	121	198	102	92	117

Source: www.comunidadandina.com

2.2. A first gravity model specification.

In order to create a background against which to analyze the growth of trade among Andean countries, we first estimated the following gravity equation:

$$\ln M_{ij} = \beta_0 + \beta_1 \ln Y_i Y_j + \beta_2 \sqrt{D_{ij}} + \beta_3 ACP + \beta_4 Border + e_{ij} \qquad (1)$$

where: M_{ij} =value of country i imports from country j ; Y_iY_j = the multiplied GDP from both countries as a proxy for size ; $D_{i\,j}$ = distance between country i and country j to

capture trade costs ; *ACP* = dummy to measure the impact of integration on the trade of member countries - it takes the value of one when both countries are members of the Andean Community and zero otherwise ; *Border* = dummy to measure the impact of adjacency - it assumes the value of one when the countries have a common border[2].

The period analyzed was 1993-1999, as integration gained momentum after signature of the FTA, in 1992, and our aim is to test the significance and value of its impact over intra-regional trade. The countries in the left hand side of (1) are the five Andean members, and those at the right, the partners, i.e. their suppliers or exporters. Partners were selected based on the existence of bilateral trade with the members.

Trade flows, in millions of current US dollars, were obtained from IMF (2001), GDP data, in current US dollars, are from the World Bank Global Development Network Database[3] and the distance between capital cities, in kilometers, was obtained from Haveman's web page.[4]

Individual regressions were run for each year based on equation (1). Before running the regressions, a descriptive analysis of the data was performed. This led to transform imports and GDP by natural logarithm and distance by taking its square root. Ordinary Least Squares (OLS) were used, with the transformed data on imports as dependent variable. A number of countries in Asia and Africa that did not trade with the Andean Community were removed in each year.

The results, in standardized coefficients, together with the R^2 for each regression and the significance of the coefficients, can be found in Table 2. The gravity equation performs well in explaining bilateral trade between the Andean countries and their respective partners. The global adjustment of the regression is satisfactory, as the R^2 coefficients present values that are superior to 0.70. The independent variables had, in all cases, the expected sign and were statistically significant according to the F and t-tests.

[2] Frankel (1997) used gravity models to show that regionalization could be explained by geographical proximity and preferential trade agreements; Krugman (1991) formalized the role played by geographical proximity in the regionalization process, dummy variables being since then used to simulate and analyze these effects; Anderson and van Wincoop (2003) is a most recent and better theoretical support for all this.

[3] www.worldbank.org/research/growth/GDNdata.html.

[4] www.haveman.org.

Table 2: Gravity Model Estimates
Standardized Coefficients

	1993	1994	1995	1996	1997	1998	1999
$\mathbf{Y_iY_j}$	0.897 *	0.862 *	0.896 *	0.882 *	0.901 *	0.867 *	0.865 *
$\mathbf{D_{ij}}$	-0.435 *	-0.403 *	-0.443 *	-0.413 *	-0.377 *	-0.347 *	-0.345 *
D ACP	0.102 *	0.101 *	0.128 *	0.155 *	0.159 *	0.143 *	0.160 *
D Border	0.2 *	0.161 *	0.129 *	0.124 *	0.127 *	0.116 *	0.139 *
No Observations	141	243	240	255	247	261	235
R^2	0.82	0.722	0.755	0.752	0.780	0.714	0.769

* Significant at 95% level

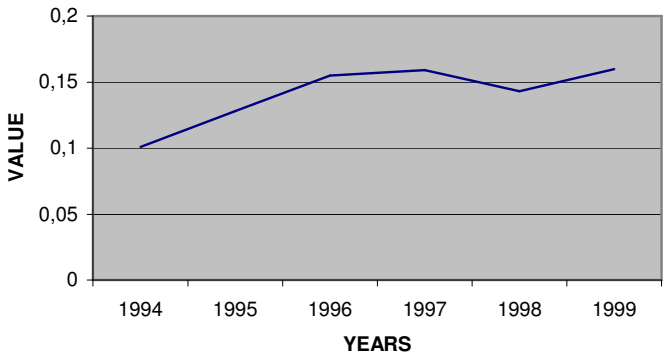
The effect of the product of the countries' GDP is positive and statistically significant, ranging between 0.862 and 0.901. These values are consistent with those found by Frankel (1997) and Echavarria (1998), for the periods 1965-1980 and 1986-1995, respectively, though slightly higher due to the fact that size is playing a more important role on trade nowadays and, of course, that the partners chosen for each analysis are different. The coefficients comply with the model assumption that trade increases with economic size, and, in the case of the Andean countries, this has a strong effect over their trade.

The distance coefficients have a negative sign, are statistically significant and present values between -0.443 and -0.345. Distance, however, has less impact than GDP. The value and sign of the distance coefficients are also similar to those found by Frankel (1997) and Echavarria (1998). These authors worked with a period before transportation services were liberalized and transportation costs reduced; therefore their coefficients are, in most cases, higher than the ones found here, when the effect of distance was already reduced.

