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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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MAIN SECTORS OF LATIN AMERICAN INDUSTRY: PROBLEMS AND PROSPECTS

Volume I

Presented by the Secretariat of the
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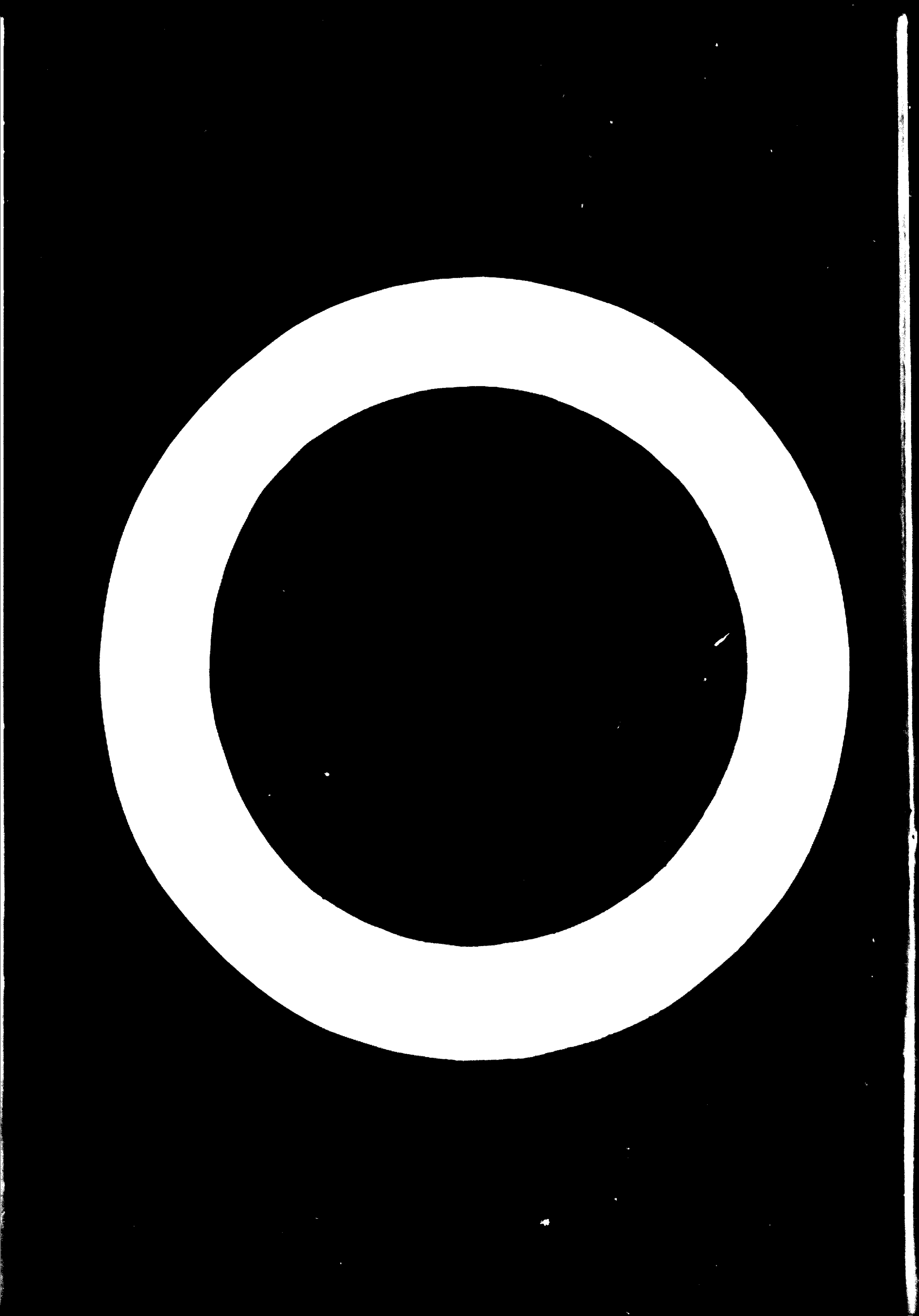

TABLE OF CONTENTS

/Chapter II.

/C. THE

/E. THE

Page

/INTRODUCTION

INTRODUCTION

1. Content of the report

The purpose of this report is to provide a comprehensive summary of the situation in the main branches of industry in Latin America, as it emerges from the studies carried out by ECLA in the last few years. The sectoral approach to the analysis of industrial development has been used by ECLA from the outset. The first industries studied were iron and steel, pulp and paper and textiles, and problems relating to the steel and pulp and paper industries were brought to the attention of meetings of experts from the public and private sectors. More recently, in addition to continuing work on those three industries research was begun on the metal-transforming and chemical industries and further meetings and seminars were convened to consider the results obtained. Detailed research has been done on aspects such as the structure and problems of existing industry, productivity and the factors determining its low level, fixed capital investment and the extent to which it is being efficiently utilized, the quantification of economies of scale, projections of demand and probable trends of supply and trends of the balance of supply and demand.

The work carried out in the last few years, which served as a basis for the main conclusions summarised in the chapters of this report, was in relation to the steel, aluminium, pulp and paper, chemical, metal-transforming and textile industries.1/ The study of these industries, which constitute most of the manufacturing sector, has for the first time provided a comprehensive view of the prevailing situation, operating conditions and prospects for future development of industry throughout Latin America, both in terms of individual countries and the region as a whole.2/

1/ The reports on each industry are normally published separately and are referred to in the relevant chapters of this study.

2/ Other work on the copper and other non-ferrous metal industries is still in progress and has not been dealt with in this report.

/It should

It should be made clear from the outset that the six major branches of industry are not discussed from the same point of view or in the same detail. The aspects dealt with in the studies used as a basis for this comprehensive review and the geographical coverage were determined by the specific features of each branch and its degree of complexity. In the case of the steel industry, for example, particular attention was given to a detailed analysis of potential production costs in relation to different technologies, plant sizes and alternative locations, since this seemed to be particularly important for the future regional integration of the industry. In such industries as textiles, on the other hand, the situation is quite different, since the main problems, from the standpoint of both labour and capital, are problems of internal organization and operational efficiency. Research on the textile industry was therefore mainly concerned with a diagnosis of the present situation in terms of productivity, the utilization and degree of obsolescence of machinery and equipment, etc. Finally, in incipient industries, such as the aluminium industry, particular emphasis was laid on the analysis of factors such as the effect of plant size on investment and production costs and the influence of alternative locations on the economy of the industry.

Moreover, in determining the geographical coverage, account had to be taken of the requirements of the various branches of industry. In some cases - the steel, aluminium, pulp and paper industries, etc. - an attempt was made to cover the whole region in preparation for regional reports. In others, because of the greater geographical dispersion of the industry or the diversity of its products, it was considered advisable to study the industry separately in each country or in a number of specific countries, with a view to preparing a regional report when all the countries where the particular industry was of interest had been covered. This basic approach was adopted in the study of the textile industry, which began by dealing with the industry in each country and then considered the region as a whole on a comparative basis, and the study of the metal-transforming industry, which by no means provides a complete picture, or even a rough outline, of the multiplicity of activities included under that head.

/Indeed, the

Indeed, the metal-transforming industry is the prime example of an industry which demanded a particularly individual approach; it is made up of a conglomeration of many industries with very diverse production techniques, equipment, plant characteristics and requirements of technically qualified personnel, which are influenced to a greater or lesser degree by economies of scale. The resulting difficulties were described in ECLA's most recent analysis of industrial activities,[3] and led to the adoption of a procedure based on a combination of studies by sub-branches of industry in the most industrialized Latin American countries and studies of the whole metal-transforming sector in the remaining countries.

2. Future work of the Joint Programme

As a result of the many ECLA studies on industrial questions in the last few years and, in particular, the recent intensification of work in this field following the establishment of the Joint Programme on the Integration of Industrial Development by ECLA, the Latin American Institute for Economic and Social Planning and the Inter-American Development Bank (IDB), a large store of data and analyses of various industries has been built up and should prove of great value in improving regional co-ordination in the development of those industries.

The main purpose of the Programme, which was established in mid-1964 and financed by the three organs referred to above, is to prepare the studies and other technical and economic material needed to promote the process of Latin American integration in the field of manufactures. It is also intended to supply the necessary data for the gradual expansion of planning in the industrial sector in each country in line with regional requirements, so that national planning will be more closely co-ordinated with regional integration.

The Joint ECLA/Institute/IDB Programme on the Integration of Industrial Development is a programme of study and research on industrial development, aimed at analysing prospects and procedures for regional integration in

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3/ See Activities of the Joint ECLA/Institute/IDB Programme on the Integration of Industrial Development (E/CN.12/L.13).

/each of

each of the main branches of industry and thus expediting the task of the inter-governmental bodies responsible for integration. The studies not only represent a vital preliminary stage in the preparation of specific integration programmes for the large industries, but will also help to identify investment projects in "integration industries", i.e. industrial projects linked with regional integration but not contingent upon any general agreement in the particular industry. These projects would be based on sectoral studies as they are completed and submitted to the Latin American Free Trade Association (ALALC) and IDB for their consideration and possible support and financing. The sectoral studies for the region as a whole would also be of great value in establishing criteria for specialisation and complementarity in the over-all industrial development programme being undertaken separately in each country. This co-ordination of regional integration with national planning is very important in the metal-transforming industry, as stated earlier, particularly if regional integration is to benefit all the participating countries equally.

This approach applies not only to the metal-transforming industry; it has been supported by the experience gained in recent studies. No progress can be made in preparing practical integration programmes, unless each country prepares its own industrial programme defining its objectives and targets for the future development of each industry. Regional specialisation schemes for dynamic growth through an optimum distribution of resources must take into account not only economies of scale and transport costs, but also such factors as the creation of external savings, the contribution to balanced national development, etc., which can only be fairly gauged within the context of a national development programme. Thus, assistance in formulating national programmes is another efficient means of promoting regional integration, and the factual and technological information and frame of reference provided by the sectoral studies will also be very helpful in national planning.

/3. The

3. The sectoral approach in the industry studies

The ECLA secretariat has for some time now been devoting considerable attention and a large proportion of its resources to the industry studies, because it is convinced that those studies can provide a combination of macro-economic criteria and technological data at the enterprise level which is extremely useful for planning purposes. The technological data relates, for example, to current production techniques, capital and labour unit inputs, the influence of scales of production on investment and production costs, etc. The sectoral approach thus makes it possible to deal with the specific technological problems of the industry and to analyse its operational machinery in greater detail than would otherwise be possible, bearing in mind that its development must be subordinated to and compatible with certain basic macro-economic criteria (growth rate of the over-all product, general policy on import substitution, key inter-relationships, etc.).

This compatibility between the aggregate level and the level of the individual enterprise is of great importance at this juncture because the new approaches to economic policy in Latin America, such as planning and integration, can only be worked out on the basis of vast documentation and experience. The documentation must be sufficiently detailed to take account of the widely different conditions in each industry throughout Latin America, and at the same time sufficiently general to indicate whether they are compatible with the main macro-economic variables.

4. Main aspects covered

The chapters of this study analyse the problems and most important features of each industry, in accordance with the particular circumstances in each of the six industries studied.

The chapter on the steel industry highlights a number of important facts:

(a) Demand is growing steadily and is expected to climb to about 28 million tons by 1975;

/(b) To

(b) To maintain the present ratio of national production to apparent consumption in 1975, production capacity will have to be increased to 23 million tons, or one and a half times present capacity (9 million tons);

(c) The heavy investment required to create this additional capacity is estimated at more than 4,000 million dollars;

(d) Despite the foregoing considerations, there is an unduly high margin of idle capacity - in 1964 only 52 per cent of total rolling capacity was used - because of the lack of co-ordination between the different departments of many plants and imbalance in the relationship between final rolling facilities and the composition of market demand;

(e) The pressure on the industry to expand and enlarge its plant has forced it to neglect the introduction of technological improvements which would raise output and get a better return on capital invested.

These conclusiones, based on research in depth on existing production and a detailed estimate of potential and hypothetical production costs, demonstrate the need for a sustained attempt to reorganise and streamline the industry, in which the stimulus provided by competition - through appropriate integration schemes - could play a key role.

The situation described in the regional report revealed that there was need for a more detailed analysis of the aspects connected with technological advances and economies of scale, and two additional reports were prepared.

The chapter dealing with the aluminium industry includes projections of demand in 1975, an analysis of existing mineral resources in the region, a detailed description of the technology of bauxite mining and the production of alumina and primary aluminium and estimates of the physical inputs required. It further includes an analysis of the effects of economies of scale on investment and production costs. Finally, it outlines a number of provi onal schemes for market groupings and the location in future of primary aluminium production centres, and presents estimates of the savings in investment and production costs that might be effected.

/The basic

The basic problem of the aluminium industry in Latin America is the rapidly growing import deficit, which is expected to amount to more than 440,000 tons by 1975. To meet this deficit, the industry would have to invest as much as 530 million dollars, for the production of primary aluminium alone, in the six or seven countries whose domestic markets are expected to exceed 10,000 tons per year by 1975.

If the annual manufacturing capacity is increased from 10,000 to 150,000 tons, which is the usual size in the more developed countries, the investment required per ton of output would fall from 1,500 to 800 dollars. This fact alone illustrates the need to plan the future development of the industry on the basis of regional integration of markets. However, the procedures for achieving this regional integration of the industry will first have to be studied in detail. The unequal distribution throughout Latin America of the basic resources required (mainly bauxite and electric power) and the possibility of developing the industry with different degress of vertical integration, in terms of its successive processing stages (bauxite, alumina, primary aluminium and processed aluminium), offer the prospect of several forms of complementarity between the countries of the region. In order to analyse each of these forms, detailed data must be assembled on the influence of economies of scale on each stage of the manufacturing process, in order to determine the probable cost levels for the different combinations (from bauxite to processed aluminium, or the processing of aluminium alone using imported primary aluminium, or some intermediate combination) in accordance with different scales of production and alternative locations.

It is possible that an ALALC Working Group on the aluminium industry will be established, to which these data and other material now being prepared will be submitted. IDB, through its Pre-Investment Fund for Latin American Integration, will probably participate in the additional studies required.

The analysis given in the chapter on the chemical industry is based on the criteria established by the United Nations Seminar on the Development of the Chemical Industry in Latin America (Caracas, December 1964).

/In view

In view of the lack of sufficiently detailed and regularly published reliable statistical information, and the importance of having such data, the Seminar strongly recommended that ECLA should take over the responsibility of gathering and periodically publishing statistics on the chemical industry.

For that purpose, an analysis was made of the foreign trade figures for all the Latin American countries (except Cuba), of the production and apparent consumption data for Argentina, Brazil, Colombia, Chile, Mexico, Peru and Venezuela in the period 1962-64 and of partial data for other countries. This information was used to analyse the evolution of the chemical sector in terms of the relative share of the different items in production and apparent consumption, import trends and the degree of import substitution achieved. Of particular interest from the standpoint of regional integration is the comparison of the growth rates of production, apparent consumption and import substitution trends throughout the region.

The Caracas Seminar also recommended that, in its future work on the chemical industry, ECLA should concentrate on three sub-branches: petrochemicals, fertilisers and sodium alkalis.

An analysis was made of the past trends and present situation of petrochemicals in Latin America, and its future development prospects were weighed in the light of the problems and limitations arising from the availability of basic raw materials (natural gas and refinery products). Emphasis was also placed on various institutional aspects which, to a certain extent, determine planning in the sector, e.g. delimitation of the field of action of public and private enterprises through governmental decisions controlling access to this industry.

The basic problem, from the standpoint of regional integration, is that each country regards its national petrochemical industry as an essential element in its "balanced industrial development" and therefore encourages the industry without due regard for production costs. This attitude, which is particularly streng in the large and medium-sized countries of Latin America, drastically limits the possibility of a division of labour in a region-wide common market.

/A country-by-country

A country-by-country analysis is made of the present production of nitrogenous, phosphate and potassium fertilizers and of the projects for installing new plants. The supply prospects of existing industry and of the projects under way in the main producer countries of the region are compared with the demand for fertilizers estimated in studies by the Joint ECLA/FAO Agriculture Division as a basis for calculating the balance which may be achived by 1970 and 1975.

The Fertiliser Group of the Inter-American Committee on the Alliance for Progress (ICAP) established some important criteria and recommendations concerning the fertiliser industry's future development.

Latin America's fertilizer industry should aim for technical structures, plant size and location which will achieve its essential objective, namely to supply these products to agriculture and the world market at the lowest possible price whenever the region has exportable surpluses. This objective will be furthered by market expansion at the regional level through gradual and substantial tariff reductions and the removal of other trade barriers. Moreover, with the industry organised on a regional basis and the necessary steps taken to harmonise external policies and tariffs, a system of trade could be developed in the foreseeable future, which would channel public and private investment in the interest of maximum efficieny and productivity.

It was recognised that the establishment of a common market for fertilisers should be accompanied by parallel action regarding other major agricultural inputs. For similar reasons, a policy should also be worked out for the manufacture of equipment needed to expand the fertiliser industry, always within the context of regional integration.

From the Joint Programme's studies it seems certain that the region will have an adequate supply of nitrogen in purely quantitative terms, over the medium term; in fact, installed capacity and the capacity of projects at different stages of execution are even expected to exceed demand. The situation is not as bright with regard to the supply of phosphate and potassium fertilisers. Reserves of the former are apparently sufficient and recent projects have been started to use them economically; but the known resources of potassium are extremely low., In both cases, the prospecting

/of natural

of natural resources will have to be intensified, and the Inter-American Development Bank (IDB) is devoting particular attention to this question through its Pre-Investment Fund for the Integration of Latin America.

Sodium alkalis: Market studies on sodium carbonate, caustic soda and chlorine have shed some light on the anticipated growth of demand over the next ten years. The main production centres and new projects being planned have also been evaluated with special attention to conditions at possible locations, i.e., the availability and cost of raw materials for the production of sodium alkalis.

The possibility was considered of submitting the studies on this industry to a working group appointed by ALALC in co-operation with the IDB Pre-Investment Fund, which could assess the region-wide impact of some of the solutions to the problem of supplying these basic products.

The chapter on pulp and paper analyses the present situation of these industries, i.e., the balance of supply and demand, apparent consumption trends, scale of regional plants compared with the optimum economic scale and other questions related both to operational efficiency and new investment for expansion of capacity.

One of the main conclusions of this analysis is that there is a huge deficit in the supply of newsprint, which is likely to increase because of the various obstacles to a rapid expansion of production capacity. A major problem in the manufacture of writing and wrapping paper is the existence of a great many plants operating on a very small scale and using poor techniques, which are protected by the lack of competition and obstruct the regional integration of this sector of industry.

In view of the wide range and diversity of products in the metal-transforming industry the Programme clearly indicates the need to work on the more homogeneous branches of activity which are classified pragmatically according to the manufacturing techniques used, the organization of production and the technological level of the establishments but not necessarily by the economic use of the products. Thus far, four major groups of products have been defined: (a) equipment for the basic industries (steel-making, electric power generation, cement, pulp and paper, etc.)

/produced by

produced by the heavy metal-transforming industry; (b) machine-tools (or metal-working machines); (c) textile machinery and equipment; and (d) motor vehicles (passenger cars, lorries, etc.). As the studies on these sectors progress and additional staff becomes available, other "homogenous" groups, such as shipbuilding and agricultural machinery, will be identified and studied.

To supplement this sub-sectoral approach, studies have been undertaken on the metal-transforming industry as a whole in the relatively less developed countries and those with insufficient markets. Important lines such as capital goods and transport equipment will only find favourable conditions for rapid development in the major countries of the region, because their manufacture is more complex, economies of scale have a greater impact and in particular, because they are located in manufacturing centres where intensive use can be made of sub-contracting. The other countries should be actively and deliberately encouraged to participate in regional specialisation schemes by establishing a group of metal-transforming industries that will form the technological infrastructure for the future development of more complex production lines. Adequate programming is essential for the modernisation, technological improvement and development of the whole metal-transforming industry, as a pre-condition for participation on a bolder regional integration scheme. The Programme accordingly carried out studies on the whole metal-transforming sector in Colombia, Ecuador, Uruguay and Venezuela, and its findings are reported in the relevant chapter of this report.

Information concerning the textile industry has made it possible to compare the situation in Latin America with that prevailing in other parts of the world. An analysis has been made of the existing and future textile market and total future consumption on the basis of various postulated price trends and the degree of competition that is likely to stimulate demand for textiles. In view of the relatively advantageous natural conditions, consideration was also given to the prospect of exporting to countries outside the region. Lastly, with due regard for various programming criteria such as economies of scale and choice of techniques, estimates

/were made

were made of the investment required to satisfy anticipated demand. This investment would be used not only to expand production capacity, but to modernize the production process, a need demonstrated in the country studies.

5. Industrial integration

While this study has highlighted the key issues for integration, it has made no attempt to draw up specific sectoral integration programmes. The Joint Programme has confined its activities to preparing the ground for action by the integration agencies by clarifying certain questions and pinpointing the problems which will have to be dealt with in due course. However, as regional integration is the underlying issue throughout this report, it may be useful to stress some basic points with respect to methods and procedures for promoting the regional integration of industry.

The ECLA secretariat's regional integration studies have shown that the paper industry should be the mainspring of the integration movement and that is should proceed by means of special agreements, tailored to suit the particular conditions in each sector of industry. The report on Latin American integration submitted to the eleventh session of the Commission analyses in detail the characteristics and modus operandi of such agreements.[4] The sectoral agreements described in that report are juridical instruments designed to adapt the general formulas and machinery of economic integration to the conditions obtaining in particular branches of manufacturing industry with the object of accelerating co-ordination of the markets for their products. The agreements represent a means of obtaining the advantages of integration and overcoming the difficulties inherent in the process - which are specified and analysed in the same report - by entering into commitments over and above those generally applicable to be negotiated empirically as the particular conditions of each sector dictate. For instance, the levels established for the reduction of internal tariffs go further than the targets generally applied. The objectives are established in accordance with regional cost conditions for

4/ See A contribution to economic integration policy in Latin America (E/CN.12/728), ch. VII.

/the products

the products of the sector concerned, especially the disparities between countries, and, in some cases, between enterprises. They take into account the possibilities of salvaging the inefficient segment of the industry and the changes that should be wrought through regional competition in its structure and mode of operation.

Perhaps the salient feature of the sectoral approach to the integration of manufacturing industry is that measures of trade policy and development promotion are taken simultaneously. Actually trade liberalisation is made conditional upon certain criteria and commitments connected with the development and structure of the sector concerned, with a view not only to activating its growth and ensuring that new production units have an economic scale of operation and are located where they can draw the greatest benefit from regional specialization, but also to developing it on a geographically balanced basis with due regard for each country's needs and possibilities.

In other words, a sectoral integration agreement would be a regional programme for the modernization and development of the sector concerned, in which market integration would have a twofold purpose: to promote economies of scale in branches of industry where market size determines the economicity of the end product, and to create the necessary climate of competition for continuing technological improvement in the industries that offer least scope for economies of scale and whose main problem is their low level of operational efficiency.

Sectoral agreements which are tantamount to development programmes based on the regional integration of major branches of industry require careful preparation, time and a large store of technical and economic data on the situation of those industries in the individual countries, their prospects of growth and the possibility of developing similar industries in each of the participating countries. Since the agreements must leave a wide margin for reconciling the interests of the various countries, a

/specialised body

specialised body with specific competence on matters of integration should be made responsible for the compilation of the necessary background information. The promotion and development agency advocated in the ECLA secretariat paper on integration policy 5/ might be entrusted with the task. The data compiled on the principal Latin American industries by the Joint Programme and summarized in this study, are therefore in the nature of a preliminary contribution only.

5/ A contribution to economic integration policy in Latin America, op. cit., ch. X.

/Chapter I

Chapter I

THE IRON AND STEEL INDUSTRY

The Economic Commission for Latin America (ECLA) began its study of the iron and steel industry in Latin America in 1951. In 1952 it convened an Expert Working Group on the Latin American Iron and Steel Industry (Bogotá), whose attention was focused mainly on problems relating to raw materials and to the reduction and refining cycles in the steel-making process.1/

In October 1956, again under the sponsorship of ECLA, another expert working group met at São Paulo to discuss the technical and economic factors involved in the manufacture of rolled steel products, and several questions connected with the metal-working and metal-transforming industries.2/

Under the influence of these groups of experts, the Latin American Iron and Steel Institute (_Instituto Latinoamericano del Fierro y del Acero_ - ILAFA) was set up in Santiago (Chile) in 1959, as an association of the steel making enterprises and allied activities operating in most of the Latin American countries. Almost simultaneously with the establishment of ILAFA, national iron and steel institutes were organized in several countries (Argentina, Chile and Mexico) while in Brasil, in addition to the Brazilian Metals Association (_Associacao Brasileira de Metais_), which was founded in 1944 and whose scientific and technical work is of very broad scope, a Brazilian Iron and Steel Institute (_Instituto Brasileiro de Siderurgia_), in which all steel manufacturers are represented, was established not long ago.

1/ _A study of the Iron and Steel Industry in Latin America_: Vol. I, _Report on the meeting of the Expert Working Group held at Bogotá_; Vol. II, _Proceedings of the Expert Working Group held at Bogotá_, United Nations publication, Sales No.: 54.II.G.3.

2/ _Problems of the Steel Making and Transforming Industries in Latin America_: Vol. I. _Report of the São Paulo Meeting_; Vol. II. (Spanish only) _Siderurgia_, United Nations Publication, Sales No.: 57.II.G.6.

/In the

In the meantime, ECLA has continued its sectoral research, and at every international meeting its studies have helped to suggest fresh fields of action, to explore new lines of approach and, in short, to augment the available stock of information on the iron and steel industry. For instance, at the United Nations Inter-regional Symposium on the Application of Modern Technical Practices in the Iron and Steel Industry to Developing Countries held at Prague in November 1963, ECLA presented two documents, one concerned with raw material supply questions, and the other discussing the industry's structure and problems with special reference to locational advantages and the impact of economies of scale.

Beginning in 1963, ECLA and ILAFA have prepared a series of monographs on the status and economy of the iron and steel industry in eleven Latin American countries. In addition, ECLA, with the co-operation of the Inter-American Development Bank, has begun a study which gives an overall picture of the economic and technical aspects of the industry and considers whether existing conditions are favourable for a beginning of regional integration in this sector.3/

This analysis, which, in view of the complexity of conditions in the iron and steel industry in Latin America, is of a purely exploratory nature, is based mainly on estimates of production costs in hypothetical plants, in alternative locations.

The valuable background material incorporated in the study represents the technical and economic information contributed by many members of the ECLA secretariat staff and a number of foreign and Latin American experts at the various conferences held over a period of several years, together with the data collected and transmitted by steel-making enterprises and by ILAFA, without whose collaboration and co-operation the work could never have been carried out.

More recently, two studies have been completed on cost variations as a function of plant size and economies of scale. The first relates to small integrated steelworks, with annual production capacities ranging from 22,000 to 270,000 tons of final rolled products.4/ The second is

3/ La economía siderúrgica de América Latina (E/CN.12/727).

4/ Economies of scale at small integrated steelworks (E/CN.12/764).

/concerned with

concerned with economies of scale in plants whose capacity ranges between 100,000 and 2,500,000 tons, and also analyses the effects on costs and investment produced by the introduction of technological improvements.[5/]

This last topic - the improvement of the steel-making techniques applied - has increasingly engaged ECLA's attention. Firstly, an attempt has been made to estimate the technological level of industry in Latin America in comparison with that of its counterparts in more developed regions, and to analyse the obstacles to the steady incorporation of more advanced techniques from abroad.[6/] Secondly, the need for increasingly independent research on steel-making techniques has also been borne in mind by ECLA. After completing a study on this subject,[7/] it has been seeking to promote the establishment of an iron and steel research centre in Latin America.

A. APPARENT CONSUMPTION OF ROLLED STEEL PRODUCTS AND PROJECTIONS OF DEMAND

1. Apparent consumption

In 1965, total apparent consumption of rolled steel products in Latin America, expressed in terms of steel ingots,[8/] amounted to 12.2 million tons, of which 9.1 million tons were covered by domestic production and 3.7 million by imports. Exports, which reached a volume of 534,000 tons, were almost entirely confined to intra-regional sales.

5/ Las economías de escala en plantas siderúrgicas de tamaño medio y grande y la influencia de los adelantos tecnológicos en las inversiones y costos de producción (E/CN.12/766).

6/ La tecnología actual y los obstáculos a su incorporación en la industria siderúrgica latinoamericana (ST/ECLA/Conf.23/L.34).

7/ Problemas que requieren investigaciones tecnológicas en la industria siderúrgica latinoamericana y prioridades para cada necesidad (ST/ECLA/Conf.23/L.44).

8/ In line with the principle usually adopted to prevent duplication, figures for rolled products are replaced by their equivalent in terms of steel ingots. To effect the conversion, 25 per cent was added to the weight of the rolled products (bars, shapes, sheet, etc.). Although the loss of weight varies according to the rolled product concerned, this was considered a sufficiently close approximation for the purposes of the present study.

/Table I-1

Table I-1 shows the growth pattern of apparent consumption from 1952 to 1965. In that interval, it increased by 7.35 million tons, i.e., at an average annual rate of 7.4 per cent. Between 1952 and 1957 it expanded at an average annual rate of 12 per cent, which dropped to 4.5 per cent in 1957-65.

Table I-1

LATIN AMERICA: PRODUCTION, IMPORTS, EXPORTS AND APPARENT CONSUMPTION OF ROLLED STEEL PRODUCTS, 1952 to 1965

(Thousands of tons of steel ingot equivalent)

Year	Production a/	Imports b/	Exports b/	Apparent consumption
1952	2 171	2 722	73	4 820
1953	2 270	2 542	106	4 706
1954	2 793	3 695	77	6 411
1955	3 320	3 514	78	6 756
1956	3 870	3 560	111	7 319
1957	4 326	4 394	173	8 547
1958	4 722	3 618	82	8 258
1959	5 172	3 325	149	8 348
1960	5 595	3 561	179	8 977
1961	6 146	3 423	137	9 432
1962	6 211	3 209	100	9 320
1963	7 703	3 270	603	10 370
1964	8 793	3 476	446	11 830
1965	9 053	3 651	534	12 170

Source: ILAFA, the Brazilian Iron and Steel Institute and foreign trade yearbooks.

a/ Including output of rolled products based on imported billet.

b/ Excluding imports and exports of billet.

/Although apparent

Although apparent consumption of rolled steel products has increased substantially in recent years, in per capita terms it is still low in comparison with the world average. From its 1952 level of 29.3 kilogrammes, it had risen to 51.3 kilogrammes by 1965, whereas the world average in that year stood as high as 138 kilogrammes.

A study of the growth and structure of apparent consumption shows that it has developed considerably faster in countries where integrated steelworks have been installed than in those not yet benefiting from domestic production of steel. While in the first group the cumulative rate of increase of aggregate consumption between 1952 and 1965 reached 7.5 per cent, in the second the corresponding annual rate was 5 per cent.

(a) Imports

Latin America's total imports of rolled steel products expanded by 929,000 tons in 1952-65, i.e., at a cumulative annual rate of 2.3 per cent, as against that of 11.6 per cent attained by steel production.

Imports began to play a more decidedly secondary role as from 1957, with the development of the substitution process. Between that date and 1962, they decreased from 4.5 million tons to 3.2 million, and although they have since followed an upward trend, they have not regained their 1957 level. Thus, in 1965 domestic production satisfied 74.4 per cent of consumer demand and net imports 25.6 per cent - proportions which differed a good deal from those registered in 1952 (45 and 55 per cent, respectively). This suggests the possibility that smaller countries, where the installation of integrated steelworks is not at present justifiable, might obtain supplies of steel by means of a procedure (such as, for example, the establishment of semi-integrated plants) that would be independent of their capacity to import, or would have less unfavourable effects on their trade balance.

In order to form a complete picture of the consumption stituation, indirect imports must be added, i.e., external purchases of equipment, machinery and other manufactures and capital goods whose chief component is steel. Their annual volume is not very large in terms of steel - 1.3 million tons - and therefore makes no difference to the consumption figures quoted above. But the unit value of such imports is considerable, and they are also significant by reason of their effect on the economy as a whole.

/(b) Exports

(b) Exports

External sales of rolled steel products have fluctuated in recent years, ranging from 137,000 tons in 1961 to 534,000 tons in 1965, and have been almost entirely confined to intra-regional exports. They have been of a sporadic and circumstantial nature, and only since last year has definite interest been shown, particularly by Brazil and Mexico, in the possibility of developing a regular intra-regional export trade in rolled steel products.

In the main, exports have become available as a result of temporary contractions of the domestic market in certain countries, which have given rise to occasional production surpluses. This was the case in Argentina in 1962 and 1963; in Venezuela in 1963, when petroleum activities slackened; and even in Mexico, when the expansion of the Monclova and Monterrey plants was completed and their output exceeded internal demand for flat products. A temporary flow of exports has also been generated by the completion of some plant whose projected capacity is in excess of local demand for the time being. This happened in Chile, which for several years after the entry into operation of the Huachipato plant was a regular exporter, and may shortly occur in Brazil, when the new production of USIMINAS and COSIPA is added to Volta Redonda's output of flat products. In such cases, however, as in Chile and Mexico, consumption has absorbed supply again, with the result that exports have been reduced or suspended.

Thus, at the present time Latin America has no real exportable surpluses of any size, and exports are restricted to the regular trade flows between neighbouring countries or to sales of occasional surpluses. But, as will be seen later, there is a trend towards the development of exports which is likely to become more pronounced in the next few years.

(c) Breakdown of consumption by flats and non-flats

Consumption should be broken down by major categories of products available and in demand on the market. In the highly industrialised countries this is virtually impossible, since too many categories are involved. In the case of regions at a stage of development comparable to Latin America's, considerable simplification is possible, and the number of important kinds

/and types

and types of products can be reduced to about 10 or 20.[9] For Latin America ILAFA has selected a classification by 14 basic types [10] which will be useful for compiling the relevant statistics and in steel trade negotiations. For the purposes of the present study, it was decided to adopt, for the time being, only the two traditional broad categories of flats and non-flats. Apparent consumption of these is shown in table I-2, broken down by countries. It will be seen from this table that consumption of flats has increased faster than that of non-flats. This reaffirms the general trend observable in countries where the industialisation process is in its initial stages which are characterised by the progressive development of the transforming industries, whose consumption of flats is high. In countries at an advanced stage of industrial development, the proportion of flats accounts for 51 per cent, and in some instances even as much as 64 per cent, of the total volume of consumption of rolled steel products. Presumably, therefore, in Latin America the corresponding proportion, which has reached barely 44 per cent, will continue to increase, and may possible rise by 1970 to an average of 47 per cent, and to 50 per cent in the case of the more developed countries.

9/ United Nations, Report on the iron and steel industry (first draft).

10/ Latin American Iron and Steel Institute (ILAFA), Cartas mensuales, December 1964 and August 1965, Santiago (Chile).

/Table I-2

Table I-2

LATIN AMERICA: APPARENT CONSUMPTION OF ROLLED STEEL PRODUCTS, BROKEN DOWN BY FLATS AND NON-FLATS, 1952 TO 1965

(Thousands of tons of steel ingot equivalent)

Country		1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Argentina	Flats	374	265	665	648	616	661	1 006	633	705	974	750	646	1 164	1 254
	Non-flats	587	604	835	1 112	837	889	1 123	1 241	1 203	1 147	1 014	1 012	1 271	1 523
Bolivia	Flats	2	5	7	12	10	10	17	11	11	11	13	13	16	16
	Non-flats	7	8	12	14	13	15	20	11	12	15	16	20	22	66
Brazil	Flats	587	532	751	737	766	842	821	1 041	1 177	1 296	1 375	1 704	1 535	1 403
	Non-flats	855	880	1 226	956	995	1 182	1 198	1 618	1 653	1 706	1 653	2 054	1 960	1 597
Central America	Flats	42	48	53	59	62	92	56	79	80	96	77	82	102	110
	Non-flats	43	48	54	59	65	82	65	62	91	109	110	92	127	254
Chile	Flats	108	92	104	136	166	147	145	166	146	168	257	336	340	325
	Non-flats	191	199	193	198	217	211	190	233	185	230	414	351	382	293
Colombia	Flats	57	102	130	131	162	116	84	147	183	172	174	202	274	158
	Non-flats	102	192	244	218	203	254	192	143	205	219	214	279	306	315
Cuba	Flats	63	65	60	69	92	109	91	33	76a/	97a/	99a/	58a/	...	...
	Non-flats	102	107	143	200	182	211	202	110	146a/	180a/	174a/	109a/	...	...
Dominican Republic	Flats	4	2	2	5	4	6	3	2	1	2	6	26	...	...
	Non-flats	36	38	42	46	46	51	58	32	34	23	42	31	...	...
Ecuador	Flats	8	10	18	20	20	19	16	18	17	18	21	18	22	22
	Non-flats	16	25	34	36	33	32	32	28	33	39	40	47	48	45
Jamaica	Flats	...	...	...	...	...	...	...	...	...	20	26	33	36	...
	Non-flats	...	...	...	...	...	...	...	...	...	41	39	35	66	...
Mexico	Flats	275	317	355	440	534	612	541	617	746	726	639	937	1 137	1 286
	Non-flats	679	545	516	694	861	1 036	981	853	1 089	1 020	1 081	1 109	1 405	1 568
Panama	Flats	5	5	6	6	9	10	7	8	10	11	14	14	15	19
	Non-flats	9	11	16	14	18	22	21	11	23	31	21	21	19	34
Paraguay	Flats	6	3	6	6	4	9	2	5	5	5	4	7	6	7
	Non-flats	11	12	6	5	6	6	3	6	7	7	5	8	11	12
Peru	Flats	54	62	53	52	75	85	58	62	88	118	113	131	115	153
	Non-flats	65	98	63	91	119	89	83	89	104	135	155	140	163	199
Trinidad and Tobago	Flats	...	...	...	...	...	...	...	...	77	37	49	63	17	...
	Non-flats	...	...	...	...	...	...	...	...	65	59	54	54	74	...
Uruguay	Flats	34	35	52	32	40	54	25	40	62	33	39	29	48	36
	Non-flats	52	58	88	85	76	164	49	55	95	78	71	53	67	56
Venezuela	Flats	182	179	194	191	238	496	304	312	222	206	236	201	322	353
	Non-flats	379	432	483	554	645	1 155	705	632	432	409	331	375	544	656
Latin America	Flats	1 701	1 729	2 456	2 534	2 925	3 208	3 176	3 224	3 606	3 770	3 886	4 580	5 250	5 272
	Non-flats	3 119	2 977	3 955	4 222	4 394	5 339	5 382	5 124	5 371	5 442	5 434	5 790	6 580b/	6 900b/

Source: Time series compiled by ILAFA, foreign trade yearbooks and data supplied by the Brazilian Iron and Steel Institute.

a/ Provisional figures.

b/ Including estimates of consumption in countries for which no data were obtainable.

/2. Projections

2. Projections of demand for 1970 and 1975

(a) Method of projection

Of the various methods in current use for projections of demand, the one selected for the purposes of the present study was the establishment of a simple double-logarithmic correlation between apparent consumption of rolled steel and the gross domestic product. This procedure was chosen for two reasons. Firstly, it produced the most consistent results for almost all the countries of the region. Secondly, although the gross domestic product is only relatively indicative of future economic trends, this is especially true in primarily agricultural economies or in countries whose development process is just beginning, and the product may be a fairly representative indicator at the intermediate stages of development, through which nearly all the Latin American countries are now passing or will be in the next few years.

Three projections were formulated, two by countries and one in the aggregate. The first was calculated for illustrative purposes on the basis of past growth rates of the gross domestic product, or, in other words, may be regarded as a minimum estimate. The second, also relating to individual countries, was based on gross domestic product growth rates estimated for the study, and was selected as the official projection. Lastly, for purposes of comparison with the other two, a third projection was formulated for Latin America as a whole, on the assumption that the <u>per capita</u> gross domestic product would increase at the average rate of 2.5 per cent established as a development target for the Latin American countries in the Charter of Punta del Este.

(b) Comparison of results of projections

The three projections described above are compared in table I-3 with those formulated in earlier studies by the Economic Commission for Europe (ECE),[11/] and by the Latin American Iron and Steel Institute (ILAFA). Analysis of the total figures shows that the lowest estimate naturally corresponds to the projection based on past growth rates of the gross domestic product. The highest is that prepared by ILAFA. However, there is a reasonable degree of similarity between the five projections obtained on

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11/ Economic Commission for Europe (ECE), <u>Long-term trends and problems of the European steel industry</u>, United Nations publication, Sales No.: 60.II.E.3, Geneva, 1959.

/such different

such different bases, since in the whole group the difference between the maximum and minimum figures is barely 12 per cent for 1970 and 19 per cent for 1975.

Table I-3

LATIN AMERICA: ECLA PROJECTIONS OF CONSUMPTION OF ROLLED STEEL PRODUCTS, COMPARED WITH PROJECTIONS FROM OTHER SOURCES, 1970 AND 1975

(Thousands of tons of steel ingot equivalent)

Country	Projections for 1970					Projections for 1975				
	ECLA					ECLA				
	Hypothesis I a/	Hypothesis II b/	Hypothesis III c/	ILAFA d/	ECE e/	Hypothesis I a/	Hypothesis II b/	Hypothesis III c/	ILAFA d/	ECE e/
Argentina	3 240	3 485		4 013	-	4 275	5 035		5 375	3 515
Brazil	5 824	6 841		7 080	-	8 206	10 630		11 563	8 784
Central America	330	389		407	-	466	599		636	f/
Chile	818	950		766	-	1 109	1 470		990	1 204
Colombia	765	848		795	-	1 070	1 254		1 003	1 587
Ecuador	135	135		102	-	203	203		180	
Mexico	3 895	3 895		3 953	-	5 542	5 542		5 100	5 077
Peru	518	557		442	-	798	807		606	744
Uruguay	190	190		254	-	250	330		342	278
Venezuela	1 240	1 240		1 792	-	1 882	1 882		2 552	4 995
Other countries (Bolivia, Paraguay)	55	77		80	-	66	113		88	1 964 f/
Total	17 010	18 607	[illegible]	19 044	-	23 867	27 865	[illegible]	28 435	[illegible]

a/ Individual country projections formulated by ECLA on the basis of past growth rates of the gross domestic product (Hypothesis I).

b/ Individual country projections formulated by ECLA on the basis of estimated growth rates of the gross domestic product (Hypothesis II).

c/ Aggregate projection formulated by ECLA on the basis of an overall annual growth rate of the per capita gross domestic product of 2.5 per cent (Hypothesis III).

d/ Projections prepared by the Latin American Iron and Steel Institute. The estimates for Brazil and Uruguay were worked out by ECLA in 1962, but subsequently, as new data had come to hand, were reformulated for the country studies concerned.

e/ Projections published by the Economic Commission for Europe in Long-term trends and problems of the European steel industry (Geneva, 1959). The per capita figures given in terms of kilogrammes in that document relate to the period 1972-75. Population data have been adjusted in accordance with the latest population statistics available for the various Latin American countries.

f/ Central America and Cuba are included by ECE in the "Other countries" group.

/In respect

In respect of Argentina, Brazil and Central America, the ILAFA projections are slightly higher than ECLA's, but the difference is not as much as 10 per cent, so that the degree of concordancy is satisfactory. The ECE figures are a good deal lower.

For Uruguay, the consumption estimate formulated by ECLA is the lowest, but even so the country's present rate of development will have to rise considerably if that level is to be attained.

In Venezuela's case, the ECE figure is definitely over-optimistic, owing to the fact that since 1958 unforeseeable changes have taken place in the petroleum industry, for which ECE could not allow in the light of the data available by 1957. The ILAFA projections for this country are based on the assumption that the development plans for the metal-working and metal-transforming industries which the Government is promoting will be implemented as scheduled, but even in the absence of financing difficulties, there are always possibilities of delay, and ECLA's projection for Venezuela is therefore considered to be perhaps the nearest approximation.

For Peru the ECLA estimate is the highest, because during the period covered by the analysis there was an exceptional boom in the fishing industry which strengthened the country's overall economy.

It is also the ECLA figures that are the highest for Mexico and Chile. The rising trend of Mexico's gross domestic product is so steep and uninterrupted that the projected consumption levels may even be surpassed. On the other hand, the progress of the Chilean economy must be carefully followed up, since the growth rate postulated is based on the assumption that Chile's development process will regain its former stability. A pointer in this direction is afforded by consumption in 1964, which had already climbed to 722,000 tons.

As regards Colombia, there are considerable discrepancies between the projections formulated by ECE, which are undoubtedly too high, since they were based on figures for the coffee boom period, and those prepared by ILAFA, which are, in their turn, 25 per cent lower than the ECLA estimates for 1975. The ECLA projection gives the impression of being more consistent with Colombia's overall situation, which is still characterised by a steady rate of development.

/Lastly, in

Lastly, in view of the importance attaching to the breakdown of consumption by the two major categories of flats and non-flats, table I-4 presents the corresponding projections, based on detailed study of trends in the two groups.

Table I-4

LATIN AMERICA: PROJECTIONS OF DEMAND FOR ROLLED STEEL PRODUCTS, BROKEN DOWN BY FLATS AND NON FLATS, 1970 AND 1975

(Thousands of tons of steel ingot equivalent)

Country	1970		1975	
	Flats	Non-flats	Flats	Non-flats
Argentina	1 638	1 847	2 537	2 518
Brazil	3 351	3 490	5 315	5 315
Central America	156	233	252	347
Chile	447	503	706	764
Colombia	399	449	602	652
Ecuador	51	84	85	118
Mexico	1 831	2 064	2 771	2 771
Peru	262	295	426	461
Uruguay	76	114	110	140
Venezuela	521	719	828	1 054
Other countries	29	48	47	66
Total	8 761	9 846	13 659	14 206

Source: ECLA estimates.

/The satisfactory

The satisfactory degree of concordance among the various projections apparently bears out the conclusion that the predictable growth rate of steel consumption will be remarkably rapid, to judge from the results for Latin America as a whole, since it implies an increase from 12.2 million tons in 1965 to 18.6 million in 1970 and 28 million in 1975.

As regards the shortage of foreign exchange and the limitations of the capacity to import, the region's circumstances are unlikely to undergo any radical modification. Accordingly, should consumption develop as projected, demand will have to be satisfied mainly by domestic production, and a substantial contribution will be required of the Latin American iron and steel industry.

In 1955-65 the cumulative growth rate of production was 10.5 per cent. Were it to remain the same in the immediate future, output would increase by about 5.8 million tons between 1965 and 1970 and by 9.6 million tons in the next five-year period, i.e., within the space of ten years it would reach a level more than two-and-a-half times higher than the 1965 figure.

On the other hand, if the slightly higher rate of 11 per cent were adopted in view of the acceleration of the iron and steel industry's development which is likely to result from the expansion and modernisation efforts under way in several countries, production increments in the above-mentioned periods would amount to 6.2 and 10.5 million tons, respectively. Increases on such a scale, despite the high production figures and heavy investment requirements they imply, would still leave a very considerable balance to be covered by imports. If production expanded at the same rate as in the past, by 1975 imports would amount to 3.4 million tons, falling to 2.1 million tons if the higher rate referred to were attained. These figures should be compared with the average volume of net imports in the last 10 years, which was 3.3 million tons, and represented an expenditure of about 495 million dollars.

On the other hand, the degree of self-sufficiency of the region as a whole, in accordance with the projection of demand and the hypothetical growth rates of production postulated, would reach 88.2 per cent by 1975 if

/production increased

production increased at the same rate as in the past, and 92.2 per cent if the more rapid rate were achieved. It would thus exceed the average figure for 1955-65, which was 65.1 per cent. This situation may be summarized in the following table:

	Average 1955-65	1970	1975
Apparent consumption	9 457	18 607	27 865
Average annual growth rate	6.1	8.8	8.4
Production	6 160	15 255	25 705
Average annual growth rate	10.5	11.0	11.0
Net imports	3 297	3 352	2 160
Average annual growth rate	0.4	-1.7	-8.4
Degree of self-sufficiency	65.1	82.0	92.2

Note: Average rates for 1970 and 1975 are estimated on the basis of the 1965 figures.

/B. SURVEY

B. SURVEY OF NATURAL RESOURCES AND OTHER RAW MATERIALS

1. Iron ore

Latin America is rich in iron ore, and a primary source of supply for the world market. During the last few years, it has been supplying around 7 per cent of total world consumption, and the volume of exports is expected to expand to 45 million tons a year in the near future.

Known reserves amount to 5,000 million tons, and there are also about 80,000 million tons of possible, probable and potential reserves. Latin America's deposits represent 32.9 per cent of the world total.

The ores are high grade, with an iron content of 54 to 68 per cent, and are mainly pure hematite, or a compound of hematite and magnetite in varying proportions. They are low in phosphorus, except for some 420 million tons in Argentina and Colombia, which have a phosphorus content of 0.8 to 1 per cent and a iron content of 40 to 55 per cent.

Although there is general interest in studying the raw materials for steel-making a number of countries still have no detailed information on their deposits of iron, coal, manganese, etc. Table I-5 provides a summary outline of proven, probable, possible and potential reserves in each country and in the region as a whole.

Table I-5 also shows that more prospecting is needed in Central America and Argentina, first of all, and then in Mexico and Colombia. However, the studies that are being carried out in these countries suggest that more ore will shortly be found and that they will have sufficient reserves to meet the needs of existing industry and its future expansion. By and large, therefore, it can be said that the Latin American steel industry commands an adequate supply of good quality iron ore.

Most of the steel plants in Latin America obtain their ore from open mines. Many of the deposits are worked on a large scale for export (e.g. in Brazil, Chile, Peru and Venezuela), and costs are very low in relation to the type of mine and volume of output.

/Table I-5

Table I-5

LATIN AMERICA: IRON ORE RESERVES, BY COUNTRIES

(Millions of tons)

Country	Known reserves	Probable, possible and potential reserves
Argentina	142	74 a/
Bolivia	15	45 000 b/
Brazil	2 012	27 955
Central America	8 c/	20
Chile	300	2 095 f/
Colombia	55	120 d/
Cuba	-	3 015 e/
Dominican Republic	-	6
Mexico	376	194
Peru	320	477
Puerto Rico	-	100
Uruguay	9	100
Venezuela	1 497	507
Total	4 734	79 663

Source: ILAFA, except for direct information from official sources indicated in the corresponding footnotes.

a/ Not including some 500 million tons of ferriferous sand.

b/ Information from the Government of Bolivia on the Mutún reserves, which are difficult to work because of transport problems.

c/ Information from the Bank of Honduras.

d/ Not including ores in the vicinity of Paz del Río which have not been studied, and only 120 million tons of low-grade Medellín ore.

e/ Mainly ores whose metallurgy is difficult because of their chrome, nickel and vanadium content.

f/ Including a deposit at Reldán with some 300 million tons of low-grade ore.

/Table I-6

Table I-6 lists the ores used by eleven of the integrated mills in Latin America, their grade and type, the distance from mine to plant, and the proportions in which the ore and sinter are mixed.

The ores cost 50 to 65 less than current prices in the major world steel centres, with the single exception of those used by the San Nicolás mill, which are imported from Brazil. The Latin American plants thus have an initial advantage in being able to obtain ores at reasonable prices. Plants with their own mines pay less than 4 dollars per ton, while those buying from third parties have to pay slightly more, i.e. 4 to 7 dollars a ton.

