TRANSPORTATION AND COMMERCIAL DEVELOPMENT IN PICHINCHA PROVINCE, ECUADOR

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PREFACE

This thesis is based on data collected during three months of field work in Pichincha Province, Ecuador during the summer of 1970.

The researcher was working within the program known as "Proyecto Pichincha", a pilot study of the problems of development in a developing country with a view to formulating a model on which might be based recommendations on regional improvement, and which could help establish criteria for a nation-wide study of a similar type. This work is being carried out by the McMaster University Department of Geography and the Instituto Geografico Militar, Quito,Ecuador, under the auspices of the Pan-American Institute of History and Geography, of which latter group, Dr. Harold A. Wood, McMaster University, is President of the Committee on Regional Geography.

Thus the area chosen for study and the data collected were determined by the requirements of the larger project. This study is based on certain aspects of the work carried out and of the information gathered, of which only a small part has been used here.

The author wishes to thank Dr. Harold A. Wood for arranging the funding that made it possible to carry out this research, and for patiently supervising the preparation of this report. In Ecuador, the staff of the I.G.M. were always most helpful in expediting the organization of the field work and in providing whatever assistance was needed to carry it out. Particular mention should be made of: Colonel Oswaldo N. Vaca L., Director of the Instituto

Geografico Militar; Major Carlos R. Espinosa, Chief, Planning Section, the person chiefly responsible for the project, on the Ecuadorian side, whose interest and assistance went far above and beyond the call of duty; and Sargento Jorge A. Benitez, the group's chauffeur, who patiently carried out all requests, and who saved us countless hours in the field by managing to find whatever we needed much faster than we could with our limited Spanish.

Finally, special thanks are in order to the more than two hundred people interviewed who gave of their time and knowledge, without which there would have been precious little to report on.

Any errors or inconsistencies remaining in this paper are the sole responsibility of the author.

Hamilton, April 1971. BRUCE E. RATFORD

CONTENTS

----- 00000 -----

MAPS (in pocket on inside back cover)

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GLOSSARY

A - Currency

The basic unit of currency in Ecuador is the 'sucre', which is subdivided into 100 centavos. As of August 21, 1970, US$ 1.00 was worth 25 sucres (S/. 25.00), and all prices and costs have been worked out using that rate of exchange.

B - Measures

Ecuador uses metric measures, and this report therefore has everything expressed in terms of metric measurements. The English equivalents are as follows:

1 centimetre = 0.394 inches

1 metre = 1.09 yards = 39.4 inches

1 Kilometre = 0.621 mile

1 hectare = 2.47 acres

1 litre = 0.220 gallon = 0.88 quart

1 Kilogram = 2.20 lbs

1 tonelada = 1000 Kg = 2205 lbs

1 quintal = 45.5 Kg = 100 lbs. (This is the amount a man can carry on his back. In practice, the quintal as used in Ecuador is almost a unit of volume, being a 'large sack' in size.)

C - Spanish Terms Used

Cabecera cantonal - 'cantonal HQ' - the administrative centre of a canton.

Cabecera parroquial - 'parish HQ' - the administrative centre of a parish.

Collectivo - 'collective' - an economy-class bus that carries passengers and freight in indiscriminate quantities. Normally older vehicles, they commonly have a 3-metre wide wooden body built on a truck chasis.

Consejo cantonal- 'cantonal council' - the decision-making body at the canton level.

Cordillera Occidental - 'Western Range' (of the Andes).

Cordillera Oriental - 'Eastern Range' (of the Andes).

Costa - 'coast' - refers to the coastal plains of Ecuador (see pp 1,2).

Empedrada - 'stoned' - describes the cobbled surface of most older highways in Ecuador. Surface is formed from stones taken from the river beds and set in the roadbed by hand. Once compacted by vehicles passing over the newly laid surface, it becomes very durable.

Hacendero - the proprietor of a hacienda.

Hacienda - large farm or estate run by hired labour.

Minga - the Inca system of shared labour on projects of benefit to the entire community. As the workers are not paid in cash, but are rewarded by the completed project and the benefit therefrom that they can share, this system has advantages for poor communities that are anxious to repair or build roads in their parishes.

Municipio - 'municipality' - often used to refer to the cantonal council, or the cantonal administration.

Nordoccidente - 'north-west' - the region of Pichincha comprising the parishes of Nono, Mindo, Los Bancos, Nanegalito, Nanegal, Gualea and Pacto.

Oriente - 'east' - the Amazon basin (see p. 3).

Registro Civil - 'registrar' - records births, marriages and deaths, and all property transactions within the parish to which he is appointed.

Secretario - a parish official who performs the same functions as a town clerk in Canada.

Sierra - The Andes (see p.2).

Teniente Politico - the top parish official, similar to a township reeve. He is

responsible for running the parochial government, for initiating projects, and for solving any problems that arise.

Tren - 'train' - is used for the lumbering freight trains, that are frequently powered by steam traction. Passenger services are almost always run using autocarril(es), or railcar, some of which are little more than a bus with flanged wheels.

Viveres - 'things for living' - a corner grocery or general store, that sells basic necessities.

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CHAPTER I

INTRODUCTION

The problem to be considered is to establish the relationships between the following elements:

a) the existing transportation links, evaluated in terms of location, and surface conditions,

b) the existing urban centres, evaluated in terms of their size and commercial importance, and

c) the constraints provided by terrain.

As this study was undertaken as part of the larger research project designated "Proyecto Pichincha", the study area will be that of the overall program, namely Pichincha Province, Ecuador.

1-1 Ecuador

As the name implies, Ecuador straddles the Equator, being located on the Pacific coast of South America, between Colombia to the north, and Peru to the south and east. The country can be divided into three very distinct physiographical regions. The Galapagos Islands (Archipielago de Colon), 580 miles to the west of the mainland, constitute a fourth which will not be mentioned further.

The Costa is mainly an alluvial coastal plain extending westwards from

the Andes, with isolated chains of hills here and there. Two large river basins, the Guayas and the Esmeraldas, constitute the central and most heavily populated part of the Costa, and are where the bulk of Ecuador's agricultural exports are produced, products such as bananas, cacao, rice, sugar, coffee and toquilla palm. Since 1951, for example, Ecuador has been the world's largest exporter of bananas (US$ 70 million in 1964).

This region is very much under a cash economy with agricultural workers engaged principally in growing export crops that can be sold for cash. Roughly half the national population of 4,649,648 (1962 census) lives in the Costa, which includes the large urban centre of Guayaquil, plus smaller towns such as Portoviejo, Esmeraldas, Manta, Babahoyo and Quevedo.

The Sierra comprises the two chains of the Andes, the Cordillera Occidental and the Cordillera Oriental, and a series of inter-montane valleys, divided by lower transverse ranges. The highest peak is Mt. Chimborazo (20,577 feet), and there are at least a dozen peaks over 16,000 feet, many of them permanently snow-covered. Some 30 of the Andean peaks are volcanoes, and this is also an area subject to earthquakes.

The population lives in the inter-montane valleys, which lie between 7000 and 10,000 feet above sea level. There are several large cities located along this chain; from north to south, Tulcan, Ibarra, Quito, Latacunga, Riobamba, Ambato, Cuenca and Loja, each with its well populated agricultural hinterland. The Sierra is cultivated by Indian subsistence farmers, or by

large hacenderos who produce for the nearby urban centres. These basins are frequently cut by deep river valleys that drain them, but at the same time, deeply incise them, making lines of communication difficult and expensive to build and maintain, and travel time-consuming. Consequently, there is less movement of goods than on the Costa, and many communities or areas are almost self-sufficient except for the minimum of manufactured goods.

The elevation modifies the climate enormously, so that the Sierra is a temperate zone, its crops being principally potatoes and maize, the staple foods of the Indians, plus wheat, barley and other grains, fruits, including sub-tropical fruits like oranges which are grown in the valleys. Cattle and sheep raising are widespread and there is considerable dairying in some areas.

The Oriente, the third region, includes the eastern slopes of the Andes and the flat, upper reaches of the vast Amazon basin. The entire area is jungle-covered and very sparsely inhabited. Communications are tenuous, there being very few roads into the area from the Sierra. There has been little development of this region though the recent discovery of large reserves of oil in the north-eastern Oriente has sparked new interest in this part of the country, and some settlement schemes are being planned for the north-east to serve the oil-workers and to take advantage of the roads that the oil companies have agreed to build into the area to link up with existing highways in from Quito.

1-2 Pichincha

The province of Pichincha has an area of 16,561 square Kilometres, located partly in the Sierra and partly on the Costa. In the Sierra, the province includes a complete inter-montane valley, that has an elevation of between 7000 and 10,000 feet above sea level. This basin is ringed by several high peaks - Cotopaxi (5897 m.), Cayambe (5790 m.), Sincholagua (4900 m.), and Pichincha (4784 m.) being the highest - which dominate the landscape, and which have considerably affected the climate and geomorphology of the region, due to volcanic, glacial and periglacial action.

Deep canyons have been cut out of the volcanic ashes that form the floor of the valley by the Guayllabamba River and its tributaries. Near Puellaro, the resulting canyon is over 2000 feet deep, and is an enormous obstacle to communication. The depth of this canyon and the softness of the ashes have resulted in many otherwise insignificant tributary streams having cut steep-sided valleys that form a deeply-incised dendritic drainage pattern across the basin floor, which is otherwise gently sloped from the base of the surrounding ranges downwards towards the Guayllabamba River.

The effect of this drainage network on communications can be best seen by going from Yaruqui to Checa (see map 1). Located 3 Km apart by line of flight, the towns are linked by a road 6.6 Km in length, which crosses three valleys that are each 50 m. deep with almost vertical sides, and only 100 to 200 m. wide. The resulting costs, in time and money, can be easily imagined.

The basin can be divided into distinct parts. Around Cayambe and Machachi, due to the high mountains to the east, there is considerable cloud cover, with cooler temperatures and good rainfall resulting, and these are rich agricultural areas with a verdant ground cover. Extensive farming is carried on: dairying and livestock raising; wheat, maize and other grains; potatoes and many varieties of vegetables and temperate fruits. Sangolqui is a similar zone, though with higher average temperatures due to its lower elevation. The slopes from Ascazubi to Pifo, at the base of the Cordillera Oriental, receive some orographic rainfall, and the higher parts have good ground cover. Towards the Guayllabamba Canyon, and in the Sierra parishes bordering it to the north, the land is very arid, and often resembles a desert, being a rain-shadow zone. Only the higher slopes are green and arable to any extent. Clearance of the natural vegetation over the years has had a disasterous effect on this zone, which used to have greater rainfall and extensive natural ground cover. This is particularly true of San Antonio de Pichincha and of Malchingui.

Temperature and rainfall may be compared for selected stations:

Station	Elevation	Mean Annual Temp	Rainfall
Puellaro	2063 m.	17.6°C	439.5 mm.
Guayllabamba	2139 m.	19.4°C	479.1 mm.
San Jose de Minas	2417 m.	15.6°C	1129.1 mm.
Sangolqui	2510 m.	15.1°C	944.3 mm.
Quito	2818 m.	13.0°C	1250.0 mm.

These stations may be compared with Santo Domingo de los Colorados on the Costa, which has an elevation of 500 metres above sea level , and has a mean annual temperature of 22.5°C. and an annual rainfall of 3131 millimetres.

The population is fairly evenly dispersed over the arable areas of the basin, and is served by a network of small commercial centres. At the same time, the enormous pull of Quito is very evident from the road pattern which, with few cross links, radiates outwards from the national capital. In addition to being the political centre of the country, Quito has a complete range of commercial services as well as over 60 per cent of the population of the province, which was estimated to be 645,836 inhabitants as of December 31,1965. Consequently, the entire province may be considered as the hinterland of its large urban centre.

The eastern boundary of Pichincha is the Cordillera Oriental, and to north and south, transverse ranges separate the province from Imbabura and Cotopaxi Provinces respectively.

To the west, Pichincha extends downslope onto the coastal plain to include the low divide between the Guayas and Esmeraldas basins. The slopes of the Cordillera Occidental receive considerable orographic rainfall and are covered by sub-tropical rain forest. The lower areas are flatter and here are found thousands of small farms that have been cleared for banana and other tropical products since the road from Quito was built to Santo Domingo de los Colorados in 1947. This area, as well as the Nordoccidente (Pacto and Los

Bancos), are undergoing considerable colonization, as more and more people leave the overpopulated Sierra, and settle in these regions where they can enjoy a better standard of living with less work.

To the west, Pichincha is bounded by Esmeraldas, Manabi, Guayas, and Los Rios Provinces. In its greatest dimension, it extends 190 Kms from east to west, and 140 Kms from north to south.

1-3 Political Organization of Pichincha

In Ecuador, provinces are divided into 'cantones', like counties in Canada, which are further sub-divided into 'parroquias' (parishes), which are equivalent to our townships. As is common in developing countries, the political system is highly centralized with most of the money and the power residing in the national capital, Quito.

The 'municipio', or cantonal government, is responsible for providing basic services, like schools, secondary roads, potable water systems, sewers, security, and justice, either from its own tax revenues or from grants from the national government. Each canton has a 'consejo cantonal', which is the decision-making authority at the local level.

The parroquias provide for local needs from property taxes, which they are often unable to collect, or more commonly, they lobby for assistance from the municipio. Their funds are expended on the provision of basic services or the improvement of local life, e.g. by caring for the town square, or building a town hall, or a stadium, constructions that are community centres and a

source of local pride.

Originally, the parishes were ecclesiastical divisions and comprised territories surrounding and supporting a church. This system was used to create an administrative system for the province in the last century. However, it has been found that the outside funds that a parish receives seldom percolate beyond the 'cabecera parroquial', so that any community of any size and a little political influence will seek parochial status in order to receive funds directly for its own use. The classic example of the resulting proliferation of parishes is Tababela, which has only four general stores in its very scattered urban development, and which is only 5.9 Kms from Puembo and 7.2 Kms from Pifo, two much larger nearby centres. In twelve years of independent existence, Tababela has just started to build a town hall and to lay out its plaza!

Each parroquia is administered by a 'teniente politico', equivalent to a township reeve or a mayor in Canada, who is usually appointed by the canton council with local blessing, and who administers to the peasants' temporal problems just as the priest administers to their spiritual ones. A dynamic teniente politico can do much to develop his community simply because of his position, if his power is exercised judiciously. Under him is a 'secretario', who is analogous to a town clerk, and who keeps all records of parochial affairs. Each parish also has a 'registro civil' who is the registrar of all births, marriages and deaths, and of all property transactions within the parish. Interestingly, these positions are sometimes filled by women.

