

Trade and infrastructure in the Andean Community

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This paper examines the key role of infrastructure in Andean Community trade patterns, using three gravity models. The first identifies the importance of preferential trade agreements and of geographical adjacency. The second and third models encompass these aspects while focusing on the inclusion of infrastructure in the gravity equation, testing the assumption that infrastructure endowments reduce “distance” (in terms of transport costs) between partners. Under the new trade arrangements, borders and previous agreements will lose significance, trade will be virtually free and bilateral flows will be defined in terms of costs and competitiveness. Competitiveness, however, can be achieved only by means of an improvement in infrastructure at all points in the production-distribution chain.

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I

Introduction

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

The work is organized as follows. The following two sections set out the framework for the analysis. Section II briefly reviews the evolution of what is now the Andean Community since it was formed in 1969 as the Andean Pact, focusing on the consolidation of the internal market and the group's trade pattern. An augmented gravity model of bilateral trade flows is applied to yearly data for 1993-1999 in order to determine whether the Andean Pact helped to increase trade within the region and to capture the effect of adjacency on trade among its members. Section III discusses the first gravity model. Section IV looks at the role of infrastructure in trade, reviewing theoretical and statistical evidence that location and resource endowments play a conclusive role in determining whether countries will decide to enhance their trading

opportunities by developing infrastructure to reduce transport costs. It then briefly reviews the transport modes employed in Andean Community trade.

Section V, where the effects of the degree of infrastructure development are fully assessed, is the core of the paper. We go beyond a traditional gravity model to discuss the notion that transport costs are not only a function of distance but also of the availability of proper means, such as roads, energy and telecommunications networks. These variables are summarized in an index measuring infrastructure development in the countries examined, 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, in which the relationship between infrastructure and geographical space is regarded as a key integration and competitiveness tool. Lastly, section VI offers conclusions drawn from the work.

II

How the Andean Community has evolved

What is known today as the Andean Community dates back to 1969, when a group of countries signed the Cartagena Agreement, also known as the Andean Pact, in which they established a customs union for the next 10 years.

Since then, Andean integration has come through a series of stages and the initial inward-looking development project, based on the import substitution model, gradually gave way to an initiative more akin to open regionalism. In June 1997, the Andean

Community came into being with the Trujillo Protocol modifying the Cartagena Agreement. The Protocol created the Andean Presidential Council and a Council of Foreign Ministers, affording both a critical role in decision-making. It also strengthened the internal cohesion of the integration process by placing all the Community's institutions and mechanisms under the management of the Andean Integration System. The Andean Community is now a regional organization endowed with international legal status. Recently, some friction has arisen among its five members —Bolivia, Colombia, Ecuador, Peru and Bolivarian Republic of Venezuela— and this last country has opted to follow an independent course. At the same time, Mexico applied for full membership of the group. These developments, however, fall outside the scope of this paper.

□ Renato Flôres acknowledges the hospitality extended by the Institute of Development Policy and Management of the University of Antwerp, where he initiated this work as a visiting scholar.

In 1987, the members of the Andean Community began to design a new strategy to keep up with the liberalization process taking place in Latin America. A free trade area was formed in 1992 and evolved into an imperfect customs union. As early as 1992, Bolivarian Republic of Venezuela and Colombia eliminated tariffs and other barriers to reciprocal trade. Bolivia joined them in September 1992 and Ecuador in January 1993, when the free trade area became fully operational among these four countries. Peru temporarily suspended its obligations under the liberalization programme, beginning, in 1992, to negotiate bilateral trade agreements with each of its Andean partners and, in some cases, partially liberalizing reciprocal trade flows. These bilateral agreements remained in place until 1997, when an agreement was reached for Peru's gradual incorporation into the Andean free trade area (Decision 414). Tariffs were eliminated on most goods by 2000, with "sensitive products", including agricultural goods, to be totally liberalized by 2005.

In 1994, the Common External Tariff (CET) was approved by Decision 370. Its implementation, however, has run up against the typical difficulties. When Decision 370 was made, Bolivia was exempt and Peru, as noted above, was not participating in the process. Here again, Bolivarian Republic of Venezuela and Colombia were the first two countries to adopt the CET in 1994, followed by Ecuador in 1995. The Andean CET is determined by level of processing: a rate of 5% is applied to raw materials and industrial inputs; rates of 10% and 15% to intermediate inputs and capital goods, respectively; and 20% to final goods. The CET average is 13.6%, with a 20% ceiling. Bolivia and Peru are becoming gradually incorporated into the customs union, which already encompasses Bolivarian Republic of Venezuela, Colombia and Ecuador. Full adoption was expected in 2005.