Transport costs will be the decisive factor in the maintenance of favourable prices. They vary from less than a dollar for the Paz del Río and Orinoco plants, which are near the ore deposits, to almost 5 dollars for others. Rail freight charges in Latin America are low at present but may go up at any time. The enterprises should try to maintain a satisfactory cost structure for transport and improve methods of handling as much as possible so as not to lose their advantages in this field.

/Table I-6

Table I-6

LATIN AMERICA: IRON ORE USED BY SELECTED STEEL PLANTS

Country and plant	Ore Name and source	Type of ore	Iron content (Percentage)	Percentage of sinter used	Distance	
					By sea or river (sea miles)	Overland (km)
Argentina						
San Nicolás	Importado de Brazil, Chile y Perú	Hematite	63.0	-	-	-
Brazil						
Volta Redonda	Casa de Pedra, Lafaiette	Hematite	65.0	90	-	480
Usiminas	Itabira, Vale do Rio Doce	Hematite	62.0	100	-	119
Cosipa	Itabira, Vale do Rio Doce	Hematite	62.0	100	480	860
Chile						
Huachipato	El Romeral	Hematite and magnetite	61.0	-	453	88
Colombia						
Paz del Río a/	Paz del Río	Limonite and hematite	46.0 a/	-	-	56
Mexico						
Monclova	La Perla	Hematite	58.0	40	-	350
Monterrey b/	Cerro del Mercado	Hematite and limonite	62.0 b/	-	-	600
Hojalata y Lámina	Durango	Hematite	62.0	-	-	600
Peru						
Chimbote	Marcona	Hematite and limonite	59.0	-	350	20
Venezuela						
Orinoco	El Pao	Hematite	58.8	40	22	-

a/ Paz del Río ore has a phosphorous content of 1.1 per cent.

b/ The Cerro del Mercado ore used by Monterrey has a phosphorous content of 0.48 per cent.

/2. Coking

2. Coking coal

The difficulty of obtaining a supply of coking coal or of coke itself is the main problem facing the Latin American steel industry in relation to raw material stocks and costs. Although some countries have big deposits, little is actually known about their volume or mining conditions, costs, processing and coking properties. The only countries in which coal was discovered a long time ago are Colombia, Mexico, Peru and Chile. In the first two, good coking coal has been found, and it was decided from the outset that their steel industries should use the local coal to produce metallurgical coke. In Chile, Mexico and Peru, non-ferrous metals metallurgy, which is a long-established industry, has been using coal regularly, and that is why those countries have more information on quality and possible uses. In Colombia, the country where coal is most abundant (with reserves estimated at 20,000 million tons), only a few of the deposits have been surveyed, and, although export possibilities have been repeatedly discussed, it is not known what the real cost of mining and transporting the coal is or whether all the coal has good coking properties. Consequently its development for different purposes must be regarded as a long-term undertaking for the time being.

Apart from the deposits in Colombia and Mexico, which yield good coking coal, the largest mines worked in Latin America are Santa Catarina in Brazil and Lota and Schwager in Chile. Forty per cent of the coal from the former and 60 per cent from the two latter are used as coking coal in integrated steel plants.

Although the local coal costs more to mine, several steel concern are making tests to see if they can use it to a greater extent so as to achieve some self-sufficiency and regulate supply. They are tending to set up their own coking plants or to buy coke locally, as their profits from the by-products are generally enough to cover coking costs.

Table I-7 lists the fuels and reducers used by the integrated plants in Latin America.

The United States, which is now the world's main supplier of coke, provides the coking coal imported by the Latin American steel plants. But as its coal reserves are not inexhaustible, prices are subject to change, and events may at any time interrupt or impede its production of coal, the

/Latin American

Latin American Governments and steel industry would do well to embark upon a more detailed study of the quality and coking properties of local coal deposits and of the cost of mining and transporting the coal needed to satisfy regional demand.

Table I-7

LATIN AMERICA: COAL USED BY SELECTED STEEL PLANTS

Country and plant	Source	Generate	Distance to be carried in the country: By sea (sea miles)	Distance to be carried in the country: Overland (km)
Argentina				
San Nicolás	100 per cent imported from the United States	Own coking plant	-	-
Brazil				
Volta Redonda	60 per cent imported from the United States	Own coking plant	-	-
	40 per cent from Santa Catarina		554	90
Usiminas	60 per cent imported from United States	Own coking plant	-	-
	40 per cent from Santa Catarina		695	431
Cosipa	60 per cent imported from United States	Own coking plant	-	-
	40 per cent from Santa Catarina		300	-
Paz del Río	Paz del Río deposit	Own coking plant	-	36
Chile				
Huachipato	40 per cent imported from United States	Own coking plant	-	-
	60 per cent Golfo de Arauco		-	42
Mexico				
Monclova	100 per cent Sabinas	Own coking plant	-	180
Monterrey	100 per cent Rosita	Mexican coke	-	300
Hojalata y Lámina	100 per cent natural gas		-	-
Peru				
Chimbote	Electric reduction and imported coke	Imported coke	-	-
Venezuela				
Orinoco	Electric reduction and imported coke	Imported coke	-	-

/3. The

3. Use and availability of scrap

(a) Use

Scrap is commonly used in the steel works' refining furnaces, since it enables steel output to be rapidly increased irrespective of blast furnace capacity, and also makes for considerable operational flexibility. It is consequently a basic raw material for the steel industry. It was the large-scale use of scrap from the great export market of the United States that enabled Japan, and, to a lesser extent, Western Europe to step up their output of steel ingot so rapidly in the immediate post-war period.

Scrap requirements are so great that it is in short supply in most of the steel-producing countries, and the majority have either placed an embargo or special restrictions on exports of scrap. This is also true of Latin America.

(b) Consumption

Table I-8 contains estimates of scrap consumption and imports in several countries of the region. Scrap consumption was calculated by subtracting production of pig iron from steel ingot production and adding the amount presumably used by the smelters. It appears from this table that consumption has been climbing steadily, and that its trend follows closely that of ingot output. Between 1957 and 1964, consumption expanded by 136 per cent and ingot production by 140 per cent in the seven countries listed.

A breakdown of supply by sources is given in table I-9 for a group of countries in 1964. It will be noted that scrap imports accounted for as much as 21 per cent of consumption. Because of the increased demand for scrap in the semi-integrated plants and steel concerns themselves, a larger proportion will have to be imported unless the collection of this important raw material is properly organised. Latin America should follow the example of other countries in which users' associations take charge of the collection, selection and transport of scrap. The usual practice at present is to buy from small businessmen who stockpile the scrap to be found in their neighbourhood and tend to fix prices at an artificially high level because of the ready market. The solution would be for the users to get together and organise the collection and selection of scrap so that the

/best and

best and most expensive type would be earmarked for the manufacturers of special steels. The users could also systematize scrap transport on the lines followed by France before its entry into the European Iron and Steel Community (CECA). In other words, they could slightly raise the price of scrap purchased near the plant in order to offset the cost of transporting it from further away.

Table I-8

LATIN AMERICA: SCRAP CONSUMPTION AND IMPORTS IN SELECTED COUNTRIES

(Thousands of tons)

Country	1957	1963	[illegible]
		Consumption	
Argentina	[illegible]	608	811
Brazil	698	1 [illegible]	1 [illegible]
Chile	59	161	[illegible]
Colombia	11	40	63
Mexico	764	1 [illegible]	1 443
Peru	-	55	69
Venezuela	98	114	[illegible]
Total	[illegible]	[illegible]	[illegible]
		Imports	
Argentina	-	9	149
Mexico	[illegible]	496	[illegible]
Total	[illegible]	[illegible]	[illegible]

Sources: ECLA estimates and foreign trade yearbooks.

/Table I-9

Table I-9

LATIN AMERICA: ESTIMATED SOURCE OF SCRAP USED BY THE STEEL INDUSTRY, 1964

(Thousands of tons)

Country	Circulating scrap a/ A	Process scrap b/ B	Scrap imports C	Total A+B+C D	Scrap consumption c/ E	Recovery scrap d/ E - D F
Argentina	[illegible]	146	149	574	811	237
Brazil	695	210	-	905	1 430	525
Chile	131	43	-	174	210	36
Colombia	52	35	-	87	63	-24
Mexico	524	153	728	1 405	1 443	38
Peru	18	16	-	34	63	29
Venezuela	99	36	-	135	165	30
Total	[illegible]	[illegible]	[illegible]	3 314	4 185	[illegible]
Percentage of consumption	43	15	21	79	100	21

Source: ECLA estimates.

a/ Circulating scrap: a by-product of steel making itself, especially the rolling stage; generally constitutes 20 to 25 per cent of the total volume of ingots produced.

b/ Process scrap: produced by the transforming industries; represents roughly 8 per cent of total steel consumption in the industrialized countries.

c/ According to table I-8.

d/ Recovery scrap: consisting of the steel waste products discarded by the economy as a whole.

/C. CURRENT

C. CURRENT OPERATING CONDITIONS IN THE STEEL INDUSTRY

1. Description of the plants

Eighteen plants form the core of the steel industry in Latin America. This section will concentrate on only fourteen of these, which have been selected for their size and characteristics and because they are largely representative of a country or area.12/ The output of these fourteen plants is estimated in table I-10 to be 83 per cent of the total volume of pig and sponge iron production and 70 per cent of the steel ingot manufactured.

Of the remaining four, the Establecimientos Militares de Argentina plant at Zapla entered into operation a short while ago and plans to turn out some 150,000 tons of ingot. The other three which are in Brasil, are the small enterprises of Aliperti, Barra Mansa and Mineraçao Geral do Brasil, which is a complex of nine smaller plants. There are also various steelworks in Latin America that operate on the basis of scrap, and numerous rerolling mills using billets as raw material. Finally, another group that operates almost entirely in Brasil produces nothing but pig iron from charcoal-fired blast furnaces. The major semi-integrated plants, that is, steelworks with rolling mills, number about 50, and their output, as table I-11 shows, is around 97 per cent of their aggregate capacity. In 1965 it was about 1.6 million tons, which was 15 per cent of the total amount of steel manufactured in the region. There are also a great many non-integrated plants engaged in only one type of steel-making activity such as re-rolling or casting, and probably more than 150 rolling mills, sixty or so in Argentina, forty in Brasil and forty in Mexico. Their installed capacity is around 750,000 tons of processed ingot, but their output varies greatly since it depends on market requirements and the supply of billets. The enterprises producing pig iron with charcoal as fuel number about seventy, and have eighty-nine furnaces, of which sixty odd are lying idle. Their potential output is about 850,000 tons, but their peak figure was 450,000 tons in 1961 and has dropped by half since then for want of a large enough domestic market.

12/ San Nicolás in Argentina; Volta Redonda, Acesita, Belgo-Mineira, Usiminas, Cosipa and Mannesmann in Brasil; Paz del Río in Colombia; Huachipato in Chile; Monterrey, Altos Hornos de México and Hojalata y Lámina in Mexico; Chimbote in Peru and Orinoco in Venezuela.

/Table I-10

Table I-10

LATIN AMERICA: PIG IRON AND STEEL PRODUCTION IN INTEGRATED PLANTS

(Thousands of tons)

Country and plant	Pig iron			Steel		
	1963	1964	1965	1963	1964	1965
Argentina:						
San Nicolás	400	547	590	511	746	769
Zapla	36	42	74	-	36	72
Brazil:						
Volta Redonda	854	957	927	1 268	1 218	1 256
Usiminas	218	276	379 b/	73	276	380
Belgo-Mineira	372	390	339	396	421	407
Mannesmann	126	160	122	189	215	195
Mineraçao Geral do Brasil	53	38	1 b/	243	232	21
Acesita	71	63	77	82	82	91
Barra Mansa	52	53	49 b/	85	85	88
Aliperti	64	61	44	85	88	82
Cosipa a/	-	-	43	-	-	30
Chile:						
Huachipato	417	437	309	500	544	441
Colombia:						
Paz del Río	209	198	199	198	196	205
Mexico:						
Altos Hornos de Mexico	575	635	559	870	1 015	1 111
Monterrey	258	291	284	412	466	448
Hojalata y Lámina	170	203	213	317	321	410
Perú:						
Chimbote	29	27	20	73	75	81
Venezuela:						
Orinoco	283	323	334	[illegible]	360	537

Sources: Information from the enterprises themselves, the Brazilian Steel Institute, the Latin American Iron and Steel Institute and ECLA.

a/ No production in 1963 and 1964.

b/ Subject to revision.

/Table I-11

Table I-11

LATIN AMERICA: CRUDE STEEL PRODUCTION IN SELECTED SEMI-INTEGRATED PLANTS, 1963-65

(Thousands of tons)

Country	Plant	1963	1964	1965
Argentina	Acindar	69	96	96
	Oroneldinie	29	27	23
	F.M. de Aceros	34	39	34
	La Cantábrica	64	67	67
	[illegible]	7	5	-
	Santa Rosa	60	59	95
	Sideroa	82	125	136
	TAMET	35	42	42
	Valcena	6	4	2
	GALA	-	10	8
		386	464	501
Brazil	Cía. Brasileira de Usinas M.	37	45	44
	Usina Queiroz Junior S.A.	1	-	-
	Riograndense S.A.	64	86	80
	Dedini	54	42	66
	Aços Villares	69	44	22
	Lanari	29	23	[illegible] a/
	Cía. Siderúrgica Paine	21	[illegible]	21 a/
	N.S. Aparecida	20	[illegible]	20 a/
	J. Torquato	6	3	-
	Pi - El	15	16	16
	[illegible]	[illegible]	[illegible]	22
	Siderurgia [illegible]	4	34	8
	Siderurgia Aponorte	-	9	6
	A. Ferrari	4	1	-
	Electro Aço Altona	5	1	5
	Metropolitana de Aços	10	11	11
	Electro - Aços Plangg	2	1	1
	Fluminense S.A.	6	-	-
	Brasileira de Aços	b/	13	14
	Aço Paulista	b/	4	-
	[illegible]	b/	9	16
	Other enterprises	[illegible]	-	35
		[illegible]	[illegible]	494
Chile	INDAC	...	...	15
	Comento Moldá	...	...	2
	[illegible]	...	...	12
		[illegible]	40	[illegible]
Colombia	Siderúrgica de Medellín	...	...	35
	Siderúrgica del Pacífico	...	...	12
		[illegible]	[illegible]	47
Mexico	[illegible]	...	[illegible]	50
	Fundiciones de Acero	...	11	...
	[illegible]	...	18	...
	[illegible]	...	[illegible]	[illegible]
	Aceros Chihuahua	...	[illegible]	[illegible]
	Aceros Nacionales	...	[illegible]	[illegible]
	Metalurgia Veracruzana	...	[illegible]	[illegible]
	Siderúrgica Nacional	...	[illegible]	...
	Siderurgia Potosina	...	[illegible]	3
	Laminados [illegible]	...	[illegible]	[illegible]
	Aceros de México	...	[illegible]	[illegible]
	Aceros Tepeyac	...	[illegible]	[illegible]
	Aceros Mexicanos	...	6	5
	Acero Solar	...	1	...
		[illegible]	[illegible]	[illegible]
Venezuela	Sivensa	70	[illegible]	[illegible]
Uruguay	Gincon	...	...	1
	Novelca	...	...	18
		[illegible]	[illegible]	[illegible]

Source: Information from the enterprises themselves, the Brazilian Steel Institute, the Latin American Iron and Steel Institute and ECLA.

a/ Subject to revision.

b/ Included under "other enterprises".

/Most of

Most of the major integrated plants in Latin America date back no earlier than 1940, having been set up as a result of the aftermath of the Second World War. The only important concerns to predate them were the Cía. Fundidora de Fierro y Acero de Monterrey, founded in 1903, and the Cía. Belgo-Mineira in Brazil. The main reasons for establishing a steel industry in Latin America were simple: to solve supply problems in a basic branch of activity; to make use of the region's abundant and easily accessible natural resources, and especially its iron ore; to replace imports; to develop the processing industry and to create new sources of employment. As preparatory work and even prospecting had to be done in many cases, private capital was not attracted to the industry during its early stages of development and the Government had to provide the bulk of the investment funds. Market limitations, on the one hand, and capital requirements, on the other, had a conflicting influence on plant design and a compromise had to be reached in plant size and equilibrium. With insufficient markets or capital or both, it was impossible to begin with large plants that would be free from the adverse effects of scale economies. But, at the same time, it was essential for capacity to exceed a certain limit so that the ratio of unit investment to output would not be too high. The result was that some plant departments and sections were over-designed in several cases. They were provided from the start with enough space and auxiliary installations to be supplemented at a later stage at a comparatively low additional capital outlay. The steel companies thus had to grapple with a series of difficulties from the beginning, most of which were caused by (a) the shortage of capital, which is a common feature of under-developed countries and compels them to turn to external funds; (b) lack of sufficient information on domestic markets and uncertainty as to their future development; (c) high initial investment per ton because of over-design and the auxiliary works that had to be carried out, such as construction of approach roads, social works, mining developments, etc., which averaged about 20 per cent of the total value of the investment; (d) imbalances between production sections because of the compromises in design, with their inevitable after effects on costs and productivity; (e) at times an exaggeratedly wide range of

/products as

products as a means of combining the maximum volume of production with a small market, which, although resulting in diversification and market development, also led to short production series and high costs; (f) transport difficulties; and (g) the lack of trained and qualified operatives.

2. Equipment capacity and methods of operation in integrated plants

Tables I-12, I-13, I-14 and I-15 list the principle characteristics of all the equipment of integrated plants, their capacity and operational methods, thus showing the present situation and production level of the Latin American steel industry.

(a) Pig iron production processes

(i) Blast furnaces. The figures in table I-12 indicate that pig iron is mainly produced in coke blast furnaces which produce 77 per cent of total output. Charcoal blast furnaces rank next in order of importance, but can be used only where wood is abundant. They are nearly all to be found in Brasil, which has six furnaces with a nominal capacity of 396,000 tons which produced 432,000 tons in 1964 by using advanced techniques. Even the biggest of these furnaces are difficult to handle because of the enormous amount of wood that they consume annually. Moreover, charcoal's physical characteristics limit the volume of output of each blast furnace and raise operating costs so that labour inputs, upkeep and so on cost more than in the case of coke furnaces. The Belgo-Mineira is a model for this type of operation and is often cited as an example in world literature on the subject.

/Table I-12

Table I-12

LATIN AMERICA: PIG IRON PRODUCTION, NOMINAL CAPACITY AND ESTIMATED CAPACITY ATTAINABLE BY USING ADVANCED TECHNIQUES IN SELECTED INTEGRATED PLANTS, 1964

(Thousands of tons and percentages)

Country and plant	Pig iron production and equivalent in 1964	Nominal capacity a/					Capacity attainable by applying advanced techniques	Production as a percentage of capacity	Production as a percentage of potential capacity
		Coke blast furnaces	Charcoal blast furnaces	Electric smelting	Sponge iron	Total			
Argentina									
San Nicolás	547	515	-	-	-	515	750	106.2	72.9
Brazil									
Volta Redonda	957	750	-	-	-	750	1 000	127.6	95.7
Acesita	63	-	60	42	-	102	150	61.8	42.0
Belgo-Mineira	390	-	336	-	-	336	470	116.1	83.0
Usiminas	276	480	-	-	-	480	750 b/	57.5	36.8
Cosipa	c/	945	-	-	-	945	800	-	-
Mannesmann	160	150	-	100	-	250	350	64.0	45.7
Chile									
Huachipato	437	290	-	-	-	290	450	150.7	97.1
Colombia									
Paz del Río	191	170	-	-	-	170	250	112.4	76.4
Mexico									
Monterrey	291	250	-	-	-	250	320	116.4	90.9
Altos Hornos de México	635	510	-	-	-	510	690	124.5	92.0
Hojalata y Lámina	203	-	-	-	170	170	210	119.4	96.7
Peru									
Chimbote	27	-	-	63	-	63	70	42.9	38.6
Venezuela									
Orinoco	353	-	-	699	-	699	700	50.5	46.1
Total nominal and potential capacity		3 660	336	904	170	5 070	6 960		
Percentage of capacity without processes		72.2	7.8	16.7	3.3	100			
Production in 1964, total and by processes	4 530	3 469	430	428	203				
Percentage of production without processes	100	76.5	9.6	9.4	4.5				
Utilization of nominal and potential capacity (excluding Cosipa)		110.5	109.1	50.0	119.4	93.4	73.0		

Sources: ECLA, the Latin American Iron and Steel Institute and the Brazilian Steel Institute.

a/ Nominal capacity after the changes made, i.e., not on the basis of past figures.

b/ With the second blast furnace in operation.

c/ The blast furnace was under construction in 1964.

(ii) Electric reduction. The output of the electric blast furnaces represents 9.4 per cent of the regional total. The most important sources are the nine Orinoco furnaces, which together process 639,000 tons a year, and the two 63,000 ton furnaces at Chimbote. Fifty per cent of capacity is currently unused, largely because of the difficulties experienced by Orinoco where the biggest furnaces of their kind have been installed from the very beginning. When they were first installed the plant had had little experience in operating them and was unaware of the practical problems of handling the volume sought. One of the furnaces was adapted for use in combined tests with the Strategic-Udy method, in which the ore pre-reduced to sponge in the Strategic-Udy unit can be used to feed the electric furnace which completes the process. Up to now, the experiments have been less successful than was anticipated.

(iii) Sponge iron. Hojalata y Lámina de Monterrey has been using its full capacity successfully. It is the only plant in the world to be commercially successful in using the direct reduction method developed by it, known as H y L. This method consists in using natural gas to reduce and manufacture sponge iron, which is then smelted in ordinary electric furnaces.

(b) Steel shops

The capacity of the steel shops, the types of furnace used and the volume of output in 1964 are given in table I-13. Open-hearth furnaces account for 76 per cent of total production, and are installed in San Nicolás, Huachipato, Volta Redonda, Orinoco, Altos Hornos de México and Monterrey. Electric furnaces come second with 12 per cent of aggregate output. This method of refining is gaining ground in countries that have ample power and scrap supplies. The new Usiminas and Cosipa plants use the LD oxygen converter process, while Paz del Río relies on the classic Thomas converter for treating phosphorus-rich pig iron (2 per cent), up to now solely on the basis of non-oxygen-enriched air.

/Table I-13

Table I-13

LATIN AMERICA: STEEL INGOT PRODUCTION IN THE STEEL SHOPS, NOMINAL CAPACITY AND CAPACITY ATTAINABLE BY USING ADVANCED TECHNIQUES IN SELECTED INTEGRATED PLANTS, 1964

(Thousands of tons and percentages)

Country and plant	Ingot production	Open-hearth furnaces without oxygen	Open-hearth furnaces with oxygen	Electric refining	L.D. oxygen converters a/	Thomas or Bessemer converters	Total nominal capacity	Capacity attainable by using advanced techniques	Production as a percentage of nominal capacity	Production as a percentage of potential capacity
Argentina										
San Nicolás	746	800	-	-	-		800	1 375	93.3	55.5
Brazil										
Volta Redonda	1 218	975	440	20	-	10-ton Bessemer b/	1 495	1 780	84.9	68.4
Acesita	83	-	-	120 b/	-		120	120	69.2	69.2
Belgo-Mineira	421	182	-	-	480		662	662	63.6	63.6
Usiminas	276	-	-	-	800		800	800	34.5	34.5
Cosipa	c/	-	-	-	1 200 c/		1 200	1 200	-	-
Mannesmann	215	-	-	170	320		490	490	43.9	43.9
Chile										
Huachipato	544	500	-	-	-	-	500	880	108.8	61.8
Colombia										
Paz del Río	196	-	-	25	-	Thomas 250	275	400	71.3	49.0
Mexico										
Monterrey	466	500	-	-	-	-	500	924	93.2	50.4
Altos Hornos de México	1 025	-	930	-	-	-	930	1 600	110.3	63.4
Hojalata y Lámina	321	-	-	340	-	-	340	360	94.4	89.2
Peru										
Chimbote	75	-	-	100	-	-	100	120	75.0	62.5
Venezuela										
Orinoco	360	750	-	-	-	-	750	1 100	48.0	32.7
Total nominal and potential capacity		3 707	1 360	775	2 800	250	8 892	11 811		
Percentage of capacity by processes		41.7	15.3	8.7	31.5	2.8	100.0			
Production in 1964, total and by processes	5 996	2 425	2 072	717	550	172				
Percentage of production by processes	100.0	40.9	34.9	12.0	9.3	2.9				
Utilization of nominal and potential capacity (excluding Cosipa)		65.4	152.4	92.5	34.4	68.8	77.2	55.9		

Source: ECLA, the Latin American Iron and Steel Institute and the Brazilian Steel Institute.

a/ Estimated capacity per ton of installed converter capacity on the basis of an annual output of 8 000 tons.

b/ This furnace works in duplex.

c/ The blast furnace and the steel shop in Cosipa have been unused since 1964.

/(c) Rolling

(c) Rolling

(i) Cogging equipment. Table I-14 shows the blooming capacity of the integrated plants in terms of ingots per year, and output in 1964. The figures for installed capacity are based on information furnished by the plants and/or the equipment manufacturers and suppliers. For purposes of calculating output in 1964, it was assumed that the total ingot production of the steel shops was bloomed in the course of the year, i.e. that the inventory was the same from one year to the next.

Average utilization of blooming capacity was barely 52 per cent, but it should be remembered that in 1964 the San Nicolás, Usiminas and Orinoco plants were not yet in normal operation. With these plants excluded, the utilization index is 68.5 per cent for the others that were running normally. This figure is far from satisfactory. In some plants, the blooming equipment is unable to handle the entire output of the steel shop, while in others the blooming mills are working at almost 100 per cent capacity. In the circumstances, those enterprises might consider installing continuous casting equipment when they expand in future so as to reduce the high rate of investment per ton of installed capacity in the conventional blooming mills.

(ii) Preparatory, intermediate and finishing mills. Table I-15 indicates the total capacity of the rolling equipment for each type of product expressed in terms of ingot tons and finished goods respectively. Hot rolling capacity has been taken for flat products, as not enough information is available on the characteristics of the cold rolling equipment. It has been assumed that the latter, which, in Latin America, is usually inadequate and operates at full capacity, is able to handle the maximum tonnage for cold rolling while also meeting minimum local requirements at a time when the market for sheet and cold rolled products is in decline, and that the hot rolling equipment could supply all the requirements of the cold finishing equipment. This is a reasonable assumption, because the equipment generally has to be highly flexible to adapt to market fluctuations and its utilisation coefficient varies widely in practice, while that of the hot rolling mills is always above average for the rest of the flat rolling equipment.

/Table I-14

Table I-14

LATIN AMERICA: TYPE OF BLOOMING MILL, CAPACITY AND VOLUME OF OUTPUT IN SELECTED INTEGRATED PLANTS, 1964

(Thousands of tons and percentages)

Country and plant	Type of rolling mill. Roll diameter a/	Horsepower	Nominal capacity in thousands of ingot tons	Ingots produced by the steel shop (Thousands of tons)	Percentage utilization of blooming capacity b/	Eighty per cent of total finishing capacity in tons of ingots
Argentina						
San Nicolás	Duo rev. 46"	2 x 3 500	1 500 c/	746	49.7	2 351
Brasil						
Volta Redonda	Duo rev. 40"	1 x 6 000	1 [illegible]	1 [illegible]	87.0	1 [illegible]
Acesita	Duo rev. 36"	1 x 4 000	[illegible]	65	94.6	191
Belgo-Mineira	Duo rev. 44" / Duo rev. 32"		690	441	64.0	447
Usiminas	Duo rev. 50"	2 x 4 500	1 800	276	15.3	1 654
Cosipa	Duo rev. 44"	2 x 4 000	1 500		-	990
Mannesmann	Three stand 30"	1 x 3 800	300	215	71.7	277
Chile						
Huachipato	Duo rev. 32"	1 x 3 500	690	504	83.7	554
Colombia						
Paz del Río	Three stand 28"	1 x 2 200	180	196	108.9	234
México						
Monterrey	Duo rev. 46"	2 x 3 500	1 500	466	31.1	1 [illegible]
Altos Hornos de México	Duo rev. 40"	1 x 5 000	1 300	1 025	78.1	1 [illegible]
Hojalata y Lámina	Duo rev. 29"		300	328	109.5	330
Perú						
Chimbote	Two stand / Three stand 26"	1 x 1 800	110	73	6[illegible].5	100
Venezuela						
Orinoco	Duo rev. 44"	2 x 4 000	1 500	360	24.0	694
Total			[illegible]	[illegible]	[illegible]	[illegible]
Total (excluding Cosipa)			[illegible]	[illegible]	[illegible]	[illegible]

Source: ECLA, the Latin American Iron and Steel Institute and the Brazilian Steel Institute.

a/ The abbreviation "duo rev." signifies a duo reversing stand with rolls of the diameter indicated.

b/ This might be termed apparent utilization of capacity, since the figures are based on the assumption that the whole volume of steel processed during the year was rolled in the blooming mill and that inventories at the beginning and end of the year were the same.

c/ To achieve this utilization of capacity, the bulk of the products for blooming must be slabs for flat products.

/For the

For the sake of simplicity the coefficient of 1.33 used in a study by the Economic Commission for Europe has been adopted here to convert tons of finished products into ingots. This coefficient will vary according to whether the products are flat or not and their range, but any margin of error will not invalidate the conclusions as a whole.

Table I-15, in which blooming capacity is compared with the capacity of the finishing mills, shows that Usiminas, Cosipa, Chimbote, Orinoco, Huachipato, Monterrey and Altos Hornos de México have enough blooming capacity to keep the finishing mills supplied and that only the Orinoco plant has surplus capacity. This surplus is due to the fact that the blooming mill was built with an eye to the second-stage expansion as well. The San Nicolás plant is alone in having a greater finishing than blooming capacity. In order to compare the two levels, it has been assumed that the average utilisation of the finishing mills as a whole was 80 per cent.

(d) <u>Conclusions</u>

The following conclusions can be drawn from the foregoing tables:

(i) There is obviously an imbalance between the smelting and the blooming sections, since the supply of pig iron needed for the blooming mills with their nominal capacity of about 13 million tons falls short by 6.2 million tons.

(ii) There is undoubtedly an imbalance, as the smelting equipment in most of the plants was operating at a higher level than that envisaged in the original project. For instance, the utilisation index for the blast furnaces in 1964 was 99.4 per cent of the nominal level if Cosipa is excluded. This does not mean, however, that the equipment has been pushed to the maximum since the utilisation index would be 73 in relation to the output that could be achieved through the integrated use of advanced techniques.

/Table I-15

Table I-15

LATIN AMERICA: ANNUAL ROLLING CAPACITY FOR FLAT AND NON-FLAT PRODUCTS IN INTEGRATED PLANTS WITH TOTALS AND BY TYPES OF PRODUCT

(Thousands of tons)

Country and plant	Capacity by types of product, expressed in terms of finished goods: Hot flat rolled products	Billets, rails and heavy shapes	Bars, light shapes and wire rods	Wire	Seamless piping	Total capacity in tons of finished goods a/	Eighty per cent of total capacity	Total capacity in ingot tons	Eighty per cent of total capacity in terms of ingots
Argentina									
San Nicolás	1 000	1 210	-	-	-	2 210	1 768	2 939	2 351
Brazil									
Volta Redonda	1 000	300	-	-	-	1 300	1 040	1 729	1 383
Acesita	50	-	130	-	-	180	144	239	191
Belgo-Mineira	150	-	150	120	-	420	336	559	447
Usiminas	1 000	-	-	-	-	1 000	800	1 330	1 064
Cosipa	900	-	-	-	-	900	720	1 197	958
Mannesmann	-	-	100	-	160	260	208	346	277
Chile									
Huachipato	350	-	170	-	-	520	416	692	554
Colombia									
Paz del Río	40	-	144	36	-	220	176	293	234
Mexico									
Monterrey	1 000	150	100	-	-	1 250	1 000	1 663	1 330
Altos Hornos de México	800	300	-	-	-	1 100	880	1 463	1 170
Hojalata y Lámina	310	-	-	-	-	310	248	412	330
Peru									
Chimbote	24	-	70	-	-	94	75	125	100
Venezuela									
Orinoco	-	-	320	-	295	615	492	818	654
Total capacity	6 574	1 960	1 [illegible]	156	[illegible]	10 [illegible]	8 [illegible]	13 [illegible]	11 [illegible]

Sources: ECLA, the Latin American Iron and Steel Institute and the Brazilian Steel Institute.

a/ Including billets for third parties.

/(iii) The

(iii) The blast furnaces are being fully utilised in most of the plants, and particularly in Huachipato, Belgo-Mineira, Monterrey, Altos Hornos de México and Paz del Río. There is no need to force the furnace into more intensive use in the latter, because its output is tied to the capacity of its finishing mills which, like the blooming equipment, have as much work as they handle at present. In other words, Paz del Río has reached the production ceiling imposed by the capacity of its equipment, in this case, of its rolling mills. Huachipato is in much the same situation. However, this does not apply to electric smelting equipment, and in Orinoco and Chimbote the pig iron deficit is the mainly factor preventing the aggregate pig iron production index from being higher and more representative. In general, all the plants have driven their smelting equipment hard in order to compensate for the imbalance in this section, but have not been able to do the same with their electric blast furnaces because of operational difficultiss.

(iv) The capacity of the steel shops is more compatible with that of the blooming equipment. In 1964 their output was only 6 million tons of ingot while their nominal capacity (excluding Cosipa) was 7.7 million, i.e., a utilisation index of 77 per cent. This means that they could not obtain enough scrap to increase their output further, or, what is even more probable, that certain steel shops such as those of San Nicolás, Volta Redonda and Huachipato were faced by difficulties in handling materials that could have been overcome by a few outlays of capital. Possible steel making capacity, which would be 12 million tons would then be practically proportionate to blooming capacity. To achieve this level, several plants would have to expand the capacity of their open-hearth furnaces slightly (Huachipato, from 100 to 200 tons), San Nicolás (from 230 to 250 tons). For purposes of calculation, it is assumed that this has been done. In order to attain the maximum utilisation levels mentioned, full use must be made of technological improvements and the open-hearth furnaces must be operated as efficiently as possible. There would, in any case, be an overall deficit of about 1 million tons of ingot in relation to blooming capacity, although the balance may of course be different in each plant.

/(v) The

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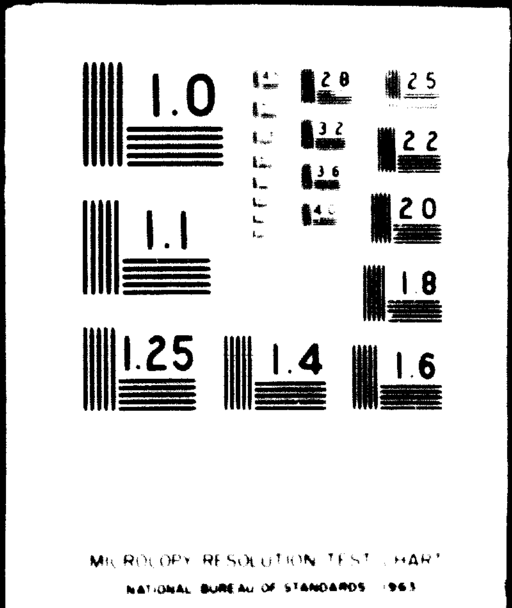
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

(v) The blooming mills have a total capacity of 13 million tons. The volume of work they can handle is generally commensurate with the capacity of their respective finishing mills, except in the plants mentioned earlier. This is the peak capacity attainable without further overall investment not merely supplementary funds. There is obviously need for expansion in the next few years to bring certain plants into balance and step up production substantially at comparatively little capital cost. Over and above the limit of 13 million tons, the possibility of additional investment will have to be considered when the capacity of the blooming mills has been exceeded. Moreover, these mills are the most costly and important investment items pending the introduction of continuous casting or other modern methods, which will be discussed under point 3 below.

3. Recent technological advances and their application in Latin America

In the twenty years following the Second World War, the steel industry has been radically changed by the introduction of technological improvements which have considerably increased the productivity of equipment and improved the metal-working processes, the type and quality of the raw materials and the quality of the steel produced.

Technological progress is important to the Latin American steel industry in three ways. It signifies:

(i) Less expenditure on certain inputs, a general increase in productivity and a consequent reduction in production costs;

(ii) Better utilisation of the original investment and reduction in capital charges;

(iii) The possibility of expanding the plants at less investment per unit of product than in the past.

The progress of steel making in the last twenty years has been essentially in ore concentration and processing and the preparation of blast furnace burdens; in smelting, with special emphasis on higher blast furnace efficiency and productivity; in oxygen converters; in the use of continuous casting on an industrial scale; in automating rolling operations; and, in fact, in automating the different processes of steel making generally.

/In the

In the study entitled La economía siderúrgica de América Latina, a brief account is given of the nature, origin and implications of these technological advances.

An attempt will be made in this paper to determine the current technological level of existing plants, and the level that can be attained through the expansions and improvements planned by the enterprises.

(a) Ore preparation and blast furnace operations

Usiminas and Cosipa, which are modern in design, are the only plants that planned to use 100 per cent sinter from the very beginning.[13/]

The only other plants to use sinter are Altos Hornos de México, Orinoco and Volta Redonda, where the proportions are 30, 40 and 50 per cent respectively. It is particularly striking that there should be no sintering at Paz del Río, since its ore has 35 per cent fines and an iron content of 45 per cent, which is below average. It is also surprising that the other plants should not have studied the possibility of using large proportions of sinter in their operations.

The Compañía de Acero del Pacífico in Chile is the only plant to make a series of innovations in its blast furnace operations, such as injected petroleum (70 kg per ton), oxygen-enriched air and moisture control. As a result it has reduced its specific coke consumption to 540 kg per ton and raised productivity to its present level of 1.9 tons per cubic metre of useful furnace capacity, which is close to a good world level of yield (2 to 2.2 tons). The result is that furnace output has been profitably increased from 600 tons a day of nominal capacity to its current level of 1,200 tons. The original furnace diameter also had to be widened from 19' to 20'9". Belgo-Mineira in Brasil is another interesting case. Its first furnaces of 90 tons capacity per day were continually improved at little cost until they were virtually new units with a hearth diameter of 15 feet. Nominal capacity was raised to

13/ Sinter was first used in Latin America by Monlevade, which is now enlarging its installations so as to base its operations entirely on sinter.

/336,000 tons

336,000 tons from its initial level of 122,000, and in 1964 output was further increased to 390,000 tons. As stated in section B, the company's charcoal furnaces operate extremely well.

Mention should also be made of Hojalata y Lámina which has discarded conventional methods and developed a new reduction process known as HyL. This has been industrially successful owing to a happy combination of technical and economic factors in Monterrey, i.e. abundant low-cost natural gas and the constant perfecting of methods of operation.

(b) Steel shops

Few steel shops have oxygen lances in their open-hearth furnaces because of the shortage of metal. Altos Hornos de México have lances in five of their eight furnaces, and Volta Redonda in two out of eight. San Nicolás and Orinoco have the necessary facilities but do not need to force their steel production. Huachipato uses this method occasionally, but prefers to keep what little oxygen it has to enrich the air blasted into the furnaces.

Paz del Río uses the classic Thomas method, but has not found it necessary to force its blast furnace or steel shop, because it is the only plant in which the intermediate and finishing mills have so much material to handle that they are working at more than nominal capacity.

Generally speaking, the use of oxygen in open-hearth furnaces has been limited by the shortage of pig iron, and has gained little ground in Latin America.

Usiminas and Cosipa are the only plants to have modern LD converters. Monlevade (Belgo-Mineira in Brasil) also has converters, and was one of the first plants (the sixth in the world) to adopt this process when it was launched.

Plans to enlarge the steel shops nearly all provide for the installation of oxygen converters. Chimbote in Peru now has two LD converters of 25 tons each.

(c) Continuous casting

Chimbote is the only integrated plant with a continuous casting line, but the process is used by five semi-integrated plants as well: Siderurgica Riograndense in Brasil, Aceros de Chihuahua and Aceros Ecatepec in Mexico, Siderúrgica Venezolana (SIVENSA in Venezuela and Lucini y Cía. in Argentina.

/The plans

The plans for expanding several of the integrated and semi-integrated plants make provision for continuous casting, which means that it has worked well in practice up to now.

(d) Rolling

San Nicolás in Argentina has the only continuous hot rolling mill for sheet in Latin America. According to information from the enterprise, it has a capacity of 1 million tons, but could undoubtedly handel a greater amount. Usiminas, Cosipa, Volta Redonda and Monterrey have semi-continuos equipment, and so will Altos Hornos de México when it modifies its present Steckel mill, which it plans to do shortly. Huachipato's capacity is limited by the characteristics of its Steckel mill (width: 1 metre). Paz del Río and Chimbote are in the process of installing rolling mills of this kind. By and large, it can be said that the plants that have the largest capacity in relation to their domestic market or have been developed with foresight were well-planned with continuous or semi-continuous mills. Other plants, however, have been compelled to install Steckel mills which do not have the same levels of productivity and operating costs because of the small size of the market, financial conditions, delays in re-equipping or the possibility of expansion.

(e) Conclusions

It is clear from the foregoing that the Latin American steel plants offer ample opportunities for the introduction of modern technical advances which are vital for their production.

A review of tables I-12 and I-14 shows that there is a wide gap between total pig iron production and the nominal capacity of the blooming mills, although blast furnace utilization has been satisfactory and their nominal design capacity has been exceeded in numerous plants. If the nominal capacity of the plants which are not yet making full use of their smelting capacity (Cosipa, Usiminas, Chimbote and Orinoco) is added to output in 1964, the production figure will be 5.6 million tons. As an output of 6.9 million tons could be obtained if all possible technological advances were introduced, the margin of increment is 1.3 million tons and possibly even 1.5 million if the electric smelting furnaces are driven to the limit.

/Similarly, in

Similarly, in the steel shops, the difference between maximum possible output and nominal existing capacity is 3.7 million tons. This is far from negligible, so any improvements that could be made in this section should be given special consideration by most of the plants in the region.

Only two newly-built steelworks in Latin America meet the most up-to-date technological standards. Most of the others could reach an intermediate level once they have systematically incorporated the technological improvements described, thereby bringing the capacity of their different sections into better balance and raising their productivity to the maximum feasible with their present equipment. If institutions interested in steel making take co-ordinated action and provide assistance to the enterprises at the lower levels, they should obtain beneficial results for the industry in a relatively short space of time.

/D. [illegible]

D. PRICES

1. Price comparisons

Price comparisons might serve to clarify two different but interrelated points: the position of metal-transforming industries in Latin America and Western Europe with regard to the price of steel used as raw material, and the position of the Latin American consumer depending on whether his steel supplies are domestically produced or imported.

An attempt was made to collect the information needed for these comparisons and give a rough idea of price levels. It was only moderately successful, however, because the data obtained was either insufficient or not uniform. Moreover, the exchange rates used for conversion into dollars introduce distortions as they get farther away from parity.

(a) Consumer prices

It is difficult, on the whole, to determine the exact trade conditions prevailing, since prices are known to vary according to surcharges or rebates which are not specifically mentioned but are applicable to individual transactions, delivery dates and terms of payment.

Table I-16 gives prices for nine steel products in seven Latin American cities. Table I-17 compares the prices of two items - concrete reinforcement bars 10 mm in diameter and cold-rolled sheets 3 x 1 m and 0.6 mm in thickness - in the seven Latin American cities and in three countries members of the European Coal and Steel Community, and export prices f.o.b. Antwerp. The following conclusions may be drawn:

(i) Domestic prices in countries members of the European Coal and Steel Community and export prices f.o.b. Antwerp are much the same for non-flat products, but the former are substantially higher in the case of flat products - as much as 25 per cent in the examples considered. This indicates the general priority given to flat rolled products and may be closely related to the scale of production and high productivity of plant manufacturing flats, which enables the Community countries to compete at relatively lower prices compared with those of non-flat products.

/Table I-16

Table I-16

LATIN AMERICA: DOMESTIC PRICES OF STEEL PRODUCTS IN SELECTED CITIES AS AT 31 AUGUST 1965 a/

(Dollars per ton)

Item	Product	Argentina Buenos Aires	Brazil Sao Paulo	Chile Santiago	Colombia Bogotá	Mexico Mexico D.F.	Peru Lima	Venezuela Caracas
1	Concrete reinforcement bars, round (7-12 m long, 10 mm or 3/8" in diameter)	238.42	139.46	163.97	121.85	154.40	206.14	147.78
2	Concrete reinforcement bars, round (7-12 m long, 20 mm or 3/4" in diameter)	232.54	123.24	163.97	105.19	152.00	205.91	134.44
3	Coiled wire rod, round (8 mm or 5/16" in diameter)	258.43	s/c	153.97	147.78	182.08	205.07	152.22
4	Hot rolled flat products or sheets, black (1 x 3 m, and 3 mm in thickness)	206.65	172.97	191.91	147.04	197.52	156.08	-
5	Cold rolled flat products or sheets, scoured (1 x 3 m, 24 BWG)	287.00	243.24	238.09	164.81	207.52	-	-
6	Galvanized flat rolled products or sheets (1 x 3 m, and 0.4 mm in thickness)	497.49	355.68	289.26	181.48	336.00	-	-
7	Galvanized rolled products or sheets, 3" corrugation (0.851 x 3 m, and 0.5 mm in thickness)	437.20	367.57	261.03	160.37	352.00	-	-
8	Angles, equal legs (7-12 m long, 38.1 x 4.8 mm)	288.57	162.16	200.74	145.56	168.00	185.91	-
9	Hot rolled flat bars (7-12 m long, 38.1 x 9.5 mm)	283.15	142.70	206.91	165.93	168.00	236.29	-
	Dollar exchange rate a/	171.50	1 850.00	3.40	13.50	12.50	26.82	4.50

Source: Latin American Iron and Steel Institute (ILAFA), Revista Latinoamericana de Siderurgia, Nº 66, October 1965.

Note: The prices are for cash purchases of 20-ton lots of SAE 1010 or the equivalent quality of steel, delivered to the cities indicated in the various countries.

a/ For imports.

/(ii) Latin

(ii) Latin American consumers pay much higher prices, even higher than the Federal Republic of Germany which pays the top prices in Europe; the differences average from 10 dollars in Colombia to over 100 dollars in specific cases. A more thorough analysis might show that these disparities are actually smaller, since it is not definitely known what additional charges the European consumer may have to pay in the home market; Latin American prices relate to transactions involving rather small lots (20 tons), whereas the European purchaser obtains the normal rebates given for large consignments bought directly from the factory. However, the differences are such that, even without a really accurate evaluation, Latin America's metal-transforming industry is evidently paying much higher prices for flat products than European industry. These differences cannot be offset by the lower cost of local labour and other compensating factors which help to reduce the cost of manufactures.

(b) C.i.f. prices of the European product

The comparison was based on the two items mentioned above because they are considered to be representative of flat and non-flat products. The c.i.f. prices at Latin American ports were calculated by adding 20 dollars per ton for freight and insurance to Atlantic ports and 32 dollars to ports on the Pacific seaboard. Shipping costs, consular fees, port dues, cargo handling charges, etc. were not included because there was no uniform method of computing them. Protective import duties were also excluded. It is clear from the above considerations that this is no more than a very rough comparison.

Table I-18 shows prices of the two items c.i.f. Latin American ports, domestic prices in Latin American cities and a comparison of the two expressed as an index on the basis of c.i.f. prices = 100. In general, the prices paid in Latin American cities are substantially higher than import prices, ranging from 6 per cent higher in Colombia to 107 per cent higher in Argentina for round bars, and from 25 per cent higher in Colombia to 117 per cent higher in Argentina for flats.

/Table I-17

Table I-17

DOMESTIC PRICES OF STEEL PRODUCTS IN LATIN AMERICAN CITIES AND SELECTED COUNTRIES MEMBERS OF THE EUROPEAN COAL AND STEEL COMMUNITY, AND COMMUNITY EXPORT PRICES

(Dollars per ton)

Product	Argentina Buenos Aires	Brazil Sao Paulo	Chile Santiago	Colombia Bogotá	Mexico Mexico D.F.	Peru Lima	Venezuela Caracas	Federal Republic of Germany	Belgium	France	Export price f.o.b. Antwerp
Concrete reinforcement bars (10 mm in diameter)	238	139	122	164	154	206	148	108	99	104	95
Cold rolled sheets	287	243	165	238	208	-	-	158	153	149	112

Sources: ILAFA, op. cit.; Economic Commission for Europe (ECE), The European steel market in 1964 (STEEL/WP.4/Working Paper No. 3), June 1965.

Table I-18

EUROPEAN COAL AND STEEL COMMUNITY PRICES, C.I.F. LATIN AMERICAN PORTS, AND DOMESTIC PRICES IN LATIN AMERICAN CITIES

(Dollars per ton)

	Argentina	Brazil	Chile	Colombia a/	Mexico a/	Peru	Venezuela
A. European Coal and Steel Community prices c.i.f. Latin American ports b/							
1. Concrete reinforcement bars, round (10 mm in diameter)	115	115	127	115	115	127	115
2. Cold rolled sheet, 24 BWG	132	132	144	132	132	144	132
B. Domestic prices in Latin American cities							
1. Concrete reinforcement bars, round (10 mm in diameter)	238	139	164	122	154	206	148
2. Cold rolled sheet, 24 BWG	287	243	238	165	208	-	-
				Index: A = 100			
C. B in relation to A							
1. Concrete reinforcement bars, round (10 mm in diameter)	207	120	129	106	134	162	129
2. Cold rolled sheet, 24 BWG	217	184	165	125	158	-	-

Sources: ECE, op. cit.; ILAFA, op. cit.

a/ Ports on the Atlantic seaboard.

b/ These prices were obtained by adding 20 or 32 dollars to the price f.o.b. Antwerp, depending on whether the exports were shipped to Latin American ports on the Atlantic or the Pacific seaboard, to cover freight and other port charges.

/(c) Comparison

(c) Comparison of steel prices in several Latin American cities

Lastly, table I-19 presents a comparison between domestic prices paid in several Latin American cities in terms of indexes, with Colombia, where prices are lowest, used as a base of 100. The purpose of this table is merely to show the wide range of steel prices in the various cities.

These variations in price may simply be due to the different structure of steel prices in the individual countries, which is closely related to the level of protection established by each State within the framework of its general import substitution policy. The circumstances have varied from country to country and from product to product, depending not only on the pressures exerted on the balance of payments and the stringency of the restrictions imposed but also largely on the type of steel industry and the kind of products being produced locally. Thus, some countries levied duties only on the series of products being produced by their own steel industries; where there was no undue pressure on the balance of payments, no restrictions were imposed on other products. The result in these cases was that prices of certain types of imported steel remained at a fairly reasonable level, while the types of steel produced locally rose in price in so far as import duties permitted. In the more extreme cases where heavy restrictions were imposed on imports, there was a general rise in steel prices. The tendency is for the price of locally produced steel to remain high under this protection, which is sometimes urgently requested and sometimes adopted as the result of a specific monetary or external payments policy, or the two factors combined.

The foregoing considerations highlight the importance of studying the domestic price structure in greater depth and the need for prices that will be competitive at the regional level.