It should be noted that parochial boundaries are defined by the general acceptance of certain limits, but that no provincial, cantonal or parochial boundary has been completely legally specified, surveyed, or marked on the ground, and that any boundaries marked on maps, including those in this thesis, represent approximations only.

The province of Pichincha is divided as follows: (cabeceras cantonales are underlined)

Canton Cayambe (8 parishes)

Ascazubi, Cangahua, Cayambe, Isidro Ayora, Juan Montalvo, Olmedo, Oton, and Santa Rosa de Cusubamba.

Canton Mejia (8 parishes)

Aloag, Aloasi, Cornejo Astorga, Cutuglagua, El Chaupi, Machachi, Tambillo, and Uyumbicho.

Canton Pedro Moncayo (5 parishes)

La Esperanza, Malchingui, Tabacundo, Tocachi, and Tupigachi.

Canton Quito (53 parishes)

Alangasi, Atahualpa, Amaguana, Calacali, Calderon, Conocoto, Cumbaya, Chavezpamba, Checa, Chillogallo, El Quinche, Guayllabamba, Gualea, Guangopolo, Guapulo, La Merced, Llano Chico, Lloa, Mindo, Nanegal, Nanegalito, Nayon, Nono, Pacto, Perucho, Pifo, Pintag, Pomasqui, Puellaro, Puembo, Quito (17 urban parishes),San Antonio de Pichincha, San Jose de Minas, Tababela, Tumbaco, Yaruqui, and Zambiza.

Canton Ruminahui (5 parishes)

Cotogchoa, Rumipamba, Sangolqui, San Pedro de Taboada, and San Rafael.

Canton Santo Domingo de los Colorados (2 parishes)

Alluriquin, and Santo Domingo de los Colorados.

CHAPTER II

TRANSPORTATION AND COMMERCIAL DEVELOPMENT

2-1 The Existing Transportation System

This section will deal with highway transportation as the railroad from Guayaquil, which enters the province below Mt. Cotopaxi, and winds past Machachi to Quito, before heading on northwards to Cayambe and Ibarra, will be discussed in Section 3-3.

The Sierra part of Pichincha is served by an extensive network of highways that radiate out from Quito, but which has few cross links, the only ones of any importance being a road linking Amaguana to Sangolqui, and the roads that link El Quinche to the Panamerican Highway to the north, and to the Quito-Papallacta highway to the south. Secondary roads radiate around the regional centres of Cayambe, Sangolqui, and Machachi, and the whole system in turn funnels into the capital.

Due to the very rugged topography of the countryside, these roads are nearly all minor feats of engineering, as they must often wind around mountains, climb painfully down into deep gorges and then somehow mount the other side, while maintaining adequate right-of-way at least for the 3-metre-wide collectivo buses, and grades that an overloaded five-ton truck will be just able to negotiate. At the same time, the Ecuadorian government has been continually

plagued by insufficient funds for all the public works that the country sorely needs, with the result that the highway system has been augmented in fits and starts, construction costs have often been kept to the minimum necessary, and maintenance has often been an unknown quantity. Only in the last few years has the value of carrying out repairs when necessary to existing routes been fully recognized.

That is not to say that Ecuadorians are not interested in developing improved communications. Highway construction has always been undertaken to link communities with the national road system, which, in fact, only became a reality in the late 1950s after the 'Plan Vial' of 1954 had been carried out. As mentioned in Chapter I, Santo Domingo de los Colorados was first linked to anywhere by road in 1947 (to Quito) and all-weather links to Esmeraldas, Chone, and Quevedo (for Guayaquil) were completed over the following nine years.

The national highways are under the jurisdiction of the Ministerio de Obras Publicas (Public Works), which entity is responsible for their construction and maintenance, as well as for the more heavily-travelled regional highways. Where traffic levels are reasonably high, Obras Publicas is trying to develop well-engineered, paved or gravel, wide driving surfaces, and to carry out maintenance on such sections of highway already in use.

For lesser regional and for local highways, construction and maintenance become the responsibility of the municipio, or, more frequently, of whom-

ever is directly interested in having a motorable link to the outside. These roads are sometimes funded out of cantonal tax revenues, but with so many demands for public services and assistance, road construction and maintenance get shortchanged, as can be shown by the expenditures on roads out of the total budget for the parishes in Canton Cayambe in 1969:

Parroquia:	Roads:	Total:
Cayambe) Isidro Ayora) Juan Montalvo)	S/.13923	S/.1,000,000
Cangahua	S/. 12475	S/171,758
Olmedo	S/. 877	S/. 4258
Oton	S/. 3000	S/. 3408
Santa Rosa de Cusubamba	S/. 0	S/. 23027
Ascazubi	S/. 0	S/. 51800

More often, local roads are built and maintained by large landowners to serve their haciendas, or are built by the parroquia, using 'minga', the old Inca system of community labour for works of common benefit. Many parroquias pay a few men S/. 15 to S/. 20 (US$ 0.60 to $ 0.80) per day to work on the roads to fix the more noticeable potholes, etc., but all such work is usually half-hearted and makeshift to say the least. However, any sort of motorable passage is an enormous advance on none.

The major difference, though, between locally maintained highways

and those under the jurisdiction of Obras Publicas, is that whereas the national highways are heavily capitalized, the local roads are not. These latter are usually built with a minimum of machinery beyond a large number of strong backs. Bridges and culverts, if not dispensed with, are concocted of rocks, slabs, and tree trunks from the immediate vicinity, and the surface is earth or a cobbled covering made from rounded stones extracted from river valleys. Considering the obstacles that have to be overcome, it is amazing how motorable and durable these locally-built highways are. Some cobbled, or 'empedrada' (stoned) surfaces have been in use for over forty years with little maintenance required.

In the Costa part of Pichincha, particularly the Santo Domingo area, the countryside is gently sloping, and Obras Publicas have built excellent through highways, into which a large number of local farm roads feed. There has been little road improvement away from the main roads as yet, as this is still an area of colonization in the process of being opened up for settlement. In addition, the much heavier rainfall on the Costa and on the western slopes of the Cordillera Occidental results in numerous washouts and landslides, and anything but a well-drained, improved surface will turn into an almost impassable quagmire during the rainy season.

Physiography and natural degradation of the roads is even more of a problem in the Nordoccidente, which is located in the foothills of the Andes and is more inaccessible, due to the many deep valleys that cross this area from

the south-east to the north-west. As a result, the road system resembles a ganglion as it winds over numerous ridges and hills in order to reach the different parts of the North-West. Obras Publicas are currently constructing a new highway link from Los Bancos to Santo Domingo that will be only 50 Kms long, compared to the present 92.2 Km road to Quito. There is also a dry-weather route westwards from Los Bancos to Puerto Quito that follows the ridge above the Rio Blanco. Many local inhabitants would like to see this road improved and continued to join up with the Esmeraldas road.

In summary, the road system that exists in Pichincha often inhibits the free movement of vehicles at low cost, but when one bears in mind the enormous constraints imposed by the extremely rugged terrain in the Sierra and by the country's lack of sufficient funds to provide all the services that would be desirable, what does exist represents quite a remarkable effort to provide an adequate transport infrastructure for the province.

2-2 Community Development

Many communities in Pichincha date far back into colonial times, and are the outgrowths of Spanish missionary activity. Others, such as San Rafael, are crossroads towns. A few, like La Merced, have developed to exploit a local resource, in this case, hot springs. In addition, many of the towns near Quito are becoming dormitory suburbs for large numbers of city workers, with the opening up of many subdivisions. Quito itself, located at the foot of Mt. Pichincha, was established on the site of a large Inca city that had been

burned by Ruminahui, the Inca general, while resisting the Spanish Conquest. The whole process of urban growth in relation to that of rural centres would make an interesting study in itself.

In this study, we are concerned more with economic development and with the factors, especially transportation, that influence the level of economic activity that a community will exhibit. Quito, by virtue of its size, dominates the economic life of the province, as a consumer of Pichincha's agricultural surplus production, and as a supplier of whatever manufactured goods the peasants need, and can afford. Thus the first important economic conditioner will be the cost of transporting a quintal of produce from a town to Quito, as market prices in the capital are constant for a kilo of potatoes whether they come five kilometres from Chillogallo, or 75 Kms. from the Cayambe area. Similarly, the wholesale price in Quito of a bar of soap is identical regardless of its destination. Thus we may hypothesize that the more inaccessible a town is, the lower the price that peasants will receive for their produce, while goods brought in from outside will cost them more. We may thus suspect that the further a town is located from its major market, and the greater the road user cost to reach that market, the lower will be the commercial development of that town due to the decreased buying power of its inhabitants. At the same time, certain larger centres form significant regional markets, or act as collection and distribution points for the Quito market. Cayambe, Machachi and Sangolqui, with their large weekly markets, are examples of this, and peasants

can cut their losses considerably by buying and selling in these regional markets, rather than by dealing directly with dealers in Quito.

Tied in with the question of accessibility are the number of vehicles owned locally and the number of trucks and buses that serve a community over a given period. These represent the capacity to move goods and people in and out of the area, as well as a demand for servicing of the vehicles and for serving the people using them. Since vehicles represent a wedding of economics and convenience, it is reasonable to expect that they will be most numerous in places where they can serve the greatest potential market at least cost. We can thus hypothesize that towns on the main, national highways will have proportionally the largest number of vehicles owned locally and the most frequent bus and truck service. Towns on regional highways will be less well-served, and towns that are at the 'end of the line' will have the fewest vehicles and the poorest transport services.

Finally, it is axiomatic that the local population is the local market, and that the economic development of a parish will depend on the size of the market available, and on the average buying power of the local inhabitants.

2-3 The Problem Restated

The problem to be considered can now be stated more concisely. The study is to determine the relationships existing between the existing transportation links and local commercial development, taking physical constraints into consideration.

The first part was to evaluate the user costs for all road links in the province, a procedure requiring an inventory of the physical condition of each section of each road. The effect of terrain on the system can be considered as incorporated in the user cost, as this cost will be based on the existing network, which is a response to human need, and to construction constraints imposed by the nature of the area traversed. Secondly, the commercial centres of the province, namely the cabeceras parroquiales and any other communities of a regional significance were surveyed to determine their levels of commercial development and transportation utilization, especially the number of vehicles owned locally and the volume of traffic into and out of the parish.

From this data, it is intended to determine some relationships between the accessibility of a parish and its commercial development, considering the effect of other factors, such as the local population and the number of vehicles owned in the parish. Specifically, it is hoped to determine what relationships exist between the level of commercial development of a town and the costs involved in reaching that town from its nearest higher-order market, and from Quito.

CHAPTER III

INTO THE FIELD

3-1 Road Conditions

To determine the accessibility of the various commercial centres in the province of Pichincha, it was necessary to conduct a survey of the highway system, or more particularly, of those roads that are used consistently for inter-community communication and transport.

To assist this survey work, a classification system was devised for measuring those factors that influence highway user costs, which could take into account all relevant variations in highway conditions, and which at the same time was practical for use in a general survey of the type required for this study. This classification system is given in Section 3-2.

When classifying a road link, each section of the link was evaluated separately, so that ultimately an accurate assessment of road user costs could be made, using the tables given by Jan de Weille (see Bibliography). The intervals employed in the highway classification were chosen to correspond as closely as possible with the intervals used by de Weille.

Because of the absence of any traffic counts except for certain stations on the major highways, the number of vehicles passed while travelling over each road was noted, in order to acquire some idea of the number of vehicles

one might expect to encounter in traversing a particular link. This information was of value in calculating the increase in user costs that would be likely to arise in narrow sections of roadway where two vehicles can pass only with some difficulty or by having one reverse to a wider section.

The highways surveyed were those that link communities one with another, particularly with their principal markets, as these routes would carry the bulk of all vehicle movement. These 'link routes' were identified from maps or from personal interviews with local informants. Some additional roads were also classified in order to compare costs and to shed further light on vehicle and trade movements within an area, where alternate routes of almost equal user cost exist.

From the data obtained, it has thus been possible to derive the cost of driving over each link of the highway system of Pichincha.

3-2 Highway Classification System

a) TYPE OF SURFACE (Roman Numeral):

I Heavy-duty, paved (asphalt/concrete) with adequate shoulders.

II Light-duty paved (asphalt), no shoulders.

III All-weather gravel.

IV Cobbled median with earth or gravel passing shoulders.

V Graded earth.

VI Ungraded earth (4-wheeled vehicles only).

b) NATURE OF SURFACE (Capital Roman Letter):

A excellent condition - no degradation or imperfections.

B good condition - minor degradation or imperfections.

C fair condition - moderate degradation insufficient to significantly reduce driving speeds.

D poor condition - considerable degradation, affecting driving speeds considerably.

E atrocious condition - completely unimproved.

c) WIDTH (Numeral):

Number is average width of the roadway, including shoulders, in metres.

d) CURVATURE (Small Roman Letter):

a No curves at all.

b Very gentle curves, not affecting vehicle speeds.

c Moderate curves, demanding minor speed reductions.

d Sharp curves, involving considerable speed reduction, and impairment of vision.

e Hairpin bends.

e) GRADE (Numeral):

(General average over a given section)

Number is the approximate rise or fall in metres per 100 metres.

f) SPECIAL CONDITIONS:

b One-way bridge - number is length in metres.

d Poor drainage - number is length in metres.

l Landslide - number is length in metres.

t Tunnel - number is length in metres.

w Wash-out - number is length in metres.

3-3 Railroads

A single-track, narrow-guage railroad traverses Pichincha, with company offices, repair shops, and main station located in Quito. The line from Quito southwards to Guayaquil was operated by La Empresa de Ferrocarriles del Estado. The line northwards from Quito was owned by La Junta Autonoma del Ferrocarril Quito - San Lorenzo, though as a result of Presidential Decree No. 183 issued August 4, 1970, these lines are now unified as La Empresa Nacional de Ferrocarriles del Estado.

To the south of Quito, the stations in Pichincha include Tambillo, Aloag, Alcasi (for Machachi), and Cotopaxi on the provincial boundary. Northwards, there are stations at Cumbaya, Tumbaco, Puembo, Pifo, Yaruqui, Checa, El Quinche, Ascazubi, Santa Rosa de Cusubamba, Oton, Cangahua, Cayambe, Tupigachi, and at Cajas on the provincial boundary with Imbabura. Each station is served by two or three trains or 'autocarriles' daily in each direction, on both lines.