The Andean Community has addressed most of the newer trade issues, such as investment, competition

policy, services and intellectual property rights and it has adopted common policies in most of these areas.¹ It has also taken steps to deal with the question of infrastructure, the focus of this paper. Furthermore, the Community is aware that the development of a common foreign policy is a main objective and involves the joint participation of all its members in the World Trade Organization (WTO) and in negotiations concerning regional agreements.

In 2004, the Andean countries formed a market of over 121 million people distributed over an area of 4.7 million square kilometers. Their combined GDP that year stood at US\$ 317 billion. The main markets for their exports are the United States, the European Union (EU) and the Community itself.

Liberalization of the internal market has had an important impact on trade among its member countries. Trade flows have reached unprecedented levels, with intraregional trade growing faster than trade with the rest of the world. After a decade of flat or declining growth in the 1980s, intra-Andean trade picked up in 1989 and grew steadily after 1990. At the end of 2004, intra-Andean exports amounted to US\$ 7.4 billion, nearly three times the 1992 level. Equally importantly, Andean trade with the rest of the world has also risen; imports and exports from and to countries outside the Community have increased steadily since the agreement was reactivated in the early 1990s.

Though there is a commitment to establish a Common Market, as noted earlier, the Community is still an incomplete customs union, since both the CET and the FTA are subject to a number of exceptions.

¹ For example, 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 addressed copyright issues.

III

A first gravity model

In order to create a framework in which to analyse the growth of trade among Andean countries, we first constructed the following gravity equation:

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

where: M_{ij} is the value of country i imports from country j ; $Y_i Y_j$ is the GDP of both countries multiplied as a proxy for size; D_{ij} is the distance between country i and country j (to capture trade costs); ACP is a dummy to measure the impact of integration on member countries' trade (it takes a value of 1 when both countries are Andean Community members and 0 otherwise); and $Border$ is a dummy to measure the impact of adjacency (it assumes a value of 1 when the countries have a common border).²

The analysis encompassed the period 1993-1999, since integration gained momentum after the formation of the free trade area in 1992, with the aim of testing the significance and value of the agreement's impact on intraregional trade. The countries on the left side of equation (1) are the five Andean Community members and those on the right are their partners, i.e., suppliers or exporters. The partners selected are those that have bilateral trade with members.

Data on trade flows, in millions of current United States dollars, were obtained from the International Monetary Fund (IMF, 2001). GDP data, in current dollars, are from the World Bank Global Development Network Growth Database³ and the distance between capital cities, in kilometres, was obtained from Haveman's web page.⁴

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 and since then dummy variables have been used to simulate and analyse these effects; Anderson and van Wincoop (2003) offer a more recent and stronger theoretical support for all this.

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

⁴ www.haveman.org.

Individual regressions were run for each year based on equation (1), following a descriptive analysis of the data, which led to the transformation of imports and GDP by natural logarithm and distance by square root. Ordinary Least Squares (OLS) were employed, with the transformed data on imports as dependent variables. 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, are shown in table 1. 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, since the R^2 values are higher than 0.70. In all cases, the independent variables had the expected sign and were statistically significant according to F and t -tests.

The effect of the multiplication 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 Echavarría (1998) for the periods 1965-1980 and 1986-1995, respectively, though slightly higher owing to the fact that size plays a more important role in trade nowadays and, of course, that the partners chosen for each analysis are different. The coefficients bear out the assumption that trade increases with economic size and, in the case of the Andean countries, this has a strong effect on their trade.

The distance coefficients have a negative sign, are statistically significant and show values between -0.443 and -0.345. Distance has less impact than GDP, however. The value and sign of the distance coefficients are also similar to those found by Frankel (1997) and Echavarría (1998). Both authors worked with a period before the liberalization of transport services and the reduction of costs, so their coefficients are, in most cases, higher than those found in this work, when the distance effect had diminished.

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 evolve positively, albeit at low levels

TABLE 1

Gravity model estimates
(Standardized coefficients)

	1993	1994	1995	1996	1997	1998	1999
$Y_i Y_j$	0.897 *	0.862 *	0.896 *	0.882 *	0.901 *	0.867 *	0.865 *
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}	0.200 *	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

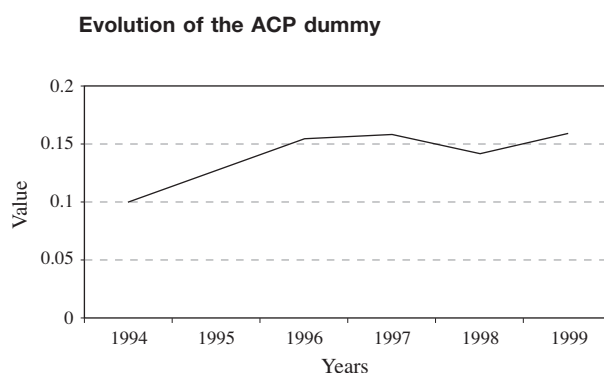
Source: authors' estimates.