The coefficients for the Preferential Agreement dummy fluctuate between 0.101 and 0.160. Their statistical significance (p-values) improves from 1995 onwards, and they have a positive evolution but low levels (Figure 1). It is important to remind that the FTA became effective only in 1993 and that Peru was out of the Pact until 1997; additionally, a high degree of exceptions applying different regulations diminish the influence of the Agreement. Stronger effects from the Pact may be expected in the coming years, as regulations are uniformly applied by all partners. The positive evolution of the coefficients and their improvement in significance reflect that member countries are trading more and more among themselves, with the exception of 1999.

This year was plagued with economic and political crises in some members, like the macroeconomic and banking crashes in Ecuador, the political problems in Peru that led to the flee of President Fujimori, and the floods in Venezuela. Overall, both our empirical results as well as the trade data show that the Agreement and the FTA had a positive impact on trade among member countries.

FIGURE 1: EVOLUTION OF THE ACP DUMMY



The dummy for adjacency tries to capture whether common frontiers, that enable border trade, do in fact increase trade flows. The coefficients for this dummy are positive and statistically significant, though low and presenting a rather negative evolution. The positive values do confirm that countries having a common border will trade more, but the low values and the lack of a positive trend - rather a declining one - suggest that these economies are relatively small and may trade more with bigger, despite geographically apart, economies. It is important to mention that sometimes countries do not engage in more border trade due to inappropriate transportation infrastructure and harsh geographical conditions, as in the Andes mountain range, which may considerably increase cost.

3. ANDEAN COMMUNITY: TRADE AND INFRASTRUCTURE

3.1 Trade, infrastructure and regional integration.

Since Krugman reminded, in 1991, that geography matters when trade is concerned, several authors, as Hummels (1998), tried to determine the effect of distance and the role of infrastructure in a bilateral trade model. Empirical works, as Porojan (2000), used investment data as a proxy for infrastructure. Nevertheless, the use of investment data to estimate infrastructure capital may present problems, as Summers and Heston (1991) argued. The effectiveness of the same investment flow may vary, in different countries, due to differences in public sector efficiency and in the prices of infrastructure capital.

Bougheas, Demetriades and Morgenroth (1999) tried to examine the role of infrastructure in a bilateral trade model and also on transport cost. Their findings predict that, for a pair of countries for which investment in infrastructure is optimal, a positive relationship between the level of infrastructure and the volume of trade takes place. As a consequence, variations in transport costs across countries may be able to account for differences in their ability to compete in international markets. Furthermore, differences in the volume and quality of infrastructure across countries may be responsible for the differences in transport costs, which in turn may account for differences in competitiveness. As a result, reducing the cost and improving the quality of transport systems improves international market access and therefore prompts an increase in trade.

There is substantial evidence linking improvements in transportation services and infrastructure in general to improvements in export performance. Hummels (1999) estimates that exporters with 1% lower shipping costs will enjoy a 5-8% higher market share. Limão and Venables (2001) estimated that the elasticity of trade flows with respect to the trade cost factor is approximately –3, and investigated the dependence of transport costs on geography and infrastructure. Limão and Venables (2001) estimated that differences in infrastructure account for 40% of the variation in transport costs for coastal countries and up to 60% for landlocked countries. Additionally, Wilson (2003) shows that the Asia Pacific Economic Cooperation countries differ substantially in the quality of their transport infrastructure and level of logistics and trade services and that these differences mark the gap of trade performance among them. The study concludes

that upgrading the transport and service infrastructure of the lagging countries will substantially increase trade.

Martinez-Zarzoso and Nowak-Lehman (2002) examined the role of economic and geographical distance for some sectoral exports of Mercosur to the EU. Their findings reveal that geographical distance, defined as the physical distance in kilometers between capitals modified by an infrastructure index, affects trade negatively. Goods have to be transported across countries and transport is not cost free. Transport costs increase with distance but may be reduced by a better infrastructure.

The real costs of trade, including transportation and the costs of doing business internationally, are important determinants of a country's ability to participate in the world economy. As Limão and Venables (2001) pointed out, remoteness and poor transport and communications infrastructure isolate countries and limit their participation in the international production chains. Improving the channels that facilitate the exchange of goods, services and people is a basic element to any strategy for increasing a region's international competitiveness.

In terms of regional integration, as stated in IDB (2000), geographical interaction creates flows that do not necessarily circulate freely, but that do so through infrastructure networks. Infrastructure networks provide the physical support through which flows circulate, but to ensure their successful influence in integration and development, a legal and institutional framework together with efficient infrastructure-related services operations are needed.

3.2 Infrastructure integration initiatives in the Andean Community.

Infrastructure development in the Andean Community was, for a long period, not only limited by the challenges presented by the natural physical barriers of the Andean range but also by economic policies that focused on domestic markets, underestimating the benefits of trade and foreign investment. Moreover, public deficits, macroeconomic instability, restrictions to foreign capital and historic patterns of trade constrained public and private investment in infrastructure.