As a means of transportation within the province, the railroad is almost ignored, and very little inter-provincial traffic emanates from any of the rural centres of Pichincha. The trains are slow, passenger trains averaging about

15 miles per hour on the Cayambe run, and are usually more expensive than buses or collectivos. Freight trains seldom exceed ten cars in length, and travel even slower, due in part to the steep grades and tight curves that are necessary in order to cross this rugged countryside. In addition, except for five recently-acquired diesel-electric engines, the motive power and rolling stock are of vintage make and breakdowns are common. Track maintenance is sporadic, if carried out at all. One section near Puembo has 45-lb. rail rolled by A. Krupp - Essen - in 1913, and almost every tie is rotten!

Consequently it is no wonder that rural stations handle less than five tons of freight a month, and that 'La Union' Mills near Cayambe receive and ship over 300,000 quintales of grains and flours each year, all of it by road, even though the railroad borders the mill's property on two sides. The picture for passenger traffic is little brighter, so that both railroad companies show perennial financial deficits.

As the volume of both freight and passenger traffic that uses the railroad is a very small percentage of the total for each parish served, train service will be ignored in this assessment of the province's transportation network.

3-4 Commercial Development

To obtain some indication of the level of local commercial development in the rural centres of Pichincha, each cabecera parroquial was visited, as well as any parochial sub-centre of commercial importance. In each locality, a survey was carried out, in part by personal interview with knowledgeable

local inhabitants, and also by wandering up every street and alley to see what types of activities were engaged in in that town, and to record the number of establishments involved with a specific commercial activity. A sample copy of the survey sheet used follows.

Centro de ..... Hecho el, ...

RECONOCIMIENTO DE ACTIVIDADES COMERCIALES

Día de mercado .....

Clasificación de la calle principal .....

Correos .....
Teléfono .....
Telégrafo .....
Electricidad .....
Tubería de Agua:
Llaves Públicas .....
Llaves Particulares .....
Médico .....
Dentista .....
Especialistas .....
Clínicas .....
Hospitales .....

Escuelas:
Primaria .....
Secundaria .....
Otras .....
.....
Policía .....
Casa Municipal .....
Ministerio de Agricultura .....
Otras Oficinas Oficiales .....
Ferrocarril .....
Empresa de Autobus .....
Otros Servicios .....
.....

Servicios:
Bomba de Gasolina .....
Reparación de vehículos .....
Banco .....
Agencia de Seguros .....
Hotel o Pensión .....

Tiendas:
Víveres:
Pequeña .....
.....
Grande .....
Carnicería .....

(continued on next page)

(from previous page)

Restaurante	Panadería .....
Bar	Librería .....
Teatro o Cine	Farmacia .....
Peluquería	Ferretería .....
Funeraria	Vestidos .....
Sastrería	Joyería .....
Otros	Gas o Combustible .....
.....	Otros .....
.....	.....
.....	.....
....., ...	.....

The main street was classified according to the highway classification system outlined in Section 3-2.

In assessing the commercial importance of a locality, the public services were ignored and only stores and commercial services taken into consideration. The reason for this is simply that local benefits provided by the government are more likely to be the result of political pressure, than to represent a response to market demand, though that is not to say that such services are provided to areas that do not need them. Certain services are ubiquitous, such as public schools, and postal service and a potable water supply are found in almost every parish, such being considered as essential services. Others may be accidental, such as proximity to a railroad, which is purely due to the economics of railway engineering. Nanegalito has a resident doctor simply because it is the most convenient town for him to reside in.

As this study is concerned with commercial development in a general sense, only the total number of types of commercial activity and the total number of commercial establishments large and small will be utilized for comparative purposes. Omitted are some activities which are distinct local responses to local resources or local needs, such as the lime burners in San Antonio or the hot-spring spas in La Merced.

It should be noted that the survey of functions was carried out only in the centre itself and not in the parish as a whole, so that the figures obtained do not present a complete picture for the most elementary functions, particularly small general stores, which were found in every centre studied. However, the people living in the country tend to go to the nearest centre for most of their needs so that we may consider each commercial centre as effectively serving the entire area. The range of commercial functions is expected to be proportional to the population of the area whereas the number of commercial outlets should be more proportional to the population of the town itself. Consequently, the range of commercial functions rather than the number of establishments would give a more realistic picture when determining the relationship between commercial development and the accessibility of a parish.

3-5 Parochial Transportation

To obtain some indication of the transportation services available to each parish, and particularly to each cabecera parroquial, a questionnaire was devised that was filled out with the cooperation of local informants. The

person first sought was the teniente politico, whose position normally results in his knowing everyone and everything in the parish he administers. In addition, the local 'registro civil' or registrar, or the 'secretario' or town clerk, were frequently mines of information. Private individuals were also consulted, including factory managers and owners in order to obtain more pertinent or accurate information.

The following questionnaire was completed as fully as possible for each cabecera parroquial and for the following local centres: Los Bancos (Mindo), Chiriboga (Chillogallo), and La Concordia and Las Delicias (Santa Domingo de los Colorados).

Centro de - Hecho el - - -/ - - - -

PROYECTO PICHINCHA

RECONOCIMIENTO DE LOS SERVICIOS DE TRANSPORTE POR LOS CENTROS COMERCIALES DE LA PROVINCIA

1. Suelen venir aquí todos los habitantes de la parroquia para vender sus productos y para comprar lo que necesitan? - - - - - - - - - - - - - - - -

   Si no?, la gente de qué parte de la parroquia suele hacer sus negocios - en otro lugar? En dónde?

   -

   Hay personas de otras parroquias que vienen regularmente aquí? De dónde?

   -

2. Cuáles son los productos principales agropecuarios o forestales de esta región? -

3. Cuáles productos se traen a esta localidad para su venta o consumo?

   -

4. Qué tipos de transporte se emplean?

   -

5. Qué cantidad de cada producto (peso o volumen) se trae a esta localidad cada año?

- -

6. Qué se hace aquí con cada producto? Y cuándo (durante el año? Reespedir? -

Consumo? - - - - - - - Industrialización local? - - - - Tratamiento?- - -

7. Para lo que se reespide:

A dónde? -

Cuánto peso o volumen se reespide? - - - - - - - - - - - - - - - - - - -

- -

Con qué transporte y a qué costo? -

- -

8. Para los productos alimenticios que se industrializa. Qué se produce?

- -

Qué peso o volumen se expide? -

- -

A dónde? -

Con qué tipo de transporte y a qué costo? - - - - - - - - - - - - - - - -

- -

9. Qué otras industrias hay aquí? -

- -

a) Qué materias primas se necesitan? - - - - - - - - - - - - - - - - - -

- -

De dónde vienen esos materiales?

b. Con qué tipo de transporte y a qué costo? - - - - - - - - - - - - - - -

- -

Qué peso o volumen se necesita? -

- -

c. Se exportan los productos industriales? - - - - - - - - - - - - - - - -

- -

A dónde? -

Qué peso o volumen? -

Con qué tipo de transporte y a qué costo? - - - - - - - - - - - - - - - -

- -

Cuándo se exporta durante el año? -

- -

10. De qué ciudad se obtienen especialmente los productos manufacturados que no se fabrican en la localidad? -
De Quito? - - - - - - - - - - - - -
De Guayaquil?- - - - - - - - - -
De otros centros de comercio al por mayor - - - - - - - - - - - - - - - -
Se suele dar una estimación del peso o volumen? - - - - - - - - - - - - - - -
Valor? -
Con qué tipo de transporte y a qué costo? - - - - - - - - - - - - - - - - -
- -
Con qué frecuencia hay servicio de transporte?- - - - - - - - - - - - - - -
Hay variaciones estacionales en la discontinuidad de transportes? - - - - -
- -

11. Son regulares los servicios de transporte de carga, hasta y desde esta región? -
Cuántos camiones llegan cada semana? -
Siempre llegan y salen cargados? -
El viaje en camión hasta - - - - - - - - - - necesita qué tiempo? - - - - -
- - - - - - - - Y hasta - - - - - - - - - - ? - - - - - - - - - - - - - - - -

12. Se produce en esta región, pero no se expende. Por qué? - - - - - - - - -
- -
Hay otros productos que los agricultores podrían o desearían producir aquí?
- - - - - - - - - - - - - - - - - - Cuáles? - - - - - - - - - - - - - - - - -
- -
Por qué no se produce? -
- -

13. Cuántos camiones (grandes y pequeños) pertenecen a personas de la localidad
- - - - - - - - - - - - - - - - - Tractores? - - - - - - - - - - - - - - - - -
Autobuses? - - - - - - - - - Taxis? - - - - - - - - =
Carros particulares? - - - - - - - - - - - - - - - - -

14. Se usan esos vehículos normalmente dentro de la Parroquia, o en viajes fuera de la misma? -

15. Cuántos autobuses, trenes, taxis, salen cada día? - - - - - - - - - - - - -
- -
Cuántas personas salen por autobús? - - - - - - - - - - - - Por tren? - -
- - - - - - - - - - - - Por taxi? - - - - - - - - - - - - - (cada día)

16. Cuándo salen esas personas? -
A dónde van? -
Con qué motivo? -
Con qué frecuencia? -
Por cuánto tiempo? -
Cu'nto cuesta el pasaje? -
17. Es esta región de interés turístico? - - - - - - - Por qué? - - - - - -
- -
Qué facilidades hay para turistas? - - - - - - - - - - - - - - - - - - -
- -
Cuántos turistas visitan esta región cada semana? - - - - - - - - - - -
Todo el año o cuándo? -
Cómo llegan? -
Por cuánto tiempo se quedan aquí? - - - - - - - - - - - - - - - - - - -
Viajan mucho a los alrededores? -
En qué transporte? -
18. Qué entidades mantienen los caminos de la parroquia? - - - - - - - - - -
- -
19. Durante el último año, cuántos sucres gastó la parroquia misma para mantener los caminos locales? -
En su presupuesto total? -

This questionnaire was designed to elicit information on the total movements of people and freight into and out of a parish. The most important aspect of this movement is, of course, the agricultural production, because all but two parishes are agricultural, whereas only twenty towns have any kind of industrial activity. It was necessary to find out what moved where, in what quantities, and at what cost in sucres and in time. In addition, the questions regarding tourism provided further background information for those communities where this is a significant activity.

Data on the number of vehicles owned locally gave an indication of

the local transportation potential, as well as an indication of the money available to local people for such capital purchases, which is dependent on local economic levels, which in turn is a function of local economic development.

While conducting this questionnaire, one further question was asked. "How many haciendas are there in this parish?", as there appeared to be some relationship between the level of agricultural exports and the number of haciendas in a parish. Then, too, the people interviewed were always cooperative and usually loquacious, so that it was often possible to gather a lot of additional information of a completely unstructured nature, which was also noted.

This data is, of course, not entirely complete, nor of absolute accuracy, as in some parishes no answers could be obtained for some of the questions, especially that concerning the volume of agricultural exports from the parish, or else the replies were spurious. In one case, the figures given would necessitate growing four crops a year on every square centimetre of the parish! Fortunately, the phenomenon known as "local boosterism" was not encountered too frequently, as most of the responses were consistent with those obtained elsewhere, and so are accepted as being reasonably accurate for the purposes of this study. More rigorous observations would have required time and manpower far beyond what was available, without significantly increased accuracy, as the answers given by respondents were normally based on estimations of the actual situation over the last few years, rather than for a specific period, during which may occur all manner of freak conditions.

The data obtained is tabulated in the following section, which also includes the distance and driving cost for a five-ton truck between each commercial centre and Quito by the most direct route and by alternate routes if they are used to some extent, as well as between the town and the nearest larger commercial centres, principally the cabeceras cantonales. The numbers listed in the '#' column under the heading 'Centre #1' and 'Centre #2' refer to the listed towns in alphabetical order. For example, Cangahua is located 16.0 Kms from Cayambe (#11) and the driving cost is US$ 3.103.

3-6 Field Observations - Summary

See Table on pages 33 to 37. Key to the data given is on page 37.

Please note the following abbreviations used in Columns #1 and #4:

EC = El Carmen

IB = Ibarra

OT = Otavalo

Q = Quito, given where there is a practical alternate routing to the one commonly used - see Maps II and III.

V = Quevedo

1	2	3	4	5	6	7	8	9	Commercial Centre	10	11	12	13	14	15	16	17
			54	10.3	1.188	20.2	2.270	1	Alangasi	4670	713	49	17	102	3000		60
			36	8.9	.844	31.6	2.946	2	Aloag	3350	1280	76	24	910	264000	10	60
			36	2.3	.394	36.5	3.468	3	Aloasi	2923	347	11	3	29			60
			59	23.9	2.439	110.5	13.279	4	Alluriquin	10000	1000	67	20	2710	481600	120	240
54	12.2	2.223	36	20.5	2.679	29.6	3.555	5	Amaguana	9978	1377	113	31	131	131500	20	90
			22	5.3	1.076	45.6	7.605	6	Ascazubi	1651	587	25	12	17	3090	6	150
55	22.8	6.170	Q	68.8	17.576	65.4	13.738	7	Atahualpa	2233	582	36	11	10	60500	4	210
			53	9.6	1.561	29.8	3.917	8	Calacali	3456	1317	37	16	140	360000		90
			26	18.1	3.139	13.3	1.135	9	Calderon	8854	803	60	21	1235			30
			11	16.0	3.103	74.2	12.754	10	Cangahua	5512	1120	64	18	43	172400	24	180
IB	57.0	5.379	OT	31.3	2.968	75.4	12.959	11	Cayambe	13389	8101	553	58			12	180
			54	7 2	.733	9 7	.961	12	Conocoto	6430	2396	180	37	1717	45800	15	25
			36	55 5	6 728	78.2	8.830	13	Cornejo Astorga	849	110	30	12	123	13000	1	180
			54	5.4	.964	22.3	2.658	14	Cotogchoa	824	416	12	5	56	24500	4	60
						9.6	.973	15	Cumbaya	2724	653	34	14	376	115200	13	30