* Significant at 5%.

(figure 1). It is important to recall that the free trade area took effect only in 1993 and that Peru remained outside the agreement until 1997. In addition, a large number of exceptions leading to the application of different regulations diluted the influence of the agreement. The impact of the Pact may be expected to become more powerful as regulations are more uniformly applied by all partners. The positive evolution of the coefficients and their significance gains reflect the fact that, with the exception of 1999, member countries have been trading increasingly among themselves. The year 1999 saw numerous economic and political crises, including the macroeconomic and banking collapse in Ecuador, the political problems in Peru that led to the flight of President Fujimori and flooding in Bolivarian Republic of Venezuela. Overall, our empirical results show that the Pact and the free trade area had a positive impact on trade among member countries.

The dummy for adjacency is used to establish whether common borders, which enable trade in those areas, do in fact increase trade flows. The coefficients for this dummy are positive and statistically significant, though their values are low and tending to decline. The positive values confirm that countries with a common border will trade more, but the low values and the non-positive trend suggest that these economies are relatively small and may trade more with larger economies, even those that are geographically more distant. Importantly, the reason adjacent countries do not engage in more border trade often comes down to poor transport infrastructure and difficult geographical conditions. In this regard, the Andes mountain range can drive up costs considerably for the Andean countries.

FIGURE 1



Source: Estimates prepared by the authors on the basis of the data shown in Table 1.

IV

Trade and infrastructure in the Andean Community

1. Trade, infrastructure and regional integration

Since Krugman (1991) recalled the importance of geography to trade, several authors, including Hummels (1998), have attempted to measure the effect of distance and the role of infrastructure in a bilateral trade model. A number of empirical works, such as Porojan (2000), have used investment data as a proxy for infrastructure. But the use of investment data to estimate infrastructure capital can present problems, as Summers and Heston (1991) argued. The effectiveness of the same investment flow may vary from one country to another, owing to differences in public sector efficiency and in the prices of infrastructure capital.

Bougheas, Demetriades and Morgenroth (1999) sought to examine the role of infrastructure in a bilateral trade model and in determining the cost of transport. According to their findings, a pair of countries in which infrastructure investment is optimal will exhibit a directly proportional relationship between infrastructure endowment and volume of trade. Consequently, variations in transport costs among countries may account for differences in their ability to compete in international markets. Furthermore, differences in the volume and quality of infrastructure may account for differences in transport costs and, hence, variations in competitiveness. As a result, reducing the cost and improving the quality of transport systems improves international market access and stimulates an increase in trade.

There is categorical evidence linking improvements in transport services and infrastructure in general to improvements in export performance. Hummels (1999) estimated that for every reduction of 1% in shipping costs, exporters will enjoy a market share gain of 5%-8%. Limão and Venables (2001) calculated that the elasticity of trade flows with respect to the trade cost factor is approximately -3. Their research into the extent to which transport costs depend on geography and infrastructure found that differences in infrastructure account for 40% of the variation in transport costs for coastal countries and up to 60% for landlocked countries. Wilson (2003) showed that trade performance

gaps among the Asia-Pacific Economic Cooperation countries were attributable to substantial differences in the quality of their transport infrastructure and level of logistics and trade services. This study concluded that upgrading the transport and service infrastructure of the lagging countries would substantially boost trade.

Martinez-Zarzoso and Nowak-Lehman (2002) examined the role of economic and geographical distance for a number of MERCOSUR sectoral exports to EU. Their findings reveal that geographical distance, defined as the physical distance in kilometres between capitals modified by an infrastructure index, has a negative impact on trade. Transport costs increase with distance but may be reduced by infrastructure improvements.

The real costs of trade, including transport 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 capacity to participate in international production chains. Any strategy aimed at increasing a region's international competitiveness must include improvement of the channels that facilitate the exchange of goods and services and the movement of people.

In terms of regional integration, as noted by the Inter-American Development Bank (IDB, 2000), geographical interaction creates flows that do not necessarily circulate freely, but do so through infrastructure networks. These networks provide the physical support for flows to circulate: they cannot be a positive influence on integration and development without an appropriate legal and institutional framework combined with efficient infrastructure-related services. Moreover, like the integration process itself, infrastructure networks constitute regional public goods (IDB, 2004) and therefore require joint, coordinated action from all the countries involved in order to fully realize their status as such.

2. Andean Community trade by mode of transport

In order to determine the variables that affect transport costs in members' intra-community trade, it is important to analyse the modes of transport used. Table 2 shows trade information by mode of transport within the Andean Community. Between 1997 and 1999, intra-community exports were delivered mainly by road—nearly 49% of the value traded. Maritime transport occupied second place, with around 38% of the total value traded, and air transport took third place with approximately 8% of the total.