Nowadays, infrastructure development is regarded as a source of competitiveness and no longer necessarily or exclusively involves the state in its direct provisioning. The priority is to update the road system to maintain and increase intra-community trade and at the same time interlink the region with the rest of South America. Regional integration flows in the Community are rarely channeled through

specific routes, but rather use networks that are shared with domestic and global traffic. In many cases, services of different geographical scope share segments of the same network; many infrastructure problems which constrain regional integration also hinder domestic development and international trade. They include a lack of capacity of existing corridors, poor state of roads that communicate with major and secondary markets, delays at border crossing and lack of multimodal connections. However, foremost since recently was the lack of financial and political commitment, in member countries, to projects that view infrastructure networks as a source of stable trade and economic development, and as part of measures that could contribute to the flows of goods and services among them.

Members are beginning to adopt common provisions on several fronts to facilitate and deregulate transportation services, electricity supply and telecommunications, in order to foster their intra-regional trade and physical integration[5]. Specific provisions for all modes of transportation, including multimodal transport, were established to determine the principles and criteria needed to provide services efficiently[6].

3.3 Andean Community trade by transportation mode.

The pattern of trade within the Andean Community is determined not only by the size of their economies and those of their partners but also by the transportation costs incurred while trading. To determine the variables that affect transportation costs when partner members chose to perform intra-community trade it is important to analyze the modes of transportation used.

Table 3 displays trade information by mode of transportation within the Andean Community. Between 1997 and 1999, intra-community exports were mostly delivered by road; actually, around 50% of the value traded. Maritime transportation occupied second place with approximately 37% of the total value traded, and air transportation was positioned in third place with approximately 7% of the total.

[5] www.comunidadandina.org/servicios/trans.htm.

[6] In the area of land transportation, for instance, Decisions 398 (passengers) and 399 (goods) determine the contractual terms and responsibilities of both carrier and user; international transportation by road is regulated by Decision 467; Resolution 300 regulates Decision 399 and determines the accepted forms to be used by country authorities and carriers. Similar important measures were taken for ocean transportation, with the purpose to harmonize policies and make companies more competitive, and in the area of air transport.

Table 3: Intra-Community Exports by mode of Transport

1997-1999
(in percentage)

Mode of Transport	1997	1998	1999
Road	49.5	51.0	45.7
Sea	38.5	36.5	39.9
Rail	0.5	0.3	0.7
Air	5.7	8.7	9.2
Multimodal	0.1	0.0	0.0
Waterway	5.6	2.9	4.4
Others	0.0	0.6	0.1

Source: www.comunidadandina.org

In 1997, road transportation was the main delivery method for Bolivia, Colombia, Ecuador and Venezuela. In 1998, Ecuador increased the participation of maritime transportation and Venezuela did the same in 1999. Venezuelan exports, between 1997 and 1999, were delivered to the other Andean members by road 48% of the time and by sea in 39%; its imports from the Andean partners were transported to the country 62% of the time by road and 29% by sea. Likewise, Colombian exports within the same period were delivered by road 55% of the time and by sea in 35%, while imports, 60% and 33%, respectively.

Maritime transportation is used mainly by Peru in all its deliveries, and by other members when trade takes place with partners that do not share a common border, making inland transportation expensive and slow. It is important to mention that maritime transportation is the traditional method of delivery for Andean countries, when trade is carried out with distant partners as the United States and the EU. This makes it the second most important mode of delivery to and from the Andean region. Nevertheless, it is important to consider that when goods are carried by sea, in most cases, an additional inland stretch is needed, either by road or rail, both at origin and destination. Bolivia, due to its landlocked location, is the main case. It normally combines shipment to a Chilean port with inland road transportation, for both its exports and imports to countries with which it does not share a common border[7].

[7]www.comunidadandina.org: Flujos Comerciales Intracomunitarios por Modos de Transporte 1997-1999.

Inland waterway transportation among members is not normally carried out due to the fact that there are not well developed corridors among the areas where this type of transportation may be possible and, in most cases, the business clusters in each country are located in areas where only road and sea transportation may be possible.

Cargo by air is relatively limited, due to the fact that shipping merchandise by road takes a shorter time, especially if carried out between members with a common border. Also, road transportation is the mode of delivery that presents the shortest delays at border crossing[8]. Air transportation with partners outside the Andean region is limited and reduced to highly perishable goods.

Border trade within the Andean members between 1997 and 1999 represented 98% of the intra-community trade by road and 49% of the total intra-community trade. Thus, trade by road between members that do not share a common border was limited. As can be observed in Table 4, border trade by road is very significant between Colombia and Venezuela, accounting for around 66% of the total border trade in the region by road. Trade between Colombia and Ecuador come in second position, with a little more than 23%, and that between Bolivia and Peru in third place (8%). The lowest level happens between Ecuador and Peru, with only 2% of the total value carried.