1	2	3	4	5	6	7	8	9	Commercial Centre	10	11	12	13	14	15	16	17
			36	20.9	1.957	14.4	1.401	16	Cutuglagua	771	159	9	5	3293	20400	10	35
55	17.4	5.128	Q	63.4	16.534	60.4	12.766	17	Chavezpamba	1144	327	5	4	27	31200	1	180
			22	7.7	1.970	39.1	6.969	18	Checa	1787	452	17	8	35	50500	9	120
						5.1	.879	19	Chillogallo	9558	1958	66	23	1001		32	20
			59	79.3	13.590	48.2	10.413	20	Chiriboga		300	9	5	14	51850	2	240
			36	15.0	3.053	49.2	6.126	21	El Chaupi	734	106	4	3	16	24600	22	100
			Q	46.8	8.940	42.7	7.025	22	El Quinche	4025	1649	104	24	62	113780	15	120
			45	9.0	2.246	86.6	18.645	23	Gualea	1006	94	5	2	34	202250		480
54	11.4	1.522	12	11.4	1.518	20.1	2.446	24	Guangopolo	940	547	12	3	20	2000	0	45
						2.1	.497	25	Guapulo	1067	803	25	9	355	3700	0	15
			22	11.3	2.751	31.4	4.274	26	Guayllabamba	3048	1253	100	26	1178	766650	2	120
			11	3.1	.563	78.5	13.523	27	Isidro Ayora	4500	1000	42	13	16	181600	11	180
			11	1.7	.296	77.1	13.255	28	Juan Montalvo	2600	742	12	5	30	94900	9	150
			59	43.9	3.715	178.3	19.433	29	La Concordia	7500	1500	98	32	260	1035140	300	300
11	13.5	2.307	61	3.8	.714	88.9	15.266	30	La Esperanza	1805	449	18	10	17	15480	3	150

1	2	3	4	5	6	7	8	9	Commercial Centres	10	11	12	13	14	15	16	17
			54	13.6	1.859	23.3	2.815	31	La Merced	2500	700	21	9	55	poco	0	75
EC	6.8	.749	59	28.1	3.010	162.5	18.729	32	Las Delicias	2750	600	22	10	1600	211050	300	210
						92.2	20.061	33	Los Bancos	6500	1500	30	14	32	139880		240
						9.5	1.861	34	Llano Chico	1427	534	10	3	178	1040		90
						10.5	2.111	35	Lloa	1075	375	7	2	42	99700		30
						35.3	3.358	36	Machachi	9857	3951	219	48	335	97330	40	60
26	21.7	6.646	11	33.6	8.811	53.1	10.920	37	Malchingui	2480	2031	57	21	8	220	4	240
			33	25.8	5.031	81.8	17.992	38	Mindo	781	193	3	2	4	32500	2	390
			40	16.0	3.047	79.1	17.169	39	Nanegal	1479	321	21	12	9	49200		270
						63.1	14.123	40	Nanegalito	2033	279	23	9	77	150940		240
						7.2	1.464	41	Nayon	2079	1135	13	6	22	15000		45
						27.1	6.006	42	Nono	2123	538	38	14	70	17400	10	90
1B	30.4	5.862	11	16.5	3.167	91.9	16.127	43	Olmedo	4011	844	40	17	49	163000	5	300
26	22.4	4.574	11	25.0	5.168	53.8	8.848	44	Oton	1132	246	11	6	1100	6840	3	120
			40	32.5	6.768	95.6	20.890	45	Pacto	1797	547	39	17	29	95900		420
						53.5	13.901	46	Perucho	541	339	6	3	72	23233	1	150

1	2	3	4	5	6	7	8	9	Commercial Centres	10	11	12	13	14	15	16	17
						26.3	3.499	47	Pifo	3159	1456	51	21	119		15	60
			54	20.3	3.054	30.1	4.136	48	Pintag	6516	1407	52	16	52		36	75
						14.1	1.648	49	Pomasqui	3085	1264	104	28	891	98000	10	60
						45.6	8.832	50	Puellaro	4019	762	28	14	24	100310	4	210
			47	6.5	1.342	23.2	3.188	51	Puembo	2039	683	33	11	63	30000	11	120
			54	14.4	3.429	31.3	5.123	52	Rumipamba	412	104	1	1	15	4300	4	135
						20.2	2.413	53	San Antonio	3003	1507	79	21	806	33270	7	60
						16.9	1.694	54	Sangolqui	10641	5501	406	59	644	89850		60
			Q	77.8	17.893	76.6	20.486	55	San Jose de Minas	6617	2085	112	26	42	18200	5	300
			54	1.5	.285	15.9	1.918	56	San Pedro de Taboada	2088	790	28	9	156	10300		60
			54	2.1	.243	14.8	1.451	57	San Rafael	901	901	48	19		0	0	45
			22	11.1	2.618	42.3	6.562	58	Sta Rosa de Cusubamba	1150	235	7	5	3	600	4	105
			V	104.5	9.609	134.4	15.718	59	Santo Domingo dIC	31345	6951	975	66	4050	4056000	25000	270
51	5.9	1.362	47	7.2	1.576	29.1	4.550	60	Tababela	1088	275	4	1	29	16800	3	105
			11	9.7	1.593	85.1	14.552	61	Tabacundo	4468	2009	128	30	150	127133	13	180
			36	13.1	1.241	22.2	2.117	62	Tambillo	2540	796	46	16	3300		20	45

1	2	3	4	5	6	7	8	9 Commercial Centres	10	11	12	13	14	15	16	17
								63 Tocachi	1525	525	14	8	8	50720	4	240
	6.8	1.392	61	7.2	1.565	82.2	14.352	65 Tupigachi	2176	519	15	4	34	79655	14	210
T1	16.9	1.942	62	3.8	.701	26.0	2.818	66 Uyumbicho	2360	1103	46	14	76	57000	10	61
36			47	10.3	2.081	32.5	5.237	67 Yaruqui	3688	723	72	23	77	26000	1	120
						7.5	1.310	68 Zambiza	1952	724	9	4	56	20		60
						14.0	1.395	64 Tumbaco	7118	1096	116	27	1038	51800	31	60
					3.622	64.7	14.516	9 - Centres studied, listed in alphabetical order.	10 - Parish, or regional population.	11 - Town population.	12 - No. of commercial outlets.	13 - Range of commercial functions.	14 - No. of buses and trucks serving the parish each week (average).	15 - Annual gross volume of agricultural exports, in quintales.	16 - No. of haciendas in parish.	17 - Driving time to Quito, in minutes.
							8 - Road user cost for driving a five-ton truck to Quito, in US$.									
						7 - Distance by road to Quito, in Kms.											
					6 - Road user cost for driving to Centre #1, in US$.													
				5 - Road distance to Centre #1, in Kms.													
			4 - Centre #1													
		3 - Road user cost for driving to Centre #2, in US$.														
	2 - Road distance to Centre #2, in Kms.															
1 - Centre #2.																

3-7 Types of Towns

While in the field, it became apparent, for reasons detailed below, that the towns could easily be grouped into three classes as follows:

(a) those on national highways, or the major through, inter-provincial routes linking the major cities of Ecuador,

(b) those on regional highways, or the roads connecting centres of a region, but which only serve that particular region, and

(c) those on terminal highways, or those towns that are at the end of the road.

It was observed that the towns on national highways had a larger range and number of commercial functions relative to their population, than did other towns, and that many of these functions were dependent to some extent on the highway traffic passing by, e.g. bars and restaurants. At the other extreme, terminal towns seemed to be characterized by retarded commercial development, in that there were relatively few services for the population. Towns on regional highways were observed to fall in between these two extremes.

A justification for considering these three groups separately can also be found in the volume of traffic using the link that connects each town to its nearest market. Highways to the terminal towns will only carry the traffic that the town itself generates. Any commercial functions will be dependent solely on the local population, as the terminal nature of its link will discourage outsiders from doing business there. In Pichincha, there is minimum convenience for the interchange of goods or people at the end of a road, as in none of the terminal towns studied does any transferral from road to any other means of transportation such as paths or waterways occur.

Towns on a regional highway are in a more favoured position in that there will be a greater movement of traffic over their links to other centres,

simply because all vehicles going to or from any town further out on the highway will have to pass through them. This increased traffic volume frequently means that the road itself will be better maintained or constructed, thereby augmenting the convenience factor still further.

In the case of national highways, there will be not only local traffic and any regional traffic passing through, but also many vehicles engaged on inter-provincial runs. This large volume is normally a sufficient basis for justifying a fairly well-constructed highway and represents a much higher level of transport service to and from the community. At the same time, these vehicles and their passengers will require various services, thus creating a demand in excess of purely local requirements.

This distinction is much more noticeable for centres of small population than for larger centres, a fact which will become much clearer when the data is analysed in detail in the next chapter.

It should be noted that the towns could be grouped or classified in other ways, based on other factors which have been largely ignored for the purposes of this study. For example, one obvious natural grouping comprises the cabeceras cantonales, which have important administrative functions. These, and some other centres, are also market centres for the surrounding region, with a resulting interchange of goods and people. Again, one might have separated out the twenty-one parishes which have industry, either of a purely extractive nature, or else requiring large quantities of raw materials from outside.

These groupings have, however, been ignored because the effect of such characteristics can be seen, to a large extent, in the existing commercial development. On the other hand, extractive industries locate independently

of the transportation system, while the existing level of local commercial development and the quality of the highway links serving a town may or may not have been significant factors in influencing the location of the manufacturing plants currently operating in Pichincha. The importance of a market centre can be gauged from the existing commercial development of a permanent nature, while a market requires customers who can reach it conveniently, and this latter factor will be inherent in the assessment of road user costs and in population statistics.

Thus we can hypothesize that a very important influence on the commercial development of a town will be its position in the road network, specifically the nature of the link to its nearest major market.

CHAPTER IV

DATA ANALYSIS

4-1 Road User Costs

Road user costs were computed for each link in the highway network using the data collected in the field, and the tables of vehicle operating cost factors given in Jan de Weille's Quantification of Road User Savings (see Bibliography).

For the purposes of this study, a gasoline-powered, five-ton truck was taken as the sample vehicle, it being analogous to de Weille's 'Truck II'. Most of the intra-provincial freight is carried on trucks of this size, or smaller models. There are some pick-ups, but few automobiles or jeeps are permanently located and driven in the rural districts of the province. Passenger traffic is by bus or 'collectivo', both of which usually have a locally-built body on an imported truck chasis. For purposes of computing average vehicle operating costs, these vehicles can realistically be considered to be five-ton trucks, as the chasis type has identical or similar specifications, and normal operation with passengers and freight would give a loaded weight of about five tons.

In determining vehicle operating costs, the following cost factors must be considered:

a) fuel consumption.

b) engine oil consumption.

c) tire wear.

d) depreciation of the vehicle.

e) interest on capital outlay.

f) maintenance of the vehicle (parts).

g) maintenance of the vehicle (labour involved).

h) occupants' time - that of the driver and (if any) helpers.

The following were the 1970 rates in Quito, as determined by checking at dealers and garages:

a) gasoline - regular S/. 4.05 per galon = 16.2¢ US per quart.

special S/. 4.55 per galon = 18.2¢ US per quart.

b) engine oil - S/. 13. per quart (52¢ US).

c) truck - 3.5 ton = S/. 120,000 (US$4800); 5.0 ton = S/. 150,000 (US$6000).

d) tires - 7.50x16 = S/. 825 (US$ 33.); 8.25x20 = S/. 1700 (US$ 68).

e) truck life - approximately 500,000 Kms over 10 years.

f) credit - 12% (official) - normally 13-14 per cent.

g) mechanic's labour - S/. 10. per hour (40¢US).

h) occupant's time - driver and occasional helper = S/. 7.50 (30¢ US).

The various surface conditions were grouped into the three basic types , namely paved, gravel, and earth, normally recognized by civil engineers, while a fourth, 'pista', was incorporated, it being defined as a basically unimproved surface, or one severely degraded, such that the average driving speed of a truck would be no more than 24 Km per hour on the level. As no cost tables exist for such an undefined highway condition, maintenance, tire wear, and depreciation were considered to be double the rates for earth surfaces, while engine oil, gasoline consumption and the other

cost factors were evaluated on the thesis of the reduced speeds that are required on such highways. Similarly, costs for extremely steep gradients (greater than 8 in 100) were estimated by graphical extrapolation (see graph, page 44), as no satisfactory tables exist for gradients up to 1 in 5, as on the road down to Guapulo. Fortunately, these approximations do not apply to long sections of highway and so the relative accuracy of the computations is maintained.

Surface designations were made as follows:

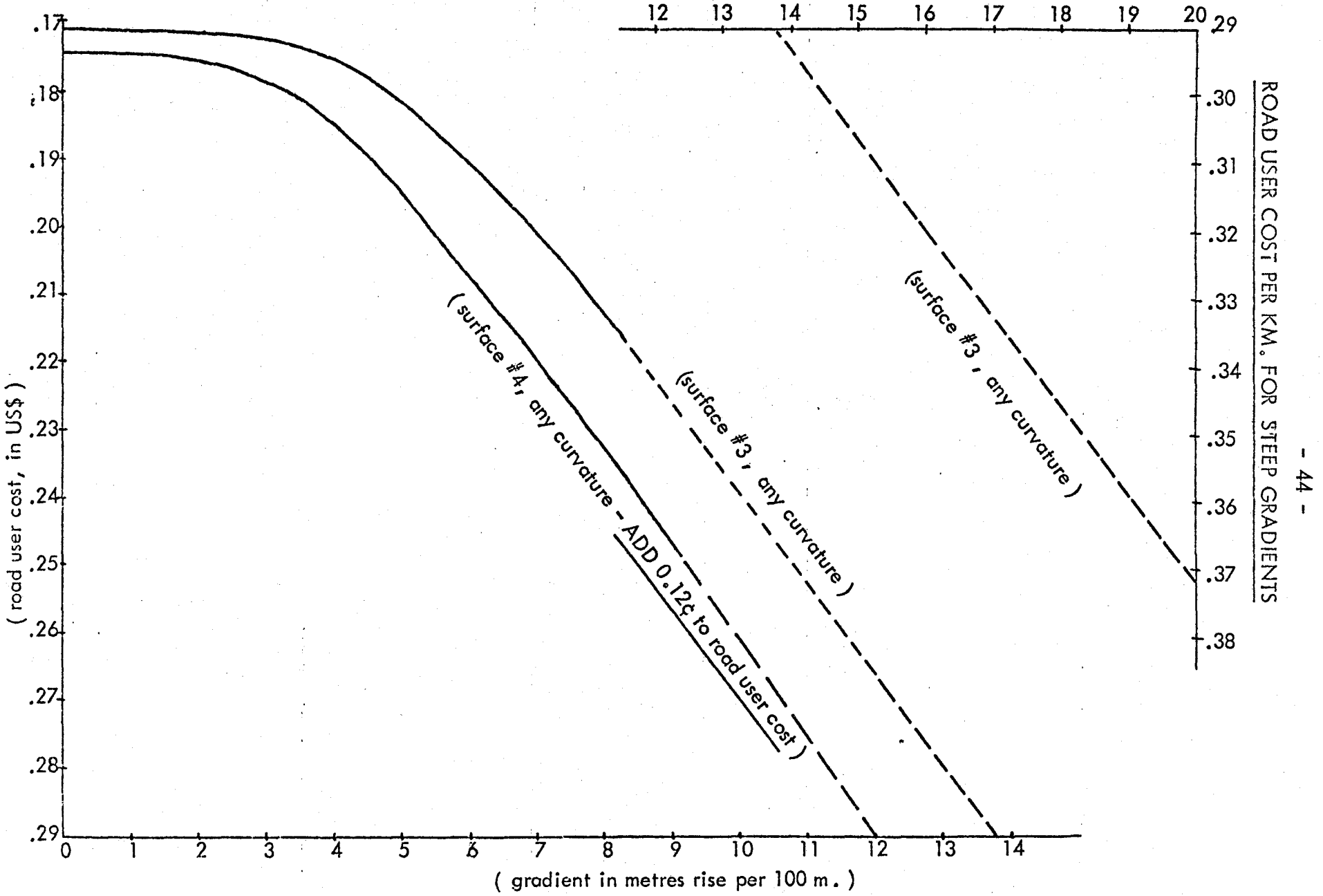
(1 = paved, 2 = gravel, 3 = earth, and 4 = pista)

Surface Quality		Surface Type					
		I- paved	II- paved	III-gravel	IV-cobble	V-earth	VI-unimproved
excellent	A	1	1	1	1	2	4
good	B	1	1	2	2	3	4
fair	C	2	2	3	3	3	4
poor	D	3	3	3	3	4	4
atrocious	E	4	4	4	4	4	4

Average operating speeds on level, straight roads for trucks are:

- paved - 72 Kph
- gravel - 56 Kph
- earth - 48 Kph
- pista - 24 Kph.