/Table I-19

Table I-19

COMPARISON OF STEEL PRICES IN SELECTED LATIN AMERICAN CITIES

(Index: lowest price = 100)

	Argentina Buenos Aires	Brazil Sao Paulo	Chile Santiago	Colombia Bogotá	Mexico Mexico D.F.	Peru Lima	Venezuela Caracas
1. Concrete reinforcement bars, round (10 mm in diameter)	195	114	134	100	126	169	121
2. Concrete reinforcement bars, round (20 mm in diameter)	222	117	156	100	145	196	128
3. Wire rod, round (8 mm in diameter)	174	-	104	100	123	139	103
4. Hot rolled products	142	118	131	100	135	106	-
5. Cold rolled products	174	147	144	100	126	-	-
6. Galvanized sheets	275	197	160	100	188	-	-
7. Galvanized sheets, corrugated	273	230	163	100	220	-	-
8. Angles, equal legs, 38.1 mm	198	111	138	100	115	127	-
9. Flat bars, 38.1 x 9.5 mm	198	100	145	116	117	165	-

Source: ILAFA, op. cit.

/2. Levels

2. Levels of tariff protection

The producing countries would have found it impossible to maintain the prices shown in the above-mentioned tables but for the exceptionally strong protection they were given, as shown in table I-20. This table gives customs duties and equivalent charges as well as import restrictions applicable in the various countries, as a percentage of the c.i.f. value of each product. All charges, even prior import deposits, are included.

Besides being highly complex, the existing systems of protection in Latin America are altered frequently in accordance with the assessment by the competent government bodies of the state of the steel market and the country's needs in terms of semi-processed products.

It is clear from table I-20 that the levels of protection enjoyed by Latin America's steel industry are excessively high. Venezuela and Chile are at opposite ends of the scale. In the former, customs duties are relatively low but locally manufactured products cannot be imported without import licenses. Chile is an outstanding example of exaggerated protection for a local industry: imports of several products on the Chilean steel making programme are prohibited, and the categories in which imports are allowed are subject to the cumulative application of all the protective measures in force. Thus, for such products as seamless piping, customs duties are as high as 750 per cent of the c.i.f. value. Of the remaining steel-producing countries listed in table I-20, Argentina and Peru allow unrestricted imports of steel products; but customs duties are high, ranging from 28 to 217 per cent in Argentina and from 32 to 185 per cent in Peru. Although duties are lower in Colombia and Mexico, the two countries use the system of import licenses. Lastly, Brazil allows unrestricted imports of many steel products and the duties range from 26 to 66 per cent.

The evaluation of levels of protection, from the standpoint of national overall trade policy, is beyond the scope of the present study. Nevertheless, in the steel sector alone it is clear that except in Venezuela, the Latin American industries are heavily protected. This, added to the fact that most steel mills are controlled by a single enterprise, or virtually by a single enterprise, might create situations likely to jeopardise the efficiency, technological progress and development prospects of the plants.

/Table I-20

Table I-20

LATIN AMERICA: APPROXIMATE LEVELS OF PROTECTION FOR THE STEEL INDUSTRY, 1966 a/

Product	Argentina		Brazil		Chile		Colombia		Ecuador		Mexico		Paraguay		Peru		Uruguay		Venezuela	
	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)	Legal category	Total import duties on c.i.f. value (percentage)
Pig iron	UI	32.60	EA	376.00	UI	514.05	PIP	19.65	UI	25.92	PIP	43.60	UI	67.17	UI	181.47	UI	48.68b/	PIP	0.039
Blooms and billets	UI	47.60c/	UI	56.00	PI	-	PIP	23.65	UI	29.99	PIP	62.50	UI	69.27	UI	40.93	UI	52.88b/	PIP	35.87
Slabs	UI	49.60c/	UI	56.00	PI	-	PIP	23.65	UI	28.84	PIP	39.12	UI	60.13	UI	37.04	UI	49.56b/	PIP	22.07
Round bars e/	UI	143.60	UI	56.00	UI	748.30	PIP	26.65	UI	32.20	PIP	23.44	UI	55.15	UI	182.91	UI	-	PIP	5.90
Shapes, less than 80 mm f/	IS	123.60	UI	56.00	UI	68.81	PIP	29.65	UI	39.07	PIP	10.52	UI	57.25	UI	184.89	UI	-	PIP	0.40
Plates, more than 4.75 mm, not clad or coated	UI	53.60	UI	26.00	UI	50.94	PIP	29.65	UI	36.01	PIP	37.67	UI	55.99	UI	32.61	UI	49.22d/	UI	0.18
Sheets, less than 3 mm, not clad or coated	UI	53.60	UI	26.00	PI	-	PIP	29.65	UI	37.13	PIP	16.68	UI	55.47	UI	33.50	UI	50.74	UI	0.05
Tinplate g/	UI	28.60	UI	26.00	UI	505.81	PIP	28.55	UI	16.55	PIP	30.14	UI	58.91	UI	33.70	UI	48.53h/	UI	0.08
Seamless piping i/	UI	217.60	UI	66.00	UI	751.20	PIP	41.65	UI	27.18	PIP	10.71	UI	59.49	UI	31.86	UI	-	UI	1.57

Source: Latin American Free-Trade Association (ALALC) (CEP/GR.2/II/di 4), 9 March 1966.

UI = unrestricted imports; EA = exchange auction; PIP = import licence required; PI = prohibited imports; IS = imports exclusively by the Sociedad Mixta Siderúrgica Argentina (SOMISA).

a/ Treatment of third countries.
b/ Official customs value: 16.58 pesos per 100 gross kilogrammes.
c/ Containing less than 0.25 per cent of carbon.
d/ Official customs value: 94.60 pesos per 100 gross kilogrammes.
e/ Round bars, 7 mm or less in diameter, except bars 2.22 mm in diameter.
f/ Constructional shapes, not less than 3 mm in thickness, 30 cm or less in width and 3 m or more in length: unequal leg angles and H, T, I, U and Z shapes.
g/ 41 kilogrammes per basic box.
h/ Official customs value: 62.40 pesos per 100 gross kilogrammes.
i/ Cold-extruded, round, with an external dimension of 11 mm or more but not exceeding 50 mm, and a wall thickness of 3 to 10 mm, except in stainless steel piping.

/Additionally, a

Admittedly, a country that is just starting a steel industry cannot be expected immediately to reach levels of productivity and returns on investment which can be regarded as satisfactory compared with countries with a long-established industry. Still, that is no reason for such strong protective measures. Prevailing levels of protection, which in general are considered excessive, must be judged in conjunction with the high prices of steel products on the Latin American markets. In all probability, the two factors have a bearing on the high costs, the result of relatively low operating efficiency. This question will be examined in the sections which follow.

/B. PRODUCTION

E. PRODUCTION COSTS AND THE EFFECT OF TECHNOLOGY ON SCALES OF PRODUCTION

1. Object and importance of cost analysis

In spite of all the attendant difficulties, cost analysis is essential because it clarifies, at least partially, a series of problems of fundamental importance for the future development of the Latin American steel industry, in particular the question of the feasibility and possible organization of a common market for steel products.

Regional integration of the steel industry depends on the extent to which the present industry can adapt to the future competition by achieving economies of scale, a high level of technology and increasing specialisation in the whole range of final rolled products in each, and every one of the plants. Cost analysis is a valuable tool for assessing the situation of the Latin American industry in this respect.

Cost comparisons can be used as a basis for evaluating the different cost factors and the prospects of producing steel in Latin America at competitive prices so that the industry can eventually form part of the world steel market.

For this purpose, the main aspects to be evalnated, within the large range of variables, are the following:

(i) The relative position of the main Latin American steelworks, in terms of international standards;

(ii) The extent to which high costs, where they are found, are the result of permanent unfavourable factors, or of temporary factors which could be modified or eliminated through expansion, modernisation and specialization; and, in general terms, the relative weight of these factors or circumstances; and

(iii) Whether conditions in Latin America for the development of the steel industry are likely to give it a comparative advantage in the world market.

(a) Apparent, potential and hypothetical cost estimates

For the purposes of the analyses outlined above, no information was available on actual production costs in Latin American steelworks, as

/calculated and

calculated and applied by the plants themselves in their current operations. Even if they were available, they would be of little value for analytical purposes, since they are based on different methods of accounting and different financial and amortization policies.

It was decided, therefore to adopt a procedure used in earlier ECLA reports,14/ based on estimates of approximate production costs. These estimates are calculated on the basis of a hypothetical plant with a particular technical structure, physical inputs and prices and a specific location, either real or imaginary, determined in accordance with the factor prices established on the basis of the criterion selected.15/

This procedure, in spite of its drawbacks, is the only way of arriving at an approximate estimate of the relative weight or influence of the factor being evaluated. The variables can then be separated and their relative weight in operating conditions or the prospects for developing an industry assessed, all of which is reflected, in the last analysis, by production costs under fixed conditions. Consequently, the use of this method is justified for the purposes of this report, although it must be emphasized that the results thus obtained are merely approximate estimates.

In the analyses which follow, three different categories of costs were used:

(i) Apparent costs: these are calculated on the basis of real inputs in existing plants in Latin America and are applied to technical structures similar to those found in such plants.

(ii) Potential costs: these are calculated on the basis of real inputs but with reference to technical structures of hypothetical plants, i.e. where production capacity, equipment, degree of efficiency, etc. are different from those of real plants. This concept is used to estimate

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14/ ECLA, La industria química en América Latina (United Nations publication, Sales No.: 64.II.G.7).

15/ For more detailed information, see La economía siderúrgica de América Latina (E/CN.12/727).

/potential costs

potential costs in actual plants when they have been modified under present or planned expansion programmes, or is applied to hypothetical plants in some place in Latin America, using real inputs available in the location selected.

(iii) Hypothetical costs: these are calculated on the basis of hypothetical inputs as well as hypothetical plants. They are used to determine prospects for competing in the world market and to analyse the effect of technology on costs by comparing plants of the same size but using different techniques, or the effect of economies of scale by estimating manufacturing costs in plants with different production capacities.

(b) Limitations of cost estimates

The approximate nature of the estimates arrived at by this method must be clearly established, mainly to avoid confusion between these estimates and real costs in existing plants, to which they bear no relation whatsoever because of the methods used in calculating them.

Thus, when any of the cost estimates described above are used to make approximate comparisons in respect of actual plants situated in different countries, the following major limitations must be borne in mind:

(i) the comparisons are only valid within certain limits of approximation, which vary in each case, and only as comparisons of orders of magnitude and not of precise and exact figures;

(ii) moreover, the value of the comparisons depends on the degree of precision and detail with which the hypothetical plant and cost structures have been established, and on how well they simulate the operating conditions of the plants being compared. Although the information used for this purpose was the best available, and was often confirmed by the plants themselves, the data could create additional factors of distortion in the comparisons it is being attempted to establish;

(iii) finally, comparisons between different countries, by means of conversion to United States dollars, suffer from the imperfections inherent in such comparisons, because of the difference between official and parity exchange rates.

/In fact,

In fact, the question of the rate of exchange used for converting local currency into dollars is the main difficulty in obtaining reliability in the comparisons, in view of the varying degrees of internal and external monetary stability in the different Latin American countries.

For the purposes of the study, the value of the dollar used was in terms of the purchasing power of the local currencies in their domestic markets, as established in December 1962. ECLA made a study of this subject between 1960 and 1962 and the procedure used is described in detail in the final report.[16/] A comparison was made of a group of at least 500 articles in the different countries, in order to determine the domestic purchasing power of the currencies and thereby establish monetary equivalents in the most satisfactory manner. The method of parity equivalents has its drawbacks and limitations, but unfortunately no better method has been found for comparing prices in countries whose currencies are subject to serious fluctuations in value, and inevitably, the results obtained are not free from distortions.

The different production cost estimates described above - apparent, potential and hypothetical - have been used in this study as an instrument for analysing the problems raised by the modernisation and reorganization of the Latin American steel industry with a view to integrating the regional market and competing on the world market at a later stage of development. The object was not to analyse the situation and present structure of existing plants, since such an analysis would have to be less approximate and more detailed in approach than the procedure used in the present case.

2. The effect of the type of technology used in the plants on investment and production costs

Of the various cost factors, the study will deal first with those related to the level of technology used in the plants and those related to the volume or scale of production, so as to be able to refer to them in subsequent sections.

In order to appraise the value of the use of technological improvements, quantitatively, three types of plant structure were selected:

16/ ECLA, A measurement of price levels and the purchasing power of currencies in Latin America, 1960-62 (E/CN.12/653).

/(i) A modern

(i) A modern plant, designed and operated with maximum efficiency;

(ii) A plant using intermediate technology, at a level attainable by present Latin American plants when they have been expanded to achieve more balanced production facilities and applied technological improvements to the extent allowed by their equipment;

(iii) A plant operating at a technological level typical of existing Latin American plants.[17/]

The analysis referred solely to hypothetical plants producing flat products, with an annual capacity of 1.5 million tons, since the effect of technology is more striking in this type of production, and because cost comparison is more difficult to interpret in the case of non-flat products, on account of the nature of the equipment and production processes used. In addition, a high level of production was assumed, in order to eliminate the effect of economies of scale.

The inputs used in the three plants were given a hypothetical value on the basis of the average prices in Latin America in 1962 and are shown in table I-21.

17/ Operating data for 1963 for a Latin American plant were used to extrapolate the sizes of production units in order to obtain a balanced hypothetical plant.

/Table I-21

Table I-21

PRICES OF INPUTS USED IN COMPARATIVE COST CALCULATIONS

(Dollars at current prices)

	Unit	Argentina	Brazil	Chile	Mexico	Peru	Venezuela	Theoretical average price
Dollar equivalents:		134.14	920.00	1 886.00	12.49	26.60	7.08	1.0
1 Manganese ore	ton	31.31 c/	12.70	-	30.00	-	30.00	30.00
2 Iron ore	ton	14.55 c/	2.82	6.45	7.50	7.63	4.81	11.70
3 Coal	ton	17.69	18.33 d/	18.33 d/	8.00	25.75 e/	19.00 e/	18.00
4 Limestone	ton	7.40	3.44	7.05	1.60	8.64	3.45	7.00
5 Cooling water	m^3	0.005	0.005	0.005	0.02	0.02	0.002	0.005
6 Hydroelectric energy	kWh	-	-	-	-	0.005	0.002	0.005
7 Thermo-electric energy	kWh	0.0124	0.016	0.016	0.016	-	-	0.016
8 Ferro-alloys (open-hearth) f/	US$/ton	3.50	3.60	3.19	3.55	-	3.00	3.60
9 Ferro-alloys (electric furnace) f/	US$/ton	-	-	-	-	1.02	-	2.25
10 Ferro-alloys (Thomas process) f/	US$/ton	-	-	-	-	-	-	4.50
11 Ferro-alloys (LD - LD/AC) f/	US$/ton	-	-	-	-	-	-	3.15
12 Lime	ton	-	-	-	-	30.00	-	30.00
13 Refractories (open hearth) f/	US$/ton	3.50	-	3.50	3.11	-	3.60	4.00
14 Refractories (electric-furnace) f/	US$/ton	-	-	-	-	2.50	-	1.50
15 Refractories (LD) f/	US$/ton	-	-	-	-	-	-	0.80
16 Refractories (LD/AC) f/	US$/ton	-	-	-	-	-	-	1.00
17 Refractories (Thomas process) f/	US$/ton	-	-	-	-	-	-	1.00
18 Direct labour	man/hours	0.55	0.42	1.10	0.50	0.80	0.97 g/	1.50
19 Fuel oil	ton	20.80	23.00	20.00	23.55	-	13.40	20.00
20 Natural gas	1 000 m^3	7.40 h/	-	-	-	-	-	12.00 i/
21 Blast furnace gas	1 000 m^3	1.17	1.17	1.17	1.17	-	-	1.17 j/
22 Steam	ton	1.60	2.10	2.00	2.10	2.10	2.10	2.10
23 Oxygen	m^3	-	-	-	-	-	-	k/
24 Cost of sintering	US$/ton	-	0.80	-	0.80	-	0.80	0.80 l/
25 Soderberg electrodes	kg	-	-	-	-	0.14	0.14	0.13
26 Graphite electrodes	kg	-	-	-	-	0.50	-	0.60
27 Coke-oven gas	1 000 m^3	4.50	4.50	4.50	4.50	-	-	4.50 j/
28 Ammonium sulphate m/	ton	50.00	50.00	50.00	50.00	50.00	50.00	50.00
29 Pure benzol m/	ton	150.00	150.00	150.00	150.00	150.00	150.00	150.00
30 Motor benzol m/	ton	130.00	130.00	130.00	130.00	130.00	130.00	130.00
31 Toluol m/	ton	130.00	130.00	130.00	130.00	130.00	130.00	130.00
32 Xylol m/	ton	100.00	100.00	100.00	100.00	100.00	100.00	100.00
33 Coal-tar oil m/	ton	40.00	40.00	40.00	40.00	40.00	40.00	40.00
34 Combustible tar m/	ton	20.00	20.00	20.00	20.00	20.00	20.00	20.00
35 Naphthalene	ton	80.00	80.00	80.00	80.00	80.00	80.00	80.00
36 Slag (Thomas or similar process)	ton	12.00	-	-	-	-	-	12.00
37 Purchased scrap n/	ton	24.00	22.88	-	30.00	26.19	-	-
38 Circulating scrap o/	ton	-	-	-	-	-	-	-

a/ Direct cost, excluding capital charges.
b/ Relating to ores with low phosphorous content and 65 per cent iron.
c/ Average price of ore imported from Brazil, Chile and Peru.
d/ Corresponding to the average weighted price: in the case of Brazil, 60 per cent of the coal is imported at 17.17 dollars per ton and 40 per cent is domestic coal at 20.08 dollars per ton; in the case of Chile, 20 per cent is imported and 80 per cent is locally produced.
e/ Relating to price of imported coke.
f/ Cost of input per ton of ingot steel.
g/ Cost of one man/hour of work is 1.30 dollars at the official rate of exchange. The figure here refers to the equivalent of the purchasing power of the currency within the country, calculated in accordance with the procedure described in annex III.
h/ Price of gas for special industrial uses south of the Colorado river.
i/ 9,200-calorie gas.
j/ Valued as an equivalent of 9,200-calorie gas.
k/ Cost varies in accordance with the production capacity of the oxygen plant.
l/ Direct cost, excluding sinter plant capital charges.
m/ Standard average prices, estimated by comparing c.i.f. prices of similar imported products.
n/ Prices relating to domestically produced process and recovery scrap.
o/ Prices of circulating scrap estimated at 90 per cent of the cost of pig iron produced in each plant.

/The technology

The technology used in the plants is as follows:

Present technology	Intermediate technology	Modern technology
	(a) Iron-making	
Own coke plant, blast furnace. No sinter or fuel oil injection used, blast temperature of 700°C, high grade ore	Own coke plant, blast furnace with 30 per cent sinter, fuel oil injection and a blast temperature of 1,050°C, selected high grade ore	Own coke plant, blast furnace with 100 per cent self-fluxing sinter, fuel oil injection, blast temperature of 1,050°C, high grade ore or with concentrates
	(b) Steel-making	
Open-hearth furnaces without oxygen	Open-hearth furnaces, with 30 m^3 of oxygen per ton of steel	LD converters and continuous casting
	(c) Rolling	
Conventional blooming, ingots, soaking pits	Conventional blooming, ingots, soaking pits	Slabbing, continuous hot rolling and continuous cord rolling

(i) Investment. Table 1-22 contains the estimated investment and production costs, per production department, for the three types of plant. The results are not without significance. There is only a slight difference between investment costs per ton for the blast furnace unit in the intermediate and modern plants, but the difference is appreciable in relation to present technology.

/Table I-22

Table I-[illegible]

EFFECT OF THE TECHNOLOGY USED IN THREE HYPOTHETICAL PLANTS WITH AN ANNUAL CAPACITY OF 1.5 MILLION TONS OF FLAT PRODUCTS

(Dollars per ton and indexes)

Department	Theoretical production costs			Investment per ton of installed capacity		
	Present plant, 1963 figures a/	Plant using intermediate technology	Plant using modern technology	Present plant, 1963 figures a/	Plant using intermediate technology	Plant using modern technology
1. Blast furnace, production of pig iron	47.67	39.97	39.41 b/	60.5	48.2	45.6
2. Steel shop, production of ingots	74.07	64.15	61.39 c/	55.80	50.6	55.2 c/
3. Blooming and rolling mills, production of sheets and plates	132.07	120.52	100.62 b/	193.00	193.0	144.0
Overall plant investment				305.0	[illegible].7	238.6
Indexes of total investment				100.0	94.0	78.0
Index of cost of sheet steel	100.0	91.0	76.0			

a/ Data for a plant actually in operation in 1963 were used to extrapolate the sizes of production units in order to obtain a balanced hypothetical plant using the same technology. Input costs are the same as those for the other two hypothetical plants.

b/ These hypothetical costs differ slightly from the potential costs contained in other tables, since average input prices were used to adjust them to prevailing conditions in the region.

c/ Continuous casting results in steel in shapes and sizes which make subsequent blooming unnecessary. Consequently, certain costs are included under steel shop (line 2) whereas for plants using the other two technologies they are included under blooming and rolling mills (line 3).

/In steelmaking

In steelmaking, investment costs in the modern plant are very favourable, if considered in conjunction with investment in rolling, since blooming has been eliminated. There is also a difference in favour of intermediate technology, but it is not as great as for modern technology.

In rolling, there is no difference between present and intermediate technology, since they use the same kind of production process, but the disappearance of the conventional blooming mill has a marked effect on investment costs in the case of the modern plant. In all, there is a difference in investment in favour of the modern plant of approximately 19 per cent in relation to the intermediate, and of 25 per cent in relation to the present type, with the result that the difference between the present and intermediate plants is not very great, scarcely 6 per cent. This is only to be expected since most of the equipment is the same.

(ii) Production costs. Once again the greatest differences are in ironmaking, but this time only between present and intermediate technology since costs are practically the same in the intermediate and modern plants. In steel making, too, costs are more favourable in the intermediate than in the present plant, and greater overall costs in the present plant increase the price of the ingot steel feeding, the rolling mill, thus increasing the cost of the final product. As a result of the disappearance of the blooming mill, lower amortisation costs and the greater efficiency resulting from direct rolling of continuously cast slabs, in the final process there is also a difference in favour of the modern plant, a difference which is not very apparent in the smelting and steelmaking processes.

/With modern

With modern technology, costs are 15 per cent lower in relation to intermediate technology and 24 per cent lower in relation to present technology, and the difference between costs of present and intermediate is approximately 9 per cent.

These estimates are a clear indication of the advantages of applying technological developments in existing plants so that they can quickly be raised to the intermediate level, particularly in iron and steelmaking where these developments can be used to the greatest advantage. Production costs would be lowered by almost 13 per cent in those two departments and by 9 per cent in respect of the final product. Similarly, the figures contained in table I-23 clearly indicate the advantages that new plants designed and equipped with the latest technological developments have over present, and even intermediate plants.

3. The effect of economies of scale in plants with an annual capacity of 1 to 1.5 million tons

Scales of production affect investment per ton of rolled products and certain direct production costs, particularly labour, maintenance costs, etc., thus giving rise to sizable economies of scale. For this reason, and in order to evaluate the overall effect, it is necessary to calculate total manufacturing costs for different plant sizes. ECLA has recently completed a special study of the effects of economies of scale in steelworks with an annual capacity of 25,000 to 300,000 tons as well as the 100,000 to 2.5 million ton range, the results of which shed more light on the subject.

For this purpose, and to ensure that the comparison would also be applicable in Latin America, hypothetical investment and production costs were calculated per ton of installed capacity in intermediate plants producing between 100,000 and 1.5 million tons of ingots; the average inputs contained in table I-21 were used in computing production costs. The inputs are therefore theoretical and do not correspond to any specific plant or location and the comparison is a purely theoretical one in which economies of scale are the only variable factor.

/Table I-23

Table I-83

EFFECT OF ECONOMIES OF SCALE ON THE LEVEL OF INVESTMENT IN PLANTS USING INTERMEDIATE TECHNOLOGY AND PRODUCING FLAT PRODUCTS b/

(Dollars per ton of installed capacity and relative indexes)

	Annual plant capacity (in thousands of tons)							Percentage variation between investment per ton for C and F (400 000 and 1 million-ton plants)	Percentage variation between investment per ton for C and G (400 000 and 1.5 million-ton plants)
	100 A	200 B	400 C	500 D	800 E	1 000 F	1 500 G		
1. Investment in blast furnace per ton of pig iron produced	94.73	86.07	75.00	69.33	57.93	52.60	48.33	29.87	35.56
2. Investment in open-hearth steel shop per ton of ingots produced	74.60	69.07	59.07	53.13	42.73	37.27	30.47	36.91	48.42
3. Investment in rolling mill per ton of flat products per year	482.07	427.20	328.67	286.07	219.13	198.33	191.87	39.66	41.62
4. Total investment per ton of products	724.35	635.42	484.51	428.76	330.04	314.58	281.86	35.11	41.83
5. Total investment indexes; 100 000 ton-plant = 100	100	88	67	59	46	43	39		

a/ Investment on basis of world prices for equipment, but 20 per cent higher than in the industrialized countries because of greater transport and assembly costs. Does not include labour or other common investment in Latin American plants, such as ports, railways, mines, settlements, etc.

b/ The table shows investment figures for the blast furnace and steel shop rather than the figures relating to the proportion of their output which goes into the rolling process.

/The results

The results are shown in tables I-23 and I-24, which indicate that economies of scale have a considerable effect on investment and production costs, particularly investment, since while production costs fall by 49 per cent as capacity rises from 100,000 to 1.5 million tons, investment falls by 61 per cent. The effect is most apparent in the 100,000 to 800,000 ton range.

Table I-25 classifies twelve Latin American plants of varying size according to their production in 1965. There are eight plants of less than 500,000 tons, two between 500,000 and 800,000 and two of more than 1 million (Volta Redonda, in Brasil, with a production of 1,256,000 tons of ingots, and Altos Hornos, in Mexico, with a production of 1,111,000 tons). Average production was about 496,000 tons; in other words, these plants are situated in the range, in terms of the concept of economies of scales, where the effect of this cost and investment factor is most striking. The plants can also be classified according to blooming capacity. Table I-26 shows that, instead of 40 per cent of total actual production occurring at a level of more than 1 million tons, there are five plants (Volta Redonda, San Nicolás, Monterrey, Altos Hornos de México and Orinoco) with a blooming capacity of more than 1 million tons, which could account for 75 per cent of total production on the basis of this production criterion. Nevertheless, there are five plants with a rolling capacity of less than 400,000 tons and two plants at the 650,000 ton level. No account has been taken of the new USIMINAS and COSIPA plants in Brasil, which are of modern design and scale, with capacities of between 800,000 and 1 million tons, but which have only just entered into operation. The total blooming capacity of the plants under consideration is approximately 9.6 million tons, but if USIMINAS and COSIPA are included, it would amount to about 13 million, whereas actual production was about 6 million tons. Consequently, there is a deficit of about 6.2 million tons in the supply of pig iron and steel 18/ for processing in the rolling mills. Thus, it is clear that, rolling capacity is not fully utilized and that there is an urgent need to remedy the shortage of ingots for processing in the mills.

18/ See calculation made under part C above.

/Table I-24

Table I-24

EFFECT OF ECONOMIES OF SCALE ON THE HYPOTHETICAL PRODUCTION COSTS OF FLAT PRODUCTS IN PLANTS USING INTERMEDIATE TECHNOLOGY

(Dollars per ton produced and relative indexes)

	Annual plant capacity (in thousands of tons)							Percentage variation between theoretical cost for C and F (400 000 and 1 million-ton plants)	Percentage variation between theoretical cost for C and G (400 000 and 1.5 million-ton plants)
	100 A	200 B	400 C	500 D	800 E	1 000 F	1 500 G		
1. Hypothetical cost of 1 ton of pig iron using 50 per cent sinter in the blast furnace	55.04	49.52	45.38	43.88	41.83	40.83	39.57	10.00	12.80
2. Hypothetical cost of 1 ton of ingots in the open-hearth furnace with oxygen	95.22	87.31	77.83	74.50	70.22	68.02	64.97	12.60	16.52
3. Hypothetical cost of 1 ton of conventional flat products	235.49	212.58	169.55	158.29	135.05	126.74	120.85	25.25	28.72
4. Index of hypothetical costs of flat products, costs for a 100 000-ton plant = 100	100	90	72	67	57	54	51		

a/ Unit prices of inputs correspond to average prices of input in Latin America.

/Table I-25

Table I-25

DISTRIBUTION OF TWELVE PLANTS, BY STEEL OUTPUT IN 1965 a/

Production of ingot steel	Number of plants	Total production	Average production	Percentage of total production
Between 1 and 1.5 million	2	2 367	1 183.5	39.8
Between 800 000 and 1 million	-	-	-	
Between 500 000 and 800 000	2	1 306	653.0	21.9
Between 400 000 and 500 000	4	1 706	426.5	28.7
Between 200 000 and 400 000	1	205	205.0	3.4
Between 100 000 and 200 000	1	195	195.0	3.3
Less than 100 000	2	172	86.0	2.9
Total	12	[illegible]	[illegible]	[illegible]

Source: ECLA, on the basis of data contained in table I-18.

a/ Usiminas and Cosipa have not been included because both plants are still not fully in operation. The plants included are: San Nicolás, Volta Redonda, Acesita, Belgo-Mineira, Mannesmann, Paz del Río, Huachipato, Altos Hornos de México, Hojalata y Lámina, Chimbote and Orinoco.

Table I-26

DISTRIBUTION OF TWELVE PLANTS, BY INSTALLED BLOOMING CAPACITY a/

Installed capacity of blooming mills	Number of plants	Total blooming capacity (Thousands of tons)	Average blooming capacity (Thousands of tons)	Percentage of total capacity
Between 1 and 1.5 million	5	7 [illegible]	1 [illegible]	[illegible]
Between 800 000 and 1 million	-	-	-	-
Between 500 000 and 800 000	2	1 300	650	13.5
Between 400 000 and 500 000	-	-	-	-
Between 200 000 and 400 000	3	[illegible]	[illegible]	[illegible]
Between 100 000 and 200 000	2	300	150	3.1
Less than 100 000	-	-	-	-
Total	[illegible]	[illegible]	[illegible]	[illegible]

Source: Calculated on the basis of the data contained in table I-14.

a/ Usiminas and Cosipa have not been included because both plants are still not fully in operation. Their blooming capacities are 1.0 and 1.5 million tons respectively, giving a total blooming capacity of 13 million.

/It is,

It is, therefore, not surprising that the Latin American steel industry, which is at present engaged in the scale of production range most affected by this factor and uses a technology already discarded in similar plants in the developed countries, is inevitably faced with higher costs, although this does not mean that there is any justification, in certain cases, for the high protection it enjoys or for present steel prices.

R. [redacted]

F. DEVELOPMENT ALTERNATIVES

1. Apparent costs in existing plants and theoretical costs in hypothetical plants

It is obvious that the expression "standard production costs" is inapplicable to the steel industry in Latin America, since its costs are influenced by a large number of factors. For the sake of simplification, the following may be regarded as representative of the main factors:

(i) The quality and type of the raw materials;

(ii) Stocking costs;

(iii) Utilisation of raw materials in the steelmaking cycle;

(iv) Production scale;

(v) Type, capacity and efficiency of the production equipment;

(vi) Labour efficiency and qualifications, and competence of the administrative and technical staff;

(vii) The range of finished products and its effect on the length of the production series.

(a) Apparent costs in existing plants

Apparent costs have been calculated for each of the production departments: the smelting section, the steel shop and the rolling mills. For the selection of physical inputs, it has been assumed that existing machinery is being fully and efficiently used in the plants, and that the physical yield and productivity of the blast furnaces, equipment and labour are in keeping with the characteristics of the raw materials. Labour productivity has been assumed to be uniform in all plants for want of data to estimate it, but this has little effect on the calculations of the relevant apparent costs. Steelmaking equipment has been calculated at replacement cost, which is 10 per cent higher than the cost of buying equipment in the United States on the basis of competitive tenders from several manufactures. This percentage has been added in order to cover transport and other related costs.

Table I-27 gives the unit price of the principal inputs taken into account in estimating apparent costs.

/Table I-27

Table I-27

LATIN AMERICA: UNIT PRICES OF THE MAIN INPUTS CONSIDERED IN CALCULATING APPARENT COSTS

(Dollars at current prices)

	Unit of measurement	San Nicolás	Volta Redonda	Huachipato	Monclova	Chimbote	Orinoco	CECA	Vitoria (Brazil)	Las Truchas (Mexico)
Iron ore										
Price	ton	14.55	3.84	6.45	7.50	7.63	4.91	12.30	4.96	3.60
Iron content	percentage	63	63	63	60	63	58.9	63	65	60
Price of coke	ton	26.28	23.67	29.57	13.50	25.75	19.00	21.24	20.00	26.90
Price of scrap	ton	24.00	22.88	25.00	30.00	28.19	25.00	30.00	24.66	27.21
Direct labour costs	m/h	0.55	0.42	1.10	0.50	0.80	0.97	1.66	0.42	0.50
Cooling water	m3	0.005	0.005	0.005	0.02	0.02	0.002	0.005	0.01	0.01
Electric power	kWh	0.0124	0.016	0.016	0.016	0.005	0.002	0.01	0.016	0.016
Ferro-alloys per ton of steel	$/ton	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31	3.31
Refractories per ton of steel	$/ton	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Fuel oil	ton	20.8	23.00	20.00	23.55	20.00	13.40	20.00	20.00	20.00
Oxygen	m3	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
Direct cost of sinter preparation	$/ton	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Rates of exchange	a/	131.14	680	1.886	12.49	26.60	7.08	-	680	12.49

Source: Information from plants in Latin America and from other sources. The rates of exchange were chosen in the manner described in the text.

a/ Monetary unit per dollar.

/(1) Pig iron:

(i) Pig iron: stocking costs. These are dealt with in table I-28, which is divided into two parts, the first dealing with stocking costs and the second with the costs of smelting itself in six Latin American plants. Table I-29 presents the figures for specific consumption of certain inputs in the same reduction units.

Table I-28 shows that stocking costs account for 53 to 74 per cent of the total cost of pig iron, and are consequently an important cost component. They are impossible to recover at later stages of the steelmaking cycle, however efficient the equipment or the methods of operation, so specific consumption of raw materials and transport costs are decisive in determining stocking costs and a major cost factor.

The Latin American steel plants could undoubtedly reduce their specific coke consumption by full utilisation of modern operational techniques in smelting. It is estimated that the reduction in coke consumption through a suitable combination of such procedures might be as much as 30 per cent, paralleled by an increase of 30 per cent in blast furnace capacity. Added to the fact that the ore placed on site costs very little in itself, this would make for a considerable reduction in the present figures and a highly favourable final cost for pig iron production.

(ii) Apparent cost of steel and of refining operations. Table I-30 shows the apparent costs of steel production in the six plants selected, while the corresponding inputs are listed in table I-31. With the exception of Chimbote, the plants have open-hearth furnaces, since this type of installation lasts for years and 75 per cent of the steel ingots were being produced in open-hearth furnaces in 1964.

It is immediately apparent from table I-30 that the primary cost of pig iron alone is nearly 50 per cent, and is followed in order of importance by the cost of the scrap used in the steel shop. The two together account for 60 to 70 per cent of the total cost, and, with the charges for amortisation of capital, which are about 10 per cent, constitute the three main cost components in steel production.

/Table I-28

Table I-28

LATIN AMERICA: APPARENT COSTS OF IRON ORE SMELTING IN SELECTED STEEL PLANTS

(Dollars at 1963 prices per ton of pig iron, and annual output in thousands of tons)

Item	San Nicolás	Volta Redonda	Huachipato	Monclova	Chimbote	Orinoco
Pig iron production (in thousands of tons a year)	515.00	854.00	400.00	464.00	40.00	555.00
1. Iron ore	22.54	2.23	10.40	7.95 a/	12.89	5.21 b/
2. Sinter	-	3.14	-	5.90 a/	-	3.88 b/
3. Manganese ore or equivalent	0.94	0.32	0.60 c/	0.90	-	0.90
4. Fuel	18.40	20.24	17.77	11.21	10.30	7.60
5. Limestone	2.18	1.52	1.51	0.72	2.36 d/	1.21
6. Electric power for reduction	-	-	-	-	13.50	5.26
7. Gas credit	-2.94	-3.00	-1.99	-2.90	-1.62	-1.62
8. Total cost of stocks	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9. Direct labour costs	0.28	0.28	0.69	0.25	2.64	1.46
10. Indirect labour costs	0.66	0.45	0.90	0.90	3.10	0.75
11. Total	[illegible]	0.73	1.59	1.15	5.74	[illegible]
12. Cooling water	0.17	0.12	0.10	0.68	0.60	0.06
13. Fuel oil	-	-	1.68	-	-	-
14. Electrodes	-	-	-	-	2.80	2.80
15. Repairs and miscellaneous expenditure	2.80	2.90	2.90	4.90	8.60	3.70
16. Total other transforming expenditure	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17. Total direct costs	45.73	28.20	33.96	30.11	55.17	31.21
18. Capital charges e/	10.99	12.30	12.00	13.00	15.99	9.91
19. Total costs	[illegible]	[illegible]	[illegible]	[illegible]	71.16	[illegible]

a/ Ore with 58 per cent iron content; sinter content 54 per cent.
b/ Ore with 58.8 iron content; sinter content 54 per cent.
c/ Ferro-manganese slag.
d/ Limestone: 207 kilogrammes; steel slag: 150 kilogrammes.
e/ In the reduction department, 150 per cent of the fixed assets, of which 6 per cent is assumed for amortization and 9 per cent for payments of interest.

/Table I-29

Table I-29

LATIN AMERICA: SPECIFIC CONSUMPTION OF SELECTED INPUTS IN THE IRON-ORE REDUCTION DEPARTMENTS

Item	Unit of measurement	San Nicolás	Volta Redonda	Huachi-pato	Monclova	Chimbote	Orinoco
System of work of the blast furnaces (thousands of tons of pig iron annually)		515.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1. Iron ore	ton	1.57	0.790	1.613	1.06	1.690	1.660
2. Sinter	ton	-	0.700	-	0.71	-	0.600
3. Manganese ore or equivalent	ton	0.03	0.025	0.15 a/	0.03	-	0.03
4. Fuel (coke)	ton	0.70	0.855	0.681	0.83	0.40	0.40
5. Limestone	ton	0.295	0.449	0.215	0.45	0.397 b/	0.35
6. Electric power for reduction	kWh	-	-	-	-	2.70	2.650
9. Direct labour	m/h	0.50	0.66	0.63	0.50	3.50	1.50
12. Cooling water	m3	54.00	24.00	20.00	54.00	30.00	28.00
13. Fuel oil	kg	-	-	54.00	-	-	-
14. Electrodes	kg	-	-	-	-	20.00	20.00

a/ Ferro-manganese slag.

b/ Limestone: 207 kilogrammes; steel slag: 190 kilogrammes.

/Table I-30

Table I-50

LATIN AMERICA: APPARENT COST OF STEEL PRODUCTION IN SELECTED STEEL PLANTS

(Production in thousands of tons of ingots annually and apparent costs per ingot ton)

Item	San Nicolás	Volta Redonda a/	Huachi-pato	Monclova	Chimbote	Orinoco
Annual capacity (thousands of tons)	988.20	970.00	500.00	610.00	62.00	288.00 b/
1. Liquid pig iron	41.69	33.66	38.56	35.00	34.09	35.38
2. Scrap c/	16.08 d/	10.02	5.29	19.01	36.50	12.22
3. Iron ore	1.02	0.84	1.13	0.49	0.93	0.18
4. Ferro-alloys	3.50	3.60	3.19	3.55	1.02	3.00
5. Total cost of furnace materials	62.29	47.52	48.17	58.05	72.54	50.71
6. Direct labour	1.02	1.10	2.22	0.88	2.24	1.89
7. Indirect labour	0.82	0.60	1.92	1.15	2.35	0.85
8. Total labour costs	1.84	1.70	3.94	2.03	4.52	2.74
9. Fuels	1.77	2.71	2.00	3.18	-	2.49
10. Refractories	3.50	4.00	3.50	3.11	2.50	3.60
11. Electric power	-	-	-	-	2.50	-
12. Limestone or lime	0.96	0.52	0.46	0.15	1.20	0.38
13. Oxygen	-	0.09	-	0.47	-	-
14. Electrodes	-	-	-	-	2.35	-
15. Supplies, services and miscellaneous expenditure	6.28	6.31	6.90	6.50	4.95	6.60
16. Total other transforming costs	12.51	14.43	12.86	13.41	13.50	13.07
17. Total direct costs	76.64	63.65	64.97	68.49	90.63	66.52
18. Capital charges	8.73	8.10	9.34	7.74	10.50	8.75
19. Total costs	85.37	71.75	73.31	71.23	101.13	75.27

a/ Calculated at the rate of 920 cruzeiros to the dollar.

b/ Production estimated on the basis of open-hearth furnaces without oxygen injection.

c/ The cost is estimated at 90 per cent of the cost of liquid pig iron.

d/ Purchased scrap is 32 per cent of the total.

/The price

The price of scrap is of considerable importance. It depends on physical conditions in the vicinity of the plant, the amount of scrap available, and the company's policy for valuing reused scrap in its internal accounts. As a rule, scrap is cheaper in Latin America than in the more advanced countries, but the volume of supplies is steadily decreasing and its prices will eventually become comparable with international prices. This will not be a favourable cost factor.

When the steel shops in Latin America have completed their programmes of expansion, are making extensive use of oxygen and have brought their sections into proper balance, they will be able to work at full capacity, increase their output and reduce amortisation charges. It is thought likely that production could exceed nominal furnace capacity by 20 to 30 per cent and its 1964 level by 50 per cent, with the consequent effect on costs.

Steel shops with LD or similar converters will be in an even better position, because they are dependent on the price of pig iron rather than of scrap, which is more likely to improve. Their capital charges are also lower, since the investment needed for converters is estimated to be 28 to 33 per cent less than the capital cost of a steel shop based on open-hearth furnaces.

Refining costs, which varied between 23.08 and 28.59 dollars per ton in the six plants, are also likely to drop in future in the steel shops that plan to install LD converters when they expand, since they would benefit to some extent from the advantages of that method.

(iii) Apparent rolling costs. Investment in rolling accounts for 40 to 60 per cent of the total cost of a steel plant, and as the process itself is not very expensive, the factors bearing on the total cost of the rolled products are the cost of the ingot as raw material, of the recirculating scrap and of the amortisation charges.

Most of the Latin American steel plants have certain initial advantages as regards the production costs of pig iron and steel, but lose them to a great extent at the rolling stage mainly for the following reasons:

/Table I-31

Table I-31

LATIN AMERICA: SPECIFIC CONSUMPTION OF SELECTED INPUTS IN SIX STEEL PLANTS

Item	Unit of measurement	San Nicolás	Volta Redonda	Huachipato	Monclova	Chimbote	Orinoco
Output of steel shapes (thousands of tons of ingot annually)		[illegible].1 a/	[illegible]	[illegible] a/	[illegible]	[illegible]	[illegible] a/
1. Liquid pig iron	ton	0.735	0.8[illegible]	0.839	0.5[illegible]	0.479	0.857
2. Scrap	ton	0.315 b/	0.275	0.128	0.490	0.570	0.3[illegible]
3. Iron ore	ton	0.070	0.085	0.175	0.065	0.122	0.1[illegible]
4. Ferro-alloys	kg	10	8	5.1	13.55	6.00	5.00
5. Direct labour	m/h	1.85	1.67	2.02	1.75	2.00	1.95
6. Fuels	kg	[illegible]	118	100	135	-	186
7. Electric energy	kWh	-	-	-	-	500	-
8. Limestone or lime	kg	150	150	65	90	40	110
9. Oxygen	m3	-	3.5	-	50	-	-
10. Electrodes	kg	-	-	-	-	4.7	-

a/ Production estimated on the basis of open-hearth furnaces without oxygen injection.

b/ Purchased scrap is 32 per cent of the total.

/Imbalances between

Imbalances between rolling, and pig iron and steel production. The result is a constant proportion of idle capacity and failure to make proper use of the capacity of the rolling equipment.
The variety of products that have to be manufactured because of market limitations. This involves short production series, loss of time due to the need to change the rolls and supplementary investment in rolls, apart from the additional cost of producing and inspecting miscellaneous products in small quantities.

It is generally considered that full use is being made of rolling equipment when about three shifts are worked daily for six days and one additional working day. This cuts the time for roll changing and upkeep to the minimum, and entails a certain amount of specialization for maintaining long production series and good operatives. In present conditions a work yield of 80 to 85 per cent may well be considered as the minimum acceptable level in Latin America, that is, a total of approximately 16 shifts a week. This means that the evening and night of Saturday and the whole of Sunday are free for repairs and roll changing.

Expressed in these terms, it can be seen from tables I-14 and I-15 that the main Latin American integrated steelworks could fully utilise the capacity of their rolling mills if the blooming mills could supply up to 80 per cent of that capacity, and if the blooming mills in their turn were fully supplied by the steel shops. Thus, when there is a proper balance between the various production processes, a satisfactory level of productivity can be achieved. In many plants, such as Paz del Río, Huachipato, a number of Mexican plants, etc., rolling has exceeded the original planned nominal capacity, and it is therefore hoped that, with efficient operation or with low-cost auxiliary equipment, the output of the rolling mills will measure up to the capacities indicated in the tables.

The efficiency of a rolling mill and its total output must be expressed in terms of hours of work and of hourly yield for each rolled product. The range of final products thus has considerable bearing on total tonnage, yield and operating costs. It is not possible, within the limits of this

/study, to

study, to specify in each particular case the effect of choosing this or that range of rolled products. However, it can be said that, within the framework of a co-ordinated steel plan for several plants and with a wider regional market, there would be many advantages to low-capacity plants specializing in certain products in order to obtain maximum yield.

Table I-32 shows the apparent costs of flat products for four plants: San Nicolás, Volta Redondá, Huachipato and Altos Hornos de México in their 1962 programmes, and table I-33 gives the apparent costs of non-flat products in the Volta Redonda, Huachipato, Chimbote and Orinoco plants, also in relation to their 1962 production.

(b) Theoretical costs in hypothetical plants

An analysis has already been made of the present situation of Latin American plants as regards production costs and how they could be reduced in the future by means of intensive reorganization and modernisation.

There remains the question of the situation of the plants when this period of reorganization is completed; whether, even where plants are comparable in size and technology, location and other inherent production factors might not give rise to differences in future costs, thus making it difficult for some of the plants to compete freely on a regional basis and to what extent the Latin American steel industry will be able at that time to compete on the world market.

In order to answer those questions, estimates were made of the production costs of hypothetical Latin American plants, well off with regard to raw materials and foreign trade, sufficiently large in size and employing modern technology, and they were compared with others in the same category and with similar plants situated outside the region. This type of analysis makes it possible to explore the question whether certain Latin American sites offer appreciable locational advantages, and whether or not costs could be reduced sufficiently to enable the industry to compete on the world market.

/Table I-32

Table I-32

LATIN AMERICA: APPARENT COSTS OF PRODUCTION OF FLATS IN SIX STEEL PLANTS a/

Cost components	Unit of measurement	San Nicolás 417 000 tons b/		Volta Redonda 549 000 tons c/		Huachipato 201 000 tons d/		Monclova 262 300 tons e/	
		Specific consumption	Cost	Specific consumption	Cost	Specific consumption	Cost	Specific consumption	Cost
1. Ingot steel	Ton	1.420	120.37	1.403	106.48	1.610	119.00	1.550	111.96
2. Fuel		-	1.48	-	1.48	-	1.85	-	1.89
3. Scrap credit	Ton	0.394	-14.40	0.360	-11.52	0.497	-16.93	0.405	-13.84
4. Total raw materials		-	107.45	-	96.37	-	103.92	-	100.01
5. Direct labour in the rolling mills	m.h.	2.30	1.87	2.65	1.75	5.55	6.11	3.15	1.58
6. Indirect labour		-	0.83	-	1.22	-	2.15	-	0.88
7. Total labour costs		-	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]
8. Refractories and spare parts		-	3.60	-	3.60	-	3.60	-	3.60
9. Supplies, services and miscellaneous expenditure		-	2.14	-	2.00	-	1.90	-	1.80
10. Electric power		-	3.00	-	3.90	-	5.45	-	5.40
11. Total supplies and services		-	[illegible]	-	[illegible]	-	[illegible]	-	[illegible]
12. Total direct costs		-	[illegible]	-	[illegible]	-	123.13	-	113.87
13. Capital charges		-	72.70	-	49.40	-	64.33	-	59.40
14. Total costs			[illegible]		[illegible]		[illegible]		172.67

a/ The production programmes considered are approximately the same as the 1962 programmes, except for those of San Nicolás, which are hypothetical.

b/ Production comprises 77 000 tons of hot rolled sheet, 200 000 tons of cold rolled sheet and 140 000 tons of tinplate.

c/ Production comprises 116 000 tons of hot rolled plate, 165 000 tons of hot rolled sheet, 154 000 tons of cold rolled sheet and 114 000 tons of tinplate.

d/ Production comprises 83 000 tons of hot rolled sheet, 11 000 tons of cold rolled sheet and 37 000 tons of tinplate.

e/ Production comprises 90 700 tons of hot rolled sheet, 102 000 tons of cold rolled sheet and 68 800 tons of tinplate. The surplus steel ingots produced are presumably to be used to manufacture billets.

/Table I-33

Table I-33

LATIN AMERICA: APPARENT COSTS OF NON-FLAT PRODUCTS IN SELECTED STEELWORKS a/

Cost component	Unit	Volta Redonda 128 728 tons b/		Huachipato 152 000 tons c/		Chimbote 52 700 tons d/		Orinoco 422 700 tons e/	
		Specific consumption	Cost (dollars)	Specific consumption	Cost (dollars)	Specific consumption	Cost (dollars)	Specific consumption	Cost (dollars)
1. Ingot steel	ton	1.265	90.26	1.250	93.39	1.295	124.90	1.385	104.25
2. Fuel		-	0.95	-	1.11	-	1.11	-	0.95
3. Credit entry for scrap	ton	0.200	-6.40	0.188	-6.97	0.176	-10.26	0.289	-9.72
4. Total raw materials		-	84.81	-	86.53	-	115.75	-	95.48
5. Direct labour	m/h	1.95	0.83	2.45	2.70	3.90	3.12	2.25	2.18
6. Indirect labour		-	0.60	-	1.10	-	1.00	-	0.70
7. Total labour		-	1.43	-	3.70	-	4.12	-	2.88
8. Refractories and spare parts		-	1.65	-	1.65	-	1.80	-	2.05
9. Materials, services and general expenditure		-	5.11	-	5.10	-	5.20	-	3.75
10. Electric energy	kWh	140.00	2.24	-	2.37	-	2.90	-	2.10
11. Total materials and other services		-	9.00	-	9.12	-	9.90	-	7.90
12. Direct expenditure		-	95.24	-	99.35	-	129.17	-	106.26
13. Capital charges		-	20.10	-	19.35	-	27.90	-	13.00
Total costs		-	115.34	-	118.70	-	157.07	-	119.26

a/ Production programmes correspond approximately to the 1962 programmes, except for Orinoco, where imaginary figures based on the capacity of the equipment have been used.

b/ Costs have been calculated on the basis of 920 cruzeiros to the dollar, a rate of exchange which probably results in costs that are slightly lower than real costs. Production can be broken down as follows: 62 390 tons of structural shapes, 2 195 tons of special shapes, 17 878 tons of round bars and 46 265 tons of square bars.

c/ Production corresponds to 140 000 tons of bars and light steel shapes and 12 000 tons of billets.

d/ Production consisted of 48 700 tons of bars and light steel shapes and 4 000 tons of wire rods. Production of 3 600 tons of hot rolled sheet steel has not been included in the calculation.

e/ The production in question relates to the supply of ingot steel and is broken down as follows: 127 000 tons of bars and structural shapes and 295 000 tons of seamless tubes.