In the late '80s, due to the lack of infrastructure and the limited relevance of the Andean Agreement, sharing a common border was extremely important in terms of trade for all the members of the Andean Pact. Trade was performed at borders and there was less interest in distant partners, as logistics and transportation services were limited and expensive. By all means, distance in those times played an important role and borders marked the natural trade partners. During the '90s, the importance of border trade diminished considerably, the coefficients for the dummy in model (1) showing this.

[8] Personal communication with the firm 'ZaiMella del Ecuador S.A', active in export-import activities in most of the countries members of the Andean Community.

Table 4: Intra-Community Border Trade by Road
1997-1999
(Millions of U$ dollars)

Countries border destinations	1997	1998	1999	1997-1999	%
Bolivia to Peru	143	120	68	331	4.50
Colombia to Ecuador	353	360	198	911	12.38
Colombia to Peru	7	2	0	9	0.12
Colombia to Venezuela	802	847	688	2337	31.77
Ecuador to Colombia	336	269	207	812	11.04
Ecuador to Peru	23	11	13	47	0.64
Peru to Bolivia	92	91	84	267	3.63
Peru to Colombia	3	1	2	6	0.08
Peru to Ecuador	64	34	14	112	1.52
Venezuela to Colombia	982	1073	470	2525	34.32
TOTAL	2805	2807	1744	7357	100.00

Source: www.comunidadandina.org

4. EVALUATING THE INFRASTRUCTURE EFFECT

4.1. Model specification and data.

The results obtained with model (1) stressed that economic size (GDP) is probably the most important variable when a trade partner is chosen, and established that distance plays a decisive role in terms of cost. Nevertheless, the value of the distance coefficients declined throughout the period, suggesting that other factors, apart from physical distance itself, may be affecting transportation cost (and therefore trade) in the Andean Region. Indeed, as the economic size of bilateral partners did not change dramatically within the period analyzed, that borders were not altered and that the basic structure of the Pact was not modified, the variable that should be further analyzed is transportation costs and all its associated factors.

Following the literature described in section 3.1, we specified an augmented gravity model where physical distance is modified by an infrastructure index, i.e. a *geographical distance* focusing on the interaction of geography and infrastructure, to determine the effect of infrastructure on trade. Transportation costs become not only a function of distance but also of the availability of public infrastructure, such as roads, railroads, energy and telecommunication networks. These public infrastructure

dimensions are summarized in an index that measures the infrastructure level of the countries, modifying the distance variable.

Re-writing equation (1), bilateral trade is then modeled as:

$$\ln M_{ij} = \beta_0 + \beta_1 \ln Y_i Y_j + \beta_2 GeoD_{ij} + \beta_3 ACP + \beta_4 Border + e_{ij} \quad (2)$$

where M_{ij} , $Y_i Y_j$, ACP and $Border$ are as in (1), while $GeoD_{ij}$ is the distance between country i and country j modified by the infrastructure index.

The analysis uses a cross section for the period 1985-1995. The countries employed as reporters are again the five Andean Community members; partners were selected according to their levels of trade with the Andean countries and the availability of information on their infrastructure stock. By keeping the dummies for the Andean Pact and border effects, the analysis continues to capture the importance of the preferential trade agreement and the significance of sharing a border, when infrastructure is considered as part of the equation

Bilateral trade flows and GDP came from the same sources as before. The Geographical Distance variable is similar to the one used by Martinez-Zarzoso and Nowak-Lehmann (2002) and Limão and Venables (2001). It is defined by the physical distance between capitals of trading partners (obtained as before) divided by the sum of the infrastructure index of both countries. The infrastructure index was based on five variables: kilometers of roads, of paved roads and of railroads, telephone main lines and kilowatts of electricity generating capacity, and is explained in the Annex . Annual data on physical infrastructure stocks for the reporter and partner countries, for the period 1985-1995, were from David Canning's 1998 Database of World Infrastructure Stocks[9]. Data reported by Canning are of two types: raw data with a minimum of manipulation and basically as they appear in the original sources, and processed data, for which some kind of interpolation is carried out (assuming exponential growth over the intervening period, for instance). Processed data were used to calculate the index, as recommended by the author for empirical work, due to its inter-temporal consistency. Population data and country area to normalize infrastructure stock were obtained from the World Bank

[9] www.worldbank.org/html/dec/Publications/Workpapers/WPS1900series/wps1929.

Global Development Network Database and the Country Watch web page, respectively[10].

4.2 Empirical results.

Separate OLS regressions were run for each year, for model (2), with the natural log of members imports as dependent variable. Again, a number of Asian and African countries that did not engage in bilateral trade with the Andean Community were removed from the sample.