Truck operating costs per 1000Km on a level, straight, paved highway can be computed as follows, using the tables given by de Weille. The average vehicle speed will be 72 Km/hour (p. 14).


ROAD USER COST PER KM. FOR STEEP GRADIENTS
(road user cost, in US$)
(gradient in metres rise per 100 m.)
(surface #4, any curvature - ADD 0.12¢ to road user cost)
(surface #3, any curvature)
(surface #3, any curvature)
.17
.18
.19
.20
.21
.22
.23
.24
.25
.26
.27
.28
.29
.30
.31
.32
.33
.34
.35
.36
.37
.38
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
12 13 14 15 16 17 18 19 20

a) fuel consumption = 232.4 l. (pp 15-19)	US$	39.62
b) oil consumption = 1.6 l. (pp 19-20)		0.88
c) tire wear = 7.8% of a new tire (pp 20-21)		2.57
d) depreciation = 0.17% of the replacement cost (pp 21-22)		10.20
e) interest = 0.22% of vehicle cost (p. 22)		6.60
f) maintenance-parts = 0.30% of vehicle cost (pp 23-24)		18.00
g) maintenance-labour = 2.35 hours (pp 23-24)		0.94
h) occupants'time = 13.88 hours (p. 25)		4.14

Total operating cost for driving 1000 Kms is therefore US$ 82.95, and the cost per kilometre is US$ 0.08295. Cost per kilometre for other highway conditions can be similarly computed. For those conditions found in Pichincha, operating costs per kilometre were found to be:

Surface Type	Curvature (see Section 3-2 for explanation of symbols)	Gradient	Cost/Km (in US$)
1	a,b	0-2	.08295
1	a,b	3-5	.08536
1	a,b	6	.09393
1	a,b	8	.10811
1	c	0-2	.09034
1	c	3-5	.09258
1	c	6	.09743
1	c	8	.10947
1	d	0-2	.09401
1	d	3-5	.09736
1	d	6	.10404

Surface Type	Curvature	Gradient	Cost/Km (in US$)
1	d	8	.11574
2	a,b	0-2	.10389
2	a,b	3-5	.11437
2	a,b	6	.12749
2	a,b	8	.14718
2	c	0-2	.10811
2	c	3-5	.11588
2	c	6	.12749
2	c	8	.14718
2	d	0-2	.12555
2	d	3-5	.12958
2	d	6	.13280
2	d	8	.15133
3	a,b	0-2	.17090
3	c	0-2	.17256
3	a,b,c	3-5	.17554
3	a,b,c	6	.19076
3	a,b,c	8	.21382
3	a,b,c	9	.2253
3	a,b,c	10	.2381
3	d	0-2	.17874
3	d	3-5	.18355
3	d	6	.19275

Surface Type	Curvature	Gradient	Cost/Km (in US$)
3	d	8	.21510
3	a-d	14	.2932
3	a-d	15	.3064
3	a-d	16	.3192
3	a-d	20	.3718
4	a-d	0-2	.2942
4	a-d	3-5	.3052
4	a-d	6	.3276
4	a-d	8	.3532
4	a-d	9	.3668
4	a-d	10	.3810
4	a-d	12	.4097

For narrow highways, the cost is increased for each vehicle coming in the opposite direction that one is likely to encounter while traversing the link, and this factor was added into the costs. For highways 4.9 metres in width or wider, there is little change in vehicle running speeds, as two vehicles could normally pass without any difficulty or by driving slightly onto the shoulder or verge. For highways between 4.2 and 4.8 m. wide, 50 m. were added for each encounter, as each vehicle would have to slow down and pass the other carefully, probably by driving over the rough verges of the right-of-way. If the right-of-way was from 3.4 to 4.1 m. wide, there was a 100 m. increment per encounter due to the increased care with which one must drive, and the manoeuvres required for passing anyone coming the other

way. These figures are estimates based on observation of traffic behaviour, and are an attempt to estimate the cost of narrow roads. Normally, widths were measured to the nearest half-metre, and for a range of road widths, the respective increment is an estimate of the average increase in user cost resulting from encountering another vehicle.

For roads 3.3 m. in width or less, 200 m. per encounter was added, as on such narrow roads, one of the vehicles would have to reverse to a wider section where it would be easier to pass. At the same time, the narrowness often reduces visibility so that drivers must proceed slowly and with due caution, thus increasing road user costs.

Hairpin bends were dealt with in like fashion, by adding a supplemental cost due to the slowing down and backtracking that may be required to navigate these very tight curves. This additional cost was added as follows to the general condition of the section in which the hairpin bend occurs:

- highways wider than 4.2 m., 50 m. was added to the section length,
- highways 3.3 - 4.1 m. in width, 100 m. was added to the section length,
- highways narrower than 3.2 m., 200 m. was added to the section length.

The cost of driving a truck over any section of highway could then be easily determined, using these figures, and by making minor adjustments for narrow bridges, landslides, and washouts, where they occur. This cost was computed for each link and the resulting values are given on Map 2.

The road user cost of driving from each commercial centre to Quito was then found, as well as the road user cost of travel to important centres located nearby that are frequently visited by local inhabitants for personal or

business reasons. For this study, the distance and cost figure used were those for travel from a given local commercial town to the nearest major market for that centre, which in practice nearly always means the nearest cabecera cantonal (of which Quito is one), as each of these latter centres, except Tabacundo, has a large market, weekly or more frequently, where people from the entire surrounding region go in order to buy and sell.

The driving time from each commercial centre to Quito is given in Section 3-6 , and is cited for interest and information only, as it is incorporated in the road user cost.

4-2 Local Commercial Development

As mentioned in Section 3-4, the two indices used to measure the commercial development in a town are the range of commercial functions present and the total number of commercial establishments that do business in the community. These are reasonable indicators of the level of business activity present, as, outside of Quito and other large cities, capital is in exceedingly short supply (e.g. only Santo Domingo and Cayambe have banks) so that stores usually have the minimum of stock and equipment. The only major exception is that the large general stores found in the more important centres usually have a large range of goods for sale, including a much bigger range of tinned and packaged foods than is normally sold in a 'viveres', or small corner store, and they quite often also have a fair selection of domestic and imported liquors. This type of outlet was specially classified under the heading of 'viveres grandes'.

In any discussion of commercial development, consideration to local

and area population must be given, for clearly the number of outlets found in a town will in all likelihood depend heavily on the size of the immediate market. Thus it is of interest to determine the effect of these two single factors. As there are certain threshhold populations required for an activity, one can surmise that the range and number of commercial establishments will be in part dependent on population. It is also reasonable to expect a positive relationship between the range and the number of commercial outlets.

Although data has been collected on the number of vehicles serving a parish in a week, except for terminal towns, there is little reason to expect a close correlation between this number and the level of commercial activity, due to the earlier-mentioned difference in levels of activity in towns dependent on their position in the transportation network. For example, Cutuglagua is served by over 3000 buses a week - roughly one every 150 seconds of the day and night! - but this is not because of the town itself, nor does it have any noticeable effect on local development other than that one does not have to worry about not being able to leave in a hurry. The simple reason is that Cutuglagua is located on the Pan-American Highway just outside Quito, and consequently buses to and from the entire southern half of the country pass right through the community.

Similarly, the volume of agricultural exports from a parish should be related to the quality of the transport links to the markets, but this figure is expected to be influenced much more by the area of the parish, its climate and soils, the availability of land for producing marketable surpluses, and, possibly most important, by whether there are large haciendas or only

smallholdings in the parish. In several parishes, agrarian reform has broken up the large haciendas into smallholdings for subsistance farming, with a marked effect on parochial export figures. The principle involved is that by breaking up the estates and giving or selling the land to the peasants in small lots, usually of 7.5 to 10 hectares each, the rural population can become economically self-sufficient and enjoy a higher standard of living. In practice, the low level of capitalization and under-utilization of land potential result in small surpluses that are traded at regional markets for manufactured goods, instead of the large surpluses formerly exported by the estates, normally to Quito. Using those parishes where data was obtained, it will be instructive to see what, if any, relationship exists between the number of haciendas in a parish and its volume of exports. If figures were available for the number of hectares actually farmed by hacenderos - many keep large tracts of land idle -, a more useful correlation could be obtained.

We can surmise that there will be some relationship between the number of vehicles owned in a parish, and the road user cost of going to market, the level of commercial development, and the population. There should be a marked difference between the relations obtained for the three different kinds of highways, though, as vehicle ownership can depend on a number of factors, there will probably be poor correlations for most of these relationships.

Industrial activity in the province is also not expected to be closely related to the road user cost of reaching the nearest market, or to the parish population, for several reasons. Extractive industries, such as the limestone

quarries in Calacali, locate close to the source of raw material, regardless of other conditions, whereas a manufacturing plant may consider transportation quality or availability of labour as important, but, in at least one instance, a steady water supply was the key factor in determining plant location. For example, a rolling mill for structural steel, serving the entire northern and central Sierra and the Oriente, was located near the Aloag junction on the Pan-American Highway so as to minimize transportation costs. (The company has other mills in Guayaquil and in Cuenca, all using imported billets.) On the other hand, a record company chose Conocoto because of its supply of labour that is cheaper than in Quito, while a bottling plant was located nearby in order to take advantage of the local water supply that is more reliable and of better quality than that of Quito. In another case, Amaguana, a town on a regional highway of fair to poor quality, has three factories as a result of initiative and investment by a wealthy local landowner. Industrial activity may well have an effect on local commercial levels due to the additional employment and income generated from it, and an indirect effect on transportation quality may occur due to the increased traffic generated. In either case, any such influence will be incorporated in other measured quantities.

In summary, it is expected to find good correlation between road user cost and distance, and between local and area population and the range and the number of commercial activities. There should also be some relationship between the range and the number of commercial activities. The number of vehicles in a parish and the volume of agricultural exports will be

correlated with population, road user costs and the range of commercial functions, but the results are not expected to be close. Finally, the range of commercial functions will be correlated with the road user cost to determine what relationship exists between them, this being, in essence, the problem being studied.

The results of this initial analysis will then be used to develop a more complete picture of the relationship between the commercial development of a town and the quality of its transportation links.

4-3 Summary of Analysis

Linear regression analysis was used to examine the data in order to evaluate the relationships discussed in the previous section. In this analysis, the communities were divided into three separate groups, viz. towns on national, those on regional, and those on terminal highways. The work was carried out on a Wang 700 Advanced Programming Calculator with the following results. (N = national, R = regional, and T = terminal highways; r = correlation coefficient of sample, se = standard error of estimate).

a) distance vs road user cost (d vs ruc):

N-	ruc = .166 + .095 d	r = .9757	se = .5604
R-	ruc = -1.066 +.233 d	r = .9698	se = 1.0783
T-	ruc = -.275 + .220 d	r = .9939	se = .6401

Using all the towns, for distance vs road user cost, one gets:

ruc = -.325 + .187 d	r = .9151	se = 1.9255

b) range vs number of commercial functions (R vs n):

N-	n = -185.367 + 13.253 R	r = .8907	se = 125.6900

R- n = -45.437 + 6.202 R r = .9477 se = 24.3301

T- n = -.897 + 2.766 R r = .9468 se = 5.4869

c) town population vs range of commercial functions (tp vs R):

N- R = 13.077 + .00683 tp r = .9440 se = 6.1316

R- R = 6.511 + .0105 tp r = .9182 se = 4.5627

T- R = 1.376 + .00955 tp r = .7735 se = 3.6987

d) parish population vs range of commercial functions (pp vs R):

N- R = 12.924 + .00194 pp r = .8467 se = 9.8894

R- R = 5.445 + .00345 pp r = .8028 se = 6.9086

T- R = 2.848 + .00227 pp r = .6435 se = 4.4666

e) town population vs number of commercial functions (tp vs n):

N- n = -26.427 + .0970 tp r = .9013 se = 119.8150

R- n = 6.555 + .0105 tp r = .9163 se = 4.6390

T- n = 1.376 + .00955 tp r = .7735 se = 3.6987

f) parish population vs number of commercial functions (pp vs n):

N- n = -62.092 + .0318 pp r = .9334 se = 99.2406

R- n = -10.5743 + .0209 pp r = .7340 se = 52.1347

T- n = 4.736 + .00734 pp r = .7001 se = 12.1739

g) parish population vs number of vehicles in parish (pp vs v):