/For these

For these purposes, it was necessary to make several types of cost analysis, such as:

(i) A comparison between hypothetical plants with identical layouts and ranges of final rolled products, situated in the main Latin American steelmaking centres, in order to study the respective locational advantages. This, of course, implies the use of real inputs for each site and is, therefore, an analysis of potential costs for those locations;

(ii) A comparison between a hypothetical plant, or several as the case may be, situated in some favourable location in Latin America, and another plant situated outside the region, both of the same size and structure and theoretically with the same degree of operational efficiency and the same range of finished products. As plants and inputs are both hypothetical, since no particular location is actually specified, this analysis amounts to an estimate of hypothetical costs, the purpose of which is to assess the region's prospects of competing in world markets.

Hypothetical modern plants with an annual capacity of 1.5 million tons of flat products were selected as the most appropriate for this type of comparison, since it is difficult to compare plants producing non-flat products, because they have different structures and systems.

Potential costs were estimated for Latin American plants in the same locations as the San Nicolás, Volta Redonda, Huachipato, Altos Hornos de México, Chimbote and Orinoco plants, and hypothetical costs were estimated for the European plant. These estimates relating to the production of flat products are presented in table 1-34.

The differences between the potential costs for plants of the same size and structure are the result of lower prices for inputs in a specific location, mainly iron ore and coal. For this reason, table I-34 shows higher costs for San Nicolás, because of the value attached to inputs and because iron ore has to be imported at San Nicolás. The same table seems to indicate that, given the stipulated theoretical conditions, the hypothetical Orinoco and Volta Redonda plants could compete with the San Nicolás plant on favourable terms, and that the former have certain locational advantages. However, since the present price of iron ore at the San Nicolás plant is lower than the price used for the estimates, and there is a possibility that it will be further reduced by obtaining iron ore from more favourable sources (Mutún and Urucum, for example), the differences in question do not mean that the Orinoco and Volta Redonda sites have any permanent advantage.

/Table I-34

Table I-34

HYPOTHETICAL AND POTENTIAL PRODUCTION COSTS IN HYPOTHETICAL STEELWORKS IN DIFFERENT LOCATIONS IN LATIN AMERICA AND ON THE COAST OF A ECSC COUNTRY a/

(Hypothetical and potential costs in dollars per ton)

	Western Europe	Plant sites					
		San Nicolás	Volta Redonda	Huachipato	Altos Hornos de México	Chimbote	Orinoco
	(Hypothetical costs)	(Potential costs)					
1. Cost of one ton of pig iron	39.45	44.11	26.39	33.26	27.75	33.44	25.68
2. Cost of one ton of continuously cast slabs for use in rolling flat products b/	60.40	61.56	46.06	53.12	49.57	53.99	46.69
3. Cost of one ton of flat products c/	99.59	99.88	81.91	91.49	85.15	89.52	80.96

Source: ECLA.

a/ This table is based on data for a plant with an annual rolling capacity of 1.5 million tons, with the following technical structure: its own coke plant, blast furnaces with a charge of 100 per cent self-fluxing sinter, fuel oil injection and a blast temperature of 1,050° C; steel shop with LD, Kaldo or similar converters; continuous casting of slabs with vacuum degassing; rolling mills of the following type: continuous rolling mill which takes the slabs from the continuous casting lines, continuous cold rolling mill; and continuous electrolytic tinning lines.
Average yield of rolled products 85 per cent. Input prices used are given in table I-29 and wages are in accordance with prevailing local rates at the time the information was collected.

b/ Continuous casting results in the direct production of slabs supplying the rolling mill and dispenses with the costly blooming process. It also dispenses with soaking pits, cranes for extracting the ingots from the moulds, etc.

c/ The range of rolled products corresponds to that normally found in Latin American steelworks: hot rolled sheet and plate steel, cold rolled sheet steel and tinplate.

/ In general,

In general, it can be said that, given equal conditions as regards size and level of technology, the present Latin American steel centres have no particular locational advantages as regards costs of production, or at least none that cannot be offset by greater costs for transport of finished products from the plant to consumer markets; consequently it is unlikely that there would be severe competition. These considerations, with due regard for the assumptions implicit in the question of size and technological level, help to shed some light on one of the most important questions raised by the creation of a common market in steel.

A comparison between the Latin American plants taken as examples, in the locations indicated, and the hypothetical costs estimated for a European plant situated in one of the ECSC countries leads to the following conclusions. In practically all cases, costs in the Latin American plants are lower. In the most favourable locations, which in these examples are Orinoco and Volta Redonda, the differences range from fifteen to twenty dollars per ton, which is probably enough to offset shipping costs between the Latin American Atlantic coast and the ECSC country, and this indicates that there is a possibility of competition. Consequently, the steel industry could plan its future development with a view to competing on international markets and becoming part of the world steel market. As the planned development is presumed to be over the long term, possibly from 1970 onwards, present steel enterprises should consider the possibility of exports and should plan further expansion programmes to succeed those at present under way with a view to participating in world steel trade.

2. Expansion and investment envisaged for the Latin American steel industry during the periods 1965-70 and 1970-75

Initial investment in Latin American steelworks was high, ranging from 375 to 600 dollars per ton of ingot steel, and at the time represented a very large investment for the Latin American countries in relation to investment in other economic sectors. It is clear, therefore, that the efficiency and economy with which these expansions are undertaken will be of great importance in achieving greater balance and reducing unit investment to a reasonable level. On the other hand, in terms of future policy on the steel industry, the size of this effort and the importance of the present

/industry, which

industry, which has an approximate value of between 3,000 and 3,200 million dollars, including investment in semi-integrated plants and small rolling mills, must not be underrated.

Table I-35, which indicates the amounts now being invested by steel companies in expanding their installations and balancing their production departments, was drawn up on the basis of information supplied by the plants themselves.

Table I-35 indicates that with relatively low investment, averaging between 150 and 200 dollars per ton, present plants can achieve complementarity and reduce the main imbalances in their smelting and steelmaking departments. But the problem which undoubtedly must be stressed is the urgency with which these expansions are required. The fact that at present only 46 per cent of the capacity of the rolling mills is utilised means that amortisation charges are double what they should be in the rolling mills, which represent from 40 to 70 per cent of the total value of the plants, and have a considerable effect on production costs and the indexes of returns on original investment. Moreover, the value of the unutilised potential production, which amounts to more than 6 or 7 million tons of ingot steel, represents, at between 60 to 70 dollars per ton, the enormous sum of 360 to 400 million dollars a year. In terms of any index of returns on investment, this provides a clear indication and justification of the urgent need for these expansion programmes to be carried out as soon as possible.

In view of the size of this figure, serious consideration must be given to three very important aspects:

(i) The possibility and advisability of promoting the rapid expansion of domestic markets through integration and, since taken as a whole they are large enough in size, of ensuring that the markets absorb the maximum possible output and, possibly, of placing part of the output on the world market;

(ii) That investment should not be staggered, as might be thought necessary because of the smallness of the markets, but that plants should be fully balanced as soon as possible; and

/Table I-35

Table I-35

LATIN AMERICA: INVESTMENT IN STEEL PLANTS DURING THE FIRST STAGE OF EXPANSION, 1965-70

Country	Plant	Present capacity	Future capacity	Capacity added	Investment (millions of dollars)	Investment per ton of capacity added (dollars)
		(thousands of tons of ingot steel)				
Argentina:	San Nicolás	800	1 100	300	30	100
Brazil:	Usiminas	600	1 000	400	60	150
	Cosipa	300	600	300	10	30
Chile:	Huachipato	600	1 000	400	95	235
Colombia:	Paz del Río	200	600	400	100	250
Mexico:	Monterrey	500	800	300	82	273
	Altos Hornos de México	1 000	1 600	600	70	117
	Hojalata y Lámina	360	700	340	65	191
Peru:	Chimbote	100	350	250	126	504
	Sub-total	4 460	7 750	3 290	638	194
	San Nicolás	1 100	2 000	900	300	333
	Volta Redonda	1 300	2 000	700	280	400 a/
	Sub-total	2 400	4 000	1 600	580	362
	Total	6 860	11 750	4 890	1 218	249

a/ With the continuation of the expansion and investment programme up to 1972, this figure will be reduced to 264 dollars, once Volta Redonda reaches an output of 3.5 million tons.

/(iii) That

(iii) That during the present stage of expansion investment plans should be formulated in such a way as to ensure that maximum benefit is derived from the expansion programme and that complementarity of the plants is pursued with an eye to greater productivity; and that, in certain cases, additional investment should be envisaged to achieve balanced overall results, instead of cutting down on items and facilities at a stage when the overall unit cost of investment in expansion is low.

Since the expansion projects may be modified at any given moment, only a brief commentary is given below for each country, with particular emphasis on the integrated plants included in table I-35, in order to indicate the purpose of the expansion projects now under way.

(a) Projects by countries

(i) Argentina. The Sociedad Mixta Siderúrgica Argentina (SOMISA) plant has already attained a daily output of 2,000 tons with its existing blast furnace, and it is proposed to improve on this figure by the use of fuel oil injection, the parallel operation of turbo-blowers and the eventual addition of a fourth heater. All these improvements are included in the immediate plan, which is already financed and represents an investment of 30 million dollars, and it is hoped that the programme will be completed in 1967.

At the same time a plant will be installed for the production of oxygen, to be used in open-hearth furnaces, permitting the capacity of the steelmaking plant to be increased to 1,100,000 tons; for this purpose there will be improvements in the furnace feed systems and the handling of materials in this section. There will also be additions to the loading dock, and to the facilities for handling raw materials, and auxiliary furnaces and equipment will be installed in the rolling mill. It is assumed that San Nicolás will go ahead at once with the execution of the next expansion programme, which already calls for the construction of a new blast furnace of the same capacity as the existing furnace, a new LD converter and an additional set of machinery, as well as modifications in the billet-rolling mills to raise their capacity to 2 million tons. This programme also includes modernising the flat-rolling, tinning and cutting sections and additions to the power plant. The result will be not only to double the

/capacity of

capacity of the present equipment, but also to open the way, in the near future, to raising capacity to 2.5 million tons. It is believed that San Nicolás intends in the first place to make full use of its tremendous capacity for the production of flat products by its continuous rolling mill, at present the only one of its kind in Latin America; for this purpose it will be necessary to add a slab blooming mill at some stage of its expansion.

The expansion projects under consideration in the Argentine steel industry also include the conversion of the ACINDAR enterprise (not included in table I-10 because this is a semi-integrated enterprise) into an integrated plant through the construction of a blast furnace with a capacity of 2,000 tons, LD converters, continuous casting lines and additions to the existing rolling mill to bring the initial capacity up to 750,000 tons, with an investment of about 140 million dollars. There is also a group of entrepreneurs who are planning to install in Ensenada a new plant of similar capacity, although this venture has not yet materialised. In addition, a number of medium-sized and small semi-integrated plants are undertaking or planning fairly large expansions of capacity in relation to their scale of production, in particular the Dalmine-Siderca enterprise, specializing in seamless tubes, and the Santa Rosa, La Cantábrica and Gurmendi plants.

(ii) Brazil. The three main Brazilian plants, USIMINAS, COSIPA and Volta Redonda, have clearly defined expansion programmes; the capacity of the first two plants will shortly be raised from 660,000 to 1 million tons, and from 500,000 to 800,000 tons, respectively, a total of some 700,000 tons. It is a striking fact that COSIPA will be investing only 10 million dollars to obtain the additional capacity; this is because it already has a potential capacity of 800,000 tons, only a few items being needed to transform this into a working capacity. USIMINAS needs improvements in the reduction plant, the installation of a third LD converter, the expansion of the oxygen plant and the installation of a cold-finishing mill, which requires a rather higher investment, about 40 million dollars, mainly for the rolling mill.

/At Volta

At Volta Redonda a large-scale expansion programme is being initiated, which will permit the gradual attainment, over a period of ten years, of a capacity of 3.5 million tons, thus converting this steelworks into the first large-scale Latin American plant; it is also the first Latin American plant to undertake a long-term expansion programme with all the details worked out in advance.

There will be a rapid increase of capacity from 1.3 to 1.6 million tons, through improvements in the blast furnaces, use of oxygen in the steelmaking plant, and strengthening of the blooming mill, cold finishing and electrolytic tinning. Large investments are contemplated, which will gradually bring plant capacity up to the above-mentioned 3.5 million tons over the ten-year period, with special emphasis on the production of tinplate and flat products, for which a special continuous blooming mill and a continuous rolling mill will be installed, and the present blooming mill will be used to feed the non-flat rolling mills. The bulk of the investment, whose estimated total is 560 million dollars, will be effected up to 1971, and the intention is for a considerable portion of the machinery to be manufactured in Brasil. Volta Redonda considers that the unit investment will amount to 232 dollars as against 450 dollars that would be needed for a new plant, because of the existing facilities available. Most important of the many other expansion projects in Brasil [19] is the Companhia Belgo Mineira project. This company is the fourth-largest in Brasil; it proposes to expand its two plants at Monlevade and Sabará; the former will expand its capacity from 380,000 to 550,000 tons, and the second will expand only the wire-drawing and rolling sections, which together will process 600,000 tons of ingot steel, with an estimated investment of 14 million dollars.

There are also a number of projects for new plants which have not yet been implemented, including the USINOR project, near Recife, for the installation of an electric reduction furnace with a daily capacity of 190 tons (60,000 tons of pig iron a year), an LD steelmaking plant with two converters, and a group of rolling mills producing bars and light steel

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19/ Brasil is supplied by 24 main plants, whose size and characteristics vary widely; total production in 1965 was about 3 million tons of ingots, of which Volta Redonda provided about 45 per cent.

/shapes with

shapes with a capacity of 120,000 tons a year; METAMIG (Metais de Minas Gerais S.A.), at Paraopeba, with an initial capacity of 1 million tons of non-flat products; COSGUA (Companhia Siderúrgica de Guanabara) at Santa Cruz, with an initial proposed capacity of 500,000 tons of non-flat products, and lastly, a series of small local plants in the States of Amazonas, Bahia, Santa Catarina and Rio Grande do Sul.

To complete the Brazilian picture mention must also be made of the Vitoria project (Via. Ferro e Aço de Vitoria), for a plant producing non-flat products with an initial capacity of 1 million tons, to be located close to the new port of Tubarão of the Cia. Vale do Rio Doce. This enterprise will be well situated for export production.

(iii) Colombia. Acerías Paz del Río is at present installing a Steckel rolling mill 1.30 m wide, a blooming mill, a sintering plant and auxiliary services, representing a total value of 30 million dollars, whose construction is expected to be completed early in 1968. However, this expansion will not increase the production capacity of the existing plant, because there is a limit as regards pig iron and there will then be a considerable imbalance between this section and the rolling mill as a whole; consequently, Paz del Río is now preparing a study for submission to international financing agencies, providing for the construction of a second sintering line, a blast furnace with a nominal daily output of 1,200 tons, a corresponding coking plant, the use of oxygenated air in the existing Thomas steelmaking plant, or some other system which could be used for its high phosphorus-content pig iron; the expansion of the existing bar mill and the addition of a continuous wire-drawing frame; cold rolling, and the auxiliary services, and an increase in mining operations for iron, coal and limestone; at present this project is estimated to involve an expenditure of between 75 million and 100 million dollars.

These improvements will permit the plant to achieve a balance of production and a fairly complete utilisation of the rolling mill group, with a total production of 600,000 tons of ingot steel a year.

Acerías Paz del Río has achieved a satisfactory use of its existing machinery, but it is obviously one of the enterprises that needs to forge

/ahead most

ahead most rapidly with its programmes for expanding capacity, and for achieving a balance of production in order to get full use out of the investment made, and above all to deal with the considerable imbalance of production that will result from the installation of the present Steckel mill.

(iv) Chile. The second blast furnace at the Compañía de Acero del Pacífico's Huachipato plant is now in operation. It has the same capacity as the first blast furnace - 1,200 tons of pig iron daily -, but additional investment could raise this to 1,900 tons. Also under consideration are the installation of a new LD steel mill with a capacity of 650,000 tons; continuous casting lines; an increase in the capacity of the bar and light steel shape mills; the addition of an electrolytic tinning line and an expansion of the coking plant. The cost of this expansion is estimated at 94 million dollars.

(v) Mexico. The main Mexican plants - Altos Hornos de México, S.A. (Monclova), and Compañía Fundidora de Fierro y Acero de Monterrey - have been carrying out vast expansion programmes over the past four years. The first stage consisted mainly in expanding rolling mill capacity, and was followed by a second stage during which the blast furnace and steelmaking sections were enlarged in order to achieve a balanced output. Altos Hornos de México has now attained a capacity of over 1 million tons, and Monterrey's capacity is close to 500,000 tons; in the next few years these two enterprises will increase their capacity to 1.6 million tons and 800,000 tons, respectively.

Despite these expansions, the overall deficit in the reduction section will not be completely met. To cover it, Monclova is now building a third blast furnace with a nominal capacity of 1,350 tons, and making other improvements. At the third stage of expansion, possibly in the immediate future, Monclova will build a fourth blast furnace, and intends to transform the existing Steckel mill into a semi-continuous rolling mill, which will raise capacity to about 1.8 million tons.

The Monterrey enterprise is building a third blast furnace with a nominal capacity of 2,000 tons, and is to add two open-hearth furnaces to the steelmaking plant, expand the auxiliary services in the rolling mill and make various changes in the rolling mills themselves.

/Another important

Another important enterprise is Hojalata y Lámina, with a capacity of 340,000 tons of ingot steel, which it now proposes to increase to 541,000 tons by adding a new direct reduction plant, expanding the steelmaking plant, and installing a continuous casting line and new rolling equipment for bars and light steel shapes.

(vi) Peru. Chimbote is at present expanding its plant, which uses the electric-reduction process and electric steelmaking furnaces, by adding a small coke-fired blast furnace that will be in operation by 1967. It will have a daily nominal capacity of 700 tons of pig iron. An LD steel mill and a continuous casting plant with an annual capacity of over 90,000 tons of billet are installed and ready to begin operating. These additions will raise production capacity to about 350,000 tons of ingot steel a year. The additional investment involved is 46 million dollars for the rolling operation and about 80 million dollars more for the present construction programme. However, the new plant will still have an unbalanced output, with surplus capacity in the rolling section; hence immediate consideration will have to be given to the installation of a second blast furnace.

(vii) Venezuela. A number of different technical solutions are being considered for the construction of a flat-rolling mill. According to the first outline given in the 1965-68 Manufacturing Industry Plan, a semi-continuous mill will be installed to meet an estimated demand of 500,000 tons, consisting of about 150,000 tons of hot rolled steel and 350,000 tons of cold-rolled steel. Of the cold-rolled products, output of tinplate will amount to about 100,000 tons, and output of galvanised sheet to about 50,000 tons. The investment in the flat-rolling mill has been estimated at 536.1 million bolívares,[20] and the value of its output at some 480 million bolívares, with an increase in direct employment in the steel industry of about 800 jobs. The entry into operation of this important project will take place at the end of the period covered by the National Plan for 1965-68.

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[20] Of this sum, about 454.1 million bolívares will be invested in the rolling mill itself, and 82 million bolívares in transport, auxiliary facilities and unforeseen expenditure.

/Similarly, Siderúrgica

Similarly, Siderúrgica del Orinoco is contemplating a programme for the expansion of its existing plant that will permit a notable improvement in output levels and costs. The proposed changes comprise an expansion of steel-producing capacity, which includes facilities for oxygen injection, at an estimated cost of 49 million bolívares, the installation of a coking plant, at a cost of 25 million bolívares, and the expansion of various general services at the plant, at a cost of 50 million bolívares.

The Venezuelan Guayana Corporation will also sponsor two important projects for the processing of iron ore, and provide a minority share of the investment involved. The plan includes the construction of a sponge iron plant with an annual capacity of 1.5 million tons, which will begin production at the level of 150,000 tons in 1968, and another enriched ore plant with an initial capacity of 1 million tons a year. In both cases the Venezuelan Guayana Corporation will enter into association with private international enterprises. The output of these plants will be mainly for export.

(b) Investment during the first stage of expansion and total investment up to 1975

(i) Investment during the period 1965-70. Table I-35 shows that the integrated steel industries are at present expanding, on well-defined bases, at a cost of some 600 million dollars; most of the projects are already financed. This will raise total capacity by 3.2 million tons, with an investment index of 150-220 dollars per ton.

During the same period, the Volta Redonda and San Nicolás plants are each expanding their capacity to 2 million tons, with an increase of 1.6 million tons in their combined output and a total investment of some 580 million dollars. These cannot be described as complementary expansions; they are new large-scale projects which have all the characteristics which would make them feasible during that period.

This means a total investment of approximately 1.2 million dollars, to which would have to be added the expansion projects being carried out by some of the semi-integrated industries and a few which might be undertaken later. It is difficult to estimate accurate investment figures for the semi-integrated enterprises, nor is it known for certain what course the new projects will take. Merely as an indication of the probable scale of

/investment, 100-150

investment, 100-150 million dollars is assumed for the former and 200 million for the latter, although the results may eventually be stabilised by variations in the total investment envisaged. On this basis, a sizable investment of about 1,500 million dollars is estimated for 1965-70, half in dollar expenditure and half in local currency.

(ii) Investment in 1970-75. There is no basis on which to estimate possible investment during this period, with the exception of 285 million dollars envisaged by Volta Redonda, assumptions regarding the possible expansion of the Orinoco plants which will no doubt be under way by that time, and some subsequent expansion of San Nicolás to bring that plant's ultimate output to 2.5 million tons.

The outlook is gloomy because consumption is expected to increase by about 10 million tons during this period. This means that from 1970 onwards, after making a tremendous effort, the Latin American industry will once again have to expand capacity by 75 per cent, or almost double it.

If the usual project figures were valid for that period, an investment of 3,000-3,500 million dollars would be needed to make good the supply shortage of 10 million tons; again, 50 per cent of this would presumably be spent in dollars and the balance in local currency.

The foregoing considerations mean that during the decade 1965-75 total investment requirements in steelmaking would amount to 4,300 to 5,000 million dollars; of this sum, 1,500 million dollars for the 1965-70 programmes have already been financed or are being negotiated. Allowing for a progressive growth and consolidation of the existing steel industries and of the national economies, these figures, though high, are not impossible to attain.

Obviously, however, in view of the size of the steel industry, its importance in relation to other economic sectors, the changing trends of world trade and the regional market, which is becoming more and more the backbone of Latin American development, and the scale on which existing plants will be operating in a few years' time, the co-ordination of this investment plan and the vital importance of planning the steel industry in the context of the Latin American common market with a view to its future participation in the world market, should be seriously and objectively considered.

/(c) Co-operation

(c) <u>Co-operation in relation to manufacture of equipment</u>

According to estimates, about one-half of the investment required for the construction of a plant is represented by the value of imported equipment, the remainder consisting of expenditure in local currency on construction and installation.

In view of the amount of investment needed for the expansion projects that will have to be carried out between 1970 and 1975, every effort should be made to reduce dollar requirements and external borrowing.

To this end, perhaps the line of action on which most emphasis should be placed is research and appropriate co-ordination with a view to the manufacture of much of the necessary equipment in Latin America itself. Financing difficulties are created because internal credit restrictions and volumes in the Latin American countries, and the structure and financial situation of the enterprises or plants that manufacture capital goods, often make local-currency credits for such a purpose harder to obtain than funds from abroad.

Nevertheless, there can be no doubt that the expansion of the heavy metal-transforming industry, by enabling it to meet the needs not only of the iron and steel industry but also of other basic industrial sectors, would do much to promote more efficient utilisation of the scanty foreign-currency resources available for investment. The question must therefore be regarded as one of vital importance, and ways and means of surmounting financing difficulties must be sought.

The following are a few examples which may give food for thought in this connexion. The second blast furnace at Altos Hornos de Monclova was designed by the enterprise itself, which also undertook most of the construction work. Thanks to the resourcefulness and imagination of the entrepreneurs, investment in this plant was long kept below 100 dollars per ton of ingots, and even now that expansion has taken place, it is very low, as can be seen from a study of the company's balance-sheets.

Argentina, Brazil and Mexico are fairly well provided with heavy metal-transforming industries and engineering services that have the capacity and know-how to design and construct much of the heavy equipment

/which will

which will be required as the iron and steel industry expands. The manufacture of equipment for basic industries in Brasil, which is the subject of an ECLA study,[21] has been undeniably successful, and has contributed to a substantial saving of foreign exchange. This applies to the production of equipment for the petroleum and chemical industries, and even for steelmaking.[22]

Accordingly, the first task of the Latin American iron and steel industry, in the forthcoming stages of its development, should be to evaluate existing metal-transforming facilities and to ascertain and support what is being done in this field in the most highly industrialised countries of the region. In this way, with the co-operation of domestic and foreign financing agencies, the dollar proportion of the investment programme for the expansion of steelmaking in Latin American can be substantially reduced.

As a corollary, research should also be undertaken on the capacity of the technical departments of enterprises or of local engineering services, and, where appropriate, on the possibility of providing the necessary training, with the aim of handling over to them - at the expense, of course, of the interested enterprise - such projects as could be carried out locally, and saving part of the cost of foreign engineering services.

In many cases, it might be found that a regional engineering service established as a co-operative undertaking, with international technical assistance would be useful.

21/ The manufacture of industrial machinery and equipment in Latin America: Vol. I. Basic equipment in Brazil, United Nations publication, Sales No.: 63.II.G.2; Vol. III. Los equipos básicos en la Argentina, United Nations publication, Sales No.: 64.II.G.5.

22/ Associação Brasileria para o Desenvolvimento das Indûstrias de Base (ABDIB), Equipamentos para as indûstrias de base en 1964, São Paulo, 1964.

/3. Prospects

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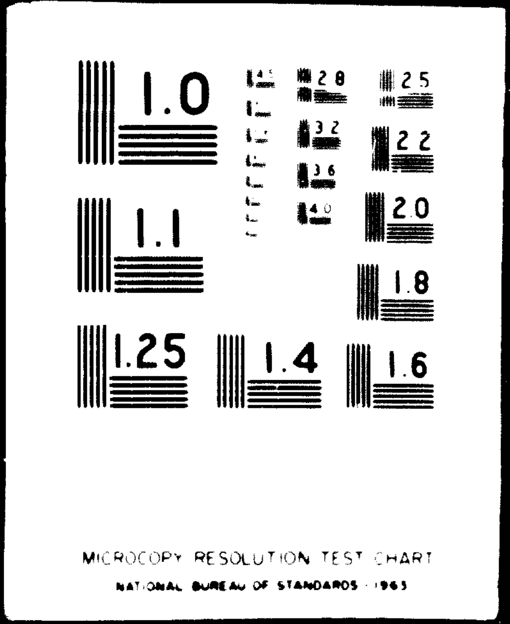
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963

3. Prospects of regionally-integrated development

In the expansion projects now under way or scheduled to be completed in the leading enterprises are carried out in their entirety and without delay, the balance of supply and demand in respect of steel products may be relatively stabilized, provided that the volume of imports is kept at more or less its present level. But this implies substantial investment amounting to approximately 1,500 million dollars (50 per cent in dollars and the remainder in local currency), and also means that current output will have to be roughly doubled.

By 1975 there will probably be another deficit of 10 million tons, which will have to be covered by additional investment in the amount of about 3,000 million dollars (50 per cent in foreign exchange and the rest in local currency). The industry will have to increase its output still further, practically trebling the existing production figure, and almost doubling the hypothetical output estimated for 1970.

In the early stages of development of the steelmaking industry, investment requirements were heavy, and still are in some parts of the region. But in most cases a considerable improvement has taken place, and the expansion projects for the immediate future will require relatively low levels of investment, since they consist in supplementing installed capacity and securing a better balance of production in plants where auxiliary services already exist and rolling equipment has been purchased. But there are still instances in which investment could be much more beneficial if there were broader markets and if the principle of specialisation were applied with a view to intra-regional trade prospects.

Since prices of Latin American steel are very high as a rule in comparison with those quoted on European markets or payable for imported products, a twofold target has been fixed for the development of steelmaking in Latin America over the next ten years: the production of steel on the basis of the lowest possible unit investment per ton, and the achievement of price levels comparable with those prevailing on the world market.

To attain this goal, the Latin American iron and steel industry will have to cope with two different kinds of problems, and in the course of the next few years will have to pass through two different stages of development, as follows:

/(a) Up

(a) Up to 1970, it will have to keep pace with the rapid growth of demand by means of expansion projects designed to supplement its installed capacity and promote more balanced production, and through the increases in productivity that can be achieved by the intensive application of those advanced techniques which involve only moderate investment. All this could be done on the basis of relatively low and attainable levels of aggregate investment, and would bring about a drastic reduction of investment per additional ton of installed capacity, an improvement in the balance of total unit investment, and a marked increase in volumes of output;

(b) In 1970-75, the major expansion required to meet demand will have to be based on the establishment of large-scale production units operating at the highest possible level of efficiency. It will entail constructing entirely new plants or greatly expanding those already in existence, whose structure, location and other characteristics enable them to produce at low costs. Another objective at this stage will be to secure a place for the Latin American steel industry in world trade. Clearly, if these aims are to be fulfilled, care must be taken to see that history does not repeat itself. There must be an end to the installation of small plants, serving inadequate markets, destined to undergo successive enlargements and designed to manufacture too wide a range of products.

If the industry itself and the national authorities are to be induced to adopt measures for the effective implementation of reorganization and modernization programmes, to reduce risks and produce viable decisions to establish large specialised units which will be a sine qua non by 1970, the first essential is to introduce the incentive of competition into the region. This can only be done through the formation of a common market for steel products.

The object of such a market would therefore be to make competition an instrument for the promotion of technological progress, economies of scale and specialization, all of which are indispensable requisites for the attainment of the final target established: the production of steel in Latin America at costs and prices comparable with world market levels and on the basis of increasingly lower unit investment.

/Accordingly, the

Accordingly, the proposed common market, which should be established in Latin America in the course of the next ten years, would consist essentially in a system of "free" trade (necessarily regulated, however, in some respects) among the member countries, operating at world price levels. Other instruments, based on somewhat narrower conceptions of regional economic integration, are not incompatible with the broader approach explored and advocated here: they might include complementarity agreements among countries, or small groups of countries (or rather of steelmaking enterprises), based on predetermined trade targets; or partial tariff reductions, confined to certain types of product. But if these are really to serve as links in the chain, and the process is not to lose momentum or stop in mid-course, the final objective should be defined from the very outset as a general common market.

The basic premises of a Latin American common market for steel products, which have been briefly substantiated in this chapter, may be summed up as follows:

(a) Steelmaking activities should be maintained and developed wherever they are located at present. This would seem to be compatible with a rational allocation of investment resources, since comparative analyses of existing locations show them to be largely comparable and equivalent to one another, once certain plants have been expanded and modernized. The differences in the potential costs estimated for steelworks in these different locations are negligible by the time freight costs and clearing and handling charges - factors which to some extent act as protectionist barriers - have been taken into account. They are also insignificant in relation to the possible margin of error in the calculation of potential costs. For these two reasons, they cannot be adduced in support of a type of regional specialization that would favour only the most advantageous locations;

(b) The door should be kept open for the establishment of an iron and steel industry in relatively less developed areas or countries which had none at the date of conclusion of the agreement (for example, Central America, Ecuador, Uruguay). That is, such countries should be allowed to apply temporary protectionist measures for an extended period, provided that they agreed to submit specific programmes for the development of the industry to the integration agencies, and those programmes were considered technically and economically sound;

/(c) Concentration

(c) Concentration of the industry's future development in certain parts of Latin America should be avoided. In other words, the member countries should envisage the development of the iron and steel industry as a smooth and balanced process taking place throughout the region, as a function of market conditions, natural resources and each individual country's experience in the field of steelmaking. This would not imply the adoption of a rigid pattern, but would help to obviate the risk that factors unforeseeable at the date of conclusion of the agreement might ultimately place a particular country in a decisively stronger competitive position, thus jeopardizing the maintenance of levels of activity or even the survival of the industry in certain other countries;

(d) To prevent distortions in existing steelmaking enterprises, necessary adjustments should be channelled along positive lines. For example, they should be introduced by means of new and corrective investment in plant expansion and modernization, not through measures that would mean jettisoning investments already made.

These proposed bases should be regarded merely as tentative and flexible suggestions, indicating the sort of precautions that would have to be taken, and not as a precise and definite statement of common market principles. Moreover, they should not be hastily interpreted as making competition too restrictive either from the standpoint of the countries best fitted to compete, which might consider that the proposed regulations would limit their future export prospects, or in relation to the smaller countries, in which conditions are less favourable, and which might think that free competition as a final objective would reduce their chances of developing their iron and steel industry. The real aim is to stress the need for any eventual integration agreements to incorporate provisions and instruments whereby the objective of smooth and balanced growth can be reconciled with the development of the integrated steelworks already in existence.

A common market in steel with these characteristics would have to be built up in two stages, for, to judge from the findings presented in sections D and E, and despite the limitations of the estimates formulated,

/there are

there are disparities in production costs in Latin America which make it difficult to suggest the immediate liberalization of trade, either in toto or to any very marked extent. Thus, the free-competition régime would begin to operate only at the end of a transitional period. During this interim period plants where conditions were unfavourable would introduce the necessary changes and improvements, such as the expansion of capacity and the establishment of a better balance among the different production sections, the adoption of more advanced techniques, and other measures, along the lines suggested in detail in parts C and E above.

The feasibility of the proposed common market is also borne out by the following conclusions, established mainly in parts C, E and F above:

(a) The locations of the existing plants are more or less comparable and equivalent for such steelworks as might result from an intensive modernization programme, duly expanded and operating at similar levels of efficiency. Accordingly, no serious difficulties are likely to arise in connexion with any of the existing establishments, once the transitional period is over;

(b) Possible cost reductions, including the effects of economies of scale, technical improvements and specialization, would place manufactures on an equal competitive footing, not only for the purposes of intra-regional trade, but also in trade at world market price levels. Accordingly, the pertinent decisions adopted by each enterprise, and the action taken as a result of those decisions, with the support of the common market's promotion and investment organs will constitute a key factor in the success of the integration movement.

Thus, the replies emerging from the study to questions bearing on the possible distortions by which enterprises might be affected, the location of plants whose size and techniques are satisfactory, and the chances of reducing costs to something like their international level support the contention that a common market for steel products is feasible to supply the Latin American consumer and the region's metal-transforming industry with steel at world market prices and to enable Latin America to participate in world trade in steel products.

/To summarise,

To summarize, a common market in steel might be formed in the following way:

(a) The process of reducing customs tariffs would be carried out in two stages. At the beginning of the first, which might be of five years' duration, liberalization commitments would be adopted, but blanket reductions would be applied only on a relatively small scale or not at all. In the course of the next five years, tariffs would rapidly be brought down to a standard internal level of, say, about 10 to 15 per cent. The object of maintaining a minimum tariff rate - or at least making provision for its maintenance in the agreement - would be to cushion the impact of the newly-introduced element of competition and of such factors militating against straightforward competition as could not concurrently be eliminated altogether (those relating to exchange rates, tax régimes, etc.). During this second stage, the tariff rates applicable to third countries would be brought down to a uniform level of, for instance, 30 to 50 per cent. Tariff rates for the period following the first ten years would be established in due course, in the light of the results obtained;

(b) An investment programme would be established jointly by the member countries, with financial support from international sources, mainly to enable countries at a competitive disadvantage to place themselves, in the course of the first stage, on an equal footing, with the other Latin American competitors. The objectives of the programme would include improving the balance of production capacity, introducing more advanced techniques and increasing scales of production. Priority investment funds would be made available for these purposes;

(c) Competition among producers would be governed by such regulations (with respect to pricing, non-discriminatory treatment of buyers, non-discriminatory freight practices, etc.) as might be necessary to normalize the marketing system and provisions for the administration of the relevant programme would also be established.

Hence, by 1975, and more particularly from that date onwards, a common market for steel products would come into being, in which trade would be carried on at or close to world market price levels. The region as a whole, despite the considerable expansion of supply, would continue to import a

/sizable volume

sizable volume of steel products, depending on the situation of each individual market, price trends and transport costs. At the same time, however, it would export a substantial volume. In other words, supply would have to increase at least enough to meet the growth of demand, but preferably to a greater extent, so that by 1975 a surplus of one to two million tons might be available for export to extra-regional markets.

Both imports and exports would be contingent upon particular world market conditions and the particular circumstances of each Latin American country, in accordance with the specialization which would have been established in the region by that time. A competitive atmosphere favourable to the application of new tecyniques would be created, and the rate of development of the iron and steel industry would be speeded up by the following factors: markets would be larger, and would presumably expand more rapidly when steel could be supplied at world market prices; and a new sources of foreign exchange would be generated by export earnings, which might in time become substantial in view of the favourable production costs that could be achieved in Latin America's iron and steel industry, given satisfactory scales of operation and levels of technology.

/Chapter II

Chapter II

THE ALUMINIUM INDUSTRY

Early in 1966, under the Joint ECLA/INSTITUTE/IDB Programme for the Integration of Industrial Development, a preliminary study was completed on the prospects for the development of the aluminium industry in Latin America and the effect of the regional integration of markets in view of its large scales of production.[1/]

The main objects of the study were: (a) to evaluate possible locations for alumina and primary aluminium plants; and (b) to estimate the savings in costs and investment resulting from the development of the industry to serve the region in plants of economic size, compared with its development for purposes of individual country markets.

The basic conclusion reached in the study is that the region is so richly endowed with the energy resources and raw materials required for the successful and vigorous expansion of primary aluminium production that several of the Latin American countries could develop this industry on a sound economic basis, achieving price levels similar to those current in the domestic markets of the highly industrialized countries. If the projections of the region's aggregate demand in 1975 are taken into consideration, and the development of the industry is planned in accordance with the principle of regional integration, several plants of economic dimensions could be installed.

The study was of an exploratory nature, and a start was made at once on research in greater depth. The Joint Programme is preparing a careful study of investment coefficients and costs per ton in plants of different capacities, in relation to different combinations of stages of production

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1/ Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional (ST/ECLA/Conf.23/L.26), prepared by Armando P.P. Martijena, consultant to the secretariat of the Economic Commission for Latin America.

/(alumina/aluminium,

(alumina/aluminium, aluminium/rolling, etc.) and different ranges of final rolled products. In the light of the new data thus obtained, the problem of future plant location will be reconsidered, as the industry develops in the framework of a common market.

A. APPARENT CONSUMPTION AND PROJECTIONS OF DEMAND

1. Apparent consumption of primary aluminium

Apparent world consumption of primary aluminium has soared in recent years. Between 1952 and 1962 it rose from 1.9 million to 4.9 million tons, i.e., at a cumulative annual rate of 10 per cent. In Latin America its annual growth rate during the same period reached 11.4 per cent. (See table II-1.)

Four countries - Argentina, Brasil, Mexico and Venezuela - account for a little over 85 per cent of the region's total consumption, Brasil's share amounting to more than 42 per cent.[2]

A breakdown of per capita consumption of primary aluminium in the various Latin American countries shows that the countries with the largest volumes in descending order, are Venezuela, Argentina, Brasil and Mexico. The high figure for Venezuela seems to reflect the advanced stage of development attained by rolling and extrusion (especially production of corrugated sheet, cables and tubes) and to a low rate of utilization of secondary aluminium. In Argentina, the level reached appears to have been determined by the country's degree of over-all industrial development, and in Brazil and Mexico by the vigoreus industrialisation in progress.

2/ In 1961-63. In 1951-53 it had been 40.7 per cent. (See again table II-1.)

/Table II-1

Table II-1

LATIN AMERICA: APPARENT CONSUMPTION OF PRIMARY ALUMINIUM

Country	Apparent consumption (thousands of tons)		Cumulative annual growth rate (percentage)	Per capita consumption (kilogrammes)	
	1951-1953	1961-1963		1951-1953	1961-1963
Argentina	4.1	20.1	17.3	0.23	0.92
Bolivia	0.1	0.2	7.2	0.03	0.05
Brazil	16.9	51.5	11.8	0.31	0.69
Chile	0.7	3.3	16.8	0.12	0.48
Colombia	2.3	8.0	13.3	0.18	0.48
Mexico	5.9	20.5	13.3	0.21	0.53
Peru	0.8	2.9	13.7	0.10	0.27
Uruguay	1.3	1.1	-1.6	0.57	0.44
Venezuela	8.8	11.8	3.3	1.59	1.50
Other countries a/	0.9	2.4	10.3	0.05	0.10
Total	42.5	121.8	11.4	0.26	0.58

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

a/ Provisional estimate, excluding Cuba, French Guiana, Guyana and Surinam.

Latin America's average per capita consumption doubled between 1951-53 and 1961-63. Nevertheless, the figure for the latter period - 0.58 kilogrammes - is low in comparison with per capita consumption in more highly industrialised countries, such as the United States (10 kilogrammes), Canada (5.6 kilogrammes) and the United Kingdom (5.4 kilogrammes). Hence it is clear that the development potential of the Latin American aluminium industry is very considerable, particularly as the region is so plentifully and favourably endowed with natural resources (see section B below), and as it imports its primary aluminium supplies almost in their entirety from extra-regional markets,3/ Canada being its leading supplier.

3/ Only Brazil and Mexico produce primary aluminium on a small scale.

/2. Projections

2. Projections of demand

Future demand for primary aluminium was estimated by correlating data on past trends in each of the nine Latin American countries where consumption of aluminium is highest. The results of these projections are shown in table II-2.

For Latin America as a whole, the average annual growth rate of apparent consumption of primary aluminium worked out at 10.6 per cent. This is a little lower than the rate attained between 1951-53 and 1961-63, but slightly exceeds the world average.[4]

B. ANALYSIS OF NATURAL RESOURCES

There are three stages in the integrated primary aluminium production process: (a) extraction of bauxite, which includes mining activities; (b) chemical refining of bauxite (which is a hydrated aluminium oxide mixed with impurities) to obtain alumina; and (c) electrolytic reduction of the alumina to produce primary aluminium.

The main determinants of the direct cost of alumina production are the raw material (bauxite), fuels for generating steam and for calcining the alumina, and caustic soda; on the other hand, the most significant cost factors in the manufacture of primary aluminium are energy resources (electric power and calcined petroleum coke) and the raw material (alumina).[5]

4/ No allowance is made in the projections for the additional aluminium consumption that may result from this product's favourable prospects of replacing or superseding others - such as wood, plastic materials copper, steel and other metals - in specific applications. One of its advantages is that its prices have followed a steady downward trend, in contrast with the price fluctuations shown by the other materials with which it competes.

5/ See tables II-6 and II-8 below.

/Table II-2

Table II-2

LATIN AMERICA: PROJECTION OF DEMAND, BY COUNTRIES

Country	Apparent consumption (tons)		Cumulative growth rate (percentage)
	1970	1975	
Argentina	36 400	53 700	10.8
Bolivia	546	772	8.0
Brazil	115 700	203 800	11.2
Chile	7 300	13 400	11.3
Colombia	18 200	31 000	11.1
Mexico	45 800	80 000	11.8
Peru	7 000	12 400	11.2
Uruguay	2 100	2 600	4.0
Venezuela	27 000	38 000	7.1
Other countries	4 900	6 700	6.5
Estimated regional total	265 096	442 372	10.6

Source: ECLA estimates. For an account of the methodology applied, see Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

/1. Natural

1. Natural resources

(a) Bauxite

More than half the world reserves of commercial bauxite with an Al_2O_3 content exceeding 45 per cent are to be found in Latin America. In addition, most of the Latin American countries possess sizable lower-grade reserves. Furthermore, in nearly all the countries of the region there are large deposits of clay and alunite, resources whose economic development is currently the object of much technological research.

The biggest reserves are located in Jamaica, Surinam and Guyana, while others on a somewhat smaller scale exist in the Dominican Republic and Brazil.6/

Jamaica possesses proven reserves amounting to 550 million tons of bauxite with a 50-per-cent Al_2O_3 content, and its potential reserves are estimated at 450 million tons. The ore is characterized by the uniformity of its chemical composition and by a low silica content.

Proven reserves in Surinam total 200 million tons, with a 58-per-cent Al_2O_3 content. According to estimates, the volume of potential reserves is the same. The ores are very similar to those mined in Guyana, whose proven and potential reserves are calculated at 80 million and 70 million tons, respectively. In both countries the reserves are accessible via inland waterways.

Brazil's reserves, notable for their high grade and for the relative ease with which the bauxite can be extracted, are found in the interior of the country. The most important deposits are at Poços de Caldas, on the state boundary between São Paulo and Minas Gerais. The others are located in the southeast and west of Minas Gerais, and in the States of Espirito Santo, Rio de Janeiro and Bahia. Phosphoric bauxite has been found on the island of Trahira, which lies off the coast of Maranhão in the mouth of the River Maracacumé.

6/ For further details, see Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración [illegible]

/Out of

Out of a total of 62 known deposits in Brazil, 43 represent proven reserves of bauxite amounting to 36,608,000 metric tons, with an average grade of 56 per cent. It is estimated that complete exploration of the 62 deposits would reveal reserves of approximately 192 million tons, most of which would be concentrated in 37 deposits at Poços de Caldas.[7]

The following is a chemical analysis of the Poços de Caldas deposits:

	Percentage content
Alumina	54-65
Silica	1- 5
Iron oxide	4-10

Deposits of bauxite have been discovered in Venezuela in the Cerro Bolívar area and in the iron-bearing district of Pao. In addition, deposits are known to exist in Upata and Urinam. Although no information is available on the quality or quantity of these reserves, there are indications that the ore has too low an alumina content to be of commercial interest for the time being.

Evidence has been found of the presence of low-grade aluminous ores in Peru. Forty kilometres away from Huancavelica there is a deposit covering an area of 200 hectares and comprising reserves estimated at 70 million tons, with a 40 per cent alumina content and 40 per cent silica. This high silica content deprives the ore of commercial value.

Nothing is known of any bauxite deposits in Argentina, but aluminous clay with a high alumina content has been found at Camarones (Chubut) and in the province of Misiones.

Commercial bauxite deposits have been discovered in French Guiana and Haiti, and lower-grade bauxite in Costa Rica and Panama.

The various countries' reserves may turn out to be substantially larger than those shown in table II-3 when systematic geological studies are carried out to locate and quantify bauxite potentialities in the region.

7/ See Special Ministry for Planning and Economic Co-ordination, Department of Economic Research (Ministério Extraordinário para o Planejamento e Coordenação Econômica, Escritório de Pesquisa Econômica Associada), Plano Decenal de Desenvolvimento Econômico e Social: Metais não ferrosos.

/Table II-3

Table II-3

LATIN AMERICA: BAUXITE RESERVES IN SELECTED COUNTRIES

Country or area	Reserves a/ (millions of tons)	Al_2O_3 content (percentage)	Potential reserves with less than 46 per cent Al_2O_3 content (millions of tons)
Brazil b/	40	59 c/	173 d/
Costa Rica b/	-	-	150
Dominican Republic b/	40	48 c/	40
French Guiana b/	10 c/	60 c/	70
Haiti b/	23	47 c/	7
Guyana a/	80	58	70
Jamaica a/	550	50	450
Panama	-	-	25
Peru	-	-	70
Surinam a/	200	58	200
Venezuela	-	-	10
Total Latin America	[illegible]	-	[illegible]
Total rest of world	220 e/	-	-
Total Latin America as percentage of world total	[illegible]		

a/ Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

b/ United States Department of the Interior, Bureau of Mines, Mineral Facts and Problems, 1960 (estimate prepared December 1958).

c/ United States Department of the Interior, Bureau of Mines, Materials Survey: Bauxite, Washington, 1953.

d/ According to the authority cited in footnote a/, these are estimated rather than potential reserves.

e/ United States Department of the Interior, Bureau of Mines, Commodity Data Summaries, February 1962.

/2. [illegible]

2. Energy resources

Latin America possesses about 10 per cent and 0.3 per cent, respectively, of the world's petroleum and coal reserves,[a] and 25 per cent of its total water resources.

While some of the Latin American countries are abundantly endowed with natural energy resources, others are virtually devoid of them. Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela possess coal reserves of varying quality, but only in Brazil, Chile, Colombia and Mexico are they developed on a scale of any significance.

Petroleum is plentiful in Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru and above all, Venezuela, which possesses over two-thirds of the region's proven reserves. Natural gas abounds in Venezuela and Chile. Except in Mexico and Venezuela, the deposits are so situated as to make it difficult to obtain supplies economically for the alumina production.

Sources of hydroelectric power are scattered throughout Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru and Venezuela. These countries are rich in potential reserves, especially Brazil, Chile, Colombia and Venezuela, where conditions are favourable for the low-cost generation of marginal electric power. Argentina's resources are on a smaller scale, and a long way from the coast.

C. OPERATING CONDITIONS IN THE ESTABLISHED INDUSTRY

1. Bauxite

World production of bauxite has boomed in recent years. From its 1952 level of 12.8 million tons, it rose to 32.9 million tons by 1962, i.e., at a cumulative annual rate of 9.9 per cent.

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[a] See Energy in Latin America, United Nations publication, Sales No.: 1957.II.G.2.

/Table II-4

Table II-4

LATIN AMERICA: PRODUCTION OF BAUXITE, ALUMINA AND PRIMARY ALUMINIUM

(Thousands of metric tons)

Country or area	Bauxite		Alumina a/		Primary aluminium	
	1952	1962	1956	1960	1952	1962
Brazil	14	98	12	34	1	35
Dominican Republic	-	1 077	-	-	-	-
Guyana	2 426	2 051	-	-	-	-
Haiti	-	459	-	-	-	-
Jamaica	346	8 977	210	676	-	-
Surinam	3 224	3 561	-	-	-	-
Total Latin America	6 010	15 683	222	710	1	35
Total rest of world	6 759	17 320	6 366	8 603	2 086	4 965
World total	12 769	33 003	6 588	9 313	2 087	5 000
Total Latin America as a percentage of world total	47.0	47.5	3.3	7.6	-	0.7

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op.cit.

a/ No data available for the years 1952 and 1962.

Latin America's output of bauxite accounts for approximately half the world total, and increased between 1952 and 1962 from 5.9 million to 15.7 million tons. Thus its annual growth rate slightly exceeded the world average, reaching 10.8 per cent. Over 93 per cent of this regional production was concentrated in three countries: Guyana, Jamaica and Surinam. (See table II-4.) Jamaica achieved so large an expansion that it became the region's leading producer, contributing 51 per cent of the total. Production in Guyana and Surinam, however, levelled off considerably.

/Bauxite prices

Bauxite prices fluctuate widely, according to the characteristics of the ore and the terms of sales contracts.[9] As a result basic prices exist for a given type of ore, and are subject to surcharges or discounts depending upon the content of impurities and other physical properties of significance from the standpoint of the metal-transforming industry.

In 1960, the Dominican Republic, Guyana, Haiti, Jamaica and Surinam accounted for approximately 82 per cent of Latin America's total flow of extra-regional exports of bauxite. North America (Canada and the United States) was the leading importer.

2. Alumina

Latin America produces less than 10 per cent of the world total of alumina, and this represents the output of only two countries: Brasil and Jamaica. Jamaica exports all it produces, mainly to supply primary aluminium plants in Canada and the United States. Brasil, on the other hand, uses its own alumina to produce primary aluminium itself. The Companhia Alumínio Minas Gerais S.A. and the Companhia Brasileira de Alumínio have alumina plants with an installed capacity (in terms of annual production) of 30,000-32,000 tons and 45,000 tons, respectively, and which can meet the primary aluminium production requirements of both companies.