TABLE 2

Andean Community: intra-community exports by mode of transport, 1997-1999 (Percentages of export value)

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 transport was the main delivery method for Bolivarian Republic of Venezuela, Bolivia, Colombia and Ecuador. The proportion of maritime transport increased in Ecuador in 1998, likewise in Bolivarian Republic of Venezuela in 1999. Between 1997 and 1999, 48% of Venezuelan exports were delivered to other Andean countries by road and 39% by sea. Of Venezuela's imports from its Andean partners, 62% arrived by road and 29% by sea. In this period, 55% of Colombian exports were delivered by road and 35% by sea, while the proportions of its imports arriving by road and sea were 60% and 33%, respectively.

In common with other Community members, Peru uses mainly maritime transport for all deliveries to non-bordering partners, since inland transport is expensive and slow in such cases. Shipping is the Andean countries' traditional method of delivery for trade with geographically distant partners such as the United States and EU and is therefore the second most important mode of delivery to and from the Andean

region. Nevertheless, in most cases, goods carried by sea must also be transported over an additional inland stretch by either road or rail at both origin and destination. Bolivia's landlocked position makes it the prime illustration of this point. For both exports to and imports from non-bordering countries, Bolivia usually combines shipment to or from a Chilean port with inland road transportation (Andean Community, undated).

Generally speaking, the Andean Community members do not engage in inland waterway transportation because the areas where it would theoretically be feasible lack well-developed corridors. Moreover, the locations of the countries' business clusters often preclude transport modes other than road and sea.

Air cargo is relatively limited: shipping merchandise by road is quicker, especially between bordering countries. Also, road transport is the delivery mode with the most expedite border crossing.⁵ Air cargo involving partners outside the Andean region is limited and confined to highly perishable goods.

Between 1997 and 1999, border trade among the members represented 98% of intra-community trade by road and 49% of total intra-community trade. Trade in road-freighted goods among non-bordering members was thus limited. As table 3 shows, Bolivarian Republic of Venezuela and Colombia have a very significant road-freighted border trade, accounting for around 66% of all trade of this type in the subregion. Trade between Colombia and Ecuador comes in second position, with slightly over 23%, and trade between Bolivia and Peru occupies third place (8%), though nearly half of all trade between these two countries—during the same period—was carried by road. The lowest level occurs between Ecuador and Peru, with only 2% of the total value carried.

In the late 1980s, the lack of infrastructure and the limited relevance of the Andean Pact meant that having a common border was extremely important for all the members' trade. Trade was conducted at borders and there was less interest in more distant trading, because logistics and transport services were few and expensive. At that time distance was certainly crucial and borders marked out natural trading partners. In the 1990s, however, the significance of border trade decreased considerably, as the coefficients for the dummy in model (1) show.

⁵ Personal discussions with the firm ZaiMella del Ecuador S.A, which operates export-import activities in most of the Andean Community member countries.

TABLE 3

Andean Community: intra-community border trade by road, 1997-1999
(Millions of dollars)

Bordering country of destination	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 (Bol. Rep. of)	802	847	688	2 337	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 (Bol. Rep. of) to Colombia	982	1 073	470	2 525	34.32
<i>Total</i>	<i>2 805</i>	<i>2 807</i>	<i>1 744</i>	<i>7 357</i>	<i>100.00</i>

Source: www.comunidadandina.org.

V

Evaluating the infrastructure effect

1. Model specification and data

The results of model (1) showed that economic size (GDP) is probably the most important variable in the choice of trading partner and established that distance plays a decisive role in cost. Nevertheless, the absolute value of the distance coefficients declined throughout the period, suggesting that other factors, apart from physical distance, may be affecting transport costs (and therefore trade) in the Andean region. Indeed, given that the economic size of bilateral partners did not change dramatically within the period examined, no borders were altered and the basic structure of the Pact was unchanged, transport cost and the associated factors represent the variable that calls for further analysis.

Based on the literature described in point 1 of section IV, we built an augmented gravity model in which physical distance is modified by an infrastructure index, i.e., a geographical distance centred on the interaction of geography and infrastructure, to determine the effect of infrastructure on trade. In this model, transport costs are a function not only 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 degree of infrastructure development in the countries, modifying the distance variable.

Rewriting equation (1), bilateral trade is thus 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 the same as in equation (1) and $GeoD_{ij}$ is the distance between country i and country j modified by the infrastructure index.