N- v = -89.245 + .0373 pp r = .9205 se = 131.3367

R- v = -20.259 + .0191 pp r = .6942 se = 53.3539

T- v = 7.713 + .00433 pp r = .4849 se = 12.6994

h) range of commercial functions vs number of vehicles in parish (R vs v):

N- v = -214.069 + 15.685 R r = .7927 se = 204.9034

R- v = -32.061 + 4.564 R r = .7235 se = 50.7310

T- v = 15.502 + .215 R r = .08659 se = 14.4661

i) number of vehicles vs road user cost (v vs ruc):

N- ruc = 2.212 + .00548 v r = .6894 se = 1.9342

R- ruc = 5.652 - .0227 v r = -.3744 se = 4.1030

T- ruc = 6.863 - .131 v r = -.3221 se = 5.4249

j) volume of agricultural exports vs road user cost (a vs ruc):

N- ruc = 2.353 + .00000172 a r = .7535 se = 1.8108

R- ruc = 5.137 - .00000861 a r = -.1067 se = 4.5312

T- ruc = 4.728 + .0000137 a r = .1708 se = 6.3718

k) volume of agricultural exports vs range of commercial functions (a vs R):

N- R = 17.801 + .0000119 a r = .7822 se = 11.4578

R- R = 16.955 + .0000117 a r = .05411 se = 12.2085

T- R = 5.639 + .0000358 a r = .4912 se = 5.1154

l) parish population vs volume of agricultural exports (pp vs a):

N- pp = 2367.516 + .00693 a r = .9298 se = 3312.6593

R- pp = 3236.760 + .00665 a r = .1495 se = 2522.8847

T- pp = 1364.588 + .0108 a r = .6006 se = 1199.7214

m) range of commercial functions vs road user cost (R vs ruc):

N- ruc = -.263 + .151 R r = .7633 se = 2.3813

R- ruc = 6.437 - .108 R r = -.2841 se = 4.2424

T- ruc = 2.003 + .321 R r = .3265 se = 5.4163

n) in addition, the following relation between the volume of agricultural exports from a parish (a), and the number of haciendas in the parish (f),

was evaluated.

$$f = -621.498 + .00596\,a \qquad r = .9229 \qquad se = 1739.4592$$

Other data pairs were examined but the resulting correlations were either found to be less useful, or else meaningless. For example, distance was used instead of road user cost for cases (i) and (m), but it was found that road user cost gives by far the better correlation between transportation and the other factors. Similarly the close correlation between range and number of commercial functions suggests that one of these may be substituted for the other. For example, for localities on terminal highways, when the town population is correlated with either factor, the same equation is obtained, viz. - n or $R = 1.376 + .00955\,tp$.

As an indicator of commercial development, the range of commercial functions gives the quality, suggesting the potential market for different goods and services within a parish, or alternatively, the existence of a willingness, and availability of money, to invest in higher order business activity. The number of facilities, on the other hand, would be dependent on the size of individual establishments, as much as on the size of the potential market.

To combine the two values into a single index, the square root of their product was taken. Taking the product, rather than the sum, allows the effect of the range value to be more significant than is the case with summing, particularly for the larger centres where the magnitude of the number would otherwise render the effect of range negligible. By then taking the square root, we obtain an index of commercial activity, $I = \sqrt{nR}$,

that is of the same order of magnitude as the individual components, but which expresses both the degree and the magnitude of commercial development, with, in fact, a numerical bias in favour of degree, which is the more independent value. This index was then compared with other quantities with the following results.

o) town population vs commercial index (tp vs I):

N-	I = 10.157 + .0265 tp	r = .9492	se = 22.5697
R-	I = 2.859 + .0281 tp	r = .9512	se = 9.1667
T-	I = 1.610 + .0163 tp	r = .7857	se = 6.0818

p) parish population vs commercial index (pp vs I):

N-	I = 4.908 + .00813 pp	r = .9183	se = 28.3959
R-	I = 2.688 + .00853 pp	r = .7734	se = 18.8700
T-	I = 3.636 + .00413 pp	r = .6834	se = 7.1769

q) road user cost vs commercial index (ruc vs I):

N-	I = 5.707 + 15.755 ruc	r = .8094	se = 42.1393
R-	I = 40.037 - 1.127 ruc	r = -.1650	se = 29.3625
T-	I = 14.331 - .365 ruc	r = -.2129	se = 9.6054

Between transportation indices and commercial levels, the basic relationships which this study proposes to examine, we find poor correlations for simple linear regression in most of the cases examined. Furthermore, binomial or exponential regression techniques did not yield better fits for the transportation/commercial development relationship. Multiple linear regression analysis was then employed in the search for a better 'fit', or ability to predict the dependent factor, commercial development, with the

relationships already evaluated being used to help in identifying the most significant factors. It was found from the data that commercial development is not closely related to road user costs alone, though from conditions prevailing in Pichincha as mentioned in Sec. 3-7, it appears that the level of commercial development of a town in the province does have some relation to its location on the road network. For most centres, the population of a town and of its parish represent the market for any commercial operations in the town, and, as the earlier analysis shows, there is high correlation between both sets of population figures and the range and the number of commercial functions. If we compare population with the commercial index derived from taking the square root of the product of the range and the number of commercial functions, an even higher correlation is obtained. As mentioned earlier (see Sec. 3-5), the number of vehicles in a parish is a measure of local transportation potential and an indirect indicator of local economic development, as is the volume of agricultural exports , which would be more a measure of transportation demand.

Taking the 'commercial index' as the measure of commercial development of a town, and as being dependent on various factors, including the population of both the town and the parish, the road user cost of reaching the nearest major market, the number of vehicles in the parish, and the annual volume of agricultural exports, all of which factors have been found previously to be significant to some degree, multiple regression equations were obtained for the three groups of communities, namely those on national, those on regional, and those on terminal highways. It was, however, found

that the volume of agricultural exports had a negative effect on the correlation, and so it was dropped. As stated in Section 4-2, and as indicated by the poor correlations obtained in equations (j), (k), and (l), agricultural exports depend on many factors. Thus the final relationship evaluated gives the commercial index (I) as a function of the road user cost (ruc), the parish population (pp), the town population (tp), and the number of vehicles in the parish (v).

r) (ruc, pp, tp, v) vs I

N- $I = -2.565 + 3.287\ ruc + .00156\ pp + .0209\ tp + .0230\ v$

$r = .9194 \quad se = 8.0289$

R- $I = 1.846 - .680\ ruc + .00211\ pp + .0285\ tp - .0869\ v$

$r = .9744 \quad se = 8.789$

T- $I = -1.182 + .323\ ruc + .00090\ pp + .0134\ tp + .0707\ v$

$r = .9327 \quad se = 6.3788$

However, it must be noted that Santo Domingo, Cayambe, Sangolqui, and Machachi are cabeceras cantonales with important market functions that serve not only the town and its parish, but the whole region as well, so that the population figures used represent an under-estimate for the higher order commercial functions, while much lower-order business is conducted by transients merchants on market days. If we omit these centres from our calculations, the following regression equations are obtained.

s)-

N- $I = .119 + 2.148\ ruc + .00051\ pp + .0313\ tp - .0255\ v$

$r = .9738 \quad se = 3.556$

R- $I = 2.072 - .676\,ruc + .00216\,pp + .0281\,tp - .0869\,v$

$r = .9696 \qquad se = 8.9698$

It will be seen that the second equation does not give a closer fit for towns on regional highways, so that only those cantonal centres on national highways represent anomalies, and they will be discussed further in Section 5-3.

For the simple linear equations, 'r' and 'se' were computed as part of the program package. For the multiple linear regression analysis, the following formulas were used:

$$r = \left[\left[\frac{SUMb(i) \left[n\,SUM[x(ij).y(j)] - SUM\,x(ij).SUM\,y(j) \right]}{n\,SUM\,y(j)^2 - [SUM\,y(j)]^2} \right] \right]^{\frac{1}{2}}$$

$$se = \left[\left[\frac{SUM\,[y(i) - y''(i)]^2}{df} \right] \right]^{\frac{1}{2}}$$

for the regression equation:

$y = b(0) + b(1).x(1) + b(2).x(2) + \ldots\ldots\ldots\ldots + b(n).x(n)$

where

$y''(i)$ = predicted value of 'y(i)' using the regression equation, and

df = degrees of freedom.

CHAPTER V

INTERPRETING THE RESULTS

5-1 The Regression Equations

The value and significance of the sets of linear regression equations obtained in Section 4-3 will now be examined.

The high correlations for the distance vs road user cost equations indicate a fairly high degree of uniformity in the quality of the road system. The coefficient of 'd' gives the average driving cost per kilometre, or 9.5¢ for national highways, 23.3¢ for regional highways, and 22.0¢ for terminal highways, with the average road user cost for a five-ton truck in Pichincha being 18.7¢ per kilometre. The constant term in the equations is a bias that, when negative, suggests that high costs on some long links have distorted the cost picture to some extent, or in the case of national links, the effect of the relative low cost of long hauls. The high average cost for regional highways, the larger standard error of the estimate, and the larger constant term would be largely due to the high cost involved in reaching the Pacto, Mindo, and San Jose de Minas areas as a result of their relatively poor road links to their major market, Quito.

Comparing the range of commercial functions with the number of establishments present in a town, we are interested first in discovering whether these two factors are interrelated. Such a relation does exist, although the standard errors of the estimates are high, and except for towns in terminal highways, the constant terms in the equations make the estimates inaccurate or uncertain for small ranges. However, if one deletes cabeceras cantonales

from the groups because of their regional services and the resulting increase in population served, we obtain much better correlation, as can be readily seen.

N-	n = -11.940 + 3.708 R	r = .9758	se = 6.6699
R-	n = -22.595 + 4.660 R	r = .9575	se = 12.6263
T-	n = -.897 + 2.766 R	r = .9468	se = 5.4869

The low coefficient for towns on terminal highways indicates that there is minimal benefit to the total level of commercial activity if a new function is added to the range already operating in the community, that is, minimal spin-off effect. The low constant term indicates that, for this type of locality, the number of commercial activities is almost directly proportional to the range of functions.

The larger coefficient terms in the other two equations are the result of the business that is generated by the traffic passing through, which creates a larger demand for goods and services, that will be dependent on the range available. The greater the range, the greater the demand that can be satisfied. Hence, the greater likelihood that a driver or a bus will stop in the town, and thus the larger the number of establishments that can profitably carry on business there. The large negative constant terms for towns on national and regional highways indicate that smaller centres have a proportionately lower number of establishments compared to the range of functions, and that the traffic passing through only affects the number of establishments if the range of commercial functions is 12 or more.

The range and the number of commercial functions depend to some extent on the market being served, and so these two factors were individually compared, first with the size of the immediate market available, namely the population of the town, and secondly, with the more realistic market drawn from the population of the entire parish. The equations derived have fairly high correlation coefficients, although when the range and number of commer-

cial functions are compared with the parochial population, there is more divergence from the regression equations using town population. A likely reason for this would be that some centres, particularly cabeceras cantonales, attract people from a wider area than just the parish. For example, Sangolqui draws people from Canton Ruminahui, Alangasi, Pintag, La Merced, Guangopolo, and Conocoto to its bi-weekly market for buying and selling, and also for providing other needed services for those who do not go into Quito.

The positive constant terms in the equations (c) and (d), range of commercial functions vs population, suggest that for each type of town, there is a basic range of commercial functions independent of population and that for communities on national highways, this basic range is much larger than for the other two cases. On the other hand, local population affects the range of functions much more in towns on regional and terminal highways, as indicated by the respective coefficients in the two sets of equations. For the number of commercial functions, highway type and population are important, increased population giving rise to a proportionately higher growth in number of outlets in towns on national highways than in those on other routes. The constant term is considerably larger and negative for towns on national highways, indicating that there is proportionately larger growth in the more populated centres, although this may also be the result of the afore-mentioned supra-parochial markets that some centres can draw upon.

To test the significance of the number of vehicles in a parish, this figure was correlated with the parochial population, and with the road user cost of reaching the nearest market, to see if vehicle population influenced the cost of driving to market, assuming that good roads would be built to provide maximum convenience and economy for the greatest number of road users. Finally, the range of commercial functions was compared with the number of vehicles to see if vehicle population was related to the level of local commer-

cial development.

In only one case out of the nine was there high correlation, and that was for the parochial population of parishes on national highways, but the standard error of the estimate was of a high enough magnitude as to make the predictions unreliable. This would suggest that the number of vehicles is a complex function, dependent upon many variables, although the correlation coefficients obtained when the number of vehicles is compared with the parish population or with the range of commercial functions indicate that these are two very significant factors, except for towns on terminal highways.

There was even less correlation using the volume of agricultural exports, as a function of parish population, of range of commercial functions, or of the road user cost. Again, parishes on national highways give relatively high correlation coefficients but the standard errors are high enough to make the equation unreliable, and for the other types of highways, no useful relationship was found. Clearly agricultural exports are dependent on a variety of factors that may or may not be interrelated, and it would appear that roads have been built for purposes other than the transport of agricultural products.

It is interesting to note that there is fairly high correlation between the volume of agricultural exports and the number of haciendas in a parish. The large negative constant term in the equation suggests that the larger a parish's agricultural output, the greater likelihood that the individual haciendas will be smaller in area, because the coefficient indicates an average exportable surplus of 168 quintales per unit. As before, the large standard error of this estimate makes the accuracy of the relation suspect.

When comparing the range of commercial functions with road user cost, it was found that there was poor correlation, thus suggesting that commercial development is also a function of at least several variables. For towns on regional highways, there is reduced commercial development the greater the

road user costs, whereas for other localities, it would appear that increasing distance from the major market will result in greater local commercial development. The large standard errors again indicate rather dubious accuracy. However, since this last relationship is the basic problem being investigated, the search for a satisfactory equation that linked the two distinct quantities was continued through the use of multiple linear regression techniques. Using the 'commercial index', instead of the range of commercial functions, gave analogous results (compare cases (o), (p), and (q), with cases (c), (d), (e), (f), and (m)), although there is slightly better correlation using the 'index'.

We saw earlier that distance and road user cost are closely related, one with the other, as are the range and the number of commercial establishments. As road user cost encompasses the effect of distance, terrain and driving time, it is the most useful index of accessibility, particularly as it can be determined quite easily and precisely. The commercial index was used as a measure of commercial development as it incorporates both the number of commercial establishments in a community and the range of types of commercial functions. And as the two quantities are related, given the index of a town, it would not be difficult to estimate what range and number of commercial functions it should have.