Alumina being an intermediate product, the volume of inter-regional exports is smaller than in the case of bauxite. Moreover, it is not quoted on the metal markets and there are no standard criteria for fixing sales prices, which are contingent upon the price levels of the factors of production in each geographical area and upon the terms of sales contracts.

3. Primary aluminium

World production of primary aluminium expanded between 1952 and 1962 at a cumulative annual rate of 9.5 per cent.

9/ Volumes, duration of contract, ore specifications, etc. For illustrative purposes, the study quotes f.o.b. prices ranging from 3.60 to 7.60 dollars per ton.

/In Latin

In Latin America the growth of apparent consumption of primary aluminium was not accompanied by an increase in the region's production. The first attempt to produce primary aluminium in Latin America was made in Brazil in 1945, when Electroquímica Brasileira S.A. began to manufacture it at Saramenha, near Ouro Preto. But owing to a number of difficulties created by the Second World War, the plant had to close down in 1946. In 1960, The Companhia Alumínio Minas Gerais, an affiliate of Alumínio do Brasil S.A. which is a subsidiary of Alumínium Limited, obtained control of the enterprise, and production was resumed in 1961.

There are two aluminium-producing companies in Brazil: the Companhia Alumínio Minas Gerais (formerly known as Electroquímica Brasileira S.A.), and the Companhia Brasileira de Alumínio, operating at Mairinque, near Sorocaba, in the State of São Paulo.[10] Both these are fully integrated enterprises undertaking the whole range of processes from the extraction of the bauxite to the production of primary aluminium and the manufacture of the final product.

Brazil has an abundance of bauxite and electric energy resources, but they are very far from the major centres of consumption. Fuel and caustic soda costs also seem to constitute a serious obstacle to the development of the aluminium industry.

The two aluminium-producing companies hold concessions for harnessing the hydroelectric potential of various rivers, but neither is completely self-sufficient and both have to purchase electric power from the interconnected systems in their respective States.

At the end of 1964, Alumínio Minas Gerais in Ouro Preto was paying 0.045 dollar cents per kWh, and the Companhia Brasileira de Alumínio 0.075 dollar cents.

The pitch used by these plants comes from Volta Redonda, and the other raw materials - such as tar, petroleum coke, cryolite and caustic soda - are imported because domestic production is either non-existent

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10/ A third enterprise may possibly enter operation in Brazil in the near future.

/or insufficient

or insufficient to meet requirements, as in the case of caustic soda. Fuel oil is bought from the companies that distribute petroleum products, and the electrodes are made in the factories' own carbon paste plants.

The rated annual primary aluminium production capacity of the two plants amounts to 34,000 tons in the aggregate. Both enterprises have expansion projects well under way.

Mexico was the second country to develop a primary aluminium industry. A plant with a rated annual capacity of 20,000 tons entered operation in May 1963. Alumina and other inputs (cryolite, petroleum coke, etc.) are imported from the United States.

Electric power is supplied by the Comisión Federal de Electricidad from the Tomascal power station.11/

In Surinam, a vertically-integrated plant with an annual primary aluminium production capacity of 60,000 tons is in the final phase of construction. Its output will be shipped to the European market.

Venezuela will shortly be joining the group of Latin American countries that produce aluminium. It affords one of the best locations for this industry, thanks to the immense hydroelectric potential of the River Caroní and the ease with which bauxite can be imported from the region's traditional producers, such as the Dominican Republic, Guyana, Haiti, Jamaica or Surinam.

The Venezuelan plant will be situated at Santo Tomé de Guayana, and in its first phase will produce 12,500 tons of primary aluminium to supply domestic market requirements. Most of its primary production will be made into wire rod and smooth and corrugated sheet in the factory itself. Alumina will be imported from the Corpus Cristi plant in Jamaica. Electric energy supplies will be obtained from the Macagua hydroelectric power station owned by the Corporación Venezolana de Guayana, at the price of 0.0222 dollar cents per kWh.

11/ No information is available on the price at which electric power is sold to the aluminium plant.

/The project

The project will be handled by Aluminio del Caroní S.A. (ALCASA), an enterprise in which the Corporación Venezolana de Guayana holds 50 per cent of the capital stock.[12] Investment in fixed capital for the plant will amount to approximately 20 million dollars in the initial phase. The establishment - including the transforming plant - will provide employment for about 300 persons, and is expected to enter production at the end of 1967.[13]

D. PRODUCTION COSTS

Over and above the normal difficulties encountered in evaluating the technical and economic aspects, cost estimates of the various stages of aluminium production are further complicated by other factors, such as the cost of transport and power inputs, which varies greatly from one country to another.

The transport problem is particularly important because bauxite and alumina lose approximately 50 per cent of their weight when processed into alumina and primary aluminium, respectively. Another important feature of the aluminium industry is the high fuel and electric power input requirements.

In the study under discussion detailed analyses are made of costs in the different stages of production in mining operations and plants of varying size, taking into account comparative locational advantages in different places in Latin America. In this section cost estimates relate only to the three stages of production (bauxite, alumina and primary aluminium) in hypothetical plants of different size. The analysis indicates the factors most affecting production costs and the economies of scale practicably at each stage. The estimates are only intended as a general frame of reference for a more detailed analysis, in which all possible variations caused by particular local conditions will be considered.

12/ The other 50 per cent is held by the Reynolds Corporation.

13/ Central Co-ordination and Planning Office (Oficina Central de Coordinación y Planificación), Plan de la Nación 1965-1968, Caracas, 1965.

/1. Bauxite

1. Bauxite

The most important inputs in the production of dried bauxite are bauxite ore, fuel and labour, but maintenance, repair and capital charges are also significant. The cost of extracting the bauxite is clearly the determining factor, but the share of fuel increases with the scale of production, as can be seen in table II-5.

Total production costs per ton of bauxite include labour costs in mining the ore, depending on the scale of production, the cost of transporting the ore to the washing and drying plant and the washing and drying operations. Estimates have been calculated on the basis of hypothetical mines in the Poços de Caldas region in Brasil.

Economies of scale in this stage of production depend largely on labour costs and, particularly, on capital charges. The sharp downward turn of the unit-cost curve in figure 1 is mainly due to these two factors. On the basis of an index of 100 for production costs in a mining operation of 300,000 tons, operations of 50,000 and 500,000 tons would have indexes of 221.3 and 88, respectively.

Figure 1 shows that in a mining operation in Poço de Caldas with an annual capacity of about 50,000 tons theoretical production costs per ton of bauxite are higher than world prices for bauxite with high and low alumina content. The same would be of true of an operation with an annual capacity of 100,000 tons, if administrative and sales costs and a fair return on capital are added to production costs. The study under discussion 14/ claims that annual capacity must exceed 200,000 tons in order to produce high-grade bauxite at international prices. The situation is different for low-grade ores, 15/ which would have to be mined in even greater quantities in order to compete on the world market.

14/ *Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional*, op.cit.

15/ Brasil has 40 million tons of high-grade ore and about 173 million tons of ore with a low alumina content.

/Table II-5

Table II-5

PRODUCTION COSTS OF DRIED BAUXITE IN HYPOTHETICAL MINING OPERATIONS

Inputs	Annual capacity (tons)											
	50 000		100 000		200 000		300 000		400 000		500 000	
	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)
Ore (cost of extraction in relation to size of operation)	5.19	58.8	2.83	50.9	2.22	50.2	1.99	49.9	1.80	49.0	1.70	48.4
Fuel	0.70	7.9	0.70	12.6	0.70	15.8	0.70	17.5	0.70	19.1	0.70	20.0
Maintenance and repair	0.35	4.0	0.33	5.9	0.32	7.2	0.31	7.8	0.31	8.5	0.31	8.8
Indirect labour	1.07	12.1	0.58	10.4	0.39	8.8	0.28	7.0	0.24	6.5	0.22	6.3
Direct labour	0.77	8.7	0.52	9.4	0.28	6.3	0.21	5.3	0.16	4.4	0.14	4.0
<u>Total direct costs</u>	<u>8.08</u>	<u>91.5</u>	<u>4.96</u>	<u>89.2</u>	<u>3.91</u>	<u>88.3</u>	<u>3.49</u>	<u>87.5</u>	<u>3.21</u>	<u>87.5</u>	<u>3.07</u>	<u>87.5</u>
Capital charges	0.75	8.5	0.60	10.8	0.52	11.7	0.50	12.5	0.46	12.5	0.44	12.5
<u>Total production costs</u>	<u>8.83</u>	<u>100.0</u>	<u>5.56</u>	<u>100.0</u>	<u>4.43</u>	<u>100.0</u>	<u>3.99</u>	<u>100.0</u>	<u>3.67</u>	<u>100.0</u>	<u>3.51</u>	<u>100.0</u>

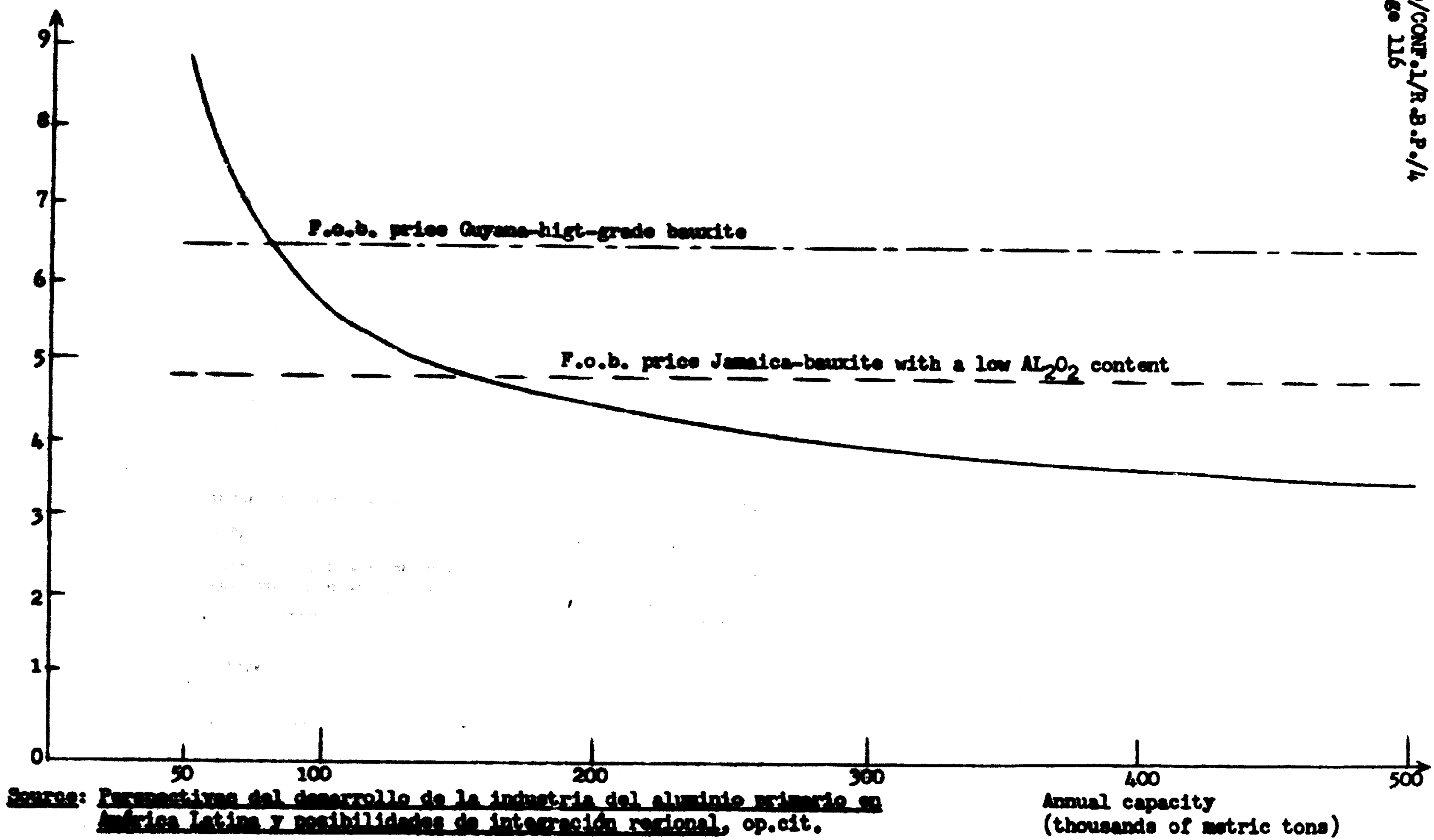
Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

Note: Includes the processes of mining, washing and drying the bauxite. Costs reflect economies of scale in the mining of the ore. It is assumed that three shifts would be working for 300 days in the year.

/Figure 1

Figure 1

BRAZIL: ESTIMATED PRODUCTION COST PER TON OF BAUXITE IN HYPOTHETICAL PLANTS OF DIFFERENT SIZE



Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op.cit.

/2. Alumina

2. Alumina

The most significant factors affecting total production costs for alumina are the cost of fuel for the production of steam and calcination of the alumina and capital charges. Within the theoretical schema presented in the study, the cost of caustic soda is also important. (See table II-6.)

Economies of scale in this stage of production are strongly influenced by the volume of bauxite, steam, indirect labour and electric power.

On the other hand, as plant size increases there is a relative decline in the cost of those factors and an increase in the cost of caustic soda and fuel for calcination. Thus, on the basis of an index of 100 for the total production costs of alumina in a plant with an annual capacity of 100,000 tons, plants of 25,000 and 250,000 tons would have an index of 146.1 and 84.8, respectively.

As noted earlier, alumina, unlike bauxite, is not quoted on the metal market and sales prices are not established according to any standard criteria.

In 1961 the domestic price in the United States was about 60 dollars per ton. In 1963 the rate for alumina transactions between economically and financially related enterprises was 63 dollars f.o.b. New Orleans, while for independent enterprises it rose to about 70 dollars per metric ton.

Figure 2 shows that if Brazil produced alumina exclusively for export to the world market, the minimum economic size of the plant to be established would have to be between 100,000 and 150,000 metric tons per year in order to benefit from the resulting sizable economies of scale. (See also table II-7.)

Figure 3 shows the trends of average investment per ton of alumina in plants with annual capacities of between 100,000 and 300,000 metric tons.

The investment indicated in table II-7 includes the cost of the complete plant (equipment, buildings, foundations, steam plants, etc.) but excludes services depending on local conditions, such as the generation of power, workers' and employees' accomodation, etc.

/Table II-6

Table II-6

PRODUCTION COSTS OF ALUMINA IN HYPOTHETICAL PLANTS

Inputs	Annual capacity (tons) 25 000 (dollars per ton)	25 000 (percentage)	50 000 (dollars per ton)	50 000 (percentage)	100 000 (dollars per ton)	100 000 (percentage)	200 000 (dollars per ton)	200 000 (percentage)	250 000 (dollars per ton)	250 000 (percentage)
Bauxite	18.54	24.1	11.68	18.4	9.30	17.7	7.71	16.9	7.37	16.5
Steam	16.20	21.1	15.28	24.1	10.98	20.9	8.88	19.5	8.88	19.9
Caustic soda	7.82	10.2	7.82	12.3	7.82	14.9	7.82	17.1	7.82	17.5
Fuel for calcination	4.11	5.3	4.11	6.5	4.11	7.8	4.11	9.0	4.11	9.2
Maintenance and repair	4.29	5.6	3.73	5.9	3.22	6.1	2.74	6.0	2.74	6.2
Direct labour	3.77	4.9	2.77	4.3	1.85	3.5	1.69	3.7	1.62	3.6
Indirect labour	3.43	4.5	2.10	3.3	1.36	2.6	0.96	2.1	0.84	1.9
Electric power	1.00	1.3	1.00	1.6	0.80	1.5	0.60	1.3	0.60	1.4
Total direct costs	59.16	77.0	48.49	76.4	39.44	75.0	34.51	75.6	33.98	76.2
Capital charges	17.63	23.0	14.97	23.6	13.13	25.0	11.12	24.4	10.60	23.8
Total production costs	76.79	100.0	63.46	100.0	52.57	100.0	45.63	100.0	44.58	100.0

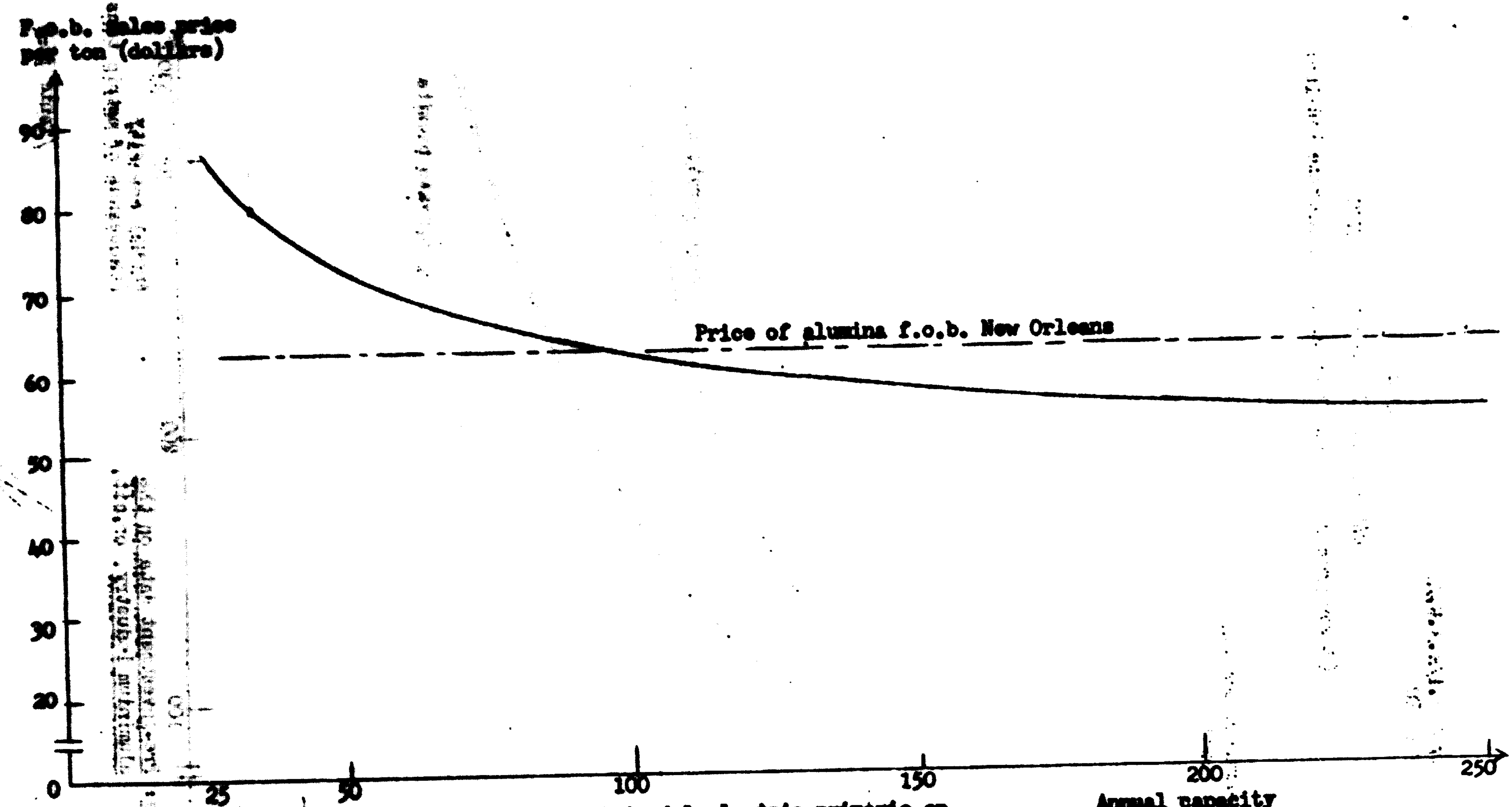
Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

Note: Costs reflect economies of scale in the processing of bauxite.

/Figure 2

Figure 2

BRAZIL: F.O.B. SALES PRICE FOR ALUMINA IN PLANTS INTEGRATED WITH THE BAUXITE MINING OPERATION



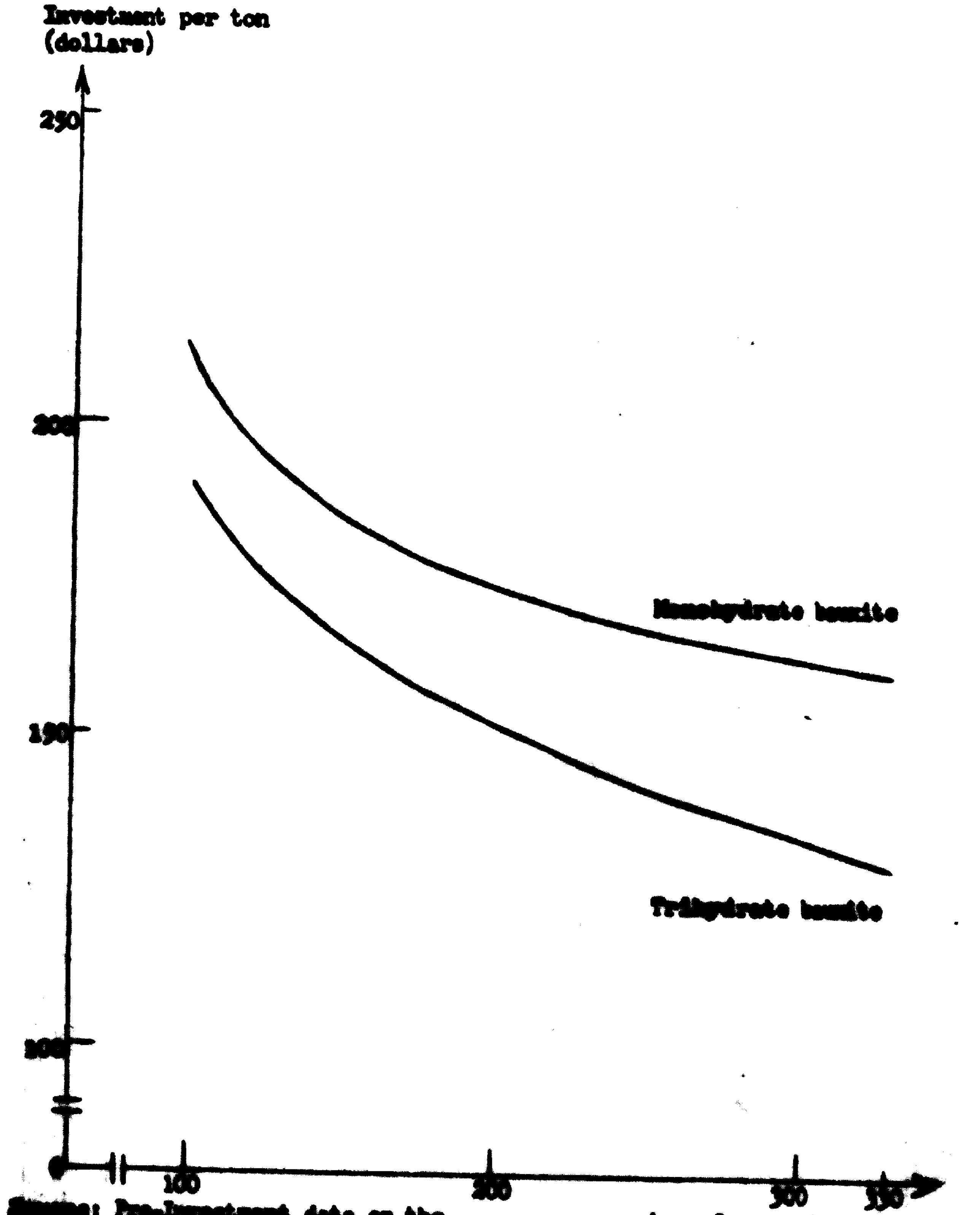
Source: [illegible] del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op.cit.

/Figure 3

Figure 3

CAPITAL COST IN ALUMINA PLANTS

(Bayer process for monohydrate and trihydrate bauxite)



Source: Pre-investment data on the aluminium industry, op.cit.

/Table II-7

Table II-7

INVESTMENT PER TON FOR OUTPUT IN ALUMINA
PLANTS OF DIFFERENT SIZE

Annual capacity (metric tons)	Dollars per metric ton of annual capacity	
	Trihydrate bauxite	Monohydrate bauxite
100 000	170 - 210	190 - 230
165 000	140 - 180	160 - 200
330 000	110 - 150	140 - 180

Source: Pre-investment data on the aluminium industry (ST/ECLA/Conf. 11/L.24).

3. Primary aluminium

The cost of alumina and electric power together make up more than half the total production cost of primary aluminium.

Electric energy, petroleum coke and other lesser inputs cost proportionally more as plant size increases, whereas considerable economies of scale can be obtained in alumina and indirect labour costs, and in general expenditure (including technical assistance) and capital charges.

However, these economies of scale are less significant than in the two earlier stages of production. Thus, on the basis of an index of 100 for the total production costs of one ton of aluminium in a plant with an annual capacity of 100,000 tons, plants with annual capacities of 12,500 and 150,000 tons would have an index of 128.3 and 91.9, respectively. (See table II-8.)

/Table II-8

Table II-8

PRODUCTION COSTS OF PRIMARY ALUMINIUM IN HYPOTHETICAL PLANTS

Inputs	Annual capacity (tons)									
	12 500		25 000		50 000		100 000		150 000	
	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)	(dollars per ton)	(percentage)
Alumina	153.58	34.7	126.92	32.6	105.18	30.5	91.26	28.5	89.16	28.1
Electric power	75.20	17.0	73.60	18.9	72.40	21.0	72.00	22.5	72.00	22.7
Calcined petroleum coke	21.25	4.8	21.25	5.5	21.25	6.1	21.25	6.6	21.25	6.7
Maintenance and repair	22.00	5.0	21.00	5.4	18.00	5.2	17.50	5.5	17.50	5.5
General expenditure, including technical assistance	21.90	4.9	16.76	4.3	14.84	4.3	14.12	4.4	14.00	4.4
Dry pitch	13.04	2.9	13.04	3.4	13.04	3.8	13.04	4.1	13.04	4.1
Aluminium fluoride	11.94	2.7	11.94	3.1	11.94	3.5	11.94	3.7	11.94	3.8
Direct labour	14.69	3.3	12.72	3.3	11.38	3.3	10.74	3.4	10.59	3.3
Indirect labour	18.88	4.3	10.42	2.7	7.40	2.1	7.09	2.2	6.94	2.2
Synthetic cryolite	5.53	1.2	5.53	1.4	5.53	1.6	5.53	1.7	5.53	1.8
Fuel oil and materials for cathodes	2.07	0.5	2.07	0.5	2.07	0.6	2.07	0.7	2.07	0.7
Fluoride and calcium carbonate	0.44	0.1	0.44	0.1	0.44	0.1	0.44	0.1	0.44	0.1
Total direct costs	360.52	81.4	315.69	81.2	283.47	82.1	266.98	83.4	264.46	83.4
Capital charges	82.63	18.6	73.28	18.8	61.84	17.9	53.30	16.6	52.73	16.6
Total production costs	443.15	100.0	388.97	100.0	345.31	100.0	320.28	100.0	317.19	100.0

Source: Perspectivas del desarrollo de la industria del aluminio primario en América latina y posibilidades de integración regional, op. cit.

Note: Costs reflect economies of scale in the production of alumina.

/The consumption

The consumption of electric power is an extremely important factor in the production of primary aluminium, since in the electrolytic reduction process 18,600 kWh are normally needed to produce one ton of aluminium. Consequently, since aluminium plants require a direct and reliable power supply, they are usually situated close to electric power stations or interconnected networks supplying power at the lowest possible prices.

Since it weighs so heavily in total production costs, this factor is usually decisive in establishing the general economic viability or feasibility of an industrial project and in determining the site of the production centre or centres. Table II-9 shows the share of electricity in the production costs of one ton of aluminium ingots in a hypothetical plant with an installed capacity of about 60,000 tons.

As is to be expected, total unit investment in aluminium plants in the United States shows the same decline in relation to plant size as the capital charges indicated in table II-8. This investment includes: electric power distribution, reduction plants, carbon plants, cast houses, services, lighting and gas removal facilities, materials handling equipment, offices, laboratories, maintenanse workshops, storeage facilities, buildings and foundations.

/Table II-9

Table II-9

SHARE OF ELECTRIC POWER IN THE PRODUCTION COSTS OF PRIMARY ALUMINIUM

Cost of electricity per kwh (thousandths of a dollar)	Cost of one ton of aluminium (Soderberg process) (dollars)	Percentage share of electricity in production costs
1	290.0	6.0
2	308.0	12.0
3	326.0	16.0
4	345.0	21.0
5	363.0	25.0
6	381.0	28.0
7	399.0	31.0
8	417.0	34.0
9	435.0	37.0
10	453.0	40.0

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

Table II-10

INVESTMENT PER TON OF OUTPUT IN PRIMARY ALUMINIUM PLANTS OF DIFFERENT SIZE

Annual capacity (tons)	Type of anode	
	Prebaked (dollars per ton)	Soderberg (dollars per ton)
20 000	1 000 - 1 300	900 - 1 200
50 000	750 - 1 050	700 - 1 000
100 000	650 - 850	650 - 850
200 000	500 - 700	550 - 750

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

/B. TECHNOLOGY

E. TECHNOLOGY AND ECONOMIES OF SCALE

The technology for aluminmium production has been developed by a few major companies, which have prefected a series of interdependent processes for completing the bauxite, alumina and primary aluminium stages in a single plant. Although these stages might be considered as separate, technically and economically they are so closely as to constitute a single sequence.

1. Bauxite

Bauxite is an alumina hydrate mixed with impurities,16/ which occurs in two main forms: as a trihydrate under the name of gibbsite, and as a monohydrate; either boehmite or diaspore. There are other ores made up of mixtures of these varieties. The consistency of bauxite can range from the earthy material found in Jamaica to the hard rock type found in Greece, but it is uneconomic to grind bauxite with a bond hardness index above 15.

Many production factors, which are often interdependent, determine whether it is economic to mine bauxite and what operational methods should be used. In some cases, the various possibilities will have to be carefully weighed and additional exploration undertaken before adopting a decision.

Production costs vary greatly depending on the volume of output, operational methods, the particular features of each deposit, and other generally less important factors.

Nearly all bauxite operations are open-pit mining; only in a few cases are they conducted underground, usually at a higher cost.

Since the grade of the ore in a deposit is not uniform and there are serious technical difficulties in using the concentration treatments normally applied in working other ores, the daily output of bauxite has to be strictly controlled and stored in separate bins, according to grade and impurities

Crude bauxite contains up to 30 per cent of free moisture; it is therefore dried before being transported long distances, and the drying is an important part of bauxite mining.

The main inputs required to produce one metric ton of dried bauxite are shown in table II-11, for different production capacities.

16/ Oxides of iron, silicon and titanium, and other impurities.

/Table II-11

Table II-11

DRIED BAUXITE PRODUCTION: INPUT COEFFICIENTS, ACCORDING TO SCALE OF PRODUCTION

(Inputs per metric ton of bauxite)

Inputs	Unit	Production (tons)					
		50 000	100 000	200 000	300 000	400 000	500 000
Ore	Tons	1.45	1.45	1.45	1.45	1.45	1.45
Fuel	Tons	0.023	0.023	0.023	0.023	0.023	0.023
Maintenance and spare parts	Dollars	0.35	0.33	0.32	0.31	0.31	0.31
Indirect labour	Dollars	1.07	0.58	0.39	0.28	0.24	0.22
Direct labour	Man-hours	1.0	0.67	0.36	0.27	0.25	0.18
Capital cost	Dollars	0.75	0.60	0.52	0.50	0.46	0.44

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

2. Alumina

There are several methods of producing alumina, the Bayer process - i.e. the chemical refining of bauxite - being the most widely used. This is ostensibly because there are plentiful supplies of ore and low-cost fuel in several parts of the world and because the industry is in the hands of a few companies.

The Bayer process consists in dissolving finely ground dried bauxite at high temperature under pressure in a caustic solution. Soluble sodium aluminate is thus obtained, while the impurities from a residue known as red mud. A filtering process follows and, finally, the coarse alumina hydrate obtained in the classifiers is calcined at high temperatures 17/ in oil-fired or gas-fired rotary kilns; once cooled, the result is pure alumina, which can then be subjected to electrolysis or used for other purposes.

The Bayer process varies greatly as regards the pressure and temperature used and the degree of caustic concentration of the solutions for treating raw material of different qualities.

17/ 1,150-1,250°C.

Acids or solutions of strong acid salts (such as ammonium sulphate) have been used in some processes for reducing bauxite. These processes are also being considered for the treatment of raw materials other than bauxite,18/ but so far they have been unable to compete with the Bayer process. However, persistent efforts to separate alumina from different types of clay are being made in various parts of the world, either by private enterprises or by Governments.

The Pedersen process is the only method which has been fully developed on a commercial scale and which can compete with the Bayer process. It is used in Norway and the Soviet Union, which together produced 20 per cent of total world output of alumina in 1960. An electric furnace is used in this reduction process; the calcium aluminate slag is leached to precipitate alumina hydrate, which is then calcined.

The principal inputs required to produce one metric ton of alumina by the Bayer process are shown in table II-12.

Table II-12

ALUMINA PRODUCTION: INPUT COEFFICIENTS, BY PLANT SIZE

Bayer process

(Inputs per metric ton of alumina)

Input	Unit	Plant size (tons)				
		25 000	50 000	100 000	200 000	250 000
Bauxite	tons	2.1	2.1	2.1	2.1	2.1
Caustic soda	kg	80.0	80.0	80.0	80.0	80.0
Electric power	kWh	250.0	250.0	200.0	150.0	150.0
Fuel for calcination	tons	0.130	0.130	0.130	0.130	0.130
Direct labour	man-hours	4.9	3.6	2.4	2.2	2.1
Indirect labour	dollars	3.43	2.10	1.36	0.96	0.84
Steam	tons	4.0	4.0	3.0	2.5	2.5
Maintenance	dollars	4.29	3.73	3.22	2.74	2.74
Capital cost	dollars	17.63	14.97	13.13	11.12	10.60

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

18/ Various clays, alumina-rich coal ashes, leucite, nepheline, andalusite, labradorite, alumita, etc.

3. Primary

3. Primary aluminium

The Hall-Heroult electrolytic process for reducing alumina and obtaining primary aluminium has been widely used since the end of the last century, and has been steadily improved.

Batteries of cells 19/ are used as cathodes, their size depending on the amperage and the "anode" system used; small cells are used in the prebaked anode system and large cells in the Soderberg process. The arrangement of cells depends largely on the climate because of ventilation requirements. In cold and temperate countries, a single raw or two parallel raws of cells are arranged in each pot-room building, while in tropical areas only one line of cells can be placed in each pot-room building to avoid over-heating.

The two anode systems described are closely competitive, and the decision to adopt either one of them depends on essentially local factors.

In the electrolytic process, alumina is fused and dissolved in a solution of double aluminium fluoride and sodium. The cryolite fuses at 1,000°C and dissolves the alumina. The aluminium is their separated from the oxygen and deposited on the walls and at the bottom of the cells, while the oxygen combines with the anode carbon and is released as a gas. 20/ The aluminium deposited in the cells is periodically extracted by means of blows, syphoning or suction; it is then fused into ingots as virgin, primary or electrolytic aluminium.

The toxic anode gas can be cleaned by a process which permits the recovery of part of the alumina and cryolite it contains.

The main inputs required to produce one ton of primary aluminium are shown in table II-13, for different plant sizes.

19/ Usually from 30 to 150 cells.

20/ Carbon dioxide.

/Table II-13

Table VI.13

PRIMARY ALUMINIUM PRODUCTION: INPUT COEFFICIENTS, BY PLANT SIZE

Soderberg process

(Inputs per metric ton of primary aluminium)

Input	Unit	Plant size (tons)				
		12 500	25 000	50 000	100 000	150 000
Alumina	tons	2.00	2.00	2.00	2.00	2.00
Calcined petroleum coke	tons	0.56	0.56	0.56	0.56	0.56
Dry pitch for paste	tons	0.18	0.18	0.18	0.18	0.18
Sodium carbonate	kgs	3.00	3.00	3.00	3.00	3.00
Aluminium fluoride	tons	0.035	0.035	0.035	0.035	0.035
Synthetic cryolite	tons	0.025	0.025	0.025	0.025	0.025
Electric power	kWh	18 800	18 400	18 200	18 000	18 000
Direct labour	Man-hours	18.6	16.1	14.4	13.6	13.4
Indirect labour	dollars	18.88	10.42	7.40	7.09	6.94
Maintenance	dollars	22.00	21.00	18.0	17.50	17.50
Capital cost	dollars	82.69	73.28	61.84	53.30	50.73

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

/F. DEVELOPMENT

F. DEVELOPMENT OPTIONS

1. Locational factors

The technical and economic aspects of the different stages of aluminium production, the availability of natural resources and of facilities for transport of end goods, from the production centres to the markets and market size and characteristics are the principal factors to be weighed in determining the best ways to plan the development of the aluminium industry in the region, and the right plant size and site for each stage of the production process.

Decisions on plant location are often influenced by political and social considerations which may prevail over those of a purely technical and economic nature. But as the former are very varied and the degree to which they affect decision-making cannot be objectively established, they were not taken into account in the study under consideration.

The question of plant location is also closely associated with production structure and plant size. When there is total vertical integration (bauxite, alumina and primary aluminium) or partial integration (bauxite and alumina, or alumina and primary aluminium), economies of scale increase of scale increase, the minimum economic scale of production is lowered and there is a shift in the relative importance of the locational factors considered at each stage. The question becomes even more complicated in relation to the transformation of primary aluminium into end goods, but this stage was omitted in the study under consideration.

In general, it can be said that vertically integrated plants (alumina-primary aluminium) tend to be located near the cheapest supplies of bauxite, electric power and fuel.

2. The aluminium industry in a common market

Regional integration is essential for the aluminium industry, particularly since it calls for heavy investment and is situated in an area where total demand is small in relation to economic plant size. As indicated earlier, only four Latin American countries have an annual apparent consumption of more than 10,000 tons of primary aluminium, which is the minimum plant size in absolute terms. (See table II-1.) By 1975, seven countries will be in the same category.

/The fact

The fact that the region has abundant bauxite and energy that are not being fully utilized and that demand for primary aluminium is expected to rise to over 400,000 tons by 1975 are clear evidence of the need to develop the aluminium industry on a region-wide basis.

A glance at the figures for overall demand in the region shows that several plants of economic size can be set up.

In 1962, Latin America provided 47.5 per cent of the world supply of bauxite, but processed only 7.6 per cent of the alumina and a mere 0.7 per cent of the primary aluminium.

The study under consideration examines several methods of developing the industry on a regional scale, but points out that the ideas are very tentative and would have to be confirmed or amended in subsequent studies; they are intended merely to give some indication of the importance of regional integration for the aluminium industry.

In reviewing the various alternatives, the factors discussed under point 1 were considered and estimates made of the reductions in transport costs that could be obtained in plants of different size. It was demonstrated that f.o.b. costs would be considerably reduced in a hypothetical vertically integrated industry in Brazil, where the cost for a plant with a capacity of 200,000 tons would be 28 per cent less than for a plant of only 12,500 tons.

The regional approach was also applied to investment requirements - which would be substantial - and it was found that the further studies would have to be made on that problem.[21/]

There are various ways of developing the primary aluminium industry on a region-wide basis. To begin with, the hypothesis of regional development assumes that the different national markets would be merged into sub-regional markets, which would be supplied with primary aluminium by one or more alumina reducing plants. In order to form an idea of the economic benefits of developing tha aluminium industry in a common market, the c.i.f. price

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21/ In the developed countries, economies of scale in investment are very big, since investment per ton of primary aluminium drops 40 per cent between a plant of 20,000 tons and one of 200,000 tons. In alumina production, a raise in scale from 100,000 to 300,000 tons lowers unit investment by 24 per cent.

/per ton

per ton of primary aluminium produced in a few hypothetical plants was compared for several of the development options. (See table II-15.) These integration alternatives were based on the following criteria: alternative I, the possibility of supplying the regional market from the existing alumina reducing plants; alternative II, the possibility of setting up a third plant in Venezuela. Venezuela was chosen because it will shortly be joining the ranks of the primary aluminium producers, and offers particularly favourable conditions for the development of the industry. Alternative III considers only those countries in which the industry would be able to develop because they offer certain competitive advantages or have a sufficiently large domestic market, while alternative IV assumes that the industry would develop concurrently in Argentina, Brazil, Chile, Mexico, Peru and Venezuela.

The principles on which those integration options are based can be summed up as follows:

Alternative I	Regional supply on the basis of plants in Brasil and Mexico.
Alternative II	Regional supply on the basis of plants in Brasil, Mexico and Venezuela.
Alternative III	Simultaneous development of the aluminium industry in Argentina, Brazil, Chile Mexico and Venezuela.
Alternative IV	Simultaneous development of the aluminium industry in Argentina, Brazil, Chile, Mexico, Peru and Venezuela.

This pattern of sub-regional plants is solely for the production of primary aluminium. It has also been tentatively assumed that as Brazil is the only ALALC country with abundant bauxite deposits, it would be the only country to produce alumina, while the others would import it.

(a) Price levels

The study first analyses the cost of producing primary aluminium in hypothetical plants of various sizes located in different countries that offer a potentially favourable medium for the development of the industry.

The f.o.b. sales price per ton of primary aluminium from plants of different size is listed in table II-14 for six Latin American countries.

/Table II-14

Table II-14

LATIN AMERICA: F.O.B. SALES PRICE PER TON OF PRIMARY ALUMINIUM IN HYPOTHETICAL PLANTS OF DIFFERENT SIZES IN SELECTED COUNTRIES

Soderberg system

(Dollars per ton)

Country	Annual capacity in tons					
	12 500	25 000	50 000	100 000	150 000	200 000
Argentina	-	-	414	394	-	-
Brazil	496	437	386	361	354	348
Chile	471	436	405	-	-	-
Mexico	-	-	423	411	-	-
Peru	502	-	-	-	-	-
Venezuela	-	-	389	370	-	-

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op.cit.

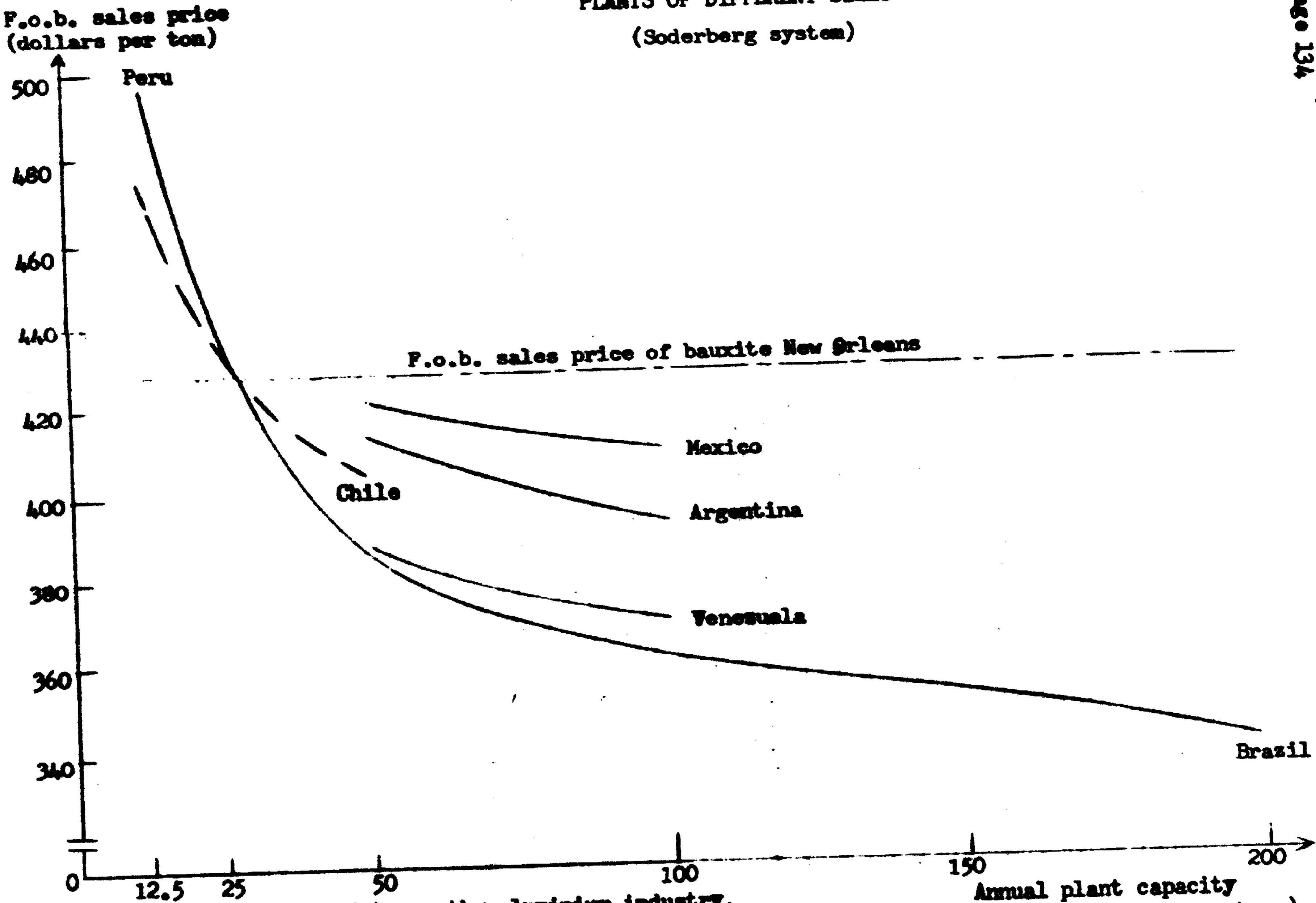
Figure IV shows the f.o.b. sales price of one ton of primary aluminium from various hypothetical plants in Latin America compared with the New Orleans f.o.b. price of aluminium produced in the south of the United States. The Brazilian price is for a vertically integrated plant, whereas the other plants would import alumina and begin the process of reduction at that level.

/Figure 4

Figure 4

F.O.B. SALES PRICE PER TON OF ALUMINIUM IN PLANTS OF DIFFERENT SIZES

(Soderberg system)



Source: Pre-investment data on the aluminium industry, industry, op.cit.

/The curve

The curve described by the different alumina reducing plants in Brazil shows that costs decrease sharply as plant capacity expands. The other distinguishing feature of the curve is that it drops below aluminium production curves for the other countries, except for the smallest plant sizes. In plants with a capacity of 12,500 to 25,000 tons a year, the sales price for Brazilian aluminium would be higher than for Venezuelan and Chilean products since the industry is presumed to be vertically integrated in the former. Alumina would be produced at a high cost in small plants with an output of 25,000 to 50,000 tons a year, while Venezuela and Chile would import alumina at world market prices. From the 30,000 ton level upwards, Brazil has advantages over all the other possible combinations because of the capacity of its alumina reducing plants and their vertical integration. The minimum economic size for Venezuela and Chile would be close to 12,500 tons a year, but for an integrated plant in Brazil it would be about 18,000 tons of primary aluminium a year. The curve for the hypothetical plants in Venezuela shows less pronounced economies of scale that the curve for Brazil and the gap between the two widnes as plant size increases. There are virtually no economies of scale in the plants in Argentina and Mexico as the curve slopes very gradually. Minimum economic plant size is much larger there than in the other countries mentioned, because one or more cost factors are higher.

To make it easier to analyse the different alternatives proposed, the production costs in each of the possible plants were calculated on a c.i.f. basis. The overhead and sales expenses were then added to the cost, plus handling charges, rail freight (where appropriate) to the port of embarkation, and port dues. The price of primary aluminium includes a 10 per cent profit on share capital, the cost of shipping the aluminium to the port of destination and consular, customs and insurance charges.

The price of primary aluminium from the United States at port of destination was used as a standard of comparison with the c.i.f. prices of aluminium exported by the various hypothetical plants. The standard price was worked out on the basis of an average export price f.o.b. port of New Orleans, plus transport, consular fees and customs and insurance charges.

/Table II-15

Table II-15 shows that primary aluminium reduced in Brazil in plants with an annual capacity of 150,000 and 200,000 tons could be exported to other parts of Latin America for less than the standard price. The prospects would be different for exports from Veracruz plant, which has an annual capacity of 100,000 tons. In this case, the price of primary aluminium at the port of destination in Colombia or Venezuela would be slightly higher that the standard and a good deal above the price of Brazilian ingot.

The price commanded at the port of destination by primary aluminium ingot exported from a 100,000 ton plant in Venezuela would be less than the standard price but 5 per cent higher than that of Brazilian ingot.

As the raw materials situation is easier in Venezuela and electric power costs less, the price of Venezuelan exports may be less that the estimated price of aluminium from Veracruz, and Venezuela would thus be brought into regional export trade. The price of its aluminium at the port of destination would be slightly less than that of United States ingot.

Ingot produced in Brazil could be shipped to Chile and Peru at a lower price than is feasible for the production of a local plant with a capacity (12,500 tons) proportionate to apparent domestic consumption. This would not apply to Argentina, Mexico or Venezuela, with plants of 50,000 tons, but would be valid for Chile if the capacity of the hypothetical plant to be set up there were raised to 25,000 tons a year.

Argentina would be unable to enter the export market on a competitive basis, because the price of its products in the nearest country - Uruguay - would be more than 20 dollars a ton, which is the benchmark level.

The 50,000 ton aluminium plant in Puerto Montt (Chile) would not be in a position to export to Peru, Ecuador or Colombia at a lower price than the cost of their imports from the United States.

On the assumption that Chile and Venezuela would be exporting primary aluminium ingot and, with plants of 100,000 tons annual capacity, would meet all the requirements of Peru, Ecuador and Colombia, Brazilian ingot would be cheapest, with Venezuelan ingot a close second. Both would at all times undercut the price of local output should the projected plant be set up with sufficient capacity to cover domestic demand.

/Table II-15

Table II-15

LATIN AMERICA: C.I.F. PRICE PER TON OF PRIMARY ALUMINIUM IN DIFFERENT PLANTS

(Dollars)

Port of destination	New Orleans standard c.i.f. price port of destination	Veracruz capacity 100 000 tons/a.	Puerto de Caldas capacity 200 000 tons/a.	Puerto de Caldas capacity 150 000 tons/a.	Guyana and Surinam capacity 100 000 tons/a.	Puerto Madryn capacity 50 000 tons/a.	Puerto Montt capacity 100 000 tons/a.	Puerto Montt capacity 50 000 tons/a.	Pisco capacity 12 500 tons/a.
Veracruz (México)	573	459	-	-	-	-	-	-	-
Barranquilla (Colombia)	563	572	500	514	535	-	-	-	-
Barcelona (Venezuela)	564	574	497	512	490	-	-	-	-
Santos (Brasil)	571	-	501	504	-	-	-	-	-
Montevideo (Uruguay)	570	-	488		-	-	-	-	-
Buenos Aires (Argentina)	572	-	488		-	483	-	-	-
Buenaventura (Colombia)	569	-	-	-		-	587	580	-
Guayaquil (Ecuador)	567		504	518	506	-	555	578	-
Pisco (Perú)	570	-	500	515	538	-	953	575	563
Valparaíso (Chile)	575	-	496	511		-	440	466	-

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op.cit.