The analysis takes a cross section for the period 1985-1995.⁶ The reporting countries are again the five Andean Community members, with partners selected by levels of trade with the Andean countries and the

⁶ The time difference in relation to model (1) was conditioned by the availability of infrastructure data.

availability of information on their infrastructure endowment. Since the model retains the dummies for the Andean Pact and border effects, it continues to capture the importance of the preferential trade agreement and the significance of a shared border when the infrastructure variable is introduced.

Data on bilateral trade flows and GDP were taken from the same sources as before. The geographical distance variable is similar to that used by Martínez-Zarzoso and Nowak-Lehmann (2002) and Limão and Venables (2001). It is defined as the physical distance between trading partners' capital cities (obtained as before) divided by the sum of the two countries' infrastructure indexes. The index, which is explained in the appendix, was based on five variables: kilometres of highways, of paved roads and railways, telephone mainlines and kilowatts of electricity generating capacity.

Annual data on physical infrastructure stocks for the reporter and partner countries for 1985-1995 were taken from David Canning's 1998 Database of World Infrastructure Stocks.⁷ Canning reports two data types:

raw data with a minimum of manipulation, basically as they appear in the original sources, and processed data with some kind of interpolation (assuming exponential growth over the intervening period, for instance). As recommended by the author, the index was calculated using the processed data because of their inter-temporal consistency for empirical work. The data on population and country area used to normalize infrastructure stock were obtained from the World Bank Global Development Network Growth Database and the Country Watch web page, respectively.⁸

2. Empirical results

In model (2) separate OLS regressions were run for each year, with the natural logarithm 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 (in standardized coefficients) for each regression are shown in table 4. The R^2 values range

⁷ See www.worldbank.org/html/dec/Publications/workpapers/WPS1900series/wps1929.

⁸ See www.worldbank.org/research/growth/GDNdata.html; www.countrywatch.com.

TABLE 4

Andean Pact, 1985-1995: first gravity model including infrastructure. Empirical results
(Standardized coefficients)

Year	$\ln Y_i Y_j$	$\ln \text{GeoDistance}$	Andean Pact dummy	Border dummy	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

Source: authors' estimates.

* Significant at 5%.

from 0.653 to 0.735 for the period 1985-1991; between 1992 and 1995, they are higher than 0.712 in all cases. Hence, the gravity equation adequately explains the bilateral trade of the five Andean Community members, especially in the second part of the period, reflecting the increasing application and importance of the preferential trade agreement.

Here again, economic size is the most important variable. This not only confirms the findings already presented but coincides with those offered in most empirical works. Nevertheless, notably, economic size (the multiplied GDP of each pair of countries) has a somewhat smaller effect when infrastructure is incorporated into the equation. Although the partner's purchasing power is the first requirement to engage in trade, the smaller GDP effect found in this second model confirms that the infrastructure stocks of both member and partner reduce the distance between them. By reducing transport costs, such endowments reduce the prices of the goods traded and make them more accessible, thus shortening the economic distance between markets. Throughout the period analysed, GDP coefficients are statistically significant, positive and show no significant variation from one year to another. They range between 0.718 and 0.791, similarly to those found by Echavarría (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 1990s, import substitution policies and inward-looking regionalism shaped a non-operational agreement rife with exceptions, since members did not fully comply with its requirements: they all applied high tariffs and multiple non-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 integration efforts. Unfortunately, in 1992, despite the creation of the free trade area, the crisis in Peru led the Bolivarian Republic of Venezuela to freeze diplomatic relations with that country. As a result, Peru temporarily suspended its obligations under the liberalization programme. These developments detracted necessary political support from the Community and brought about a decline in trade among members, as confirmed by the drop in the dummy coefficient, though this trade remained significant. Since then the values have shown a positive trend, indicating the consistent enforcement of the agreement.

The new values for the Pact dummy are also higher than those obtained before the incorporation of

infrastructure endowments into the model.⁹ Inclusion of infrastructure endowments not only lessened the distance effect but also strengthened the role of the preferential trade agreement. The combination of appropriate infrastructure and continuous building of regional integration on different fronts will certainly continue to influence intra-community trade in a positive manner.

The border dummy not only showed statistically significant results throughout the period, but gained importance as a trade determinant. As with the previous dummy, the inclusion of infrastructure heightened the importance of borders. All coefficients were above 0.620, about twice as high as those found in model (1), for the corresponding years (1993-1995). The importance of borders in Andean Community trade is consistent with the fact that nearly 50% of the trade within the subregion is road-freighted and 98% of road transport takes place in border areas, as noted earlier. However, one of the most important traits of the results for this variable in model (1), the decreasing trend of the coefficients, is maintained in model (2). Until 1992, the coefficients present higher values, indicating that a common border had a stronger influence on trade than the existence of a trade agreement which, though signed, was yet to be fully enforced. These higher values also reflect two additional issues: the poorer infrastructure and the greater cost resulting from delivering merchandise other than by road. After 1992, when the free trade area became operational and maritime transport costs decreased to affordable figures in terms of transit and frequency, shared borders became less important and the coefficients approached the levels posted by the geographical distance and Pact dummy coefficients.