The commercial index was finally related to the town and parish population, the road user cost, and the number of vehicles in the parish. Discarding or adding any of the variables studied increased the standard error of the estimate, thus indicating that equations (r) are the closest fit.

As noted earlier, some cantonal centres have a level of development different from what would be expected from the performance of the average town which is dependent solely on its hinterland. Thus if Santo Domingo de los Colorados, Cayambe, and Machachi are omitted from the group of towns

located on national highways, the standard error of the estimate is reduced by over one-half.

Thus the equations that will be considered in depth are:

N- $I = .119 + 2.148\ ruc + .00051\ pp + .0313\ tp - .0255\ v$

$r = .9738 \qquad se = 3.556$

R- $I = 1.846 - .680\ ruc + .00211\ pp + .0285\ tp - .0869\ v$

$r = .9738 \qquad se = 8.789$

T- $I = -1.182 + .323\ ruc + .00090\ pp + .0134\ tp + .0707\ v$

$r = .9327 \qquad se = 6.3788$

These equations imply that, given the road user cost of linking a town with its market, and given the population of that town and of its parish, and given the number of vehicles in the parish, one can predict, with a small margin of error, the level of commercial development that will occur in that town. Such information would be particularly useful for estimating the possible effects of highway improvement schemes on local commerce, as the populations and the number of vehicles can be easily measured in the field or from government records, and highway user costs for new highway routes can be estimated accurately using maps and the methodology outlined in Section 4-1. However, we should look in some detail at the relationships expressed in these three equations in order to obtain a better understanding of the major factors affecting the commercial development of towns in Pichincha Province.

The constant term in equation N is almost negligible, thus indicating that the commercial index can be expressed almost completely adequately in terms of the four independent variables. The larger constant terms in the other equations are indicative of the greater relative uncertainty of the prediction, at least for smaller centres. The positive constant for towns on regional highways suggests that they will have a small impetus to commercial growth due to location, whereas the negative constant for terminal towns indicates

that the terminal nature of such a town will reduce the level of commercial development. In all three cases, this is relative to the four independent variables used, and suggests that other minor variables contribute to the commercial development of towns on regional highways, while reducing that of terminal towns.

For each equation, we can determine the relative significance of each factor by the standard formula:

$$b'(i) = b(i).\left(\frac{SUMx(i)^2}{SUM\,y^2}\right)^{\frac{1}{2}}$$

where $b(i)$ = coefficient of $x(i)$ in the regression equation,

and $b'(i)$ = measure of relative significance of variable $x(i)$.

- which gives the following sets of values:

N-	b'(ruc) = .189	b'(pp) = .0781	b'(tp) = .831	b'(v) = -.0683
R-	b'(ruc) = -.0922	b'(pp) = .214	b'(tp) = .946	b'(v) = -.171
T-	b'(ruc) = .323	b'(pp) = .155	b'(tp) = .687	b'(v) = .0491

From these values, it is very apparent that the town population is the most significant factor in determining the level of commercial development in a locality, though the effect of this factor is least in the case of towns on terminal highways. Clearly a town's commercial development depends on the market size, and the inhabitants of the town itself would be the greatest number of people both immediately accessible and having a higher demand for goods and services than the rural peasants. One would normally expect terminal towns to be most dependent on their immediate market, as indeed they are but the lower significance of town population on commercial development in these localities is a reflection of likely lower per capita disposable incomes due to these towns being the most inaccessible in the road network (see p. 16).

For 'terminal' and 'national' towns, the second most significant factor is the road user cost. This would, as it is positive, represent a reaction to relative isolation. For terminal towns, there is a consequent need to try to satisfy needs as much as possible locally, while for national highways, a greater distance between centres will result in the long-distance traffic being more likely to stop for food, gasoline, and other requirements.

The next most significant factor for each type of town is the parish population, as one might expect from the simple relationships evaluated earlier. Both population figures represent the strength of the market, which is obviously an important conditioner on economic and commercial development. This is a much stronger factor for centres on regional highways than the others, probably because such towns would tend to draw more on their actual hinterland, whereas towns on national highways would get considerable business from the highway, and people would tend to leave a terminal town for the nearest larger centre due to the greater level of commercial activity that it would have.

For both 'national' and 'terminal' towns, the number of vehicles in the parish is relatively insignificant. The negative sign in the first case suggests that vehicles mean increased mobility and the chance to go elsewhere, hence a diminuation in commercial activity, whereas, for terminal towns, a vehicle means being able to overcome the constraint of isolation by moving people and goods in and out, and thus an increase in commercial activity results. In many cases, some or most of the vehicles serving these towns are owned elsewhere.

For towns on regional highways, both the road user cost and the number of vehicles in the parish is fairly significant, but in a negative way. With regard to vehicles, it would seem that they represent mobility, and more of a chance to move over the road network, so that people can satisfy their

needs in other places, with a corresponding drop in commercial activity locally. The same type of effect would probably account for the road user cost being negative, because there is undoubtedly a tendency in these towns to move in towards the centre of the network, whereas in the terminal towns, isolation provides more physical inertia. Alternatively, the farther out that a town is located on a regional highway, the more that the locality approximates a terminal town. Consequently the negative road user cost is a bias that would tend to lower the value of the commercial index for a more remote town to approximate the lower level of activity found in a terminal town of the same size.

For all three cases, the correlation coefficient is very high, and the standard error is low, although it should be noted that for equation 'T', ten out of the 25 towns used in the sample have a commercial index that is less than the standard error of the estimate.

For each centre in the province, we can now compare its actual commercial index with the value predicted from the derived equations.

5-2 Actual vs Predicted Values of the Commercial Index

N- towns on national highways: (se = 3.556)

Aloag	actual I = 42.708	predicted I = 42.354	difference = +0.354
Alluriquin	36.606	40.846	-4.240
Calderon	35.496	30.254	+5.242
Cornejo Astorga	18.973	18.366	+0.607
Cutuglagua	6.708	7.985	-1.277
Guayllabamba	50.990	49.665	+1.325
La Concordia	56.000	56.652	-0.652
Las Delicias	14.832	15.529	-0.696
Tambillo	27.129	27.705	-0.576

R- towns on regional highways: (se = 8.789)

Alangasi	actual I = 28.861	predicted I = 30.083	diff. =-1.222
Amaguana	59.186	55.370	+3.816
Ascazubi	17.320	20.372	-3.052
Conocoto	81.608	68.273	+13.335
Cumbaya	21.817	21.719	+0.098
Chavezpamba	4.142	9.920	-5.778
Checa	11.661	16.117	-4.456
Chillogallo	38.961	52.365	-13.404
El Quinche	49.959	49.693	+0.266
Gualea	3.162	4.252	-1.090
Isidro Ayora	23.366	35.808	-12.442
La Esperanza	13.416	16.014	-2.598
Nanegalito	14.387	4.054	+10.333
Nono	23.065	16.968	+6.097
Olmedo	26.076	29.951	-3.875
Perucho	4.242	3.027	+1.215
Pifo	32.726	42.937	-10.211
Pomasqui	53.962	34.830	+19.137
Puellaro	19.978	24.910	-5.112
Puembo	19.052	20.492	-1.440
San Antonio de Pichincha	40.730	42.366	-1.636
Sangolqui	154.770	154.029	+0.741
San Jose de Minas	53.962	60.525	-6.563
San Rafael	30.199	22.916	+7.283
Tabacundo	61.967	63.536	-1.569
Tocachi	10.583	15.004	-4.421
Tumbaco	55.964	43.590	+12.374

Uyumbicho	25.377	35.377	-10.000
Yaruqui	40.693	25.805	+14.888
T- towns on terminal highways: (se = 6.379)			
Aloasi	actual I =5.744	predicted I =9.748	diff. = -4.004
Atahualpa	19.899	11.301	+8.598
Calacali	24.331	21.848	+2.483
Cangahua	33.941	22.501	+11.440
Cotogchoa	7.745	7.196	+0.549
El Chaupi	3.464	4.214	-0.750
Guangopolo	6.000	7.463	-1.463
Juan Montalvo	7.745	12.510	-4.765
La Merced	13.747	10.773	+2.974
Los Bancos	20.493	32.101	-11.608
Llano Chico	5.477	9.110	-3.633
Lloa	3.741	7.315	-3.574
Malchingui	34.597	30.824	+3.773
Mindo	2.449	8.047	-5.598
Nanegal	15.874	6.057	+9.817
Nayon	8.831	17.103	-8.272
Oton	8.124	5.144	+2.980
Pacto	25.748	15.050	+10.698
Pintag	28.844	28.355	+0.489
Rumipamba	1.000	2.533	-1.533
San Pedro de Tabacda	15.874	12.899	+2.975
Santa Rosa de Cusubamba	5.291	4.258	+1.033
Tababela	2.000	5.505	-3.505
Tupigachi	7.745	10.776	-3.031

Zambiza actual I = 6.000 predicted I = 10.882 diff. = -4.882

5-3 Anomalies in Commercial Development in Pichincha

In this section, it is proposed to examine those towns that have a level of commercial development that is substantially different from the predicted level for them. These can be grouped into certain classes according to the major factor accounting for the noted variance.

(A) Conditions Promoting Hyperdevelopment

(a) expanding suburbs

These communities exhibit commercial development in excess of predicted levels, and are towns located near to Quito that are expanding, primarily due to subdivisions being laid out for the wealthier to build homes on. Though they could in many ways be classified as being dormitory suburbs, because many people do work and shop in the capital, there are striking differences between these towns and those described later under 'urban shadow zones'. In all cases, they are located on good highways that are not dead-ends. Also, and possibly more important, these communities all have some local industrial or tourist activity that contributes to local economic growth, either through increased personal incomes, or through providing goods and services to visitors.

Pomasqui is the most developed member of this group, having an index over fifty per cent higher than the predicted value. There is considerable lime-burning done in local kilns, these being a major supplier of the lime used in the province for construction. In addition, Pomasqui is the home of 'Vino Nuestro', Ecuador's largest-selling domestic wine. This town also gets some spin-off from the tourist traffic to the Mitad del Mundo Monument just north of San Antonio, and probably another factor would be that Pomasqui has a weekly market, whereas its larger neighbour, San Antonio, does not, and so it effec-

tively serves a bigger market than the parish alone.

Conocoto has developed a small industrial base with three factories producing corn starch, a large textile mill, a soft drink bottling plant, and a factory producing phonograph records, all of which help to improve the local employment situation, which in turn boosts the local economy.

Tumbaco is a very fertile parish that exports large quantities of agricultural products to Quito. Unlike Pomasqui, which is a rather dry, arid parish, the pleasant verdure of Tumbaco, combined with several hot springs, a few good restaurants, and a good highway to Quito, have resulted in Tumbaco being able to attract people from other parishes but particularly from Quito itself - it is, for example, a popular area for picnics on week-ends.

Other towns of this type are San Rafael and Calderon. The former is a noted hot spring resort, with a large tourist traffic that is carefully catered to. The parish has been completely subdivided for homes for the wealthy, even though this area is one of the richest agricultural zones in the province. The parish is located very close to Sangolqui, but it has developed because the residents have more money, as well as due to tourism and the presence of the Ondutex Textile Mills. One interesting note is that San Rafael does not have a single public water tap - every house has its own, the only such case in the province.

Calderon is a noted centre for handicrafts, particularly bric-a-brac made from marzipan bread, that attracts large numbers of people from Quito, especially on Sundays. Though the area is poor agriculturally, large numbers of local residents commute into the city for work and on business.

(b) isolation and good agriculture

This class includes parishes located on terminal highways that have good agricultural land that is extensively farmed. The result of these factors is that the isolation seems to encourage self-sufficiency in that it becomes

more economic to provide goods and services of higher order and in greater number, simply because it is impractical or inconvenient to seek satisfaction in another centre. At the same time, the advantageous conditions for agriculture provide employment and more money for the inhabitants to spend on items other than absolute necessities.

The best example of this is Cangahua, located in the mountains to the south of Cayambe, which is an important grain-growing parish. Cangahua is too far, by an inferior road, from the larger centre to be readily dependent on it, and with its large urban population, there is an adequate economic base and a stimulus to establish commercial facilities locally to satisfy a broad range of needs.

This hyperdevelopment is even more apparent in the Nordoccidente, where there is good, accessible and available agricultural land that is extensively cultivated to produce cash crops for export to the Sierra. Tenuously linked by a narrow, winding road, these towns are very isolated from Quito, and are served by limited truck and bus transportation, so that there is considerable stimulus to develop a semblance of self-sufficiency. In addition, there is a trickle of tourists into the zone, as this is a noted area for hunting and fishing. Thus Pacto, Nanegal, and Nanegalito are developed to a greater degree than we would predict. Nono's lesser (relatively) development would reflect its nearer location to Quito, and consequently less pressure towards self-sufficiency. It should be noted that Gualea is slightly underdeveloped, in part because there is some dependence on Pacto, 9.0 Km. away, but mainly because the parochial population is very scattered, and is served by the villages of Gualea Cruz and Santa Elena in addition to the cabecera parroquial, which, apart from its administrative function, provides commercial services for only the immediate vicinity.

Lastly, mention should be made of Atahualpa, which is a better

producing agricultural area than the neighbouring parishes. The town is isolated, being 19.8 Km from Puellaro and 20.7 Km from San Jose de Minas, via poor highways. Atahualpa does draw people from Chavezpamba, a nearby parish that is poor agriculturally, being located on the slopes of the very arid Guayllabamba Canyon. However, the most important factor of all seems to have been the progressive local administration, which has encouraged local development by the establishment of a thriving savings and loan cooperative, which acquired a working capital of S/. 300,000 from 85 members during its first year of operation. Spinning and weaving have been started as a cottage industry, and it is hoped to start a boarding house and a proper restaurant in the near future, though the area unfortunately has too few visitors to support any large scale operations.