The results obtained (in standardized coefficients) for each regression are in Table 5. The R^2 values range from 0.653 to 0.735, for the period between 1985 and 1991; between 1992 and 1995, they are in all cases above 0.712. Hence, the gravity equation performs well in explaining the bilateral trade of the five Andean Community members, especially in the second part of the period, reflecting the increased applicability and importance of the Preferential Trade Agreement among the Andean countries .

The results place once again economic size as the most important variable. They do not only confirm the findings in section 2 but comply with those found in most empirical works. Nevertheless, it is important to point out that economic size (the multiplied GDP of each pair of countries) has a somewhat lower effect when infrastructure is considered in the equation. Despite the fact that the purchasing capacity of the partner is the first requirement to carry out trade, the lower effect of GDP identified in this second model confirms that the infrastructure stocks of both a member and its partner reduce distance between them. In fact, they reduce transportation cost and therefore reduce the prices of the goods traded, making them more accessible and shortening the economic distance between markets. During the whole period analyzed, the value of the GDP coefficients are statistically significant, positive and do not vary significantly from one year to another. They range between 0.718 and 0.791, similar to those found by Echavarria (1998) and Frankel (1997) in previous empirical work on the Andean Community, though again higher.

The Andean Pact dummy was not significant before 1990. Until the '90s, import substitution policies and inward looking regionalism marked the existence of an agreement full of exceptions and without operational functions, as members did not fully comply with its requirements: all presented high tariff levels and multiple non-

[10] www.worldbank.org/research/growth/GDNdata.html ; www.countrywatch.com.

tariff measures. The results for the Pact dummy confirm that the Preferential Trade Agreement did not influence trade among members before market-oriented reforms set the groundwork for boosting the integration efforts. Unfortunately, in 1992, despite the launching of the FTA, the Peruvian crisis led Venezuela to freeze diplomatic relations with Peru. As a result, Peru temporarily suspended its obligations under the liberalization program in the same year. These events left the Community without the much needed political support and brought down trade among members as confirmed by the drop in the dummy coefficient, though still significant. The values since then evidence a positive trend, indicating the sustained enforcement of the Agreement.

Table 5: Gravity Model including infrastructure
Empirical Results (Standardized Coefficients)
Andean Community Pact: 1985-1995

Year	ln Y_iY_j	ln GeoDistance	Dummy ACP	Dummy Border	R^2	n
1985	0.744 *	-0.252 *	0.007	0.410 *	0.677	125
1986	0.729 *	-0.250 *	0.021	0.384 *	0.664	129
1987	0.743 *	-0.243 *	0.032	0.374 *	0.666	131
1988	0.780 *	-0.211 *	0.041	0.390 *	0.717	134
1989	0.727 *	-0.244 *	0.080	0.371 *	0.653	133
1990	0.773 *	-0.206 *	0.170 *	0.386 *	0.692	140
1991	0.798 *	-0.228 *	0.243 *	0.349 *	0.735	132
1992	0.791 *	-0.256 *	0.159 *	0.371 *	0.757	135
1993	0.786 *	-0.245 *	0.197 *	0.339 *	0.777	143
1994	0.750 *	-0.256 *	0.227 *	0.307 *	0.728	146
1995	0.718 *	-0.293 *	0.237 *	0.264 *	0.712	151

(*) Significant at 95 % level.

These new results for the Pact dummy are also higher than those obtained when infrastructure endowments were not considered in the model[11]. Inclusion of infrastructure endowments did not only modify distance but also strengthened the role of the Preferential Trade Agreement. The combination of the appropriate infrastructure and the continuous reinforcement of regional integration among members on different fronts will certainly continue to influence their trade in a positive way.

The border dummy did not only present statistically significant results throughout the period but also gained more importance in determining trade. All coefficients were above 0.260, being about twice as high as those encountered in model (1). The increased importance of border in the Andean Community trade complies with the already mentioned fact that nearly 50% of the trade within the region is performed

[11] Throughout this and the next subsection, when assertions on the relative sizes of the same coefficients in different regressions (either in different models, for the same year, or the same model, in different

by road and 98% of it is at frontiers. However, one of the most important features in the results for this variable is its decreasing trend. Until 1992, the coefficients present higher values, indicating that sharing a common border was far more important than having a trade agreement. Although existing, the agreements were not fully applied. These higher values also reflect two additional issues: the poorer infrastructure and the higher cost resulting from delivering the merchandises by other means than road transport. From 1992 onwards, when the FTA was becoming operational and transportation costs by sea decreased to affordable values in terms of transit and frequencies, the importance of sharing a common border on trade within the region was reduced, and reached levels closer to the coefficients for geographical distance and for the Pact dummy.