The geographical distance coefficients were statistically significant and negative, confirming that transport costs, as represented in the model, reduce trade. The results also support the theoretical framework mentioned earlier, insofar as infrastructure endowments reduce bilateral distances. The geographical distance coefficients are roughly half those obtained from

⁹ In this subsection and the next, 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 years) are supported by the appropriate significance tests. To avoid encumbering the text, these results are not included; they are, however, available from the authors.

proxying transport costs by physical distance alone.¹⁰ From 1990 onwards, they show a positive trend. This pattern is the opposite of that encountered when physical distance alone was used, revealing that the distance variable became more important as competition for transport services increased and new and better ways of shipping goods were found, thus making transport more flexible and reducing its impact on trade. Therefore, a key issue in increasing trade flows is to develop infrastructure and build up the countries' capability to mobilize efficient delivery services and thus reduce the prices of traded goods.

3. Further results: the importance of infrastructure in reporting and partner countries

To analyse the role of the infrastructure of reporting and partner countries separately, a third gravity model was built within the same theoretical framework. The difference with respect to the previous models was the inclusion of two geographical distance variables instead

of one: the geographical distance of the reporter (the five Andean members) and that of its partner.

The findings are shown in table 5. The coefficients for economic size and the Andean Pact and border dummies show more or less the same evolution, exactly the same sign and approximately the same level. Economic size continues to have a positive effect on trade. Similarly, the common border dummy posts important and significant values up to 1992, before the preferential agreement gained momentum.

Table 5 shows that, until 1992, the infrastructure of the reporting countries, i.e., the Andean Community members, had a larger negative effect on trade than the partners' infrastructure endowments. This clearly indicates that in the late 1980s and early 1990s the lack of infrastructure and the corresponding disadvantage with respect to other countries in the region had a negative impact on the trade opportunities of the Andean Pact signatories. The infrastructure in these countries, like many others in Latin America, deteriorated significantly in the 1980s and early 1990s, when the region lost considerable ground to the industrialized countries and faster-growing emerging economies (Calderon and Servén, 2003). The coefficients show that lack of infrastructure at home narrowed the reporting countries' trade possibilities

¹⁰ It will be recalled that model (1) used the square root of distance, though this does not refute the arguments made in this paragraph.

TABLE 5

Andean Pact, 1985-1995: second gravity model including infrastructure. Empirical results (of the reporting and partner country). Empirical results
(Standardized coefficients)

Year	$\ln Y_i Y_j$	$\ln \text{GeoDistance}$ Reporter	$\ln \text{GeoDistance}$ Partner	Andean Pact dummy	Border dummy	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

Source: authors' estimates.

* Significant at 5%.

more than the same lack in partner countries. In 1989 and 1990, the reporters' infrastructures had a negative impact about two-and-a-half times that of partner-country infrastructures.

Once infrastructure became an important government objective, transportation costs decreased and a greater number of more distant destinations could be reached for the same price. Hence, partner-country infrastructure gained in importance while the reporters' infrastructure lost influence. The results indicate that the Andean countries' major efforts to increase private-sector involvement in infrastructure development were successful. Moreover, the absolute value of distance elasticity rises after 1990. Progress has been made in reducing public-sector funding shortfalls and improving infrastructure productivity (Estache, Wodon and Foster, 2002), thus making distance more flexible again. By 1995, the infrastructure of both countries was equally relevant in cost reduction and efficiency determination.

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. We will refer briefly to the state of the art as regards infrastructure in the Andean region. By discussing the traits of existing corridors and outlining the position regarding those with the highest apparent potential for development, we attempt to link our findings to the situation on the ground. The members are, in fact, beginning to adopt common measures on several fronts to foster intraregional trade and physical integration, by facilitating and deregulating to facilitate and deregulate transport services, electricity supply and telecommunications.¹¹ Specific provisions for all modes of transport, including multimodal transport, have been made to determine the principles and criteria of efficient service provision.¹²

Growing intraregional trade in the Andean Community, as discussed in the previous sections, was

¹¹ See www.comunidadandina.org/servicios/trans.htm.

¹² As regards overland transport, for instance, Decisions 398 (passengers) and 399 (goods) set out the contractual terms and responsibilities of both carrier and user; international transport by road is regulated by Decision 467; Resolution 300 regulates Decision 399 by determining the forms to be used by country authorities and carriers. Other important measures have been taken for maritime and air transport, in order to harmonize policies and make firms more competitive.

followed by market concentration. Bolivarian Republic of Venezuela and Colombia form the country pair with the highest share of intraregional trade, following by the Colombia-Ecuador.