(c) market capture

Yaruqui has above-normal development for no readily discernible reason. However, it is centrally located for Checa, Pifo, Puembo, and Tababela parishes, with a better organized weekly market than Pifo, the only other market town in the area. While Yaruqui's actual index is 14.888 above the predicted value, the four neighbouring parishes have a combined deficit of 19.612 in their actual vs predicted commercial indices. Pifo alone accounts for 10.211 of this deficit. While local officials in the five towns admitted that there is some movement between them for purposes of trade, these figures would suggest that this trade movement is not of great magnitude, except in the case of Pifo, but that it is centred on Yaruqui. The parish of Yaruqui has a much lower number of large haciendas than the other parishes (one vs 11 in Puembo, and up to 30, as in Pifo), and this may result in there being higher disposable income amongst the people in the parish, and consequently more commercial establishments to cater to the increased potential demand for goods and services. It is also true that with the

larger number of buses serving the Papallacta highway than the other routes, people in Pifo can more conveniently go to Quito than can the inhabitants of the other parishes, and from conversations with residents of the town, it would seem that this would account for part of Pifo's commercial underdevelopment. However, people from Pifo, where few fruits and vegetables are grown, travel to Yaruqui in order to buy such produce where it is more plentiful, and thus a travel and buying pattern has been established - one focused on Yaruqui. Lastly, it should be mentioned that the local officials of Yaruqui seemed to be more dynamic and innovative than elsewhere, and as already noted, this can often be a stimulant for latent local initiative.

The under-development that has occured in Uyumbicho has again no readily assignable cause. There would appear to be some dependency on Amaguana, and possibly on Tambillo, both of which are located nearby. However, Amaguana is relatively over-developed and it is clear that there must be some movement to this slightly larger centre which has a weekly market, whereas Uyumbicho does not.

(B) Conditions Inhibiting Commercial Development

(a) urban shadow zones

The inhabitants of small localities in close proximity to a large urban centre will frequently have easy access to the markets of the centre, thereby resulting in lessened commercial activity in the smaller communities. It simply becomes more economic or convenient to satisfy one's needs in the city. This effect can be observed in several of the places studied.

The best examples are Chillogallo, 5.1 Km from Quito, and Isidro Ayora, located 3.1 Km from Cayambe, which have a commercial index that is respectively 13.262 and 12.465 less than the predicted value. Chillogallo is effectively a dormitory suburb, with large numbers of people working and doing business in the city. This town is served by a frequent urban bus

service that serves the populated area of the parish, for although the parish is vast in area, extending almost to Alluriquin, the western part is very sparsely inhabited, and even then, principally along the old road to Santo Domingo via Chiriboga, which is now used only for local access.

Isidro Ayora began as a suburban subdivision of Cayambe, and has since acquired three large milk processing plants, and a de facto separate urban identity. Bypassed by the new Pan-American Highway to Otavalo, this community is now very obviously an economic satellite of the larger centre.

Nayon, 7.2 Km from Quito, has the additional handicap of not having electricity service. Zambiza, Lloa and Llano Chico are other towns near Quito that are also underdeveloped commercially though to a much lesser extent. The same is true of Juan Montalvo, located just south of Cayambe, all of these being terminal towns.

Alluriquin's commercial index is substantially below the predicted value, which may be due to this centre relying on Santo Domingo for higher order needs, simply because it is easily accessible by frequent transport services over a good highway. However, it is more likely that the population figures quoted for this parish may be too high, as those given and used in this study are based on local estimates. Alluriquin was granted parochial status on February 23, 1970, and so census data does not, as yet, exist for this parish considered as a separate entity.

(b) isolation and poor agriculture

This condition applies to Mindo, which is surrounded by two large haciendas owned by absentee landlords who have done almost nothing to develop their property. The nearest available unclaimed or unowned land that could be cultivated by the local inhabitants is located over two hours away on foot. Located at the end of a branch off from the Los Bancos road,

this town is very pretty, but it has completely stagnated, as one very astute local observed, "The only smart thing for a person to do is to leave, as there is no opportunity here." That sums up Mindo perfectly, for its isolation from the Quito market, plus the lack of land for the local people to cultivate have combined to thwart any hope of improvement in local economic conditions. Mindo's population works a little on the haciendas, and there is some lumbering and charcoal production. It appears that the people remaining can just eke out an existence and/or have been overcome by inertia.

(c) frontier towns

Only Los Bancos is classed in this category, because it has developed out of the jungle in the last five years, and there is a noticeable lag in providing goods and services, both commercial and public. The entire area is undergoing colonization, with a large influx of people who are engaged in opening the region up for permanent agricultural settlement. At this time, it would seem likely that people are still involved in developing their land holdings and have as yet few salable commodities, and thus lower incomes. The level of commercial activity would be below predicted levels, particularly as most higher order requirements, such as machinery and other capital goods, would have to be obtained directly from Quito. It should also be noted that the population figures are based on local estimates, and could be inflated, especially the parish figure.

(C) Major Regional Centres

During the analysis, we omitted the cantonal centres from the calculations due to their distinct regional orientation, as opposed to a purely parochial orientation. For regional highways, Tabacundo, a cantonal centre, was treated as an ordinary town since it is located only 9.7 Km from Cayambe, and is commercially dependent on that centre. As a better correlation was obtained by keeping Sangolqui, an important commercial centre

serving a much larger region than just Canton Ruminahui, in the sample used, it would appear that cantonal centres on regional highways are not anomalies, and that the method of analysis used in this thesis can be used to predict to within a small margin their level of commercial development.

For parochial centres on national highways, the formula derived gives a close fit, but it does not work for predicting the level of commercial development in major regional centres, as can be seen from the folowing.

Machachi	actual I = 102.6	predicted I = 141.9	diff. = -39.3
Santo Domingo	253.7	285.4	-30.7
Cayambe	179.1	272.3 (- vehicles)	

Note: No data for the number of vehicles in Cayambe could be obtained so that an accurate predicted value of the commercial index, using the derived formula, cannot be determined for this centre.

The formula obtained earlier does not work for these centres for several reasons. One is that they serve a regional, rather than a parochial market, so that the estimate should, in theory, be revised upward, by using the regional population in place of the parochial population. Then, too, each centre has a large open-air market with a weekly turnover of as much as S/. 3,000,000 or more, and this activity is really an additional concentration of commercial outlets that was not computed into the figures used in this analysis. This would revise the commercial index upward.

On the other hand, these centres serve regional markets of in excess of 30,000 people, and while this is an economic base that will support more higher order functions than the average parish can, one starts to find economies of scale, in that large stores with considerable stocks of a wide variety of goods will take the place of several small, poorly-stocked establishments. Though large and small general stores were differentiated in the field, in recognition of their different qualities, there is considerable difference in terms of sales volume, and

one cannot be equated with the other. It should be noted that townspeople in these centres, because of the large regional trade that is carried on there, plus the boost provided by catering to the needs of the inter-provincial traffic passing through, will likely have a higher disposable income, thus providing a bigger market for commercial services.

In examining the commercial development of cantonal centres on national highways, the population of the entire economic region served by the centre should be utilized, along with the town population, and the road user cost of driving a five-ton truck to the nearest higher-order centre. Rather than the number of vehicles owned locally, it would probably be more realistic to employ the figures for the average number of buses and trucks that depart from the centre in a given period, as this is a measure of the relative importance of the town as a service centre or loading point for long-distance traffic. At the same time, a commercial index should be computed in such a way that it considers not only the range and number of permanent commercial establishments, but also that there is some weighting system that takes cognizance of the great diversity of business size that one finds in these centres. In addition, the weekly market should somehow be incorporated into the final index. The most practical method of computing a commercial index would probably be to determine the monetary value of the average weekly or monthly trade that is conducted in the entire town, and which would take care of the factors mentioned above.

Unfortunately, such statistical analysis is not really feasible, because there are so few cantonal centres in the sample group of towns.

CHAPTER VI

CONCLUSIONS

6-1 The Problem Revisited

The basic problem of this thesis has been to define the relationships between the existing transportation links, the existing urban centres, and the constraints provided by terrain. By working out the cost of using a road link, it was possible to take into account the influence of terrain by means of its effect on the total road user cost for a given section of road. It was then found that there exist three types of town, corresponding to location on a national, a regional, or a terminal highway. When computing road user costs, gradient was found to be the dominant factor, along with surface type. The average driving cost is 9.5¢US per Km for national highways, 23.3¢US for regional highways, and 22.0¢US per Km for terminal highways. The figure for regional highways is higher than for terminal ones due to the poor roads into the Nordoccidente and the San Jose de Minas area. For the road network of Pichincha as a whole, the average driving cost for operating a five-ton truck is 18.7¢US, which is the equivalent of driving on an earth road in fair to good condition, that is over 4.8 m. wide, with fair to sharp curves, and a gradient of 5-in-100.

The commercial development of a centre, as represented by the commercial index (I), which is the square root of the product of the range and of the number of commercial functions in the centre, is related to the road user cost (ruc), the town population (tp), the parish population (pp), and the number of vehicles in the parish (v), by the following equations.

For towns on national highways:

$$I = .119 + 2.148\ ruc + .00051\ pp + .0313\ tp - .0255\ v$$

$r = .9738$ $se = 3.556$

For towns on regional highways:

$$I = 1.846 - .680\ ruc + .00211\ pp + .0285\ tp - .0869\ v$$

$r = .9696$ $se = 8.7498$

For towns on terminal highways:

$$I = -1.182 + .323\ ruc + .00090\ pp + .0134\ tp + .0707\ v$$

$r = .9327$ $se = 6.3788$

These formulae indicate that increasing population in either the town or in the parish will result in increased commercial development, as one would expect, but the town population is at least thirteen times as important a commercial stimulus as the rural population. This would suggest that the rural population has less purchasing power than the town population, and would tend to patronize only stores selling such necessities of life as those which cannot be produced on the farm.

With regard to driving costs, increasing inaccessibility, represented by increasing road user costs, will stimulate local commercial development for national and terminal highways. For regional highways, increasing distance will have a debilitating effect on commercial development as increasing the road user cost along a regional road is to approach the condition of a terminal highway, with the latter's correspondingly lower level of development. However, distance on national highways does not affect towns this way, because a large proportion of the traffic, and the road quality, is a function of these roads' nature as inter-city links, and distance will simply cause an increased demand for goods and services.

From the equations derived, for equal values of the independent variables, towns on national highways clearly have a greater basic range of

commercial functions than towns on the other types of highways. Also for these towns, increasing the town population or the road user cost increases this range at a faster rate than for the other types of towns.

Vehicle ownership in a parish is a relatively minor factor affecting the level of local commercial development, and can have two opposite effects. A vehicle can either take goods to people, or people to goods. In the case of terminal towns, increased vehicle ownership will mean increased ability to overcome the effect of isolation by bringing more goods in, and thus raising the level of local commercial activity. For the other types of highway where towns are usually far more accessible, a vehicle will mean easier movement over the road system, and people are thus more likely to travel to the larger centres, with a consequent diminuation of commercial development in the smaller towns.

6-2 Possible Improvements to the Model

In addition to the four factors used in the final analysis, certain other influences will affect local commercial development, for better or for worse. The most common is the urban shadow zone. This extends around Quito, Santo Domingo and Cayambe, and is a zone of easy accessibility to the urban centre. The consequence is that any agricultural community located adjacent to a large centre will be commercially underdeveloped because people will commute to work, and to buy and sell in that centre.

Agriculture can considerably affect a town's economic level, as it is the main, and often only, source of livelihood in the parishes outside of Quito. If the land is fertile, and accessible, the return per man-day of labour can be quite high, and result in relatively high levels of disposable income. On the other hand, if the countryside is arid, or inaccessible, the output per unit of labour will be small, and such an area will have little commerce. If this factor is complicated by isolation from markets, the result can be almost crippling

on local development, as was seen in the case of Mindo. In a frontier area, there will be lower commercial development than predicted, due in part to a natural lag between supply and demand in a rapidly-expanding economy, but principally because the new settlers will be still opening up their lands, and the output per unit labour will therefore still be low.

By contrast, hyperdevelopment will be found in an expanding suburb that has a strong industrial, or service economic base, due to the direct and the indirect spin-off effects. A community may also serve commercially an area which is smaller or larger than its own parish, in which case, development may be below or above predicted levels, as the parochial population has been considered to be synonymous with the commercial hinterland market of a parish.

The model could be made more accurate by the use of more reliable population figures, as those used came from the 1962 National Census, and from 1970 estimates. The 'pp' term is really the population of the total commercial hinterland, and could be made more realistic by determining the variations between the hinterlands and the respective parishes and revising the population data accordingly. If the weekly markets (where held), plus the varying sizes of commercial establishments could be taken into consideration when computing the commercial index, the model's reliability would be improved. However, this would involve a much more complex study that might well yield only a marginal improvement in accuracy.

The above factors are very definite shortcomings in the model if it is to be applied to major regional centres on national highways. In addition, it does not take into account the level of bus and truck service of such communities, which would indicate the relative importance of such a centre, as well as being an indicator of the demand for goods and services that these vehicles and their drivers and passengers would create.

In conclusion, it has been found that the commercial development of

a town in Pichincha Province is primarily dependent on the town population, with the population of the town's economic hinterland, the cost of driving a five-ton truck to the nearest higher-order centre, and the number of vehicles in the parish, all being contributing factors, but to a lesser extent. Various factors, such as urban shadow, suburban development, market capture, and the quality of local agricultural land, especially in more isolated communities, all have considerable effect on the commercial development of certain localities. Cantonal centres on national highways do not fit the relationships derived, and require specialized treatment, moreso as there are only three such towns in the province, a group size that does not lend itself to statistical analysis.

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BIBLIOGRAPHY

1. Hurtado, Oswaldo. Dos Mundos Superpuestos. Quito: INEDES, 1969.

2. Junta Nacional de Planificacion y Coordinacion Economica, Division de Estadistica y Censos. Segundo Censo de Poblacion y Primer Censo de Vivienda. Tome: Pichincha. Quito, November 25, 1962.

3. Lenke, Lilo. Ecuador, Country of Contrasts. London : Oxford University Press, 1960.

4. Navarro, Andrade Ulpiane. Geografia Economica Del Ecuador. Quito : Editorial "Santo Domingo", 1965.

5. Parsons, Brinkerhoff, Quade, and Douglas. National Transportation Plan. Quito : Junta de Planificacion, marzo 1964.

6. Preston James. Latin America. New York: The Odyssey Press, 1969.

7. Secretaria General de Planeacion Economica. Division Territorial de la Republica del Ecuador. Quito: Junta Nacional de Planificacion y Coordinacion, 1968.

8. Snedecor, George W. Statistical Methods. Ames, Iowa: Iowa State University Press, 1956.

9. Teran, Francisco. Geografia Del Ecuador. Quito: Editorial Colon, 1966.

10. de Weille, Jan. Quantification of Road User Savings, World Bank Staff Occasional Papers, No.2. Washington: International Bank for Reconstruction and Development, 1966.

11. Yamane, Taro. Statistics, An Introductory Analysis. New York: Harper and Row, 1967.

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