Geographical Distance presented statistically significant, negative coefficients, confirming that transportation costs, even as proxied in the model, reduce trade. The results also confirm the theoretical framework in section 3.1: infrastructure endowments reduce bilateral distances. The geographical distance coefficients present values that are roughly half of those obtained when transportation costs were proxied by physical distance only[12]. From 1990 onwards, they show a positive trend. This evolution is the opposite of the one encountered when only physical distance was used, and tells that "distance" - as competition for transportation services increased and new and better ways of shipping goods were used - became more flexible, reductions in it having a greater impact on trade. Therefore, a key issue in increasing trade flows lies in the development of infrastructure and the capability of countries to mobilize efficient delivery services, reducing the prices of goods traded.

4.3 Further results: importance of partners and reporters infrastructure.

To analyze the separate role of the infrastructure of both reporters and partners, a third gravity model was estimated, under the same theoretical framework. The additional feature of the new model was the consideration of two geographical distance variables instead of one: Geographical Distance of the reporter (the five Andean members) and geographical distance of its partner.

The results obtained are in Table 6. The coefficients for economic size and the ACP and border dummies present more or less the same evolution, exactly the same

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years) are made, the appropriate tests of significance were performed. In order not to encumber the text, we avoided showing their results; they are however available from the authors.

sign and approximately the same level. Economic size continues to have a positive effect on trade. In the same line, the dummy for common border presents important and significant values until 1992, before the Preferential Agreement really gained significance.

Table 6 shows that, until 1992, the infrastructure of the reporters, i.e. the members of the Andean Community, had a higher negative effect over trade in the region than the infrastructure of the bilateral partner. This clearly points out that, the lack of infrastructure and the corresponding gap, compared to other countries in the region in the late '80s and early '90s, negatively affected the trade opportunities of the Andean members. As in many other countries in Latin America, their infrastructure deteriorated significantly during the '80s and early '90s, when the region lost considerable ground relative to the industrial countries and faster growing emerging economies (Calderon and Servén (2003)). The coefficients show that the lack of infrastructure of the reporters reduced the possibilities of trade to a higher degree than the level of their partner. In 1989 and 1990, the negative effect of the infrastructure of the reporter was approximately two and a half times that of the partner.

Table 6: Gravity Model considering infrastructure of reporter and partner
Empirical Results (Standardized Coefficients)
Andean Community Pact: 1985-1995

Year	ln Y_iY_j	ln GeoDistance Reporter	ln GeoDistance Partner	Dummy ACP	Dummy Border	R^2	n
1985	0.782 *	-0.207 *	-0.179 *	-0.034	0.374 *	0.687	125
1986	0.775 *	-0.278 *	-0.161 *	-0.087	0.337 *	0.695	129
1987	0.798 *	-0.243 *	-0.182 *	-0.017	0.327 *	0.688	131
1988	0.843 *	-0.302 *	-0.127 *	-0.031	0.328 *	0.764	134
1989	0.802 *	-0.338 *	-0.135 *	-0.010	0.302 *	0.704	133
1990	0.840 *	-0.267 *	-0.107 *	0.119 *	0.330 *	0.722	140
1991	0.841 *	-0.262 *	-0.142 *	0.175 *	0.295 *	0.765	132
1992	0.825 *	-0.215 *	-0.196 *	0.118 *	0.330 *	0.777	135
1993	0.806 *	-0.199 *	-0.187 *	0.154 *	0.301 *	0.795	143
1994	0.770 *	-0.191 *	-0.203 *	0.190 *	0.271 *	0.747	146
1995	0.750 *	-0.227 *	-0.211 *	0.190 *	0.220 *	0.729	151

(*) Significant at 95 % level.

When infrastructure started to gain relevance within government targets, transportation costs decreased and more and farther destinations could be reached at similar prices; the importance of the partner's infrastructure increased while that of the reporter lost influence. The results evidence that the major efforts made by the Andean

[12] The reader should bear in mind that the square root of distance was used in model (1), though this does

countries to increase the extent of private participation in infrastructure development proved successful. Moreover, the absolute value of the distance elasticity increases from 1990. Progress indeed has been made in reducing public sector funding shortfalls and improving productivity in infrastructure operation, Estache, Wodon and Foster (2002), making, again, distance more flexible. In 1995, the infrastructure of both countries becomes equally relevant in cost reduction and efficiency determination.

4.4. Regional infrastructure perspectives for the Andean Community.

Infrastructure should be considered not only as a key tool for integration but as a link to sustainable development. This section briefly connects this new view of infrastructure to the state of the art in the Andean region. By addressing the actual characteristics of the existing corridors, and outlining those that reveal the highest potential for development, we try to link our findings to reality.