/The lowest

The lowest cost and price levels in Latin America are to be obtained by producing primary aluminium in plants that are vertically integrated from the mining of the bauxite onwards. However, ingot manufactured in Brazil could not be sold in Argentina, Chile, Mexico or Venezuela at a lower price than that of local output from plants with an annual capacity of over 25,000 tons. Theoretically, then, these countries are in a favourable economic position for developing aluminium metallurgy. In any case, the price of the local aluminium would be lower than that of ingot from the traditional suppliers.

Peru is in a different situation for the time being mainly because electric power is relatively expensive there and the domestic market is small. The price of Peruvian aluminium in nevertheless likely to be close to the price of imports from the traditional exporters or from hypothetical plants of 50,000 tons in Venezuela and Chile.

(b) <u>Investment requirements</u>

The study estimates the investment needed, first, to carry out the various regional integration alternatives and cover demand for primary aluminium by 1975 (regional hypothesis), and, secondly, to establish a primary aluminium plant in any country whose apparent consumption exceeds 10,000 tons in that same year (national hypothesis).

(i) <u>Total investment estimates according to the national hypothesis.</u> Table II-2 shows that, on the basis of this hypothesis, Argentina, Brasil, Chile, Colombia, Mexico, Peru and Venezuela would be in a position to have primary aluminium plants in 1970, since all of them would have a high enough consumption level by then to support a plant of absolute minimum size.

Two of these countries - Brazil and Mexico - already have primary aluminium plants and a third - Venezuela - is about to enter into production.[22] (See table II-16.)

22/ However, Brasil is at a competitive disadvantage on the world market because of the size of its plants, its lack of cheap fuel and shortage of caustic soda.

/Table II-16

Table II-16

SUB-REGIONAL PLANTS: SIZE AND CAPITAL COEFFICIENT

Size (ton per year)	Capital coefficient (dollars per ton)
10 000	1 476
30 000	1 225
50 000	1 100
100 000	930
150 000	800

Source: Perspectivas del desarrollo de la industria de aluminio primario en América Latina y posibilidades de integración regional, op. cit.

Table II-17 indicates the investment required for new plants in 1975.[23] The figures were obtained by multiplying new capacity by the capital coefficient, allowance being made for economies of scale.

According to this hypothesis, Brazil would supply only its own primary aluminium plants with alumina. The other six countries would import alumina from outside Latin America. Brazil's alumina output in 1970 and 1975 would therefore be 170,000 and 320,000 tons respectively. This would entail an investment of 20 to 33 million dollars in the new alumina plants to be set up there.

(ii) Total investment estimates based on the regional hypothesis. On the assumption that a common market will be formed in Latin America, and that the aluminium plants will be located as indicated in the four alternatives explained above with their respective market areas, investment requirements would be approximately those shown in table II-18.[24]

23/ The investment is expressed in net terms, i.e., the plants now in operation have been discounted.

24/ This and the preceding table include investment in the primary aluminium plants already established in Brazil and Mexico. Both amounts were calculated at replacement cost.

/Table II-17

Table II-17

LATIN AMERICA: INVESTMENT REQUIREMENTS IN HYPOTHETICAL NATIONAL PRIMARY ALUMINIUM PLANTS

(Millions of dollars)

Country	Investment in 1975 a/
Argentina	59.5
Brazil b/	250.1
Chile	20.1
Colombia	38.0
Mexico	77.6
Peru	17.5
Venezuela	45.0
Other countries c/	22.2
Total	530.0

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

a/ The capital coefficient used in the study was the highest for a particular size of plant in the United States. A decreasing percentage was added (15 per cent for a plant of 10 000 tons and 5 per cent for a plant of 150 000 tons a year) to cover higher installation costs, the transport of machinery and equipment, etc.

b/ The investment requirements for the three plants was computed on the assumption that bauxite mining and alumina production would be integrated.

c/ Investment in these countries was estimated by adding the capacity of the countries with an annual consumption of under 10 000 tons and multiplying the result by the capital coefficient indicated in table II-16 for that particular size of plant.

/Table II-18

Table II-18

LATIN AMERICA: INVESTMENT REQUIREMENTS IN REGIONAL PRIMARY ALUMINIUM PLANTS

(Millions of dollars)

Sub-region and plants	Alternative I	Alternative II	Alternative III	Alternative IV
Mexico (Veracruz)	99.4	77.6	77.6	77.6
Brazil (three plants)	366.8	301.4	306.9	306.9
Venezuela (Guyana)	-	87.2	50.3	50.3
Argentina (Puerto Madryn)	-	-	55.3	55.3
Chile (Puerto Montt)	-	-	18.5	33.2
Peru (Pisco)	-	-	18.5	-
Total	466.2	466.2	527.1	523.3

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op.cit.

A comparison of the investment needed for Alternative I of the regional hypothesis and for the national hypothesis shows that the former would result in a saving of 64 million dollars, or 12 per cent.

Regional programming of the aluminium industry, and the reduction in investment and costs that it would bring about, would create a new structure of intra-regional trade which would in time lead to competition among the different Latin American plants. The new regional trade flows in primary aluminium that would emerge round each sub-regional plant have been estimated according to the anticipated distribution of demand in the different countries and the international price of aluminium at the end of 1965. (See table II-19.)25/

25/ Five hundred and thirty dollars a ton.

Table II-19

LATIN AMERICA: ESTIMATED VALUE OF TRADE UNDER EACH ALTERNATIVE

(Millions of dollars)

Sub-region	Alter-native I	Alter-native II	Alter-native III	Alter-native IV
Mexico	16.0			
Brasil	67.0	35.0	24.0	24.0
Venezuela		33.0	4.0	4.0
Argentina				
Chile			6.0	
Peru				
Total Latin America	83.0	68.0	34.0	28.0

Source: Perspectivas del desarrollo de la industria del aluminio primario en América Latina y posibilidades de integración regional, op. cit.

If the primary aluminium plants are situated in the major consumption centres trade would decline as aluminium production was decentralised. Under Alternative II, regional exports would be approximately 120,000 tons, whereas Alternative I envisages a total of 159,000 tons. With Alternative IV, which provides for the most complete decentralisation, trade would be down to 52,000 tons a year compared with 63,000 tons under Alternative III.

The regional hypothesis postulating a few big plants does not mean that the future development of the industry will be focused on a small number of locations, since technological progress over the years is giving the industry a wider margin of choice in this respect. Table II-20 shows the increased efficiency of the reduction cells, whose size, measured in amperes, has been growing constantly to the benefit of the reduction process.

/Table II-20

The fact that the amount of electric power needed to produce a ton of primary aluminium declined 58 per cent between 1892 and 1958 has given the industry a measure of flexibility. But this does not represent a radical change in the factors determining location; electric power is and will continue to be a fundamental factor in production. New sources of low-cost energy will be found in Latin America and will offer suitable sites for the development of the industry. The trend towards physical decentralization will be reinforced by the diseconomies of scale that may take place in the initial plants if they exceed the potimum production scale.

The main conclusions that emerge from the study are that the region possesses a plentiful supply of the basic natural resources needed for this type of industry, that several of the Latin American countries could develop aluminium production economically enough to achieve price levels comparable to those prevailing in the domestic markets of the highly industrialised countries, and that the creation of a regional market would enhance their prospects of doing so.

Table II-20

EFFICIENCY OF THE REDUCTION CELLS

Year	Cells		Efficiency of power kWh/ton
	Voltage	Amperes	
1892	20	4 000	41 800
1950	5 - 7	30 000	22 000 - 26 400
1958	4.5 - 5	100 000	18 600

Source: The Aluminium Development Association, A Guide to Aluminium.

/Chapter III

Chapter III

THE CHEMICAL INDUSTRY

After it had prepared a series of studies on the chemical industries ECLA published in 1963 the final version of its report La industria química en América Latina.[1] In the light of the report's conclusions and in view of the complexity of harmonizing and co-ordinating development in this sector, it held a Seminar on the Integrated Development of the Chemical Industry, in December 1964 at Caracas, which was attended by a noteworthy number of experts. The object of the Seminar was to have an interchange of opinions concerning the concrete prospects of integration in this field, and for that purpose the ECLA staff had prepared a series of documents analysing the sector as a whole [2] and, in greater depth, its chief branches.[3] It also submitted monographs on the advantages of integration in the sector [4] and on the possibility of establishing in Latin America a permanent mechanism for the periodic and systematic collection of statistical information on the sector's production and consumption and on new projects from the national agencies, responsible for sectoral planning or from industrialist's associations.[5]

1/ (E/CN.12/628/Rev.1).

2/ Evolución de las industrias químicas en el período 1959-1962 (E/CN.12/726).

3/ Desarrollo de las industrias de álcalis sódicos en América Latina (ST/ECLA/Conf.15/L.5/Rev.1).
La industria petroquímica en América Latina (ST/ECLA/Conf.15/L.6/Rev.1).
La industria de fertilizantes en América Latina (ST/ECLA/Conf.15/L.7/Rev.1).

4/ Posibilidades de un desarrollo regionalmente integrado de las industrias químicas (ST/ECLA/Conf.15/L.8/Rev.1).

5/ Centralización y actualización de las informaciones estadísticas sobre las industrias químicas en América Latina (ST/ECLA/Conf.15/L.9).

/It was

It was strongly recommended at the Seminar that as a preliminary to concrete schemes of integration, ECLA should without delay make further studies of the present state and development prospects of the industry in terms of specific products or groups of products, giving priority to the following branches:

a) Fertilizers;

b) Sodium alkalis;

c) Basic petrochemical products.

It was also to continue the comprehensive compilation of production, capacity and foreign trade statistics in the order periodically to bring up to date the general survery of the sector given in recent ECLA documents and distribute annually to each of the Latin American countries a synthesised, uniform and summary analysis of these data.

A further account of the Caracas Seminar is given in Report of the Seminar on the Development of the chemical industry in Latin America (E/CN.12/719/Rev.1) which was prepared by the ECLA staff and reflects their impression of the discussions; it summarizes the different opinions expressed in the documents submitted and in the speeches made during the working sessions, brings up to date and completes these analyses of the sector in the light of new information and points of view, and suggests concrete lines of future action.

As had been recommended, in 1965 and 1966 ECLA made studies and published reports 6/ on each of the specific branches of the industry.

These studies provided background information and drew provisional conclusions on the development of basic branches of the chemical industry, their structure in the different Latin American countries and the orientation of current programmes in relation to regional demand.

6/ La industria química latinoamericana en 1962-1964 (E/CN.12/756), July 1966.
La industria petroquímica en América Latina (E/CN.12/744).
La oferta de fertilizantes en América Latina (E/CN.12/761).
La industria de los álcalis sódicos en América Latina, provisional text, December 1966.

/This work

This work has continued in 1967 with a study of rubber use and production in the region and the collection of general information on the sector for use in an overall survey covering the period 1959-1965, which will give statistics for each of these years, and preliminary indicators for 1966 on regional production, exports, imports and consumption of chemical products. An attempt will also be made to quantify factors such as present and projected production capacity, price levels, employment, etc., in order to provide an up to date picture of the development of the industry in Latin America.

In response to suggestions made at hte Seminar, several meetings of a Working Group of representatives of the regional bodies concerned with promoting fertiliser use and production were held in 1965 and 1966. The first was in June 1965, at the invitation of the Inter-American Committee of the Alliance for Progress.7/ It met again in May and November 1966 to discuss the conclusions of studies that had been made into the Latin American market for fertilisers 8/ and their regional production. The results of this research had been condensed in a provisional report which was submitted at the May meeting and a revised text 9/ at the November meeting.

7/ The first meeting made use of the following ECLA documents:
La situación de los fertilizantes en América Latina y posibilidades de una acción coordinada (E/CN.12/L.3).
Antecedentes sobre la industria de fertilizantes en América Latina (E/CN.12/L.4).
At the end of the meeting a report was prepared with the title:
Informe final de la primera reunión del grupo de trabajo de CIAP sobre fertilizantes (OEA/Serv.H/XIII CIAP/228 (Español) Rev.) 14 June 1965.

8/ El uso de fertilizantes en América Latina (E/CN.12/760), ECLA/FAO Joint Group on Agriculture.

9/ La oferta de fertilizantes en América Latina (E/CN.12/761).

/A. THE

A. THE CHEMICAL INDUSTRY AS A WHOLE

1. Recent trends in the Latin American chemical industries [10]

By and large, the growth of the Latin American chemical industries during 1959-1964 measured in terms of output was faster that that of the manufacturing sector as a whole, with the result that they constituted a dynamic element in overall industrial development (see table III-1). However, their development is still partly held back by backward technology, poor use of investments, high costs and the poor supply prospects for their growing demand.

Table III-1

LATIN AMERICA: INDUSTRIAL PRODUCTION INDEXES IN SEVEN COUNTRIES IN 1962, 1963 AND 1964

(1959=100)

Countries	Manufacturing sector [a]			Chemical sector		
	1962	1963	1964	1962	1963	1964
Argentina	109	103	118	109	118	138
Brasil	133	132	138	141	155	168
Chile	115	122	128	116	127	134
Colombia	123	128	135	127	148	173
Mexico	120	129	149	151	168	197
Peru	139	149	164	143	160	183
Venezuela	121	131	150	128	148	169

a/ Statistical annex (mimeographed) to The industrial development process in Latin America (E/CN.12/716/Rev.1).

10/ For a more detailed analysis of the evolution of the branch see Evolución de las industrias químicas en el período 1959-1962 (E/CN.12/726) and La industria química latinoamericana en 1962-1964 (E/CN.12/756).

/Consumption of

Consumption of chemical products in the broad sense (including the traditional manufactures such as soaps, toilet preparations, matches and candles, and pharmacentical and other formula products) was 3,715 million dollars in 1962, 4,065 million in 1963 and 4,500 million in 1964. Its cumulative annual growth rate was 9.3 per cent in 1959-1964 and 8.7 per cent in 1959-1962. The average regional per capita consumption was 18 dollars in 1962 and 21 dollars in 1964.[11/] Comparing these figures with the 126 dollars per capita of the Unites States (in 1957) and the 60 dollars of a large group of European countries, it is obvious that the Latin American market has enormous room for expansion.

Although the regions production grew considerably during the period (from 1,865 million to 3,080 million dollars, with a cumulative annual growth rate of 10.5 per cent), Latin American imported an increasing value of chemical products (1,052 million dollars in 1962, 1,077 million in 1963 and 1,209 million in 1964). And though these imports grew more slowly than output their share in total regional imports rose from 12.2 per cent in 1959 to 14.9 per cent in 1964. Thus the industry exerted increasing pressure on the limited resources available to finance imports.

Domestic production satisfied 74 per cent of the region's demand in 1964, as against 70 per cent in 1959 and 72 per cent in 1962. However, these overall figures disguise the relative backwardness of regional supply in particular branches, such as sodium alkalis, chemical products for agriculture, synthetic rubber and plastic products, in all of which imports had to be used to satisfy 40 per cent or more of demand.

In 1959 two-thirds of Latin American chemical production consisted of consumer goods and parachemical items produced by "light industries"; only one-third was basic and intermediate goods. By 1964 this situation had change, since one development of the period was the establiament of a number of new lines of production, notably fertilisers and petrochemical products, which had been projected some years before. Ammonia and fertiliser plants in Colombia, Costa Rica, El Salvador. Mexico and Venezuela have reached full operating capacity, making a considerable addition to regional supply.

11/ Preliminary figures for 1965 give a consumption of slightly less than 4,950 million dollars (9.5 per cent above 1964).

/Interest in

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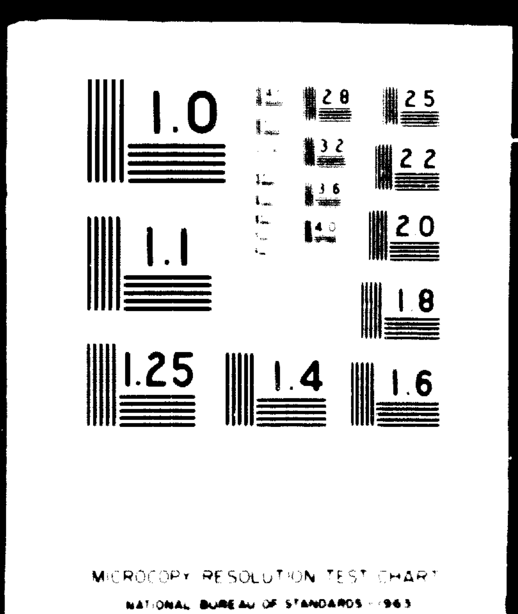
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

Interest in the petrochemical sector has been on the increase in several countries. Mexico has made notable progress in the last few years and is now producing dodecylbenzene for manufacture of synthetic detergents on a scale large enough for intra-regional export as well as anhydrous ammonia, urea, ammonium nitrate, carbon black, ethyl benzene, cyclohaxane and complex fertilizers of nitrogen, phosphorus and potassium base. In Argentina carbon sulphide of petrochemical origin, carbon black, isopropyl alcohol, polyethylene, phenol, ethylene, methanol, benzene and toluene are now being manufactured.

Production of synthetic rubber began in Brazil in 1962, but continues to be dependent for its raw materials, butadiene and styrene on imports. In Colombia a synthetic ammonia plant, with associated units for urea, mixed fertilisers, etc., is being brought into operation and cellophane and phthalic anhydride production is beginning. In Chile production of alkyd resins is being developed. In Peru there are now outputs of ammonia, aluminium sulphate and calcium carbide and in Venezuela of carbon black, nitrogen fertilizers, sodium silicate and polyvinyl acetate.

Latin America exports of chemical products grew more rapidly in 1963 and 1964 than in any previous year and showed some degree of difersification. This is a sign of maturity in the regional industry.

Traditional products still account for most of total chemical exports, but their share has been reduced over the period. Thus, eleven of these products - quebracho extract, casein, ethyl alcohol, menthol, furfural sodium and potassium nitrate, iodine, natural and synthetic hormones, colophony, litharge and asphalt - accounted for 72 per cent of the total export value in 1962, but only 62 per cent in 1964. Meanwhile, the following items were exported for the first time in 1964: SBR elastomers, from Brazil (2.1 million dollars); artificial silk yarns made from cellulose acetate and viscose, from Colombia (1.5 million dollars); pyrethrum-based insecticides, disinfectants and similar products, from Ecuador (1.2 million dollars); chemical fertilisers and urea, from Mexico (3.3 and 1.4 million dollars); chemically based nitrogen fertilisers, from Venezuela (2.6 million dollars).

/Of total

Of total exports in 1962 (117 million dollars)[12/] 24.1 per cent were intra-regional and of the total in 1964 (151 million dollars)[13/] 30.7 per cent, an insignificant increase. This tendency for intra-regional trade to remain stationary calls for more enegetic measures if it is to be accelerated and expanded. There is now a growing desire to utilise the new channels being opened for the industry by the application of the Montevideo Treaty.

As a result several attempts have been made to promote the establishment of factories capable of satisfying regional demand which would not only increase intra-regional trade but would reduce costs as a result of the economies of scale involved. An example of incipient international complementarity is the Central American fertiliser factories, whose raw material, ammonia, is partly supplied by Colombia.

2. Recent trends in the chemical industry by countries

Of the aggregates for the region, a mayor proportion comes from the countries with the largest domestic markets (see table III-2). In 1964 Brazil contributed 38.6, Mexico 22.7 and Argentina 19.1 per cent of total regional output. While regional *per capita* output in that year was 15 dollars, Argentina's was 26 dollars, Mexico's 17 and Brazil's 15 (as against 12, 21, 14 and 13 dollars respectively in 1962).

The trend towards an increasing concentration of the chemical industry is most apparent in consumption and exports.

12/ Excluding nitrate exports.

13/ In 1965 total exports were about 178 million dollars, roughly 40 per cent inter-Latin America.

/Table III-2

Table III-2

LATIN AMERICA a/: REGIONAL CONCENTRATION OF INDUSTRY

(In percentages of the total for each item)

	Largest countries b/				Medium countries c/				Small countries d/			
	1959	1962	1963	1964	1959	1962	1963	1964	1959	1962	1963	1964
Gross domestic product	65.2	65.6	64.7	64.8	24.7	24.6	25.1	25.3	10.1	9.8	10.2	9.9
Gross industrial product	75.2	75.6	74.6	74.9	18.6	18.5	19.4	19.2	6.4	5.9	6.0	5.9
Population	63.9	64.0	64.0	64.0	20.4	20.3	20.3	20.3	15.7	15.7	15.7	15.7
Chemical sector												
Gross production	79.9	81.0	80.5	80.4	14.7	14.0	14.4	14.6	5.4	5.0	5.1	5.0
Exports	66.8	68.7	68.4	68.0	18.9	19.3	16.6	16.9	14.3	12.0	15.0	15.1
Inter-Latin American trade	62.1	64.4	63.5	61.7	17.8	18.5	16.3	19.9	20.1	17.1	20.2	18.4
Imports	46.1	46.9	45.9	46.3	35.2	36.5	37.1	36.0	18.7	16.6	17.0	17.7
Apparent consumption	69.9	71.4	71.0	71.5	21.1	20.4	20.8	20.4	9.3	8.2	8.2	8.1

Note: Preliminary figures for the chemical sector in 1965 give the percentage shares of the major countries as follows:

	Percentage
-Production	80
-Exports	60
-Inter-Latin American trade	61
-Imports	47
-Apparent consumption	71

a/ Excluding Cuba.

b/ Argentina, Brazil, Mexico.

c/ Chile, Colombia, Peru, Venezuela.

d/ The remaining Latin American countries.

/The cumulative

The cumulative growth rate of regional consumption, which was 8.7 per cent for the period 1959-1962, rose to 10.1 per cent in 1962-1964. Detailed analysis of table III-3 will show that in two countries (Argentina and Colombia) the faster growth of consumption reflected a faster growing domestic supply. Argentine production increased at an annual rate of 3 per cent in 1959-1962, at the end of which, in tune with the rest of the economy, it became stagnant; in the second half of 1963 it showed a marked recovery and went on to achieve a growth rate of 12.4 per cent for the two years,14/ largely as a result of more intensive use of installed capacity and, in particular, the opening of the main petrochemical plants. After the carbon black plant inaugurated in 1962, three ethylene plants (32,000 tons/year), two polyethylene (25,000 tons/year), two menthanol (26,500 tons/year), one carbon sulphide (14,000 tons/year), one phenol (8,000 tons/year), one new benzene and toluene plant (42,000 tons/year), one styrene (14,000 tons/year) and one propylene (5,000 tons/year) began production (1963 and 1964). Colombia's increase in consumption in 1962-1964 was mostly due to a growing domestic output, but partly to larger imports. The greatest increases in production occurred in group I, basic inorganic chemical products, and group III, chemical products for agriculture (from 4.7 million dollars in 1962 to 10.1 million in 1964 in group I, and from 3.0 million dollars in 1962 to 71.2 million in 1964 in group III). There was also a substancial increase in production of artificial fibres from cellulose acetate. In 1963 and 1964 plants for nitrogen fertilisers, ammonia, nitric acid, phthalic anhydride, etc. had come into operation.

The opposite ocurred in Chile, Peru and, to a lesser degree, Mexico, where faster growing consumption was due to mounting imports. The most striking example was Chile, whose imports almost doubled between 1962 and 1963 (52 million dollars in 1962, 93 million in 1963, 76 million in 1964, and 93 million in 1965). The largest increases were in group III, products for agriculture, IV, plastics and synthetic resins and VII, painting, dyeing, tanning and colouring materials and the largest individual increases in ammonium nitrate, Thomas slag, insecticidal powders, mouldrite (plastic), unspecified synthetic resins, aniline, titanium dioxide, quebracho extract, etc.

14/ Preliminary figures for 1965 indicate a drop in the growth rate (11.6 per cent in 1964-1965).

/Table III-3

Table III-3

LATIN AMERICA a/: GROWTH RATES IN THE CHEMICAL SECTOR, BY COUNTRY

(Cumulative annual percentage growth rates for each period)

Country	Production		Exports		Imports		Apparent consumption	
	1959-62	1962-64	1959-62 a/	1962-64	1959-62 a/	1962-64	1959-62 a/	1962-64
Argentina	3.0	12.4	-7.2	17.7	2.0	17.2	3.4	12.8
Brazil	12.1	9.1	36.0	18.9	11.3	-4.7	11.8	7.1
Chile	4.6	7.7	5.7	-	3.8	21.0	4.4	13.5
Colombia	8.3	16.8	31.0	23.0	9.4	13.3	8.4	15.5
Mexico	14.6	14.4	26.0	6.6	5.7	7.9	11.5	13.5
Peru	12.6	13.4	15.6	-3.0	8.2	15.0	10.4	14.4
Venezuela	8.5	15.1	7.3	6.0	6.8	-9.2	7.3	-0.2
Average for the 7 countries	10.0	11.7	9.8	11.5	7.0	5.3	9.2	10.0
Remaining countries a/	7.4	11.8	2.5	27.0	2.9	9.4	3.9	9.7
Latin America as a whole a/	9.8	11.7	8.8	13.5	6.3	6.0	8.7	10.1

Note: Preliminary figures on Latin America as a whole for 1965 indicate the following increases on 1964:

	Percentage
-Production	7.0
-Exports	9.9
-Imports	13.3
-Apparent consumption	9.5

a/ Excluding Cuba.

/The largest

The largest increase in production was in group IV, plastic materials and synthetic resins (from 2.6 million dollars in 1962 to 6.5 million in 1964). Chile already manufactures alkyd resins (2,500 tons/year), unsaturated polyester resins (2,000 tons/year), phenol-formaldehyde resins (3,500 tons/year), urea-formaldehyde (3,000 tons/year) and vinyl emulsions, almost all from imported raw materials.

The Chilean chemical industry's share in regional production has been declining yearly (from 3.7 per cent in 1959 to 3.1 per cent in 1964 and 1965), but should increase with the opening of the petrochemical plants planned for 1968-1969.

Peru's rising consumption was also mainly due to heavy increases in imports. In the plastics and synthetic resins group, where domestic production mostly depends on imported raw materials, there was a considerable increase in imports of bakelite, cellulose acetate, cellophane, plasticizers, etc. In group V, artificial and synthetic fibres, a rising consumption of polyamides (for nylon) had similar effects. In paints and pharmaceutical products, in spite of the substantial progress made, domestic production still only replaces imports of final products and depends on imported raw materials.

On the production side there has been progress in output of nitrogen and phosphate fertilizers and in the manufacture of viscose rayon, acetate and nylon fibres (at present only nylon 66 is produced; that of monomer nylon is projected) and paints and pharmaceutical products.

Mexico's substancial increase in consumption reflects both its rapidly growing imports and the dynamism and diversification of its domestic industry. In 1964 it had 30 state petrochemical plants and 48 of private or mixed ownership producing ammonia, dodecylbenzene, benzene hydrocarbons, acetaldehyde, ethylene, urea, ammonium nitrate, carbon black, nitrogen and phosphate fertilizers, acetic acid and anhydride, butanol acetone, polyester fibres, caprolactam, surface-active agents, etc. Expansions and new plants more recently have substantially increased the country's production capacity. Ethylbenzene, cyclohexane, carbon black, tetraethyl lead, styrene and urea were all first produced in 1963-1964; at the same time ammonia and synthetic resin capacity was increased. Until the end of 1963 the aromatic products were only produced as by-products of coal coking, which heavily restricted supply; at that date the aromatic products plant of Petróleos Mexicanos began producing

/considerable quantities

considerable quantities of benzene, toluene, the xylenes and their mixtures. But although imports of almost all the products mentioned have been eliminated or reduced, the increase in the volume of foreign chemical purchases shows no sign of slackening (180 million dollars in 1959, 247 million in 1964, 296 million in 1965).

In Venezuela, and Brazil consumption grew more slowly in 1962-1964 than in 1959-1962. In Venezuela the import substitution process received a powerful boost during the more recent period from the beginning of operations in the Morón complex as regards nitrogen fertilizers, and from the beginning of domestic production of nitric acid, ammonia and a series of plastics. However, this was accompanied by a severe retrenchment of imports (from 174 million dollars in 1962 to 143 million in 1964), which resulted in a drop of 0.2 per cent in consumption. The largest decrease occurred under the head of medicinal products in general (from 37 million dollars in 1962 to 16 million in 1964).

The growth rate of consumption in Brazil also fell in the latter period, to below the average for the region. This was partly due to a decline in production, where priority is now being given to the basic inorganic chemicals, fertilizers, plastics and rubber groups. Even so output volumes were substantial. Prospects of a faster growth of production are very good, particularly in petrochemicals. There are at present projects under study for manufacture of nitrogen fertilizers from coking gasses and naphtha, dodecylbenzene, styrene, cyclohexane, acrylonitrile, terephthalic acid, butadiene, adipic acid, phthalic anhydride, polyethylene, phosphoric acid, caustic soda, nitric acid, etc.15/

The slower growth of consumption was further due to the extremely variable behaviour of imports, which rose from 184 million dollars in 1962 to 198 million in 1963, fell to 167 million in 1964 and rose again to 185 million in 1965. The marked decreases in groups III, IV and VI (from 63 to 50 million dollars) reflect progress made in import substitution.

15/ However, it would appear from preliminary figures that Brazil's 1965 production was less than in 1964 (1,190 million dollars in 1964 and 1,185 million in 1965).

/Because the

Because the chemical industries of the various countries have reached different stages of development and have evolved in different ways, the share of domestic supply in consumption, varies considerably from one to the next (see table III-4). In 1964 it was 89 per cent in Brazil, 82 per cent in Argentina, but only 44 per cent in Venezuela, where, however, it had risen from 32 per cent in 1962; in Chile it fell from 63 to 57 per cent in the same period. It would appear that, except in Mexico and Venezuela, the import substitution process is practically at a standstill, a fact which is harshly incongruous with the dynamic character of the industry, the ambitious expansion plans of many countries and the difficult balance of payments situation of nearly all of them.

Table III-4

LATIN AMERICA: SHARE OF DOMESTIC SUPPLY IN CONSUMPTION OF CHEMICAL PRODUCTS, 1959-64

(Ratio of production to consumption)

Country	1959	1962	1963	1964
Argentina	83	84	85	82
Brazil	86	86	86	89
Chile	62	63	51	57
Colombia	61	60	61	62
Mexico	68	73	77	75
Peru	45	48	47	47
Venezuela	31	32	41	44
Average for the 7 countries	73	74	75	76.5
Remaining countries	41	42	43	43
Latin America as a whole a/	70	72	73	74

a/ 73 per cent in 1965, according to provisional figures.

/3. Recent

3. Recent trends in the chemical industries, by major branches

A chemical industry can be said to have reached maturity when it produces a large proportion of intermediate goods. Studies of the industry in Latin America indicate that in 1959 nearly two-thirds of production was carried out by light industry producing consumer and parachemical goods. Later studies reveal a gradual improvement in this respect: during 1959-1964 production of carbon black began in several countries, production of ammonia, nitric acid, nitrogen fertilizers and plastics increased and production of synthetic rubber got under way for the first time in the region, even so, the volumes of Latin American output of some of the main basic and intermediate chemical products are low in comparison with those of more industrialized countries.16/

More detailed analysis of the production structure of the Latin American chemical industry in comparison with that of a more industrialized country (United States) reveals considerable disparities that confirm these general conclusions (see table III-5).

Much of production in groups I and II basic organic and inorganic products, is ethyl alcohol and glycerine. Without these groups, share in total output would have been only 6.7 instead of 11.5 per cent in 1964 and only 4.2 per cent in 1959. In the United States it is 17.5 per cent (1957).

On the other hand, the share of group III, chemical products for agriculture, is almost 100 per cent higher in Latin America than in the United States. This is due to the implementation of fertilisers use policies, which in many of the countries has resulted in increased output on the part of existing plants and in new plants and projects. There was an enormous increase in nitrogen fertiliser production in 1962-1964.

16/ See, E/CN.12/756, table 9.

/Table III-5

Table III-5

LATIN AMERICA: EVOLUTION OF THE STRUCTURE OF THE CHEMICAL INDUSTRY IN SEVEN COUNTRIES a/ AND COMPARISON WITH THE UNITED STATES OF AMERICA

(Percentages of the total value of production)

		Latin America				United States
		1959	1962	1963	1964	1957
I and II	Major inorganic and organic chemical products	10.5	10.7	11.0	11.4	17.5
III	Chemical products for agriculture	4.6	4.8	5.4	6.3	3.3
	III-A Fertilisers	0.9	1.7	2.0	3.0	2.3
	III-B Pesticides	3.7	3.1	3.4	3.3	1.0
IV	Plastics and synthetic resins	3.7	5.1	6.0	7.2	8.8
V	Artificial and synthetic fibres	8.6	9.9	10.4	10.6	9.5
VI	Synthetic rubber and related products, including carbon black	0.1	0.8	1.2	1.3	4.7
VIII	Surface-active agents and bleaches	27.2	23.8	22.2	20.5	9.8
	VIII-A Soaps	20.1	15.3	14.9	14.2	1.8
	VIII-B Detergents	3.3	5.0	5.5	5.9	4.5
XVI	Pharmaceutical products	15.9	16.4	16.0	15.4	13.5

a/ Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

Even so, fertilizers accounted for only 35 per cent of the group in 1962 and 48 per cent in 1964, as against 70 per cent in the United States.17/

17/ This branch of the chemical industry was studied in detail by the ICAP Working Group on Fertilisers (see introduction to the present chapter). The results of their work were published in El uso de fertilizantes en América Latina (E/CN.12/760) and La oferta de fertilizantes en América Latina (E/CN.12/761).

/Output.in

Output in group IV, plastics, and synthetic resins, soared by 33 per cent in 1964 exceeding the growth in consumption and thus allowing further import substitution. This was due to the stepping-up of production in Brazil, where the branch had been well established as far back as 1959, in Chile, Colombia, Peru and Venezuela where it had just started and in Argentina and Mexico with the opening of new petrochemical plants.

Increases in group V were mainly on the productions of the more modern fibres, most of which, however, are still made from imported raw materials. Output of cellulose fibres also grew in the period (chiefly in Colombia), but less than that of polyanide fibres.

Regional production of synthetic rubber began for the first time in 1959-1964 and that of carbon black increased, bringing group VI's share in total output up to 1.3 per cent, as against 4.7 per cent in the United States. Latin American production in these lines is, then, still incipient and, as only 25 per cent import substitution has been reached, has ample room for development.

Group VIII's share has decreased, but is still very high (20.5 per cent in 1964). Detergents, a fast-growing sub-group in the modern chemical industry, accounted for 18 per cent of the group in 1962 and 28 per cent in 1964.

Like the manufacture of soaps, though to a smaller degree, that of pharmaceutical products accounts for a larger proportion of the total value of chemical production than in more industrialised countries, a situation which is all the more serious because most of its raw materials have to be imported from outside the region.

While there were no major changes in the geographical distribution of consumption during 1959-1964, there were changes in its internal structure. These were for the most part of a progressive character, reflecting a strengthening of the trend towards greater use of modern synthetic products which has been for some time apparent in the more developed countries of the region. Table III-6 shows which groups and sub-groups substantially increased their share in consumption and which declined sharply. The two categories considered the fast-growing and slow-growing groups together accounted for 71.2 per cent of total consumption in 1959 and 71.7 per cent in 1964.

/Among the

Among the former are group I, major inorganic chemical products, sub-group III-A, fertilizers, group IV, plastics and synthetic resins, group V, artificial and synthetic fibres, group VI, synthetic rubber and related products, and sub-group VIII-B, detergents. Their joints share in total consumption rose 24.1 per cent in 1959 to 34.6 per cent in 1964.

The other category, comprising the slow growing groups covers the products that have been traditionally used or are already in wide use in Latin America, with a less rapid potential growth. Their joint share in total consumption fell from 47.1 per cent in 1959 to 37.1 per cent in 1964. They mostly consist of parachemical, made-up and formula products, such as soaps, pharmaceutical products, matches and explosives and toilet preparations.

While domestic supply's overall share in consumption is in some cases much the same as in more developed countries (Brazil's 86 per cent is the same as the average for a group of European countries) in some of the more important groups of products there remains a wide margin for substitution (see table III-7).

As regards basic chemical and petrochemical products, progress in import substitution was comparatively slow in the countries with the smaller domestic markets; but in parachemical products, chemical products of natural origin and the traditional consumer products it was rapid.

The above data on domestic supply's share in consumption in the different groups of chemical products may be considered of the first importance, since it provides a preliminary indication of the classes of products for which new industrial projects are needed, either for individual countries or for several in combination. The need is obvious with regard to sodium alkalis, chemical products for agriculture, synthetic rubber and certain types of plastic materials, at least 40 per cent of whose demand is still satisfied by imports.

/Table III- 6

Table III-6

LATIN AMERICA: MAJOR CHANGES IN THE STRUCTURE OF CONSUMPTION OF CHEMICAL PRODUCTS IN SEVEN COUNTRIES a/, 1959, 1962 AND 1963

(Percentages of total consumption)

	1959	1962	1963	1964
A. Fast-growing groups				
I. Major inorganic chemical products	4.2	4.4	4.8	5.2
IV. Plastic materials and synthetic resins	5.3	6.4	7.5	8.6
V. Artificial and synthetic fibres	7.5	9.0	9.2	9.5
VI. Synthetic rubber and related products, including carbon black	1.6	2.4	2.4	2.4
Sub-group III-A Fertilizers	2.7	3.4	3.6	4.2
Sub-group VIII-B Detergents	2.8	3.7	4.0	4.7
Sub-total	24.1	29.3	31.5	34.6
B. Slow-growing groups				
IX. Explosives and products for matches and fireworks	2.9	2.5	2.4	2.3
XI. Toiletry products, essences and flavourings	5.4	4.8	4.6	4.5
XVI. Pharmaceutical products	17.5	16.7	16.5	15.4
Sub-group III-B Pesticides	4.3	4.1	4.0	3.9
Sub-group VIII-A Soaps	15.4	12.3	11.4	10.0
Sub-group VIII-F Products for cleaning, excluding soaps and detergents	1.6	1.5	1.3	1.0
Sub-total	47.1	41.9	40.2	37.1
Total	71.2	71.2	71.7	71.7

a/ Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

/Table III-7

Table III-7

LATIN AMERICA: GROWTH RATES OF CONSUMPTION AND PRODUCTION AND PROPORTION OF DOMESTIC SUPPLY IN THE MAIN GROUPS OF CHEMICAL PRODUCTS IN SEVEN COUNTRIES a/

Groups of products	Growth rates b/ (percentages)				Proportion of domestic supply c/			
	Production		Apparent consumption					
	1959-1962	1962-1964	1959-1962	1962-1964	1959	1962	1963	1964
I. Major inorganic chemical products	20.5	21.0	10.6	19.5	59	76	75	78
II. Major organic chemical products	5.4	11.0	7.5	9.0	92	87	87	88
III. Chemical products for agriculture	11.4	28.0	11.2	15.2	49	50	55	59
IV. Plastics and synthetic resins	22.5	33.0	16.0	28.0	53	62	63	66
V. Artificial and synthetic fibres	15.2	15.3	15.8	13.1	86	84	87	88
VI. Synthetic rubber and related products, including carbon black	100.0	40.0	26.0	6.2	6	26	35	43
VII. Painting, dyeing, tanning and colouring materials	9.3	6.9	10.0	7.8	74	77	75	74
VIII. Surface-active agents and bleaches	5.2	3.8	5.4	3.8	97	96	96	96
IX. Explosives and products for matches and fireworks	4.3	5.7	3.2	6.1	84	86	88	87
X. Industrial gases	15.0	12.5	14.5	11.9	95	96	96	97
XI. Toiletry products, essences and flavourings	8.0	4.8	5.4	6.5	80	81	82	81
XII. Products for other specific uses	3.8	12.5	7.5	12.0	47	45	43	45
XIII. Tar, pitches and similar by-products	14.1	7.8	11.9	9.3	75	78	77	80
XIV. Salts, oxides and other inorganic compounds of unspecified uses excluding those in group I	19.1	44.0	7.7	25.0	...	28	38	46
XV. Organic compounds of unspecified uses, excluding those in group II	11.5	29.0	10.6	27.5	51	51	45	48
XVI. Pharmaceutical products	11.0	8.1	7.5	5.8	66	71	72	75
XVII. Chemical products, n.e.	4.8	18.3	6.1	-5.7	33	31	45	50
Total	9.8	11.7	9.2	10.0	73	74	75	76.5

a/ Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

b/ Cumulative annual growth rates for each period.

c/ Ratio of production to apparent consumption.

/4. Future

4. Future trends and prospects for regional integration

It was stated in La industria química en América Latina 18/ that regional consumption of chemical products would grow at a cumulative rate of 8.9 per cent a year in 1960-1965 and would rise from 5,275 million dollars in 1965 to 7,800 million in 1970.

In the light of known development trends, the authors of the document envisaged a profound change in the structure of this consumption namely: a fall in the relative importance of traditional goods in favour of more modern consumer goods, such as fibres, plastics and detergents; growing imports of synthetic and petrochemical products in basic organic chemicals sector; a gradual increase in the share of intermediate goods, including fertilizers. These predictions began to be confirmed in 1959-1964 (see table III-6).

Taking into account the new projects envisaged and assuming that import substitution would take place in accordance with the observed trends, they calculated that production would have to increase at a cumulative annual rate of 11.5 per cent in the period, yielding a 1965 output almost doubled that of 1959.

However, the data for 1959-1964, given above show that except in Brazil, Colombia and the group of "remaining countries" this growth rate was not achieved; the regional growth rate was only 9.8 per cent in 1959-1962 and 10.6 per cent in 1959-64 (see table III-8).

18/ ECLA, (E/CN.12/628/Rev.1).

Table III-8

Table III-8

LATIN AMERICA: GROWTH RATES OF CHEMICAL PRODUCTION

(Percentages)

	Average annual growth rate	
	Real rate	ECLA's 1960 estimate
	1959-1964	1960-1965
Brazil and Colombia a/	11.3	11.1
Argentina, Chile, Mexico, Peru, Venezuela a/	10.6	12.9
Remaining countries b/	9.2	8.1
Latin America as a whole	10.6	11.5

a/ Arithmetical average.

b/ Excludes Cuba.

Taking these retrospective figures in conjuction with the known plans for future expansions in the sector, it is unlikely that output will grow any faster in more than a very few of the countries (prospects are better in Mexico, whose plans are of wider scope and have reached a more advanced stage of implementation).

This makes it essential that careful study should be given to the ways in which the sector's development can be speeded up and, in particular, the effects in this respect of the formation of a common market for chemical products.19/

19/ An attempt was made in Las industrias químicas y la integración económica regional (ST/ECLA/Conf.15/L.8/Rev.1) - a document sumitted to the Latin American Seminar on the Integrated Development of the Chemical Industry - to show the advantages of increasing the regional co-ordination of the chemical industries as they develop in future. It concentrated on the effects on cost and investments of alternative locations and different scales of operation, which it analysed and documented mainly in terms of specific examples.

/B. THE

B. THE FERTILIZER INDUSTRY

The following aspects of the fertilizer industry have been analyzed:

(a) Existing industries. Their raw material supplies, production costs, ex-factory prices, technological, financing and marketing problems, other problems that tend to prevent full utilization of production capacity.

(b) Projects in progress. The capacities envisaged dates on which they come into operation, their probable cost situation, etc.

(c) Projects under study. The scales of production envisaged, the stage reached in their study and other information that enables their position with regard to overall supply to be assessed.

(d) Prospects for new projects. Medium-term future supply in the light of the projects considered in comparison with the development of fertilizer consumption according to accepted alternative hypotheses; the availability and costs of the main raw materials in the different countries; in the light of this latter, the long-term development of the industry (1966-1975).

In view of their importance for the future work that may be carried out in this field by the staff of the Programme on Industrial Integration or by other organizations such as the IDB Preinvestment Fund, there follows a summary of some of the ideas and principles that appear in the conclusions and recommendations on the fertilizer industry adopted in the second meeting of the ICAP Working Group on Fertilizers, at which the results of the above mentioned research were discussed.

The Latin American fertilizer industry must try to ensure that its technical structures, plant dimensions and locations are compatible with its primordial function, which is to supply agriculture and - when there are regional surpluses - the world market at the lowest possible prices. This would be as much furthered by creating a regional-scale market through gradual and large single reductions in tariffs and other trade barriers as by individual efforts. Moreover, the trade system that would be built up within a fairly short time after the industry had begun to operate on a regional basis and the other measures necessary for harmonizing external policies and tariffs had been taken would tend to force public and private enterprises to make their investments in accordance with the principles of maximum efficiency and productivity.

/The Group

The Group considered that the creation of a common market for fertilizers would have to be accompanied by similar measures for the other major inputs of agriculture and the manufacture of the equipment that the industry would need for its expansion.

In the light of the information given in the studies submitted to it, the Working Group agreed that, as regards quantity, regional supply of nitrogen fertilizers presents no problems over the medium term, since existing installed capacity and that of the projects in progress will in fact exceed the estimated demand. It nevertheless felt that it should review the projects being formulated for these fertilizers in the separate countries in order to assess their economic value.

The situation is different as regards supplies of phosphorus and potassium fertilizers. Latin America's source of phosphorus are apparently adequate and there have been several recent projects for their economic exploitation. But potassium sources are singularly scarce. More prospection of natural resources is needed in both cases.

A document submitted by the ECLA staff - La oferta de fertilizantes en América Latina (E/CN.12/761) - provides an overall picture of the industry. Its conclusions will be summarized here below.

Fertilizer consumption in Latin America has expanded rapidly in the recent years, doubling in about the last seven. The 1964 consumption of a group of countries which represent 88 to 90 per cent of the Latin American market was 986,000 tons of nitrogen, phosphorus and potassium as against 520,000 in 1957 and 715,000 in 1961.

Although regional output of nitrogen fertilisers will soon be leaving surpluses for extra-regional export, there is still a deficit of potassium and, to a lesser degree, phosphorus fertilisers. The deficit in phosphorus fertilisers will be largely eliminated in the next four years with the implementation of the development programmes already decided upon and, more important, the opening up of several major local raw material sources, which will even give surpluses by 1970. Production of potassium fertilisers - which is not strictly a part of the chemical industry - is based on the extraction of natural potash salts, which have not yet been found in sufficient quantities in any Latin American country.

/Latin American

Latin American fertilizer production - which is mostly nitrogen fertilizers - has developed rapidly in the present decade, its value rising from 40 million dollars in 1962 to 88 million in 1964. Even so, in 1963 and 1964 eight countries 20/ imported 87 million dollars worth (roughly 43 per cent nitrogen, 34 per cent phosphorus and 23 per cent potassium). Of these imports 72 per cent were received by Brazil, Chile, Colombia and Mexico.

<u>La oferta de fertilizantes en América Latina</u> offers the following suggestions, in the light of its analysis of supply over the next five and the next ten years:

i) That exploitation of some of the major sources of raw materials, such as phosphates (Peru and Brazil) and sulphur, should be speeded up;

ii) That more attention should be paid to raw materials costs and scales of manufacture in view of their incidence on production costs;

iii) That steps should be taken to provide more flexible and efficient regional and national transports systems for fertilizers themselves, their raw materials and their main intermediate inputs, ammonia, phospheric acid and natural phosphates;

iv) That research into possible sources of sulphur and potash salts should be carried out;

v) That the present production costs of manufactured nutrient elements, particularly nitrogen and phosphorus, might be greatly reduced. However, this would be useless if it was not backed up by measures for developing the infrastructure needed for fertilizers to reach farmers with reasonably low charges for marketing, transport, storage, etc.;

vi) That special measures should be taken to promote intra-regional trade in order to eliminate the present desequilibria in production, whereby some areas of the region have surplus capacity while others must import from third countries;

vii) That steps should be taken to standardize the different types of fertilizers marketed in the region.

20/ Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay and Venezuela.

/Several of

Several of these suggestions would now need to be revised, since they were based on inadequate official information on current and officially approved projects. It would be useful to make a more detailed study of supply - and of the balance of supply and demand - as soon as decisions to carry out projects are made and their technical characteristics known. But for this it would be necessary to have greater access to official and private plans and projects.

As a reference, two tables from the ECLA/FAO/IDB report are given on the following pages, showing fertiliser consumption and projected demand in 13 Latin American countries. (See tables III-9 and III-10.)

/Table III-9

Table III-9

LATIN AMERICA: FERTILIZER CONSUMPTION IN 13 COUNTRIES, 1957-59 TO 1964

(Annual averages in thousands of nutrient tons)

Country	N				P_2O_5				K_2O				Total NPK			
	Average				Average				Average				Average			
	1957-1959	1960-1962	1963	1964	1957-1959	1960-1962	1963	1964	1957-1959	1960-1962	1963	1964	1957-1959	1960-1962	1963	1964
Argentina	8.4	9.7	22.1	33.2	5.1	4.0	6.7	10.4	2.4	2.8	5.0	4.9	15.9	16.5	33.8	48.5
Brazil	38.2	57.4	62.1	50.8	128.7	123.4	153.4	135.1	60.9	81.7	91.8	69.6	227.8	262.5	307.3	255.5
Central America a/	22.9b/	28.2	38.4	54.6	7.1b/	10.1	13.3	20.3	7.7b/	8.7	9.6	15.1	37.1b/	47.0	61.3	90.0
Chile	11.6	17.8	27.3	32.7	36.7	50.3	77.1	73.2	7.1	9.9	12.0	4.2	55.4	78.0	116.4	120.1
Colombia	9.3	13.7	22.5	41.0	37.8	42.5	45.3	29.8	13.9	17.5	24.6	24.0	61.0	73.7	92.4	94.8
Ecuador	2.8	3.0	3.2	3.4	1.9	2.1	2.8	...	1.4	1.7	2.7	...	6.1	6.8	8.7	...
Mexico	87.3	128.4	190.4	228.5	32.0	42.9	61.5	59.5	12.1	14.2	11.3	12.5	131.4	185.5	263.2	300.5
Peru	44.1	61.4	69.2	73.0	21.4	18.6	24.6	...	5.2	4.7	5.7	...	70.7	84.7	99.5	...
Uruguay	2.2	4.6	7.3	10.5	8.0	17.2	15.6	19.7	2.2	3.4	4.0	5.1	12.4	25.2	26.9	35.3
Venezuela	5.6	7.6	9.5	13.3	2.3	5.9	6.0	7.6	3.7	7.6	8.3	11.1	11.6	21.1	23.8	32.0
Total	231.8	331.8	452.0	541.0	281.0	317.0	406.3	390.0c/	116.6	152.2	175.0	165.0c/	629.4	801.0	1 033.3	1 096.0c/

Source: ECLA/FAO Joint Agriculture Division.

a/ El Salvador, Guatemala, Honduras and Nicaragua.

b/ 1959.

c/ Estimates; preliminary data for 1965 show a very slight increase in the total consumption (NPK) to 1 108 000 tons., but a slight decrease in that of nitrogen to 520 000 tons.

/Table III-10

Table III-10

LATIN AMERICA: PROJECTIONS FOR 1970 AND 1975 OF FERTILIZER DEMAND IN 13 COUNTRIES

(Thousands of nutrient tons)

Country	1970						1975					
	Minimum hypothesis			Maximum hypothesis			Minimum hypothesis			Maximum hypothesis		
	N	P	K	N	P	K	N	P	K	N	P	K
Argentina	67	35	13	67	35	13	117	66	22	117	66	22
Brazil	78	169	107	91	198	127	84	183	117	191	377	267
Central America a/	107	48	33	107	48	33	149	78	53	149	78	53
Chile	60	117	19	60	117	19	85	154	23	85	154	23
Colombia	46	72	37	97	125	60	58	96	51	152	179	89
Ecuador	4	3	3	12	10	9	5	4	3	28	25	22
Mexico	341	85	16	509	196	51	476	114	19	720	330	95
Peru	114	28	6	116	48	16	141	32	7	168	96	40
Uruguay	14	44	9	22	71	12	21	71	14	98	136	19
Venezuela	24	13	19	36	21	30	39	20	30	82	49	69
Total	855	614	262	1 117	869	370	1 175	818	339	1 790	1 490	699

Source: ECLA/FAO, Agriculture Division.
a/ 4 countries: El Salvador, Guatemala, Honduras and Nicaragua.