According to IDB (2000), trade flows in South America are concentrated in a few major corridors and associated hubs of activity, but only one of the six main hubs is located in the Andean Community. The largest flows do not take place in the Community, but in the Southern Cone, with Brazil, Chile and, until 2001, Argentina occupying the main positions (see table 6). Nevertheless, the Colombia-Bolivarian Republic of Venezuela hub, linking Bogotá to Caracas, moves more than 3 million tons of cargo annually and is second only to the Argentina-Brazil flow. Half of this cargo, which amounted to US\$ 2.5778 billion in 1998, is transported by truck and half by river and maritime transport. There is also a 380 MW electricity transmission line. The Ecuador-Colombia trade flow ranks ninth, with US\$ 856.5 million in 1998. These intraregional exchanges are being gradually upgraded. By 2002, around 50% of the goods traded were high value-added products and, among the remaining 50%—low value-added products—petroleum is prominent.

This paper has discussed the conceptual issues, frameworks for analysis and provisions for regional infrastructure development being made in the Andean Community. As well, however, seeking a common strategic vision on development not only within the Andean region but also for all of Latin America, the Community joined the Regional Infrastructure Integration in South America (IIRSA) initiative.

TABLE 6

South America: ten main bilateral trade relationships, 1998 (Millions of dollars)

Bilateral trade partners	Flows	%
Argentina-Brazil	14 411.3	38.64
Colombia-Venezuela (Bol. Rep. of)	2 577.8	6.91
Argentina-Chile	2 413.5	6.47
Brazil-Chile	1 851.0	4.96
Brazil-Uruguay	1 815.6	4.87
Brazil-Paraguay	1 598.7	4.29
Brazil-Venezuela (Bol. Rep. of)	1 367.3	3.67
Argentina-Uruguay	1 338.1	3.59
Colombia-Ecuador	856.5	2.30
Argentina-Paraguay	751.7	2.02

Source: Interamerican Development Bank (2000).

IIRSA is a political and strategic regional vision revolving around the development of a hub encompassing the 12 South American countries. It represents a new planning approach in which countries coordinate both national sectoral policies and projects that are consistent with the policies of their regional partners. In view of this, the analysis of potential corridors should consider those in which the Andean members participate under the Andean Agreement as well as those linking them to other existing and potential trading partners in Latin America.

The exchange hubs channelling the largest flows are complemented by others which mobilize smaller volumes but have significant growth potential. It is precisely in these corridors with somewhat lower volumes where fresh investment may have the highest returns, by reducing bottlenecks and expanding capacity. Approaching regionalism via a framework of hubs and corridors helps to identify flows that could be stimulated by furthering integration in different areas, building on complementarities between economies

and developing plans to tie other regions into the existing network. This approach aims to transform trade hubs into axes of integration and development, with infrastructure construed not in isolation but as part of a set of activities, linking —through different kinds of integration— physical investment with social dimensions of development.

Our results confirm the relevance of the above points and add to the motivation to pursue such initiatives. But there are competing options for infrastructure investment, ranging from local or domestic options (the “country cost”) to those favouring distant partners. From a regional development perspective, the preferred options would be domestic and IIRSA-related, whether within or outside the Community.

The operation of new free trade areas in the region, such as the MERCOSUR and Andean Community area, may change the trading map of South America. The evidence set forth in this paper suggests that the development of the hubs and corridors should form one of the main priorities in such agreements.

VI

Conclusions

Three different, though related, gravity models were examined in this paper. The first confirmed the relevance of the Andean preferential trade agreement and of adjacency to the members’ trade flows. The second and third models also took the trade agreement and adjacency factors into account, but factored in the role of infrastructure. One model evaluated the general importance of reducing distance between bilateral partners and the other separated the effects of importers’ and exporters’ infrastructure endowments, in order to determine which had most impact in terms of reducing physical distance.

All the results confirmed that economic size is crucial to trade. Even within regional agreements, size determines a country’s level of bargaining power. When it comes to trade, States are interested in relative purchasing capabilities and, therefore, in the economic power of the others. Given that economic size cannot readily be modified by short-term policies, countries should focus first on such variables as infrastructure or preferential agreements to foster not only trade but

growth as well. Nevertheless, economic size will be a consideration in any regional negotiation.

The first gravity model confirmed the Andean Community’s positive impact on trade within the region and with third partners. The positive evolution and low values of the coefficients show that the preferential trade agreement gained strength slowly, due to the complexity of the integration process and the high number of exceptions involved. The second model indicated that the preferential trade agreement became relevant only in the 1990s, when the free trade area became operational. It also showed that the impact of the preferential regime is greater when infrastructure endowments are considered. Reducing the cost and improving the quality of transport systems through infrastructure development improves international market access and helps to increase trade.