The trend of growing intra-regional trade in the Andean Community, ascertained in the previous sections, was followed by market concentration. The pair with the highest share of intra-regional trade is Venezuela and Colombia and, in second place, Colombia and Ecuador. Trade flows in South America are dominated by a few major corridors and associated hubs of activity, IDB (2000), but out of the six top hubs only one is located in the Andean Community. The bigger flows are not in the Community, but rather in the Southern Cone, with Brazil, Chile and, until 2001, Argentina occupying the main positions (Table 7). Nevertheless, the Colombia-Venezuela hub, linking Bogotá to Caracas, carries more than 3 million tons of cargo annually and is second only to the Argentina-Brazil one. Half of this cargo is moved by truck and half by river and sea transportation; all this amounted to 2,577.8 million dollars in 1998. There is also an electricity transmission line with 380 MW of capacity. The Ecuador-Colombia flow is the ninth in the ranking, with 856.5 million dollars in 1998. These intra-regional exchanges are being progressively upgraded. By 2002, around 50% of the goods traded were high value-added products, and among the remaining 50% low value-added products, petroleum stands out.

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not invalidate the comments in this paragraph.

Table 7: Ten Main Bilateral Trade Relationships
In South America (1998)
(Millions of U$ dollars)

Bilateral Trade Partners	Flows	%
Argentina-Brazil	14411.3	38.64
Colombia-Venezuela	2577.8	6.91
Argentina-Chile	2413.5	6.47
Brazil-Chile	1851	4.96
Brazil-Uruguay	1815.6	4.87
Brazil-Paraguay	1598.7	4.29
Brazil-Venezuela	1367.3	3.67
Argentina-Uruguay	1338.1	3.59
Colombia-Ecuador	856.5	2.30
Argentina-Paraguay	751.7	2.02

Source: Interamerican Development Bank, 2000

The conceptual issues, frameworks and provisions for regional infrastructure development being put into practice in the Andean Community have been previously mentioned. Nevertheless, the Community, searching for a strategic and common vision for development, not only within the Andean region but also within the whole of South America, joined the Integration of Regional Infrastructure in South America (IIRSA) initiative.

IIRSA is a political and strategic regional vision based on the development of a hub encompassing the twelve South American countries. It represents a new planning approach, coordinating national sectoral policies as well as implementing projects consistent with the regional partners' policies. Therefore, the analysis of potential corridors should be performed considering those in which the Andean members participate as part of the Andean Agreement *and also* those with the rest of their existing and potential trading partners in South America.

Exchange hubs, which channel the strongest flows, are complemented by others with smaller volumes but significant growth potential. These corridors with somewhat lower volumes are exactly those where additional investment may have the highest returns, by reducing bottlenecks and expanding capacity. Approaching regionalism via a framework of hubs and corridors contributes to identify potential flows that could be promoted by additional integration in different areas, exploiting complementarities between economies and developing plans to tie other regions into the existing network. This new view aims at transforming trade hubs into integration and development hubs, in which infrastructure is not isolated but forms part of a set of activities, linking –

through different kinds of integration - physical investment with social dimensions of development. Our results strongly confirm the relevance of these points and add further motivation to pursue such initiatives.

The operation of new FTAs in the region, like the Mercosur-Andean Community one, may change the trading map of South America. The evidences provided in this paper warn that the development of the corresponding hubs and corridors must be one of the main priorities of these agreements.

5. CONCLUSIONS

Three different, though related, gravity models were examined in this paper. The first model checked the relevance of the Andean Preferential Trade Agreement and of adjacency on the members' trade flows. The second and third ones also considered the evolution of the Trade Agreement and adjacency factors, but included the role of infrastructure. One model evaluated the global importance of reducing distance among bilateral partners and the other separated the effects on the reporter and partner, to determine which infrastructure endowments play a more relevant role in reducing physical distance.

All the results showed that economic size is the most important variable when trade is concerned. Even within regional agreements, it is important to stress that economic size marks the level of bargaining a country faces. When trade is involved, states are interested in their relative purchasing capabilities and, therefore, in the economic power of the others. As economic size cannot be easily modified by short-term policies, countries should focus initially on other variables, like infrastructure or preferential agreements, to foster not only trade but growth as well. Notwithstanding, in any regional negotiation, the impact of the size of the economies should be considered.

The first gravity model confirmed that the Andean Community had a positive impact on trade within the region and with third partners. The positive evolution of the coefficients, together with their low values, means that the Pact gained strength slowly, due to the complex and full of exceptions integration process. The second model did confirm that the Preferential Trade Agreement became relevant only in the '90s, when members made the FTA operational. It also pointed out that its impact is larger when infrastructure endowments are considered. Differences in the volume and quality of infrastructure across countries may account for differences in transport costs, which in turn may account for differences in competitiveness. As a result, reducing the cost and

improving the quality of transport systems through infrastructure development improves international market access and prompts an increase in trade.

As the New Regionalism takes place in the world in general, and liberalization continues to reduce trade barriers and tariffs, the effective rate of protection due to transportation costs derived from poor infrastructure is nowadays considerably higher than the one provided by tariffs. Undoubtedly, the Andean Community should restate its integration approach and set in motion the appropriate mechanisms to improve its geopolitical stability, attract foreign direct investment, foster functional regional cooperation - especially in infrastructure - and improve its economic and political negotiating position *vis à vis* other groups or countries. It should foster a new type of integration oriented to macroeconomic stability, cooperation at different fronts and global competitiveness, rather than to purely trade measures; otherwise the impact of the Agreement will dilute as tariffs between the Latin American countries come down with new regional agreements. In this perspective, bilateral trade will ultimately be defined in terms of costs and competitiveness. But competitiveness will only be achieved by an improvement in logistic and transportation services at all points in the production-distribution chain, and the respective reduction in costs brought out by a more modern type of Regional Integration.