/1. Nitrogen

1. Nitrogen fertilizers

Study of present and projected supply of nitrogen fertilizers shows, first, that in 1970 and 1975 there will be large surpluses, even on the maximum demand hypothesis.

Secondly, many of the national projects now prepared are for large-scale units that will produce basically for the external market. Lastly, still more projects have been formulated in purely national terms, without regard to regional developments or the situation in the world market; these envisage medium- or even small-scale markets, to be supply by units whose costs will be uncompetitive abroad but which will produce surpluses once maximum hypothetical internal demand is satisfied.

The probable demand of 13 countries for nitrogen fertilizers in 1970 is estimated 21/ at a minimum of 855,000 and a maximum of 1,175,000 tons of nitrogen a year. In that year supply will reach 1,998,000 tons of nitrogen. Chilean natural nitrates and less important recoveries will account for 180,000 tons, Peruvian guano and ammonium sulphate from coking another 36,000 tons, and synthesis of ammonia from different raw materials the remaining 89 per cent.

It is believed that total supply will increase to 2,681,000 tons by 1975 as a result of Mexico's production after 1970 and the projects that Argentina and Venezuela have in view.

The balances given in table III-11 are the differences between each country's projected total supply and its demand 22/ according to the maximum hypothesis.

21/ Study on inputs prepared by the ECLA/FAO Joint Agriculture Division with assistance from IDB, whose conclusions appear in El uso de fertilizantes en América Latina (E/CN.12/760).

22/ See, El uso de fertilizantes en América Latina, op.cit., table 16.

/Table III-11

Table III-11

LATIN AMERICA: NITROGEN BALANCE a/

(Thousands of tons.)

Country	1970			1975		
	Probable supply 1968-70	Maximum demand	Balance	Probable supply 1971-75	Maximum demand	Balance
Argentina	145	67 b/	+78	290	117 b/	+173
Brazil	194	91	+103	(194)	191	+3
Chile	460	60 b/	+400	(460)	85 b/	+375
Colombia	300	97	+203	(300)	152	+148
Mexico	552	509	+43	820	720	+100
Peru	185	116	+69	(185)	168	+17
Uruguay	-	22	-22	...	38	-38
Venezuela	162	36	+126	432	60 c/	+372
Sub-total	1 998	998	+1 000	2 681	1 531	+1 150
Other countries	-	119 d/	-119	...	177 d/	-177
Total	1 998	1 117	+881	(2 681)	1 708	+973

a/ Not including Bolivia, Costa Rica, Cuba, Haiti, Paraguay, Santo Domingo, the Antilles or Trinidad and Tobago. The supply figures are for primary nitrogen (ammonia from synthesis coal coking and other primary sources).

b/ A single, mean hypothesis.

c/ Average of maximum and minimum hypotheses, see table III-10.

d/ Ecuador, El Salvador, Guatemala, Honduras and Nicaragua.

/The regional

The regional surpluses would, even on the maximum demand hypotheses, be as much as 880,000 tons in 1970 and 973,000 tons in 1975. Moreover, some of the countries considered have planned projects which have not been included in the calculations and would, therefore, make the surpluses still greater.

If demand does not conform to the maximum hypotheses, the surpluses might be as high as 1,145,000 tons in 1970 and 1,528,000 tons in 1975.[23/]

Extra-regional export prospects connot be estimated a priori, because they depend on the situation in the world market in the next decade, transport costs, f.o.b. production costs, variables in the different Latin American countries and the evolution of external market prices.

The main features of the world nitrogen market in 1964-1965 were extreme mobility of supply, continuous growth of demand (12 per cent) and rapid expansion of production capacity through the establishment of new large-scale units.

2. Phosphorus fertilizers

It appears that under current projects overall supply of phosphorus fertilisers will about balance maximum demand by 1970, though there will be deficits and surpluses in individual countries. There will again be an overall deficit by 1975.

Because of the small size of the domestic markets, the plants so far installed have all been of small capacity. A few recent projects envisage larger units, but not on the scale normal for export production in other regions.

Since most of the Latin American countries are short of or completely lacking in phosphorus sources, Peru's phosphate rock deposits have become important for the whole region.

23/ Existing plants in Aruba and Curaçao will supply, in addition, an estimated minimum of 400,000 tons of nitrogen a year. As these islands have practically no consumption, this output will be for export. There are plans in Central America for a production of about 180,000 tons of nitrogen a year.

/The ECLA/FAO

The ECLA/FAO report estimates the minimum 1970 demand of the 13 countries referred to at 614,000 tons a year and the maximum at 869,000 tons 24/ (refer back to table III-10). Supply in terms of manufacturing capacity for raw materials of every origin - should then be 1,027,000 tons a year. This includes a small proportion of guano and dephosphorization slag (3 per cent), a major proportion of triple superphosphate (55 per cent), superphosphate (30 per cent) and ammonium phosphate, bicalcic phosphate and complex fertilizers (12 per cent).

Table III-12 shows the supply and demand balance for each of 8 countries. The deficit of 423,000 tons of P_2O_5 that appears for 1975 will only occur if consumption is as large as the projected maximum; on a minimum hypothesis the same projected capacity of the 8 countries would give a surplus of 249,000 tons.

3. Potassium fertilizers

The potassium fertilizer sector, which is relatively small, was treated very briefly in the ECLA/FAO study. Neither the chemical synthesizing industry, of importance for nitrogen fertilizers, or the mineral raw material processing industry, of importance for phosphorus fertilizers, play more than an occasional part in potassium production, since most of consumption is covered by products derived directly from extraction. The regional balance appears in table III-13.

According to the demand projections, potassium will only represent 15 to 16 per cent of regional consumption of nutrient elements in 1970, almost the same as in 1964, and the total volume consumed in 13 countries of the region will be negligible in comparison with the normal outputs of the world surpplying centres. None of the Latin American countries except Brazil, whose maximum 1975 demand is estimated at 267,000 tons of K_2O and at 1970 demand at 127,000 tons, will consume as much as 100,000 tons in 1975 or 60,000 tons in 1970.

24/ All tonnages in terms of phosphoric anhydride.

Table III-12

Table III-12

LATIN AMERICA: PHOSPHORUS BALANCE a/

(Thousands of tons of P_2O_5)

Country	1970			1975		
	Probable supply 1966-70	Maximum demand	Balance	Probable supply 1971-75	Maximum demand	Balance
Argentina	5	35b/	-30	(5)	66b/	61
Brazil	260	198	+62	300	377	-77
Chile	115	117b/	-2	(115)	154b/	-39
Colombia	16c/	125	-109	(16)c/	179	-163
Mexico	379	196	+183	(379)	330	+49
Peru	42	48	-6	(42)	96	-54
Uruguay	40	71	-31	(40)	136	-96
Venezuela	170	21	+149	(170)	35d/	+135
Subtotal	1 027	811	+216	1 067	1 387	-320
Others	...	58e/	-58	...	103e/	-103
Total	1 027	869	+158	1 067	1 490	-423

a/ Not including Bolivia, Costa Rica, Haiti, Paraguay, Santo Domingo, the Antilles or Trinidad and Tobago.
The supply figures generally refer to manufacturing capacity for assimilable phosphates.

b/ Single, mean hypothesis.

c/ Only in the form of dephosphorization slag.

d/ Average of the maximum and minimum hypothesis (49 and 20 thousand tons).

e/ Ecuador, El Salvador, Guatemala, Honduras and Nicaragua only.

Table III.13

LATIN AMERICA: POTASSIUM BALANCE

(Thousands of tons of K_2O)

	1964	1970		1975	
		Minimum	Maximum	Minimum	Maximum
Demand (13 countries)	165	262	370	339	699
Present and projected production (Chile, Peru)	24	24	25	75 a/	125 a/
Balance: regional deficit	...	238	340	264	574

a/ Includes a production of 100,000 to 200,000 tons of potassium chloride at Sechura, Peru.

The value of potassium fertiliser imports in 1964 was 20.4 million dollars, or 23 per cent of the total value of imported fertilisers. The average cost of the potash salts imported 25/ was 146 dollars per ton potassium content. The price paid to the producer (Canada 1963) is from 28 to 30 dollars per ton for potassium chloride (which contains 60 per cent potassium) and 44 dollars per ton for potassium sulphate (which contains 50 per cent).

25/ This average is influenced by the inclusion of the potassium content of complex fertilisers, and their prices are relatively high.

/C. THE

C. THE SODIUM ALKALIS INDUSTRY

The Latin American sodium alkalis industries have developed in difficult conditions that have been common to a number of basic chemical process industries in the region: high initial investments; lack of adjustment between production structure and a demand that does not tend to promote the balance between products (chlorine alkalis, traditional and recent uses) characteristic of a developed market; dependence on domestic natural resources often still exploited in a rudimentary fashion; transport costs often incompatible with product values and raw material costs; the availability of extremely low price foreign supplies produced at marginal cost by maximum utilization of large-scale capacity.

This has given rise to a situation in which the region continues to satisfy nearly 50 per cent of its consumption with imports, has at the same time unused production capacity and, despite this, suffers financially from having too small a market for chlorine, an essential input of caustic soda 26/ production.

If the region's raw material sources and investments in the industry are to be properly used and a degree of self-sufficiency compatible with its economic development plans is to be reached, the development of the sector in the different countries must be co-ordinated. As a first step, more must be known of the industry, its structure and its market trend.

More exact information is also needed on the uses of its output in each national market, the costs and available reserves of its raw materials, the sums invested in the sector, etc. than is normally available in official or private statistics, particularly those of the countries where the industry is most diversified (Argentina and Brazil).

Without such information it is difficult to draw up realistic alternative programmes for the development of the industry on a regional scale, that might serve as bases for complementarity agreements between countries and as a guide to entrepreneurs' development and expansion programmes.

26/ The term caustic soda is used for sodium hydroxide and the terms sodium carbonate and soda ash indifferently for commercial sodium carbonate.

/1. General

1. General conditions of supply and demand

The sodium alkalis constitute a well-defined group within the major inorganic products, comprising sodium hydroxide or caustic soda, sodium carbonate or soda ash and sodium bicarbonate. The first two, from their wide spread use in industry, provide an index of the stage of industrial development of a country, such as does sulphuric acid.

Caustic soda was one of the first chemical products to be produced in Latin America, although until the forties output was not large.

Caustic soda and soda ash are indispensable not only to traditional manufactures such as glass, soaps, pulp and paper and textiles, but to many chemical processes, petroleum refining, artificial fibres, etc.

Regional consumption of sodium alkalis is already over 1 million tons a year and their production accounts for about 1 per cent of the total production value of the chemicals sector.

While in the industrialized countries their consumption normally grows at a slow and stable pace, absolute consumption levels are still low enough in Latin America for the growth rate to be rapid. The average annual rate in 1959-1962 was 6.4 per cent.27/ Total apparent consumption in these years is shown in table III-14.

Table III-14

LATIN AMERICA: APPARENT CONSUMPTION OF SODIUM ALKALIS a/

(Thousands of tons)

Year	Tons
1958	738
1959	851
1960	810
1961	930
1962	1 002
1963	1 090
1964 b/	1 100 b/

a/ Not including Bolivia, Cuba, Dominican Republic or Paraguay, because complete information is not available.

b/ Preliminary estimate.

27/ The rate is 8.1 per cent for 1958-1963 owing to a large increase in 1959.

/1970 demand

1970 demand is estimated at 1.5 million tons and 1975 demand at double 1962 consumption. The 1964 consumption appears from preliminary figures to have been about 1.1 million tons.

The situation of the two main products - sodium carbonate and caustic soda - and of chlorine was considered in a recent study, whose preliminary text was published in December 1966. It examines Latin America's prospects of achieving self-sufficiency through the establishment of sodium carbonate plants in favourable locations; it also makes projections of the balance between electrolytic production and probable chlorine demand in order to assess the future marginal capacity available for increasing production of caustic soda by chemical means.

According to the conclusions of the study, as yet unrevised, the evolution of consumption will be as shown in tables III-15 and III-16.

Unless new projects are carried out there will be a regional deficit in caustic soda of 436,000 tons in 1975. However, much of this should be covered by electrolytic production in chlorine manufacturing plants, in view of anticipated expansion of demand for this latter substance; even so there will remain some 150,000 to 160,000 tons to be covered by imports or conversion of sodium carbonate. There will be a deficit of about 520,000 tons in sodium carbonate, not including the additional, contingent demand for its use in caustic soda production.

It is calculated in the study that the probable cost levels of regional-scale sodium carbonate plants would be low enough for it to be supplied at prices similar to those of the world market (roughly 55 to 60 dollars a ton c.i.f.) and in any case much lower than those which must at present be paid in several countries of the region.

/Table III-15

Table III-15

LATIN AMERICA: PROJECTED CONSUMPTION OF CAUSTIC SODA

Country	1964	1970	1975	Annual growth rate 1964-75
	Tons			Percentages
Argentina	79 000	107 000	138 000	5.2
Brazil	220 000	335 000	450 000	6.7
Central America	11 000	17 500	25 600	8.0
Chile	18 300	30 000	36 000	6.4
Colombia	43 150	72 000	103 000	8.3
Ecuador	2 400	3 800	5 500	7.8
Mexico	124 000	195 000	290 000	8.0
Peru	14 500 a/	23 000	33 700	8.0 b/
Venezuela	20 500	32 400	47 500	8.0
Total	532 850	815 700	1 129 300	7.1

a/ 20 653 tons in 1963.
b/ 1963-1975.

Table III-16

LATIN AMERICA: PROJECTED CONSUMPTION OF SODIUM CARBONATE a/

Country	1964	1970	1975	Annual growth rate 1964-75
	Tons			Percentages
Argentina	100 000	159 000	224 000	7.6
Brazil	78 500	185 000	260 000	11.4
Central America	1 300	2 100	3 100	8.2
Chile	27 500	39 900	58 000	11.4
Colombia	29 200	58 000	85 000	10.1
Ecuador	500	850	1 250	8.7
Mexico	135 000	209 000	295 000	7.5
Peru	15 500	24 600	36 000	8.1
Venezuela	21 200	40 000	64 000	10.0
Total	398 700	727 850	1 096 350	9.4

a/ Not including sodium carbonate for use in the manufacture of caustic soda by chemical means.

/D. THE

D. THE PETROCHEMICAL INDUSTRY

1. The petrochemical industry in Latin America

The present review of the problems and prospects of the petrochemical industry in Latin America is based on an ECLA report [28] on its characteristics and the conditions necessary for its establishment.

The industrialization processes that had been gathering momentum in several of the Latin American countries since the end of the Second World War and the existence of abundant natural resources (petroleum and natural gas) awakened from the fifties onwards rapidly growing interest in the region in the development of petrochemical industries.

Until a few years ago most of the constantly increasing demand for intermediate organic chemical products for use in industry was satisfied by imports or, for a few products, by domestic production from coal or other raw materials of vegetable origin. In some of the countries this demand has now reched or is close to levels at which their manufacture from petrochemical products is economically viable, at any rate where there is also an expanding petroleum industry capable of supplying the raw materials needed.

The factors that have made investment in the industry attractive have been, in Venezuela, Mexico, Argentina and Colombia, large petroleum and natural gas reserves, and in Brazil the size of the potential market. Plants have been installed near the raw material sources in some cases and near the consuming markets in many others.

The petrochemical industry - which is really a branch of the modern organic chemical products industry - primarily operates by synthesis. On the basis of petrochemical products certain natural

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28/ La industria petroquímica en América Latina (E/CN.12/744).

/products can

products can be replaced by cheaper synthetic materials, entirely new products with unknown properties can be developed, and natural and synthetic products can be combined (textiles, rubber, etc.).

Industrial installations in the branch usually involve relatively large investments which can only give a reasonable rate of return when production capacity is above a certain minimum appropiate to each case, but evenly matches the demand of the market to be supplied.

The financial structure of the industry in Latin America to some extent reflects this cumpulsory immobilisation of large capital resources in that in several countries it is controlled by state enterprises which engage mainly in the manufacture of basic raw material and a few essential products. In others partially or wholly foreign owned companies manufacture the whole range of products from the basic to final items. The share of domestic private capital in Latin American enterprises is still relatively small. In addition, the loans nedded by domestic enterprises, whether private or public, are usually granted only under prior agreements to use foreign licenses and technical assistance. This situation should change, however, if the plans announced by private domestic groups in different countries take effect, although nearly all demestic enterprises will continue to be associated with the great international petrochemical companies and dependent on the state petroleum enterprises of their own countries for their raw materials.

An important characteristic of the petrochemical industry is its rapid technological development, which is due to the enormous effort put into scientific and technological research by the great international companies. Since cheaper manufacturing processes or completely new products are continually being developed, petrochemical plants often become obsolete within a short period from their installation. Latin America does not yet provide the conditions necessary for carrying out technological research at a level that would yield greater progress than that already achieved in the industry in the industrialised countries. Moreover, close collaboration in research between the industry and the technical universities has not yet been established.

A further feature of the industry is that it often uses different raw materials and different technological procedures to produce the same product. A choice of processes can therefore be made in terms of the costs of the available raw materials and the manufacturing costs involved in each.

In view of the different alternatives offered by petroleum and its products such as natural gas as raw materials and of the different processes that can be used to suit different economic conditions and goals, the petrochemical industry may be regarded as providing a complex variety of possibilities for development in countries whose industrialization is in its initial stages. It is perhaps for this reason that the national planning authorities and even the private sectors of each country have encountered serious difficulties in establishing lines of development in this field that would be economically realistic.

With regard to petrochemical raw material supplies, it is of the first importance to consider not only the overall natural gas output and refining capacity of each country, but the size of the refinieries and the processes used in their units. The fragmentation of refining capacity among numerous small capacity establishment that can be observed in Argentina, Brasil and Colombia will tend to complicate or prevent the production of refining derivatives at the costs and in the quantities suitable for petrochemical plants.

/The petroleum

The petroleum refining industry in Latin America has hitherto taken the form of large-scaled distillation units, relatively small catalytic cracking units, and, relative to the total capacity of each country, catalytic reformation units of very small capacity.

However, the changes that have occurred in the nature and composition of demand for petroleum products (fuels and lubricants) during the present decade and the current plans for raw refineries indicate that by 1970 the average size of the cracking and catalytic reformation units will have increased in existing refineries and those under construction.

The introduction of the exhaustive cracking processes for producing the basic petrochemical raw materials, which use liquid fractions of petroleum (propane, naphta and fuel oil) or even petroleum itself, has made the petrochemical industry less dependent on the refining industry and hence has eliminated a locational factor that previously gave a great advantage to the countries or regions of countries where petrochemical units could be combined with petroleum refineries.

2. Present state and recent evolution of the industry

The figures available suggest that the industry is still in its incipient stages in Latin America, a fact which must be attributed to the precarious basis on which its development took place in the last decade.

Among the factors that prevent it from developing in the dynamic fashion characteristic of it in the highly developed countries are the structure of the domestic markets of some of the countries of the region and the absence of some of the economic policy measures that could increase markets.

As a result, there was a real deficit in supply in 1965, particularly of basic and intermediate products. However, the margins unsatisfied were not large enough to justify the installation of new plants producing for national markets. Moreover, some of the enterprises that operated small-scale

/plants have

plants have expanded their capacities in order to improve their costs structures and be able to compete at the national or regional levels (Argentina, Brasil, Colombia, Venezuela).

The evolution of the gross value of production in 1963 and 1964 from a base of 100 in 1962 is shown in table III-17. It was determined in accordance with the methodological principles established in the study referred to. 29/ The values were calculated in terms of international prices.

Table III-17

LATIN AMERICA: RECENT EVOLUTION OF PETROCHEMICAL PRODUCTION IN CERTAIN COUNTRIES

(1962= 100)

Country	1963	1964
Argentina	155.7	304.6
Brasil	114.6	108.0
Colombia	... a/	... a/
Mexico	149.0	216.5
Venezuela	100.0	186.6
Total	151.6	211.7

a/ Petrochemical production only began in 1963.

Even though the increase in output was considerable over 60 per cent of capacity for manufactured products in six countries 30/ was idle in 1964-1965, as can be seen from the recent opening of operations in plants in several countries (Argentina, Mexico, Colombia). Even so, table III-17

29/ *La industria petroquímica en América Latina*, op.cit.

30/ Argentina, Brasil, Colombia, Mexico, Peru and Venezuela.

/shows tremendous

shows tremendous advances on the part of Argentina and Mexico. It was only fitting to include Colombia, which is a producer, but it was imposible to quantify its industry's evolution, since it only began production in 1963 (ammonia, carbon black, etc.). The contraction of Brazil's output in 1964 was due to the phase through which its whole economy was then passing.

Table III-18

LATIN AMERICA: SHARE OF PETROCHEMICAL PRODUCTS IN THE GROSS VALUE OF SEVEN COUNTRIES' TOTAL CHEMICAL PRODUCTION

(Thousand of dollars) a/

	1962	1963	1964
Petrochemical industry	27 756.50	37 089.10	50 570.60
Chemical industry as a whole	2 946 000	2 600 000	2 930 000
Percentage share	1.10	1.43	1.73
Percentage annual growth			
a) Petrochemical industry	-	+10.8	+12.7
b) Chemical industry as a whole	-	+33.6	36.3

a/ At international prices.

Petrochemical products' share in chemical production (see table above) was extremely low until 1964. It is important to remember, however, that the number of petrochemical products proper is very small (see La industria petroquímica en América Latina). In two countries (Mexico and Peru) their share was just over 3 per cent in that year.

Causes for the relatively slow growth of the industry are not hard to find. The political and social instability of the region discourages foreign investors, even when governments make special efforts to attract capital to the branch. The bureaucratic delays in authorising projects for basic products have enormously increased the costs of their by products by forcing these to be made from imported raw materials. A number of plants have begun production but have not been able to achieve a full turnover because of the small size or slow growth of the markets for which they were planned.

/Poorly planned

Poorly planned growth has resulted in the installation of plants for intermediate and final products and not for the basic products used in them or in production bottlenecks - particularly where input transactions under contracts between private and state enterprises were involved -, because the capacities installed were too small.

Despite this, petrochemical production grew faster than any other in the sector. And it would appear from information on plants that began to produce after 1964 that its share in the sectorial total is now somewhat larger.

The most important consumer or petrochemical products in the countries referred to was the plastics industry, which by 1964 had been developed on a considerable scale, at first on the basis of imported raw materials, in anticipation of local petrochemical production of its basic inputs. The petrochemical based plastic materials in greatest demand were polyethylene, polystyrene, polyvinyl chloride and polyesters.

One of the most dynamic of the industry's markets has been chemical products for agriculture, particularly nitrogen fertilizers, whose manufacture in some countries of the region (Mexico, Venezuela, Colombia) has begun to require enormous volumes of synthetic ammonium.

Consumption of synthetic elastomers and carbon black and of synthetic products for the manufacture of synthetic fibres has been growing rapidly because of the uses of these products in substituting or supplementing natural equivalents traditionally produced in the region.

The growth of the last major consuming sector, manufacture of synthetic detergents, has been limited by strong competition from soaps, whose production is highly developed in almost all the Latin American countries.

3. Existing industries

Table III-19 gives the details of the main petrochemical plants in operation, expanding or projected in the region, according to the infomation available in March 1966. 31/

31/ Taken from La industria petroquímica en América Latina, March 1966.

/Table III-19

Table III-19

ARGENTINA: INSTALLED PETROCHEMICAL CAPACITY IN 1970, TONS/YEAR a/

Product	Enterprise	Location	Total installed capacity 1970	Expansions b/ tons/year	New projects tons/year	Operating date c/	Petrochemical raw material	Uses
Ethylene	Ipako S.A.	Ensenada - Buenos Aires	33 000	22 000	-	1968	Refinery gas	Polyethylene
	Duperial S.A.	San Lorenzo - Santa Fe	90 000	-	75 000	1969	Naphtha	Polyethylene - Miscellaneous
	P.A.S.A. d/	San Lorenzo - Santa Fe	7 500	-	-	1965	Propane	Styrene
	Sub-total	-	130 500	22 000	75 000	-	-	-
Propylene	P.A.S.A.	San Lorenzo - Santa Fe	5 000	-	-	1965	Propane	...
	Y.P.F. e/	La Plata - Buenos Aires	8 000	-	8 000	1967	Refinery gas	Isopropanol
	Copet S.A.	Campana - Buenos Aires	10 000	-	10 000	1969	Refinery gas	Polypropylene
	Carbocler S.A.	Campana - Buenos Aires	12 000	-	12 000	1967	Refinery gas	Isopropanol
	Sub-total	-	35 000		35 000	-	-	-
B.T.X. f/	P.A.S.A.	San Lorenzo - Santa Fe	42 000	-	-	1965	Naphtha	Miscellaneous
	Fábricas militares	Campana - Buenos Aires	8 000	-	-	1965	Naphtha	Miscellaneous
	Sub-total	-	50 000	-	-	-	-	-
Methanol	Atanor S.A.M.	Río Tercero - Córdoba	10 000	-	-	1965	Natural gas	Formol
	Cía. Casco S. A.	Pilar - Buenos Aires	33 000	16 500	-	1968	Natural gas	Formol
	Petrosur S.A.	Campana - Buenos Aires	13 200	-	13 200	1970	Natural gas	...
	Sub-total	-	56 200	16 500	13 200	-	-	-
Butadiene	P.A.S.A.	San Lorenzo - Santa Fe	32 000	-	-	1965	Butane	Synthetic rubber
Carbon black	Cabot Arg. S.A.	Campana - Buenos Aires	20 000	7 000	-	1966	Aromatic residues	Rubber manufactures
	P.A.S.A.	San Lorenzo - Santa Fe	7 000	-	7 000	...	...	Rubber manufactures
	Subtotal	-	27 000	7 000	7 000			
Carbon sulphide	Duperial S.A.	San Lorenzo - Santa Fe	14 000	-	-	1965	Natural gas	Miscellaneous
Ethylbenzene	P.A.S.A.	San Lorenzo - Santa Fe	15 000	-	-	1965	Naphtha	Styrene
Butene	Carbocler S.A.	Campana - Buenos Aires	4 000	-	4 000	1967	Butane	2-butanol
Ammonia	Petrosur S.A.	Campana - Buenos Aires	68 000	-	68 000	1967	Natural gas	Fertilizers - Miscellaneous
	Ipagro S.A.	Bahía Blanca - Buenos Aires	100 000	-	100 000	1969	Natural gas	Fertilizers - Miscellaneous
	Y.P.F.	San Lorenzo - Santa Fe	180 000	-	180 000	1970	Natural gas	Fertilizers - Miscellaneous
	Y.P.F.	Chachapoya - Salta	30 000	-	30 000	1968	Natural gas	Fertilizers - Miscellaneous
	Gummidi S.A.	Tucumán	30 000	-	30 000	...	Natural gas	Fertilizers - Miscellaneous
	Sub-total		408 000	-	408 000			

a/ Assuming that all the projects for new plants and expansions that are officially known will be carried out.
b/ Of plants already in existence before December 1965.
c/ Where the year is 1965, it means before December 1965.
d/ P.A.S.A.: Petroquímica Argentina S.A. (Argentine Petrochemical Corp.).
e/ Y.P.F.: Yacimientos Petrolíferos Fiscales (State Petroleum Corp.).
f/ B.T.X., i.e. Benzene, Toluene and the Xylenes.

/Table III-19 (cont.)

Table III-19 (continued)

BRAZIL: INSTALLED PETROCHEMICAL CAPACITY IN 1970, TONS/YEAR a/

Product	Enterprise	Location	Total installed capacity 1970	Expansions b/ tons/year	New projects tons/year	Operating date c/	Petrochemical raw material	Uses
Ethylene	Petrobras	Cubatao - S.P.	117 300	36 500 d/	60 000 e/	1969	Refinery gas-Naphtha	Miscellaneous
	Union C do Brasil		122 000	-	122 000	1969	Naphtha	Polyethylene
	Sub-total		[illegible]	36 500	182 000			
Propylene	Petrobras	Cubatao - S.P.	[illegible] 000	10 000	10 000 f/	1966	Refinery gas-Naphtha	Isopropanol
Butadiene	Petrobras	Caxias - R.J.	33 000	-	33 000	1966	Butane	Synthetic rubber
	Coperbo	...	26 500	-	-	1965	Butane	Synthetic rubber
	Sub-total		59 500	-	33 000			
Methanol	Alba S.A.	Cubatao - S.P.	42 800	-	33 000	1967	Fuel oil	Formol
	Prosint	Rio - GB	16 500	-	16 500	1968	...	...
	Sub-total		58 300		49 500			
Carbon Black	Copebras	Cubatao - S.P.	36 000	-	-	1965	Aromatic residues	Rubber manufactures
	Copebras	Candeias - B.A.	43 000	-	43 000	1966	Aromatic residues	Rubber manufactures
	C.C.C.	Candeias B.A.	15 000	-	15 000	1967	Aromatic residues	Rubber manufactures
	Sub-total		94 000	-	58 000	-		
Ammonia g/	Petrobras	Cubatao - S.P.	34 500	-	-	1965	Refinery gas	Fertilizers
	Petrobras	Camacari - B.A.	73 000	-	73 000	1968	Natural gas	Fertilizers
	Ultrafertil		165 000	-	165 000			
	Sub-total		272 000	-	238 000			
Benzene	Petrobras	Cubatao - S.P.	73 000	-	73 000	1968	Naphtha	Miscellaneous
	Petrobras	Cubatao - S.P.	[illegible]	-	[illegible]	1969	Naphtha	Miscellaneous
	Sub-total		109 000	-	109 000			
Toluene	Petrobras	Cubatao - S.P.	30 000	-	30 000	1969	Naphtha	Miscellaneous
Xylene	Petrobras	Cubatao - S.P.	10 000	-	10 000	1968	Naphtha	Miscellaneous
Ethylbenzene	Cia. Brasil de Estireno	Cubatao - S.P.	23 000	-	23 000	1967	Naphtha	Styrene

a/ Assuming that all the projects for new plants and expansions that are officially known will be carried out.
b/ Of the plants already in existence before December 1965.
c/ Where the year is 1965, it means before December 1965.
d/ Refers to an expansion of the plant at Cubatao, Sao Paulo.
e/ Location of project not yet known.
f/ New Project of Petrobras for Matarife, Buenos Aires.
g/ Private Projects for ammonia are not included for lack of specific up-to-date information.

/Table III-19 (cont.)

Table III-19 (continued)

MEXICO: INSTALLED PETROCHEMICAL CAPACITY IN 1970 (TONS/YEAR) a/

Product	Enterprise	Location	Total installed capacity 1970	Expansions b/ tons/year	New projects tons/year	Operating date c/	Petrochemical raw material	Uses
Ethylene	Pemex	Coatzacoalcos - Ver.	36 000	-	-	1965	Ethane	Chlorinated products
	Pemex	Reynosa - Tams.	36 000	-		1966	Ethane	Polyethylene-Ethylene oxide
		Poza Rica	180 000	-	180 000	1969	Ethane	Miscellaneous, for export
	Subtotal		252 000	-	180 000	-		
Propylene	Pemex	Azcapotzalco	60 000	-	-	1965	Refinery gas	Dodecylbenzene
Benzene	Pemex	Minatitlán - Ver.	63 000	-	-	1965	Naphtha	Dodecylbenzene-miscellaneous
Toluene	Pemex	Minatitlán - Ver.	120 000	-	-	1965	Naphtha	Miscellaneous
Xylenes	Pemex	Minatitlán - Ver.	46 000	-	-	1965	Naphtha	Miscellaneous
Ethylbenzene	Pemex	Minatitlán - Ver.	11 000	-	-	1965	Naphtha	Styrene
	Pemex	Ciudad Madero - Tams.	32 000	-	-	1965	Naphtha	Styrene
	Subtotal		43 000					
Carbon black	Negromex	Salamanca - Gto.	40 000	-	-	1965	Aromatic residues	Rubber manufactures
Ammonia	Pemex	C. Camargo - Chih.	132 000	-	-	1965	Natural gas	Fertilizers
	Pemex	Minatitlán - Ver.	60 000	-	-	1965	Natural gas	Fertilizers
	Pemex	Salamanca - Gto.	66 000	-	-	1965	Natural gas	Fertilizers
	Pemex	Coatzacoalcos - Ver.	330 000	-	330 000	1968	Natural gas	Fertilizers
	Guanomex	Cuautitlán - Ver.	20 000	-	-	1965	Natural gas	Fertilizers
	Subtotal		608 000	-	330 000			
Methanol	Petroquímica Nacional	State of Puebla	15 000	-		1965	Natural gas	Formol
Butadiene	Pemex	C. Madero - Tams.	45 000	-	-	1965	Butane	Synthetic rubber

a/ Assuming that all officially known projects for new plants and expansions will be carried out.
b/ Of plants already in existence before December 1965.
c/ Where the year is 1965, it means before December 1965.

/Table III-19 (cont.)

Table III-19 (cont.)

CHILE, COLOMBIA, PERU, VENEZUELA: INSTALLED PETROCHEMICAL CAPACITY IN 1970, (TONS/YEAR)a/

Product	Enterprise	Location	Total installed capacity 1970	Expansions b/ (tons/year)	New projects (tons/year)	Operating date c/	Petrochemical raw material	Uses
1. Chile								
Ethylene	Corfo-Enap d/	Concepción	60 000	-	60 000	1969	Naphtha	Polyethylene-Styrene-P.V.C.
B.T.X.	Corfo-Enap	Concepción	5 000	-	5 000	1969	Naphtha	Miscellaneous
Methanol	Corfo-Enap	Concepción	15 000	-	15 000	1969	Natural gas	Formol
Ammonia	Corfo-Enap	Magallanes	350 000	-	350 000	1969	Natural gas	Fertilizers-Miscellaneous
2. Colombia								
Ammonia	Intern. Petroleum	Mamonal-Cartagena	98 500	-	-	1965	Refinery gas	Fertilizers
	Petroquímica del Atlántico	Barranquilla	300 000	-	300 000	1967	Natural gas	Fertilizers
	Subtotal		398 500	-	300 000	-		
Carbon black	Cabot Cía. S.A.	Mamonal-Bolívar	7 300	-	-	1965	Aromatic residues	Rubber manufactures
	Phillips Colombia Company	...	11 200	-	11 200	1966	Aromatic residues	Rubber manufactures
	Subtotal		18 500	-	11 200	-		
Ethylene	Ecopetrol	Barrancabermeja	20 000	-	20 000	1967	Refinery gas	Polyethylene
Ethylbenzene	Ecopetrol	Barrancabermeja	10 500	-	10 500	1968	Naphtha	...
Propylene	Ecopetrol	Barrancabermeja	10 000	-	10 000	1966	...	...
Benzene	Ecopetrol	Barrancabermeja	40 000	-	40 000	1968	Naphtha	Miscellaneous
Xylenes	Ecopetrol	Barrancabermeja	35 000 e/	-	35 000	1968	Naphtha	Miscellaneous
3. Perú								
Ammonia	Fertisa	Callao	27 000	-	-			
	Cosmofer-E.P.F.	...	66 000	-	66 000			
	Subtotal		92 000					
4. Venezuela								
Carbon black	United Carbon	Valencia	6 400	-	-	1965	Aromatic residues	Rubber manufactures
Ammonia	I.V.P. f/	Morón	198 000	-	165 000	1968	Natural gas	Fertilizers
	I.V.P.	Zulia State	330 000	-	330 000	1969	Natural gas	Fertilizers
	Subtotal		528 000	-	495 000	-		
Ethylene	I.V.P.	Tablazo, Zulia	150 000	-	150 000	1969	Ethane	Polyethylene-P.V.C.

a/ Assuming that all officially known projects for new plants and expansions will be carried out.
b/ Of plants already in existence before December 1965.
c/ Where the year is 1965, it means before December 1965.
d/ CORFO: Corporación de Fomento (Development Corporation); ENAP: Empresa Nacional de Petróleo (National Petroleum Company).
e/ Including ortho-, meta- and para-xylene.
f/ I.V.P.: Instituto Venezolano de Petroquímica (Venezuelan Petrochemical Institute).

/It is

It is interesting to note that most expansions of installations and production reflect an effort to correct the mistake, widely made in the region, of installing small-scale plants. This was particularly serious at the basic products level where economies of scale are vital for competitive production costs.

The number of new projects, some for integrated complexes, announced officialy of unofficialy during the last five years is impressive. Some of these, moreover, were to be carried out in countries whose refining industries were incipient or whose natural gas and petroleum outputs were negligible.

Substitution of imports of basic and intermediate petrochemical products has become urgent in view of their mounting toll on the countries' trade balances. This induced the governments to make provisions in their industrial target plans for priority development of the industry. But since definite principles for developing an industry of this complexity along rational lines were not always known, in some cases many of the projects and plans submitted were not economically viable and in others economically unrealistic investments were authorized, which then had to be given excessive protection against international competition.

From the installed capacity figures of table III-19 conclusions of some interest can be drawn. The petrochemical products proper that will be manufactured in 1970 are ethylene, propylene, butadiene, butane, benzene toluene, the xylenes, ethylbenzene, carbon black, methanol, carbon suphide and ammonia. The largest increases in capacity between 1965 and 1970 will be for ammonia (465 per cent) and ethylene (540 per cent), followed by methanol (187.3 per cent) and benzene (104.9 per cent). In 1965 ammonia capacity accounted for 36.3 per cent, toluene capacity for 11.6 per cent and benzene capacity for 8.8 per cent of the total of 1,290.8 thousand tons/year for all the products mentioned. By 1970 ammonia capacity will have increased to 59.2 per cent, and ethylene capacity to 11.8 per cent of a total of 4,093.7 thousand tons/year; benzene capacity will have fallen to 5.7 per cent.

To sum up, it would appear that the main aims in supply are on the one hand, to satisfy the fast growing demand for petrochemical products under the headings mentioned earlier in this section and, on the other,

/to achieve

to achieve internationally (or at least regionally) competitive cost levels on the basis of the natural resources abundantly available (natural gas and petroleum) and modernization of the refining industries supplying the raw materials of the industry. This latter trend is particularly obvious in the case of ammonia, for which there are several projects (in Mexico, Venezuela, Chile and Colombia) that involve the maximum capacity feasible under present technology and will produce mainly for the international market. The extremely low price at which they can obtain natural gas (3.50 dollars per 1,000 cubic metres) will enable them to produce anhydrous ammonia at a cost of about 20 dollars a ton.32/

4. Prospects for integrated development

In the light of the above, the petrochemical industry would seem to have a bright future in the Latin American countries. But, as has already been stressed, above, it is vital, for this as for other branches of the chemical industry, that regional considerations should begin to play a major part in national industrial development plans.

The generally beneficial effects of regional integration would be particularly great in the basic chemical products sector, to which the petrochemical industry belongs. Most of these products are liquid hydrocarbons which can now be transported over great distances in quantity and at competitive costs. Hence, an increase in their trade within the region, which would enable industries dependent on them to be developed in widely different localities presents no difficulties.

Integration would further result in an intra-regional demand large enough to enable large-scale industrial complexes to be installed and reach full production on a profitable basis. This would provide a basis for truly competitive extra-regional exports. It must be remembered that even when sub-regional demand levels that are close to the economic minimum can be achieved in national market groupings there is no real guarantee that the sub-regional industries developed will be competitive against the international producers, and they will anyway have to be given temporary protection in their initial stages.

Finally, the acknowledged lack of national capital (whether public or private) on the scale necessary for petrochemical projects would be partly solved by combining the resources of different countries of the region for those of most importance.

32/ See, La oferta de fertilizantes en América Latina (E/CN.12/761).

Chapter IV

THE PULP AND PAPER INDUSTRY

In response to the United Nations concern to ensure an adequate world supply of pulp and paper, ECLA began its work on this subject in 1953, with the preparation of a document which explored the possibilities of developing the pulp and paper industry in Latin America. This document was submitted to the fifth session of ECLA, which recommended the convening of a meeting of Latin American experts on the pulp and paper industry. The meeting was held in Buenos Aires in October 1954 and recommended that a group of experts on the pulp and paper industry should be placed at the disposal of the Latin American countries.

In accordance with this recommendation, the Pulp and Paper Advisory Group for Latin America was set up in 1955, under the joint auspices of the Economic Commission for Latin America (ECLA), the Food and Agriculture Organization (FAO) and the Bureau of Technical Assistance Operations (BTAO). The purpose was to assist Governments and their development agencies in the preparation of general plans, preliminary surveys and feasibility studies required in the development of the industry within Latin America.

Since its inception, the Advisory Group has prepared various country studies.1/ On the basis of these studies, a general report on the present situation and future trends of demand, production and trade in the Latin American pulp and paper industry was prepared in 1962 and revised and brought up to date in 1965 and 1966.2/

In March 1966 a Review Consultation on Pulp and Paper Development in Latin America was held in Santiago, Chile, simultaneously with the Latin American Symposium on Industrial Development. The documents submitted at that meeting served as a basis for the discussions and recommendations

1/ See Pulp and Paper Prospect in Latin America (United Nations publication, Sales No. 63.II.G.7), p. 1, footnote 3.

2/ Ibid.

/on the

on the subsequent activities of the Advisory Group, which have been particularly concerned with preparations for the forthcoming Pulp and Paper Conference, as well as with the usual advisory servises for the different Latin American countries.[3]

This chapter has been prepared on the basis of the information contained in the published studies and of the Advisory Group's knowledge of the pulp and paper industry, and is intended to provide a brief summary of the major problems affecting the industry's development.

A. APPARENT CONSUMPTION AND PROJECTIONS OF DEMAND

1. Past trends

Apparent consumption of paper and paperboard in Latin America rose from 1.4 million tons in 1950 to 2.5 million in 1960 and 3.4 million in 1965, which meant an increase of 70 per cent in per capita consumption, which rose from 9 kg in 1950 to 15 kg in 1965. However, despite the advances made, this figure is only half the average world per capita consumption.

Table IV-1 shows the past trends of production, imports and apparent consumption of paper and paperboard.

The most striking feature of the development of the paper industry is the increasingly rapid rate of import substitution in recent years. In 1950 only 58 per cent of demand of paper and paperboard was met by local production, but this proportion was increased to 63 per cent in 1960 and to 70 per cent in 1965. The newsprint situation is less encouraging, since local production accounted for only 30 per cent of apparent consumption in 1965.

3/ For list of documents, see appendix III of the Report of the Review Consultation on Pulp and Paper in Latin America, which appears as annex IV of the "Report of the Latin American Symposium on Industrial Development" (United Nations publication: E/CN.12/755/Rev.1, February 1967).

/Table IV-1

Table IV-1

LATIN AMERICA: APPARENT CONSUMPTION OF PAPER AND PAPERBOARD, 1950, 1960 AND 1965

(Thousands of tons)

	1950			1960			1965		
	Production	Imports a/	Apparent consumption	Production	Imports a/	Apparent consumption	Production	Imports a/	Apparent consumption
Newsprint	55	325	380	156	543	699	232	535	767
Printing and writing paper	780	276	1 056	329	127	456	500	77	577
Other paper and board				1 068	223	1 291	1 645	427	2 072
Total	835	601	1 436	1 553	893	2 446	2 377	1 039	3 416

Source: ECLA/BTAO/FAO Pulp and Paper Advisory Group, on the basis of official statistics.

a/ Net imports.

There are a number of adverse factors responsible for the unfavourable newsprint situation in Latin America, including:

(a) Small domestic markets which prevent the introduction of the economies of scale so important in newsprint production;

(b) The high cost of electric energy in comparison with the large centres of production;

(c) The shortage of reasonably-price softwood and slowness in adopting new processes which would enable other raw materials to be used;

(d) The fact that in most Latin American countries newsprint is exempt from import duties, or subject to very low charges;

(e) The fact that installed capacity is much greater than world demand, with the result that world prices have been stable since 1957, despite the increase in manufacturing costs.

/These adverse

These adverse factors are not expected to undergo any substancial changes in the next few years, and it is therefore unlikely that there will be any radical change in the production of newsprint in Latin America.

The significance of the region's imports of paper and paperboard is demonstrated by the fact that in the last few years about 180 million dollars of foreign exchange have been spent every year to satisfy demand.

As noted newsprint constitutes the bulk of the imports; it accounted for 535,000 tons in 1965, or 51 per cent of total paper and paperboard imports. The rest is mainly made up of paper and board for packing bananas for export, and to a lesser extent of various types of special paper which demand is too small to justify local production. Nevertheless, the natural growth of the markets and the possilility of expanding them by means of regional integration should soon make it possible to replace imports by local production.

The figures for production, imports and consumption of pulp - the raw material for the manufacture of paper and paperboard - are contained in table IV-2.

A comparison of these figures with those for paper and paperboard production (see table IV-1) shows a strong difference between the growth of the finished product and that of the pulp used as raw material in its manufacture. In 1950, for example, Latin America produced 294,000 tons of pulp, or only 48 per cent of its requirements, but output was nearly three times larger in 1960 and five times larger in 1965, accounting for 70 to 79 per cent of demand, respectively. As table IV-1 showed, output of paper and paperboard in 1965 was less than three times larger than in 1950.

The different trends followed by the finished product and the fibrous raw materials is one of the outstanding features of the industry's devolopment in the last few years and points to a progressive integration, in the sense that Latin America is less and less dependent on supplies of paper pulp from outside the region.

Table IV-2

Table IV-2

LATIN AMERICA: APPARENT CONSUMPTION OF PULP, 1950, 1960 AND 1965

(Thousands of tons)

<table>
<tr><th rowspan="2"></th><th colspan="3">1950</th><th colspan="3">1960</th><th colspan="3">1965</th></tr>
<tr><th>Production</th><th>Imports a/</th><th>Apparent consumption</th><th>Production</th><th>Imports a/</th><th>Apparent consumption</th><th>Production</th><th>Imports a/</th><th>Apparent consumption</th></tr>
<tr><td>Groundwood</td><td>127</td><td>15</td><td>142</td><td>223</td><td>24</td><td>247</td><td>394</td><td>28</td><td>422</td></tr>
<tr><td>Chemical and semi-chemical wood-pulp</td><td rowspan="2">167</td><td rowspan="2">304</td><td rowspan="2">471</td><td>398</td><td>319</td><td>717</td><td>688</td><td>358</td><td>1 046</td></tr>
<tr><td>Chemical and semi-chemical pulp of other fibres</td><td>185</td><td>-</td><td>185</td><td>398</td><td>-</td><td>398</td></tr>
<tr><td><u>Total</u></td><td><u>294</u></td><td><u>319</u></td><td><u>613</u></td><td><u>806</u></td><td><u>343</u></td><td><u>1 149</u></td><td><u>1 480</u></td><td><u>386</u></td><td><u>1 866</u></td></tr>
</table>

Source: Pulp and Paper Advisory Group, on the basis of official statistics.

a/ Net imports.

When the production trends of the different pulps are considered separately, it can be seen that the production of groundwood increased more slowly. This was the result of the difficult situation of newsprint, a type of paper which requires a large proportion of groundwood in its manufacture (85 per cent groundwood and 15 per cent chemical pulp).

In contrast, chemical and semi-chemical pulps show the largest increases in the whole sector. To achieve this increase - and in view of the shortage of coniferous pulpwood - the region has to use an increasingly large proportion of non-traditional fibre resources, such as the hardwoods (eucalyptus, the salicaceae and tropical woods) and vegetable wastes, particularly sugar-cane bagasse. The pulp produced from these resources is the short-fibre variety, which has to be mixed in varying proportions with long-fibre (softwood) pulp to give it the special characteristics needed for the various types of paper.

/For these

For these reasons, Latin America must continue to depend on imports to satisfy part of its demand. Imports amount to about 385,000 tons a year, cost aproximately 65 million dollars, and more than 90 per cent consists of long-fibre chemical pulp.

2. Analysis by countries

Table IV-3 contains the figures for production, imports and consumption of paper and paperboard, by countries. The bulk of production is concentrated in a small number of countries: in 1965 Argentina, Brazil and Mexico together produced 71 per cent of the total.

The countries which show the most rapid growth and which at least doubled their output between 1950 and 1960 are Chile, Colombia, Cuba, Mexico, Peru and Venezuela. Of these the most outstanding are Chile, which was the only net exporter of paper and board, and Mexico, which was the largest producer of this group in 1950. The increase in output is less striking in the other countries, because in most of them the industry was still in its early stages in 1950. Subsequently, with the establishment of one or two fairly large new plants, they considerably increased their low initial production.

Development was less rapid in Argentina, Brazil and Uruguay. This is not surprising in the case of Argentina and Brazil, since they were already the main producers in the region in 1950; nevertheless, 95 per cent of their domestic consumption of paper and board, except for newsprint, is supplied by local production. Their imports are restricted to certain special papers for which there is not enough local demand to justify production.

The situation in Uruguay warrants closer analysis, because Uruguay shows the smallest increase in production between 1950 and 1965, despite the fact that its installed capacity was sufficient to meet greater demand. This was mainly because the Government of Uruguay established a more realistic exchange rate at the end of 1959, which brought about a large increase in the prices of imported paper products and thus strongly affected the paper industry. Since most paper mills in Uruguay are not integrated and have to import their basic raw material - pulp - the price of paper shot up and consumption declined considerably.[4/]

4/ See ECLA, Posibilidades de ampliación de la industria de papel y celulosa en Uruguay (E/CN.12/697), July 1963.

/Table IV-3

Table IV-3

LATIN AMERICA: APPARENT CONSUMPTION OF PAPER AND PAPERBOARD, 1950, 1960 AND 1965, BY COUNTRIES

(Thousands of tons)

Country	1950						1960						1965					
	Newsprint			Total paper and paperboard			Newsprint			Total paper and paperboard			Newsprint			Total paper and paperboard		
	P	I	C	P	I	C	P	I	C	P	I	C	P	I	C	P	I	C
Argentina	3	101	104	211	195	406	9	162	171	291	171	462	3	220	223	478	236	714
Brazil	38	61	99	306	69	375	66	164	230	474	190	664	117	54	171	624	64	688
Chile	11	19	30	45	22	67	52	-24	28	106	-20a/	86	97	-56a/	41	188	-53a/	135
Colombia	-	20	20	8	57	65	-	33	33	51	76	127	-	45	45	126	60	186
Cuba	-	32	32	36	76	112	15	25	40	79	101	180	-	33	33	100	65	165
Mexico	3	36	39	180	53	233	14	90	104	412	123	535	14	85	99	591	135	726
Peru	-	8	8	15	13	28	-	18	18	47	28	75	-	40	40	60	58	118
Uruguay	-	18	18	24	28	52	-	20	20	39	21	60	1	24	25	38	26	64
Venezuela	-	10	10	8	39	47	-	23	23	69	89	159	-	44	44	155	91	246
Others	-	20	20	2	49	51	-	31	31	4	114	118	-	46	46	17	357	374
Total	55	325	380	835	601	1 436	156	542	698	1 573	893	2 466	232	535	767	2 377	1 039	3 416

Source: Pulp and Paper Advisory Group, on the basis of official statistics.