As the new regionalism becomes established in the world in general (IDB, 2002) and liberalization policies continue to lower trade barriers and tariffs, transport costs derived from poor infrastructure may come to

represent a much higher level of effective protection than tariffs do. Undoubtedly, the Andean Community should reformulate its approach to integration and set in motion 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. But it should also foster a new type of integration aimed, not simply at trade measures, but also at cooperation on different fronts and global competitiveness. Otherwise the impact of its preferential agreement will be gradually diluted as new regional agreements lower tariffs among other Latin American countries. From this perspective, bilateral trade will ultimately be defined in terms of costs and competitiveness. But competitiveness can be achieved only through improvements in logistical and transport services at all points in the production-distribution chain, and the respective reduction in costs brought about by a more comprehensive type of regional integration.

The second model also showed that the influence of a shared border, enabling border trade, is declining. As transport costs decreased and the preferential trade agreement became consolidated, promoting infrastructure development in the process, shared borders became less important. However, since land transport is the favoured mode for much of the increasing flow of goods and border trade is an important source of economic activity between neighbours, intra-Andean

borders should be properly equipped to efficiently interlink national economies. This is crucial to open trade corridors and development hubs that connect interior regions of the Andean countries, through border regions, with Pacific and Atlantic ports. Such corridors will allow true crossroads to be established, building on their privileged geographic position as a main asset.

Here again, the evolution, sign, significance and values of the geographical distance variable highlighted infrastructure's positive influence on trade and strongly suggest that, as the Andean Pact evolves into a more sophisticated and complex integration scheme, infrastructure will be the most manageable variable available to governments for reducing transport costs.

The results of the final gravity model, which considered the infrastructure of the Andean countries and their partners separately, show that today a country's infrastructure is decisive not only as regards the import of goods needed locally, but also in order to qualify as a trading partner. Improving infrastructure in poor and middle income countries, like the Andean ones, brings high global returns in terms of trade (Brun, Carrère and others, 2002).

Lastly, better infrastructure should not only be regarded as a tool to increase trade: within the framework of functional cooperation among South American economies, it should be considered as a major driver of development, enabling the region as a whole to gain in competitiveness and become an attractive partner for other, more distant locations.

APPENDIX

The infrastructure index

Several approaches to building an infrastructure index have been employed by different authors. Owen (1987) graded countries in terms of infrastructure by using a linear average of several infrastructure measures, establishing a value of 100 for one country and relating the others to it. Hulten (1996) 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) built an index from four variables: kilometres of road, of paved highways, and of railways per square kilometre of country area, and telephone mainlines per person. Factor components were used to normalize the variables and a Cobb Douglas production function was employed. The authors—like others employing similar methods—stated that the normalization did not affect the results in general terms. Martínez-Zarzoso and Nowak-Lehmann (2002) used the same four infrastructure variables but normalized only the variable of telephone lines

per 1,000 people, obtaining a simple average infrastructure index per country.

The index used in his work was calculated on the basis 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 country size; hence, telephone mainlines and kilowatts of electricity were divided by population, and roads, paved roads and railways were normalized by square kilometers of country area. This procedure was inspired by Canning, who proposed normalizing rival goods by population, on the basis that the quantity of the good divided by population indicates average consumption.¹³ For

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).

non-rival goods, however, normalizing by population does not give average per capita consumption, since an increase in population does not reduce average consumption with a fixed stock of non-rival infrastructure. Hence, it makes sense to normalize transportation infrastructure data by area, as Ingram and Liu (1997) and Limão and Venables (2001) did—and as we have done.

The rationale for including kilowatts of electricity was that electricity contributes to economic activities in general and is crucial for telecommunications, computers and machinery. Also, most activities rely on electricity at (at least) one point in the transport and trade process, such as port operation and data processing. Moreover, proper electrification along roads allows safe and efficient movement of cargo, especially at night, when most road transport take place in the Andean countries.

Ports and airport data which, in any case, represent a small share of overall infrastructure endowments, were

excluded owing to a lack of comparable data across countries and over a sufficient period of time. For similar reasons, power refers only to electricity. Moreover, the analysis incorporates only quantitative stocks rather than qualitative measures, since there is almost no data on operational efficiency.

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. Index values for the countries for which regressions were calculated are available from the authors. As noted, normalization of the infrastructure variables eliminates the size effect; hence, small countries with well-developed infrastructure, such as Belgium, the Netherlands and Japan, rank high, even though in absolute terms their kilometres of roads or numbers of telephones appear to indicate a less developed infrastructure.

(Original: English)

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