The second model also showed that the influence of sharing a common frontier, enabling border trade, is losing importance. As transportation costs decreased, and the Preferential Trade Agreement shaped up, promoting also infrastructure development, the importance of borders lessened. However, as land transport is the favored mode of a large percentage of the growing flows of goods, and border trade is an important source of economic activities at frontiers, intra-Andean borders should be properly equipped to efficiently interlink national economies. It is crucial to open trade corridors and centers of development that connect, through their border territories, interior regions of the Andean countries with Pacific and Atlantic ports. These corridors will enable the existence of true crossroad spaces whose privileged geographic position would be their main asset.

The evolution, sign, significance and values of the Geographical Distance variable confirmed the positive influence of infrastructure on trade, and strongly suggest that, as transportation costs decrease and the Andean Agreement evolves into a more sophisticated and complex process of integration, infrastructure is the most manageable variable in the hands of governments.

The results of the final gravity model, separately considering the infrastructure of the Andean countries and their partners, illustrate that nowadays the infrastructure of a country is decisive not only to import the locally required goods but also to qualify as a trade partner. Improving infrastructure in poor and middle income countries, like the Andean ones, has high returns in terms of trade (Brun, Carrere, Guillaumont, and De Melo, 2002)

Finally, the development of infrastructure should not only be regarded as a tool to increase trade. Infrastructure development within the framework of functional cooperation among South American economies should be regarded as a major development factor.

Annex: THE INFRASTRUCTURE INDEX

Several approaches to construct an infrastructure index have been used by different authors. Owen (1987) graded countries in terms of infrastructure by using a linear average of several infrastructure measures and establishing a value of 100 to one country and relating the others to it. Hulten (1997) chose to normalize individual measures of infrastructure in quartiles. He then assigned a value to each of the ordered quartiles and, from these infrastructure rankings, constructed an index by taking simple averages, Calderón and Chong (2004). Limão and Venables (2001) obtained an index from four variables: kilometers of road, of paved road, and of railroads per square kilometer of country area, and telephone main lines per person. Factor components to normalize the variables and also a Cobb Douglas production function were used. Nevertheless, the authors - as others of similar methods - stated that the normalizations did not affect the results in general terms. Martinez-Zarzoso and Nowak-Lehmann (2002) used the same four infrastructure variables but only normalized the telephone lines variable for 1000 people. The authors obtained a simple average infrastructure index per country.

The index we used is calculated on the base of five infrastructure variables: the four used by Limão and Venables (2001) plus kilowatts of electricity generating capacity. Usually, quantity variables are normalized to make them independent of the size of the country; therefore telephone main lines and kilowatts of electricity were divided by population (roads, paved roads and railroads were already normalized by square kilometers of country area). This procedure was inspired by Canning, who

considered that normalization of rival goods by population seems appropriate since the quantity of the good divided by population indicates average consumption[13]. Nevertheless, for non-rival goods, normalizing by population does not give average per capita consumption, as an increase in population with a fixed stock of non-rival infrastructure does not reduce average consumption. Hence, to normalize transportation infrastructure data by area, as done by Ingram and Liu (1997), Limão and Venables (2001) and in our case, makes sense.

The reason to include kilowatts of electricity is due to the fact that electricity contributes to the general economic activities, being crucial to telecommunication, computer and machinery operations. Also, most activities, at least at one point in the transportation and trade processes, like port operation and data processing, rely on electricity. Moreover, proper electrification along roads allows safe and efficient movement of cargo, especially at night, when most of the road transportation is carried out in the Andean countries.

For lack of comparable data across countries and along a sufficient period of time, we excluded ports and airport data, which represent a small share of overall infrastructure endowments. For similar reasons, power only included electricity. Moreover, the analysis only incorporates quantitative stocks rather than qualitative measures, as data evidencing efficiency of operation is hardly available.

The final index is a linear average of the five (normalized) infrastructure variables, calculated for each country in the sample, for the period 1985-1995. The value of the index for the countries in the regressions can be obtained from the authors. We mention that normalizing the infrastructure variables eliminated the effects of size; small countries like Belgium, the Netherlands or Japan rank high, as their infrastructure is well developed, despite the fact that in terms of absolute kilometers or number of telephones they may seem to have a lower level of infrastructure.

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[13] A good is rival in nature when the use of that good by one agent precludes the simultaneous use of the same goods by other agents. (See "Non-rival productivity inputs", available at: www.hassler-j.iies.su.se/Courses/macro/2000/growth3.pdf).

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