Note: Dashes signify that the figure is less than 500 tons; P = Production; I = Net imports and C = Apparent consumption. Total paper and paperboard includes newsprint.

a/ Net exports.

/Despite the

Despite the increase in newsprint production, no new countries joined the ranks of the traditional producers except Cuba, which began production in 1959 but which, for technical and economic reasons, from 1962 onwards switched production in its newsprint mill over to other types of printing and writing paper, leaving Argentina, Brazil, Chile and Mexico as the sole newsprint producers in the region. Chile is the only country which fully satisfies local demand and even exports part of its production. Brazil increased its output considerably when the largest mill in Latin America went into full operation at the end of 1962, and was able to make a correspondingly large reduction in its imports of newsprint.

The remaining producer countries continue to be largely dependent on imports to meet their requirements.

Of the other types of paper, consumption of paper used in the manufacture of corrugated-board boxes, has increased strikingly in the last three years, particularly in Ecuador and Central America, and imports are now required to satisfy total demand.

The present practice of packing bananas for export is the reason for this sharp rise in consumption and the impact is such that the countries in question, which, except for Guatemala, have practically no paper industry, are studying the possibility of developing a large pulp and paper industry exclusively for the manufacture of this type of paper.

The figures for production, imports and consumption of pulp, by countries, are contained in table IV-4.

The most significant facts shown in the table are the situation in Chile, which began to export pulp, whereas previously it had been an importer, by making use of its plantations of non-indigenous fast-growing conifers (Pinus radiata); the increase in output in Brasil, which, from being the region's largest importer of pulp, achieved a positive trade balance; and the start of production in Cuba and Venezuela, using sugar-cane bagasse as the raw material.

The foreign trade situation in countries which formerly depended on imports to meet the bulk of their demand changed radically between 1950 and 1965, as in the case of Chile, mentioned above, and Brasil and Mexico.

/Table IV-4

Table IV-4

LATIN AMERICA: APPARENT CONSUMPTION OF PULP, 1950, 1960 AND 1965, BY COUNTRIES

(Thousands of tons)

Country	1950						1960						1965					
	Groundwood			Total pulp			Groundwood			Total pulp			Groundwood			Total pulp		
	P	I	C	P	I	C	P	I	C	P	I	C	P	I	C	P	I	C
Argentina	9	14	23	38	73	111	18	20	38	73	86	159	23	20	43	134	170	304
Brazil	82	-	82	155	125	280	92	-	92	330	81	411	200	-9a/	191	619	-40a/	579
Chile	15	-	15	19	19	38	52	-	52	105	7	112	102	-	102	199	-18a/	181
Colombia	-	-	-	1	0	1	-	-	-	9	31	40	-	-	-	89	40	129
Cuba	-	-	-	-	23	23	-	-	-	22	35	57	-	-	-	30	45	75
Mexico	21	1	22	73	53	126	59	3	62	235	34	269	66	10	76	338	43	381
Peru	-	-	-	5	7	12	-	-	-	28	11	39	-	1	1	48	21	69
Uruguay	-	-	-	3	12	15	2	1	3	5	26	31	3	-	3	7	12	19
Venezuela	-	-	-	-	7	7	-	-	-	-	31	31	-	2	2	19	105	124
Others	4	-	-	-	-	-	-	1	1	-	1	1	-	4	4	3	8	11
Total	127	15	142	294	325	619	223	25	248	807	343	1 150	394	28	422	1 480	386	1 866

Source: Pulp and Paper Advisory Group, on the basis of official statistics.

Note: Dashes signify that the figure is less than 500 tons; P = Production; I = Net imports and C = Apparent consumption. Total pulp includes groundwood.

a/ Net exports.

/In Brazil

In Brazil in 1965 exports of pulp (46,000 tons) for the first time exceeded imports (6,000 tons). However, this situation is unlikely to continue, since domestic demand was abnormally low in that year, and this forced pulp producers to seek foreign markets. Future prospects indicate that Brazil will have to continue to import pulp, although in small amounts, until the new plants go into operation and the expansions now being undertaken are completed.

Mexico, whose pulp production was small, has rapidly increased its output to the point that it now meets 90 per cent of domestic demand.

The remaining producer countries have not been able to increase production to the same extent, mainly because of the shortage of softwoods, and are still largely dependent on imports to satisfy demand. Argentina provides an interesting example: it has not exploited to the full its plentiful short-fibre resources, particularly the salicaceae plantations in the River Plate delta very near Buenos Aires, the main centre of consumption, which would enable it to slow down its growing imports of long-fibre pulpwood.

The use of pulp is becoming more widespread throughout the region and is no longer confined to the countries with large markets. Thus, in 1950 Argentina, Brazil and Mexico consumed 84 per cent of the region's pulp, but only 67 per cent in 1965. However, there are still nine Latin American countries which do not produce pulp and hardly use this raw material.

3. Projections of demand

Preliminary projections of demand indicate that the region will consume 4.9 million tons of paper and paperboard in 1970 and 7 million in 1975, which represents a doubling of consumption between 1960 and 1970 and a 43 per cent increase in the subsequent five-year period.

These figures reveal the size of the projected increase and will mean a doubling of per capita consumption from 12 kg in 1960 to 24 kg in 1975.

This increase in demand is based on the hypothesis that there is a fairly close relationship between the groth of the gross domestic product and the increase in paper and board consumption. The projected annual increase is very high (8.1 per cent) and exceeds the highest annaul rate recorded for any five-year period (6.7 per cent between 1955 and 1960).

/The region's

The region's plans for meeting this greater demand are dealt with in this study according to different criteria, depending on whether the projection relates to 1970 or to 1975. In the first case, a list was made of the projects envisaged by the Latin American countries for increasing capacity, and once the most feasible projects had been selected they were added to the capacity figures for 1964. This gave the probable capacity for 1970 and probable production of both pulp and paper for that year was calculated on the basis of different utilization coefficients established in accordance with the past experience of each country. Probable exports or imports, as the case maybe, were calculated by comparing these figures with projected demand.

For 1975 a different approach was adopted, since entrepreneurs plans to expand capacity are usually made on an ad hoc rather than on such a long-term basis. Consequently, the situation in 1975 was projected on the hypothesis that production trends between 1970 and 1975 would be such that the absolute level of net imports in 1975 would be the same as in 1970.

Table IV-5 contains projections of production, imports and apparent consumption of paper and paperboard for 1970 and 1975.

A comparison of these production figures with previous figures reveals the size of the effort required in Latin America to attain these targets. Nevertheless, the targets can be considered feasible, with the probable exception of newsprint, whose output would have to double between 1970 and 1975

In foreign trade, Latin America should be increasingly less dependent on imports, with the result that in 1975 imports should represent only 18 per cent of consumption as against 30 per cent in 1965.

Newsprint imports would continue to account for the bulk of this percentage, because of the special conditions described earlier in this study.

The projections of production, imports and apparent consumption of pulp are contained in table IV-6.

/Table IV-5

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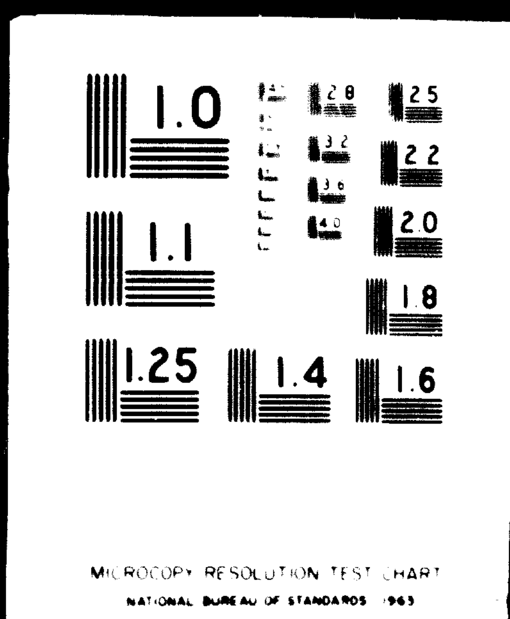
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Table IV-5

LATIN AMERICA: PROJECTIONS OF PRODUCTION, IMPORTS AND APPARENT CONSUMPTION OF PAPER AND PAPERBOARD, 1970 AND 1975

(Thousands of tons)

	1970			1975		
	Production	Imports	Apparent consumption	Production	Imports	Apparent consumption
Newsprint	423	815	1 238	916	815	1 731
Printing and writing paper	768	104	872	1 139	104	1 243
Other paper and board	2 462	359	2 821	3 716	359	4 075
Total	3 653	1 278	4 931	5 771	1 278	7 049

Source: Pulp and Paper Advisory Group.

Table IV-6

LATIN AMERICA: PROJECTIONS OF PRODUCTION, IMPORTS AND APPARENT CONSUMPTION OF PULP, 1970 AND 1975

(Thousands of tons)

	1970			1975		
	Production	Imports	Apparent consumption	Production	Imports	Apparent consumption
Groundwood	863	78	941	881	78	959
Long-fibre chemical pulp	1 067	115	1 182	1 424	115	1 539
Short-fibre semi-chemical and chemical pulp	980	0	980	1 924	0	1 924
Total	2 910	193	3,103	4 229	193	4 422

Source: Pulp and Paper Advisory Group.

/The figures

The figures contained in table IV-6 reveal the emphasis placed on integration of the industry. The share of foreign markets in the region's supply of pulp will be insignificant in 1975 - less than 5 per cent - in comparison with 21 per cent in 1965.

To achieve this degree of integration, production of pulp would have to increase in a much higher proportion than that of paper and board. Thus, it is hoped that for the period 1963-1975 the annual growth rate of production will be 9.3 per cent for paper and 11.2 per cent for pulp. Despite the size of this increase it is believed feasible in the light of the precedent created in 1950-1960 when the annual growth rate of pulp production was 10.6 per cent.

It was assumed that in 1970 and 1975 the proportion of both long-fibre pulp and waste paper used in the total fibre furnish would continue to decline in accordance with past trends: from 33 per cent in 1960 to 32 per cent in 1970 and to 27 per cent in 1975 for long-fibre pulp, and from 35 per cent in 1960 to 29 per cent in 1975 for waste paper.

This decline would be offset by the substantial increase in the proportion of short-fibre pulp (mainly from hardwood and bagasse), which from 17 per cent in 1960 would amount to 27 per cent in 1970 and 33 per cent in 1975.

The increase in pulp production will have a considerable effect on the region's vegetable resources, and it is estimated that there will be no shortage of short-fibre resources.

On the other hand, the softwoods situation is more uncertain, since the main producers - Brasil, Chile and Mexico - may not have sufficient resources to meet the high demand for coniferous pulpwood. Brasil obtains wood from the araucaria forest, which have been intensively exploited in the last few years. Mexico has large reserves of softwoods in the north of the country, but they are in areas difficult to exploit and far from the main centres of consumption. Chile has plentiful resources from its forest plantations, which have enabled it to develop a prosperous and fast-growing pulp and paper industry, but there is no assurance that these plantations can supply enough raw material to expand the industry beyond what is envisaged in the plans under consideration for the period up to 1970, unless the plan to increase the plantations is put into effect.

/B. OPERATING

B. OPERATING CONDITIONS IN EXISTING INDUSTRIES

A comparison of the production figures with installed capacity reveals the surprising fact that in a region which still depends to a large extent on imports production of paper and paperboard is scarcely 71 per cent of capacity and that of pulp only 68 per cent.

It seems, moreover, somewhat paradoxical that this industry should be considering expansion projects when it could substantially increase production, and even satisfy total demand for both pulp and paper - except for newsprint - by fuller utilization of installed capacity. However, the real situation is quite different; in the first place, the installed capacity is theoretical and is calculated in terms of round-the-clock work, whereas there are many small mills in Latin America which because of special conditions - which will be analysed below - cannot work twenty-four hours a day. Similarly, present labour legislation in many countries makes it uneconomical in practice to work on Sundays and feast-days, and to this must be added the widespread tendency for industrialists to exaggerate the capacity of their plants.

Under-utilization of capacity is another reason why the prices of paper and paperboard are so high in Latin America. Thus, the countries which showed the greatest differences in domestic prices (Chile and Uruguay) in a survey carried out in 1962 and again in 1965 (see table IV-9 below) are also at opposite ends of the scale in utilisation of capacity, which is 95 and 50 per cent, respectively.

Progress in expanding existing plants and building new ones is slow in Latin America in comparison with the more advanced countries. It is quite common for five to six years to elapse between the study of a project and the entry into operation of the plant, whereas in other countries it takes no more than two to two and a half years. This can be attributed to the indecisiveness of entrepreneurs, the lack of a clear government policy on industrial development planning and the chronic shortage of capital, although in this sector economically sound projects have been able to secure external financing either from international or private banks or agencies.

/Thus, the

Thus, the projected additions to the industry's capacity (an increase of 75 per cent for paper and of 170 per cent for pulp) considered feasible for the period 1958-1965 in the study entitled Pulp and Paper Prospects in Latin America, op. cit., had already been completed in 1964 and, in the case of pulp, had even exceeded the original projections.

Pulp and paper mills in Latin America can be devided, according to their size, into tree categories:

(a) Very small mills with an annual capacity of less than 1,500 tons. In general, these mills, either have obsolete equipment (e.g., manual barking of logs in the mill, paper machines with wooden suction rolls, etc.) or their production is intermittent. In southern Brazil, for example, there are 140 groundwood plants which in 1963 had a capacity of 124,000 tons but only produced 78,000 tons. In this category there are a large number of small mills producing low-quality wrapping paper or paperboard.

(b) Medium-sized mills with an annual capacity of 10,000 to 20,000 tons. There are fewer mills in this category and, with certain exceptions, their production is more flexible. Although most of them concentrate on a single product as their main line of production, they occasionally manufacture other types of paper in response to changes in the market. Some of these mills are integrated and in most cases due attention is paid to maintenance, although equipment is generally obsolete.

(c) A relatively small group of large mills, most of which have an annual capacity of 250,000 tons. In this particular case there are four lines of production, the largest having an annual capacity of 140,000 tons. All the mills in this category are integrated and are equipped with the most modern machinery in Latin America (continuous digesters and high-speed paper machines of modern design).

The construction of large integrated mills is a fairly recent phenomenon, stimulated by the increase in demand for certain standard products, such as packing material. The paper industry was started up in Latin America with no provision for the local manufacture of pulp. In other words, it was initially an industry for processing imported pulp and local waste paper, mainly because short-fibre raw materials were not considered suitable at the time and it was cheaper to import pulp and convert it into paper (particularly printing, writing and packing paper) than to inport the paper itself.

/Mills were

Mills were built near the centres of consumption and, because demand was low, were small in size. Protected by customs duties on imported paper but not on the imported raw material, some of these enterprises expanded and bought additional equipment, which was sometimes rather outdated. At the same time, they began to produce special articles, which were profitable because of the high prices and protective customs tariffs, despite the fact that the volume of production continued to be small. In addition, new mills were built, also small in size, to meet the marginal demand for these articles, particularly wrapping paper and paperboard, which the existing mills did not produce in sufficient quantity.

This tendency still persists in some countries, such as Brazil, where more than fifty mills with an annual capacity of between 1,500 and 3,500 tons went into operation in the period 1960-1965. The situation in the Brazilian pulp and paper industry is illustrated in table IV-7.

The industry in Mexico (one of the three main paper producers in Latin America) has developed out of a similar pattern of many small units. In the last few years the domestic market has favoured a large increase in average capacity. Table IV-8 illustrates that the Mexican industry is at a more advanced stage of development.

In the remaining producer countries, except for Argentina, the industry is well developed from the standpoint of mill size. Venezuela and Colombia have mills whose production is intended solely for the domestic market. Chile is an exception, because its industry not only satisfies local demand for most types of paper but also exports large quantities of pulp and newsprint. Its pulp mills have modern equipment and are able to take advantage of economies of scale. They enjoy the special advantage of being supplied by large pine plantations with low-cost wood as raw material for mass production of products which are in short supply in the region.

/Table IV-7

Table IV-7

BRAZIL: PULP AND PAPER INDUSTRY, 1965

Production capacity	Pulp mills			Paper mills		
	Number of mills	Percentage of capacity	Tons per year	Number of mills	Percentage of capacity	Tons per year
Up to 5 000	167	22	187 000	128	28	297 000
From 5 001 to 10 000	8	7	56 000	19	13	139 000
From 10 001 to 25 000	7	13	112 000	16	25	257 000
From 25 001 to 60 000	4	16	138 000	5	15	154 000
More than 60 001	3	42	355 000	1	19	200 000
Total	189	100	848 000	169	100	1 047 000

Source: Pulp and Paper Advisory Group.

Table IV-8

MEXICO: PULP AND PAPER INDUSTRY, 1964

Production capacity	Pulp mills			Paper mills		
	Number of mills	Percentage of capacity	Tons per year	Number of mills	Percentage of capacity	Tons per year
Up to 5 000	6	5	19 000	11	6	41 000
From 5 001 to 10 000	1	2	8 000	7	8	50 000
From 10 001 to 25 000	4	18	69 000	10	27	169 000
From 25 001 to 60 000	4	36	143 000	6	42	260 000
More than 60 001	2	39	153 000	1	17	105 000
Total	17	100	392 000	35	100	625 000

Source: Pulp and Paper Advisory Group, on the basis of official statistics.

/In general,

In general, it can be asserted that the Latin American mills which are considered small or medium-scale and which are now encountering economic difficulties have not satisfied one or more of the basic conditions necessary for success. There are:

1. Suitable local raw material;
2. A local market which guarantees low distribution costs;
3. Low capital requirements;
4. Cheap energy;
5. Cheap housing for workers;
6. Low-cost sewage disposal;
7. A high-quality product.

However, it can be assumed that the large number of small mills merely represent an intermediate stage in the development of the region. A number of such mills will always be necessary, and those which encounter insuperable difficulties can either change their production schedules, modernize or merge with their larger competitors.

This fragmentation of the markets, with the consequent lack of specialization, means that there is no possibility of introducing economies of scale, which are much more important in pulp and paper than in most other industries. Thus, of the non-integrated chemical-pulp mills in Latin America, only four have a daily capacity of more than 200 tons, which is considered to be the smallest economic size, and two have a capacity of between 100 and 200 tons, out of a total of sixteen plants in operation. Of the twenty-five to thirty integrated mills in Latin America producing kraft pulp and paper, with a minimum economic daily capacity of 100 to 200 tons, only three have a capacity of more than 100 tons. The minimum daily capacity for integrated semi-chemical pulp mills is considered to be between 100 and 150 tons, but not one of the five existing plants has a capacity of more than 100 tons.

Only one out of a total of five plants in the region meets the requirements for newsprint, yet the minimum daily capacity considered economic for one production line is only about 300 tons.

/C. PRICES

C. PRICES AND PROBLEMS OF THE INDUSTRY

The Latin American pulp and paper industry does not take advantage, except to a very limited extent, of possible economies of scale. However, even the economic sizes mentioned above might well prove too small to meet the growing needs of the domestic market in each country, and in particular the demand of an integrated regional market.

The effects of this situation are clear from a comparison of domestic prices with prices of similar imported articles or prices in other Latin American countries where production is more efficient. Table IV-9 contains the figures for certain types of paper and paperboard in the main producer and consumer countries, gathered for a study carried out by the Advisory Group in December 1962 and again in 1965.

However, because of the difficulties of comparing prices for very different types of paper, and the great variations in exchange rates, the results obtained in this inquiries cannot be definitive. Thus, the data presented here are merely intended to suggest an order of magnitude that will give an approximate idea of the present situation in the countries under consideration.

In analysing the reasons for the great variation in prices between the main producer countries, mention should be made of special situations which have nothing to do with the degree of efficiency in the industry. Uruguay, for example, has the highest prices in Latin America in both periods, not only because of the low utilization coefficient, but also because of the over-valuation of the Uruguayan peso in recent years.

At the other extreme is Colombia, where the rate of exchange was raised but the Government did not authorize an automatic adjustment of domestic prices for paper.

Chile and Brazil have the lowest prices in the region, largely as a result of the low cost of raw materials in both countries. This has enabled them to develop a prosperous industry which practically satisfies total domestic demand for paper products - except for newsprint - and, in Chile leaves a considerable margin for export.

/Table IV-9

Table IV-9

LATIN AMERICA: COMPARISON OF SELLING PRICES FOR CERTAIN TYPES OF PAPER IN SELECTED COUNTRIES

Product	Producer country	Percentage of [illegible] price, December 1962	Percentage of lowest regional price, December 1962	Percentage of lowest regional price, August 1965
Newsprint	Argentina	117	130	-
	Brazil	-	-	124
	Chile	90	100	100
Printing paper (wood containing)	Colombia	184	177	152
	Uruguay	184	177	301
	Brazil	182	176	121
	Argentina	144	139	202
	Mexico	126	122	[illegible]
	Chile	104	100	100
Printing paper (100% chemical pulp)	Uruguay	217	154	262
	Peru	198	140	191
	Argentina	167	118	195
	Brazil	164	116	100
	Mexico	164	116	159
	Colombia	154	109	106
	Venezuela	-	-	116
	Chile	141	100	161
Sack kraft	Uruguay	237	208	273
	Brazil	[illegible]	178	106
	Colombia	185	166	103
	Argentina	185	142	158
	Mexico	131	115	106
	Venezuela	118	104	100
	Peru	-	-	144
	Chile	114	100	121
Ordinary wrapping paper	Peru	243	313	131
	Uruguay	214	178	[illegible]
	Colombia	184	237	172
	Venezuela	177	202	[illegible]
	Brazil	123	159	138
	Chile	108	139	100
	Argentina	90	105	160
	Mexico	78	100	138
Fluting paper	Uruguay	231	289	322
	Brazil	164	206	-
	Peru	161	201	121
	Chile	124	155	117
	Mexico	119	146	100
	Venezuela	-	-	122
	Colombia	-	-	109
	Argentina	80	100	117
Corrugated board liner	Uruguay	242	236	363
	Brazil	194	129	-
	Peru	176	116	147
	Chile	167	111	130
	Mexico	158	105	112
	Venezuela	-	-	[illegible]
	Colombia	-	-	100
	Argentina	151	100	134

Note: Domestic prices are average prices, calculated on the basis of data supplied by the mills which answered the questionnaires. They are cash prices for the product in the warehouses of the mills themselves, not including sales taxes. For the purpose of comparing prices in different countries, domestic prices were converted into dollars at the following rates of exchange:

		1962	1965
Argentina	m$n	[illegible]	179.00
Brazil	Cr.	475.00	1 890.00
Chile	Eo.	1.00	[illegible]
Colombia	$	9.00	13.50
Mexico	$	12.50	12.50
Peru	$	26.76	26.80
Uruguay	$	11.00	24.00 a/
Venezuela	B	4.54	4.54

a/ Soon after the survey was taken, the rate of exchange was established at $60.00 to the dollar, thus considerably altering the results presented here.

/The great

The great disparity between prices is not entirely a matter of economies of scale; it is also connected with the poor internal organization of the mills, particularly small and medium-size mills. The failure to grant authority to the technical staff is one aspect of that poor organization. Most of the mills were established and are run by people with little knowledge of the manufacture of pulp and paper who came from sectors of the economy in which general and specialized technical knowledge is less important than business ability, with the result that they take decisions on purely technical matters on the basis of business principles or intuition. Such a practice is diametrically opposed to that followed in countries with a well-established and competitive paper industry and in the large-scale industry in Latin America itself.

The same attitude is reflected in the lack of suitable vocational and professional training in Latin America for all levels of technicians in the pulp and paper industry. It is the responsibility of the leaders of the industry to take the initiative in establishing the necessary university and vocational training facilities. If this is left entirely to Governments, not only will it take much longer but the industry will lose the opportunity of shaping trainig facilities to suit their special needs. Moreover, the industry is apparently not taking full advantage of the fellowships and training opportunities now offered by countries outside Latin America.

The lack of university-trained technical personnel is also reflected in the fact that a recently qualified university graduate can secure an important post in a mill and soon rise to a high administrative position, with the result that he is neither fully conversant with the production process nor fully conpetent to perform his administrative fuctions. The situation is completely different in North America and the Scandinavian countries, where a university graduate may begin at the bottom and work his way up gradually to a higher level either in production or administration.

Moreover, the salaries for technical personnel in Latin America tend to be too low to keep foremen and tour bosses for very long. When their base salary is devalued as a result of inflation and they receive no compensatory increase, these men tend to look for other jobs and the industry loses their benefit of experience. The low level of salaries also militates against the efforts of the industry to recruit competent technical personnel from outside Latin America.

All this shows that the management of small and medium-size paper mills has not improved commensurately with the progress of the industry as a whole.5/ Industrialists running this type of mill are likely to find it more difficult to adapt to the new competitive conditions created by regional integration and, in many cases, they will be unable to introduce the necessary changes without technical assistance from the Common Market organs.

For several other reasons (the impossibility of obtaining machinery in the country, import restrictions, high interest rates on loans and financing with bank guarantees), Latin American plants cannot replace their equipment rapidly, as North American plants can, and in many cases recently acquired equipment is obsolete in comparison with that of truly modern plants. This is because decisions are taken on a business rather than a technical basis, for reasons already explained, and prices, rather than quality or productive efficiency, is the overriding factor in the purchase of equipment.

Before initiating a new project, competent assistance should be sought in solving the engineering problems. In other regions this assistance can often be obtained from existing plants, which are generally open to those seeking advise; in Latin America, however, plant personnel tend to regard their information as secret, despite the fact that real secrets in the pulp and paper industry are rare.

Moreover, many local manufactures of machinery are unable to offer their clients the kind of engineering assistance provided in countries where the machinery industry is established on a wider base. Even where the mills are able to pay for such services, there are only a few firms of consultant engineers in Latin America working in this field. However, in many cases, it is surprising how local manufacturers, or the staff of the mills' own repair shops, find ingenious solutions for complicated technical problems.

5/ See Aspectos económicos y condiciones de operaciones de pequeñas plantas de celulosa y papel elegidas en Argentina y Brasil (ECLA/BTAO/FAO PREP CONS/PAPER II/2).

/Despite the

Despite the efficiency of the shops attached to certain mills, in general equipment maintenance is unsatisfactory, as is reflected in the results of a study on Argentine paper mills in 1963: in mills representing 20 per cent of total installed capacity operating conditions were regarded as unsatisfactory, in 49 per cent conditions were more or less acceptable and the rest (31 per cent) were operating efficiently. Special importance was attached in this study to the overall operation, than to the individual features of the component elements.6/

Moreover, in many cases manufacturers of equipment have been slow in designing machinery specially adapted to the needs of the Latin American industry. One example of this is the need for a modern system for the recovery of chemical products in small mills producing Kraft or soda pulp. This need became evident about 1950 and several foreign manufacturers were informed, but only now is it becoming to find such systems, either locally produced or imported, for mills with a minimum daily capacity of 20 tons.. The reasons for this delay be sought in the situation existing in the rest of the world, where in the last decade the larger Kraft mills expanded their daily capacity from 400 to 1,000 tons, with the result that manufacturers of recovery boilers, in particular, were not interested in designing small-size units.

The differences which need to be overcome in the operation of the industry are illustrated by the fact that it is common to find Latin American mills in which 11 to 12 man-hours are needed to produce one ton of pulp, as aginst the 8.5 needed in Scandinavian mills of the same age and approximately 3 man-hours in modern mills.

The general aim of the industry in planning new plants must be to apply modern methods so that technology will be used to full advantage to make production more efficient.

In addition to the problems listed above, the industry encounters difficul s of a technical nature in attemping to use local natural resource o meet the demand for paper products. There is a wide gap between what is technically possible and actual practice in producing paper from existing regional resources.

6/ See National Development Council (CONADE), Industrial del papel y celulosa, Internal Document No.47, Buenos Aires, 1965.

/Softwoods (long-fibre)

Softwoods (long-fibre) are available only in very few Latin American countries, and this means that short-fibre resources must increasingly be used to satisfy growing regional demand, in view of the large reserves of hardwoods and agricultural waste (mainly bagasse).

World attention is increasingly being paid to the need for more detailed research on short-fibre materials in the manufacture of pulp and paper. Notable experimental work has been done in Brazil, Colombia, Mexico and Venezuela on the use of mixed tropical hardwoods, and has been successful even on an industrial scale mainly in Brazil and Colombia. There is still much room for more advanced research and, despite the fact that the use of mixed hardwoods is an economic rather than a technical problem, the discovery of more efficient processes will undoubtedly help to make fuller use of tropical resources in the manufacture of paper.

It is no exaggeration to say that present techniques for using bagasse as a raw material are obsolete and relatively expensive. One striking exception is Mexico, where valuable experimental work is being done and where are mills using modern processing techniques.

Another technological problem of some importance to Latin America is the use of hardwood in the manufacture of high-yield, i.e. groundwood pulps, particularly for the manufacture of newsprint and printing paper. Except for Argentina, where salicaceae are used in manufacturing newsprint, little is known in Latin America about this subject. The use of eucalyptus for producing disc groundwood could open up interesting possibilities, which would fundamentally influence the development of a large part of the Latin American industry.

There are several technological research institutes in Latin America styding the problems of the pulp and paper industry.[7] Some have done excellent work on the manufacture of pulp but, as often occurs in other regions, in general no research has been done on certain aspects of paper manufacture, since these present greater difficulties. For the most part, research on paper tends to be concentrated on property studies and quality control.

7/ For further details, see Research on pulp and paper in Latin America (ST/ECLA/Conf.23/L.6), 30 December 1965.

The problem of co-ordinating the research done by the different countries is a difficult one and will be of great importance in the futture, but for the time being it is preferable that the technological studies should be carried out by existing institutes, which should be expanded and given greater resources so that they can meet national needs.

As a first step towards regional integration, research activities should become more specialized, with one regard for the particular conditions of the different countries. The main field of research that could be undertaken by each country are roughly as follows:

(a) Argentina: refining, use of short-fibres (mainly for mechanical pulps), sheet forming and printing problems;

(b) Chile: lixiviation and grinding of pulps, manufacture of newsprint and paper for containers;

(c) Colombia and Venezuela: use of short-fibres (bagasse and tropical hardwoods), printing and packaging problems;

(d) Brazil and Mexico: the different stages of lixiviation, with emphasis on the production of dissolving pulp and the manufacture of printing and packaging papers.

Finally, although it is not a technological problem, the lack of training facilities in Latin America must be emphasized. The one exception is Mexico, where a number of training programmes for mill personnel have been successfully launched. There is almost a virgin field for developing training activities and very promising results could be obtained with a little more effort.

D. TECHNOLOGY AND ECONOMIES OF SCALE

There is a close relationship between a mill's production costs and its installed capacity. As the size of the mill increases, labour requirements, administrative costs and general expenditure do not increase commensurately, in other words, unit costs are lower. Investment does not increase in proportion to the size of the mill either, with the result that investment per unit of production and capital charges are lower.

/This effect

This effect is not indefinite; there comes a moment when economies of scale becomes insignificant and tend to disappear. In the case of pulp and paper, this limit is a daily production of about 500 tons (or double in the case of paperboard).[8]

Table IV-10 shows the differences in investment and production costs for paper in relation to different capacities. Economies of scale vary manufacturing processes as well as with finished products, with most concentrated in the manufacture of paper (mainly because of the investment cost of paper machines), particularly where there is mass production (newsprint, wrapping paper and linerboard).

Economies of scale are less significant - although still considerable - in pulp production and depend on the size of the pulp manufacturing units and bleaching and recovery facilities. Economies of scale in pulp production are shown in table IV-11.

The data used to illustrate these economies of scale are strictly for purposes of comparison and do not relate to actual conditions in any particular country. Naturally, the minimum economic mill size varies according to actual local conditions: the cost of the raw material, labour costs, tariff protection, transport costs, taxes, the cost of electric energy, etc., with the result that the validity of the concepts of minimum and optimum sizes is relative and varies from one country to another and even from one region to another within the same country.

In Latin America mill size tends to remain below what is considered to be the minimum economic size in the more industrialized countries and very far from the optimum size. There is, for example, only one pulp mill, situated in Chile, with an optimum daily capacity of 500 tons; all the rest have much lower capacities and at present there are no expansion plans that would enable them to approach that figure, except for Celulosa Chihuahua in Mexico.

8/ For further details see ECLA, Programming data and criteria for the Pulp and Paper Industry (E/CN.12/702).

Table IV-10

PRODUCTION COSTS IN PARTIALLY INTEGRATED OR NON-INTEGRATED PAPER MILLS

(Dollars per metric tons daily)

Product	Daily capacity in metric tons				
	25	50	100	200	500
Newsprint					
Investment per ton	210 000	185 000	155 000	130 000	120 000
Total production cost per ton	195	175	140	120	105
Printing and writing paper					
Investment per ton	350 000	295 000	215 000	180 000	170 000
Total production cost per ton	315	270	215	173	160
Linerboard					
Investment per ton	160 000	135 000	95 000	90 000	80 000
Total production cost per ton	170	150	125	105	95

Source: FAO/ECAFE, Pulp and paper development in Asia and the Far East, 1962 (E/CN.11/[illegible]).

/Table IV-11

Table IV-11

PRODUCTION COSTS OF WOOD PULP

(Dollars per metric ton daily)

Product	Daily capacity in metric tons				
	25	50	100	200	500
Groundwood					
Investment per ton	105 000	75 000	60 000	55 000	50 000
Total production cost per ton	103	88	75	69	57
Bleached semi-chemical pulp (without recovery)					
Investment per ton	130 000	110 000	85 000	75 000	65 000
Total production cost per ton	185	165	140	130	115
Bleached sulphate pulp (with recovery)					
Investment per ton	140 000	120 000	105 000	100 000	95 000
Total production cost per ton	200	175	150	135	120

Source: FAO/ECAFE, Pulp and paper development in Asia and the Far East, 1962 (E/CN.11/587).

Domestic markets in Latin America are influenced by powerful factors very different from those operating in an economically free market, particularly protectionist measures which enable local industries to develop, even though their prices are much higher than in the industrialized centres where free competition forces the industry to make full use of economies of scale.

Moreover, the evolution of the pulp and paper industry in Latin America ruled out economies of scale from the outset, because of the small size of the domestic markets. Even today, when consumption of paper and board has increased considerably, not all Latin American countries have markets which enable them to take full advantage of economies of scale.

/Thus, there

Thus, there are a large number of small and medium-size mills in Latin America which have more than one production line and process a great variety of products, with a consequent increase in production costs. For certain types of special paper, even the whole Latin American market would not be sufficient to absorb the production of an optimum-size mill.

In order to satisfy growing demand in recent years, medium-size units have frequently been established, without regard for the savings that would result from expanding mills already in operation and utilizing existing facilities. However, a number of countries, conscious of the advantages, have expanded existing pulp and paper mills with a view to reducing production costs.

Table IV-12 shows the variations in mill size and the predominance of small mills in the Latin American pulp and paper industry.

As can be seen, mill sizes are far below what is considered the minimum economic size for world market conditions. Thus, out of a total of 235 pulp mills, only 7 have a daily capacity of more than 200 tons, and out of a total of 295 paper mills, only 25 have a daily capacity of more than 100 tons, the minimum economic size for certain types of special paper, which is aggravated by the fact that most of these 25 mills reached this capacity by successive additions of small machines and are forced, as a result, to employ an unduly large staff. The types of paper principally consumed (newsprint, paper for bags, and corrugated board) require minimum economic daily capacities of more than 200 tons.

The foregoing has shown how the smallness of national markets has in most cases been one of the factors preventing the Latin American countries from benefiting from the economies of larger-scale production. In planning the industry's future development, particular emphasis should be laid on the introduction of economies of scale by creating the necessary conditions, expanding existing mills and recommending that future installations should take full advantage of these economies in order to make better use of limited capital resources.

In addition, as many mills as possible should be integrated, since an integrated mill is obviously more economic than a non-integrated mill of the same size. For this reason particular support should be given to projects for providing non-integrated mills with means of producing the raw material (pulp), as a first step towards reducing costs.

/Table IV-12

Table IV-12

LATIN AMERICA: PULP AND PAPER INDUSTRY, 1964

Production capacity	Pulp mills			Paper mills		
	Number of mills	Percentage of capacity	Tons per year	Number of mills	Percentage of capacity	Tons per year
Up to 5 000	184	18	342.5	180	17	524.9
From 5 001 to 10 000	13	5	95.0	47	12	365.5
From 10 001 to 25 000	20	19	358.5	43	20	642.0
From 25 001 to 60 000	11	22	431.5	17	24	735.0
More than 60 001	7	36	703.5	8	27	855.6
Total	235	100	1 931.0	295	100	3 123.0

Source: Pulp and Paper Advisory Group, on the basis of official statistics.

Note: Production capacity was calculated on the assumption that the mills work 330 days in the year, twenty-fours hours a day.

The creation of a common market for pulp and paper would facilitate the applications of measures for introducing economies of scale, by opening up national frontiers to regional competition. A further advantage would be that the production of certain types of special paper and board could be concentrated in countries with the best manufacturing conditions.

These benefits would reduce investments and production costs and would enable the producer countries to enter the export market, which up to now has been closed to them, by reducing prices without loss of profits to the advantage of both producers and importers.

E. ALTERNATIVE GROWTH POSSIBILITIES

1. Saving on investment and production costs in a common market

Projections of future consumption of pulp and paper in Latin America indicate that there will be a sizable increase in the various categories, as shown in table IV-13.

/Table IV-13

Table IV-13

LATIN AMERICA: PRODUCTION, IMPORTS AND CONSUMPTION FOR 1964 AND PROJECTIONS FOR 1975

(Thousands of tons)

	Pulp				Paper and board			
	Groundwood	Long-fibre chemical pulp	Short-fibre chemical pulp	Total	Newsprint	Printing paper	Other paper and board	Total
1964								
Production	379	445	484	1 308	219	452	1 543	2 214
Imports	19	354	-	373	508	77	247	832
Apparent consumption	398	799	484	1 681	727	529	1 790	3 046
1975								
Production	881	1 424	1 924	4 229	916	1 139	3 716	5 771
Imports	78	115	-	193	815	104	359	1 278
Apparent consumption	959	1 539	1 924	4 422	1 731	1 243	4 075	7 049

Source: Pulp and Paper Advisory Group.

The theoretical calculation of the economies of scale that could be obtained by building production units of economic size to meet increased demand is very revealing. It is estimated that in Latin America these units should have a daily capacity of about 200 tons except in the case on newsprint, for which the minimum economic capacity is higher. This size would be sufficient to supply most domestic markets and would yield fair return on capital and eliminate the need for high protectionist tariffs. It is estimated that the production costs of an efficient mill of that size manufacturing printing and wrapping paper would in most cases enable prices to be internationally competitive and still yield a reasonable, if not high profit. Moreover, such production units would allow firms considerable flexibility within a wide range of products. This seems to be the best solution for the problem of paper consumption in Latin America,

/since the

since the more drastic solution of concentrating production in a smaller number of large mills (with a daily capacity of 500 tons or more) and opening markets to international competition is not feasible at the moment.

In the regional study,[9] a careful analysis was made of the balance of supply and demand for pulp products on the assumption that all the projects for expanding capacity considered feasible for the period 1965-1970 would be completed and that the demand projections contained in the study would be fulfilled. A different approach was adopted for 1975. It was almost impossible to predict how much the industry's capacity might expand over so long a period. Consequently it was decided to estimate production for 1975 on the arbitrary assumption that it would be sufficient to maintain the same absolute level of imports as in 1970.

Table IV-14 shows how much capacity would have to be increased between 1970 and 1975 for the purpose of the above assumption. These data serve as a basis for calculating the saving that would result from applying economies of scale.

The installation of new capacity to meet the expected increase in demand for the period 1970-1975, if the relationship between demand and production is to remain at the 1970 level, is analysed on the basis of two hypotheses:

(a) The installation of mills with a capacity equal to the present average capacity in the region, and

(b) The construction of a smaller number of mills of an economic size (daily capacity of 200 tons).

Solution (b) is based on many simplified theoretical calculations. There are specific cases in which small mills are built because of technical or market problems, and others in which small plants in certain localities are protected by transport charges - and this happens frequently in Latin America - against competition from plants of more economic size.

9/ <u>El papel y celulosa en América Latina: situación actual y tendencias futuras de su demanda, producción e intercambio</u> (E/CN.12/570/Rev.3).

Table IV-14

LATIN AMERICA: CAPACITY DEFICIT BETWEEN 1970 AND 1975 a/

(Tons)

	Capacity deficit
Total pulp	1 729 000
Groundwood	418 000
Long-fibre chemical pulp	367 000
Short-fibre chemical pulp	944 000
Total paper and board	2 118 000
Newsprint	493 000
Printing paper	371 000
Other types of paper	1 254 000

Source: Pulp and Paper Advisory Group.

a/ Assuming that mills are working at 100 per cent capacity.

Perhaps the more important simplification is that no account is taken of the basic problem of plant location in terms of the availability of raw materials. Moreover, in many cases, to be able to establish mills of economic size it would be necessary to have free access to the whole regional market.

Notwithstanding these limitations, this theoretical calculation gives some idea of the saving on investment and of the reduction in production costs that could be obtained from establishing mills of regional economic size, if intra-regional trade is organised on an increasingly free basis. In view of the high degree of capital formation in the industry, this would enormously facilitate its future development.

Table IV-15 shows the saving that would be made on investment and production costs by applying economies of scale in the planning of the development of the pulp and paper industry.

/Table IV-15

Table IV-15

LATIN AMERICA: ECONOMIES OF SCALE FOR MILLS DESIGNED TO COVER THE ANTICIPATED CAPACITY DEFICIT BETWEEN 1970 AND 1975

Latin America	Total of pulp		Total of pulp and paper		
	Total	Long-fibre chemical pulp	Total	Newsprint	Other printing and writing paper
Anticipated capacity deficit of between 1970 and 1975 (thousands of tons)	1 719	357	2 118	493	571
Hypothesis A (mills with average capacity)					
Average capacity of existing plants (tons per day)	56	72.5	36	100	32
Number of mills needed to cover the deficit	93	15	179	15	35
Investment in mills of average capacity (thousands of dollars per ton per day)	127	114	226	155	334
Total investment required to cover the present deficit (millions of dollars)	661.4	124.0	1 456.3	232.5	374.1
Production costs per ton (dollars)	163	179	215	140	384
Total cost of production to cover the deficit (millions of dollars)	280.2	63.9	455.4	69.0	112.8
Hypothesis B (mills with daily capacity of 200 tons)					
Number of mills needed to cover the deficit	26	6	32	8	6
Investment in mills (thousands of dollars per ton per day)	85	73	133	130	180
Total investment needed to cover the deficit (millions of dollars)	442.0	87.6	851.2	208.0	216.0
Production costs per ton (dollars)	119	126	133	120	173
Total cost of production to cover the deficit between 1970 and 1975 (millions of dollars)	204.6	45.0	281.7	59.2	64.2
Saving in the period 1970-75 (difference between hypothesis A and hypothesis B)					
On investment (millions of dollars)	219.4	36.4	605.1	24.5	158.1
On production costs (millions of dollars)	75.6	18.9	173.7	9.8	48.6
Total	295.0		778.8		

Source: Pulp and Paper Advisory Group.

Note: Since this table is intended for purposes it was not considered necessary to study in detail investment and production costs for each product and process. A simpler criterion was therefore adopted: a weighted average was used of the production costs and investment needed in the region for the two main groups, pulp and paper.

/An analysis

An analysis of the figures contained in the table, despite the illustrative nature of the calculations, indicates the benefits to be obtained from the correct aplication of such measures. On the basis of the assumptions mentioned above, there would be a hypothetical saving of 825 million dollars on investment and a reduction of about 250 million in production costs in the period 1970-1975. Particularly striking is the fact that the saving on investment to cover the capacity deficit for paper is much larger than for pulp, although the deficit in the paper industry is only slightly larger than in the pulp industry. The saving on investment in the paper industry is almost three times as much as in the pulp industry, because the economies of scale are much greater in the manufacture of paper and because existing pulp mills have a larger average capacity than paper mills.

In view of the fact that one of the problems limiting the industry's development in Latin America is the shortage of capital, the need to move towards true integration in the industrial field is increasingly urgent.

2. Liberalisation of trade

Now that the advantages of adopting a regional approach to the future development of the pulp and paper industry have been illustrated, a brief account should be given of some of the most important aspects of this regional co-ordination.

Integration of the markets should be the main instrument for achieving a gradual change in the industry's present situation, with its insufficient scales of production, inefficiency of operation, high costs and prices, high tariffs and other forms of protection. However, in applying this instrument account should be taken of the very different circumstances in the two most dissimilar pulp and paper manufacturing groups, namely:

(a) Mass-produced standard products, such a newsprint, Kraft wrapping paper, chemical pulp (mainly long-fibre), which are most susceptible to economies of scales; and

(b) Products of more limited production, mainly groundwood, printing and writing paper, certain types of board and special paper, which are generally less amenable to economies of scale and in respect of which it is a great advantage for mills to be close to the centres of consumption.

/Moreover - and

Moreover - and this is perhaps the most important f ctor in ensuring that integration is tailored to fit each type of production - the geographical distribution of long-fibre resources in the region conditions the possibilities of regional specialization more than the availability of short-fibre resources.

There is, therefore, a well-defined pattern of regional specialization in long-fibre products, in which Chile, and to a lesser extent Central America and Mexico, are in the best position to meet regional demand.

Table IV-16 summarises the customs duties and similar taxes levied on pulp imports in the main importing countries of the region, and for purpose of comparison, the prevailing tariffs in France and the United Kingdom.

Most of the ALALC countries have already lowered their tariffs on pulp imports, in several cases considerably. These reductions have led to a substantial expansion of the pulp and paper industry in Chile and are the main incentive behind projects for building new pulp mills in that country.

However, tariff reductions for paper and board have been much smaller than for pulp, and have been more or less limited to the types of paper not produced in the countries granting the concession or not produced is sufficient quantity to satisfy domestic demand (newsprint).

The situation is different with regard to products for which short-fibre resources are used. The fact that most of the countries have a plentiful supply of short-fibre resources and that operating conditions and existing prices vary widely makes it extremely difficult to arrange for certain countries to specialize in these products.

The tariff reductions agreed to in ALALC, together with others that should be easy to secure, such a reductions in tariffs on special paper, produced by a very small group of countries (mainly Argentina, Brazil, Chile and Mexico) which the remaining countries import from outside the region, will enable imports from outside Latin America to be replaced by regional production. The assumption continues to be that there will be a great increase in intra-regional trade in the next few years and an improvement in the operating conditions of mills producing for export.

/Table IV-16

Table IV-16

LATIN AMERICA, FRANCE AND THE UNITED KINGDOM: CUSTOMS DUTIES AND SIMILAR TAXES ON IMPORTS OF PAPER PULP AND PAPER AND BOARD

(Percentages of c.i.f. value)

	Argentina	Brazil	Colombia	Chile	Ecuador	Mexico	Peru	Uruguay	Venezuela	United Kingdom	France
Groundwood											
A	38.0	316.0	22.6a/	39.1	41.8b/	5.6	11.6	35.5	13.5	Free	6.0
B	1.8a/	316.0	1.0	39.1	Free b/	5.6	Free	6.1	13.5	Free	Free
Chemical pulp											
A	38.0	26.0d/	22.7a/	39.1	40.1b/	44.0g/f/	12.8	35.5	13.5	Free	6.0
B	1.8a/	1.0	1.0g/	39.1	Free b/	30.0g/f/	Free	Free	13.5	Free	Free
Newsprint											
A	1.8	1.0	1.0h/	90.0	24.8i/	34.6f/	12.0	3.4	Free	Free	7.0
B	1.8	1.0	Free	90.0	4.4i/	11.0f/	Free	Free	Free	Free	Free
Printing and writing paper											
A	89.0	221.0	35.8	90.0	49.8i/	79.5	65.1	...	28.5	16.6	1 16.0j/
B	48.0	221.0	35.8	90.0	30.8i/	79.5	65.1	...	28.5	6.6	10.0
Kraft paper											
A	142.5	316.0	46.3	(Ban on imports)	44.0	82.1	60.7	...	100.5	13.5	16.0
B	142.5	316.0	46.3	id.	44.0	82.1	60.7	...	100.5	5 3/5	8.8

Source: ECLA, on the basis of national tariffs and/or the ALALC negotiations consolidated list.

Note: Interest on prior deposits is not included. This interest is difficult to compute because of the great differences between the time-periods and interest rates which apply to these deposits. The figures for Latin America refer to the beginning of 1965.

A = Duties levied on imports from the rest of the world.

B = Duties aplicable to member countries of ALALC. For France: EEC, and for the United Kingdom: EFTA.

a/ 65 per cent of prior deposit.
b/ 50 per cent of prior deposit.
c/ For hardwood pulp, 3.0 per cent.
d/ 100 per cent of prior deposit.
e/ Pulp which is not produced in the country.
f/ Import permit needed.
g/ For hardwood pulp, 5.0 per cent.
h/ 30 per cent of prior deposit (before the latest changes).
i/ 25 per cent of prior deposit.
j/ Temporarily suspended.

/There are

There are a large number of obstacles to such an increase in trade. However, a first step towards wider regional integration could be the reduction of all existing customs duties to a pre-determined level. This presents enormous difficulties because prices vary so much from country to country, as was shown in table IV-6. Before introducing such a measure, domestic prices in Latin America for the different types of paper and board would have to be carefully studied. If such a study confirmed the great disparity between prices found in the surveys carried out by the Advisory Group, some mechanism for the gradual reduction of customs duties should be established, with longer periods and smaller reductions for countries with the highest prices. That would give industries which were established with the assistance of extremely high tariff protection time to modernize their plants and improve operating conditions.

The gradual reduction of all customs duties would introduce a permanent factor of competition that would tend to have a moderating influence on sharp price rises.

There are fewer practical obstacles to integration in the countries of the Central American Common Market. The non-existence of a real pulp and paper industry in any of the five countries and the small size of the national markets open up great possibilities for true integration. There are at present several projects for establishing mills that would satisfy the Central American market. They have been abetted by the unrestricted internal trade in these products between the countries of the Common Market (except for trade in certain types of paper between Nicaragua and the remaining countries) and the common external tariffs that are to be applied to countries outside the Market at the end of 1970.

3. Competition in world markets

At first sight it would seem contradictory that a region with a large pulp and paper deficit and an unsatisfactory industrial structure should consider selling its products on the world markets. However, there are, a number of indications that certain products of the pulp and paper industry could complete successfully in a free market without special protection.

/Studies carried

Studies carried out by FAO and the United Nations regional commissions 10/ indicate that the main producer and consumer regions of Western Europe and Japan will be faced with serious shortage of pulpwood in the not too distant future.

There are certain intermediate products, such as pulp, in which the value of the raw material - wood or vegetable waste - is a very important factor in mills of economic size. Since pulpwood is of little value in relation to its weight, world production of pulp is concentrated in localities close to the source of the raw material (forests and plantations) and there is a thriving world trade in this product.

Centain Latin American countries are in a very favourable position in comparison with other regions of the world. This is particularly true of Chile, where the rapid growth of non-indigenous pine plantations gives an annual yield per hectare five to ten times greater than in the cold temperate zones of the Northern Hemisphere, with the result that the price of softwood is exceptionally favourable in that country.

A study prepared by FAO in 1963, 11/ comparing prospects in four regions of the world for exporting Kraft pulp to the European market, describes the favourable conditions in Chile at the present time for competing in that market. The study estimated capital and manufacturing costs and profits for mills producing exclusively for the export market on the basis of information then available. The calculations were based not on selected locations or projects for building specific mills, but on regions with suitable sites and the costs of similar mills built at that time and in the experience.

Notwithstanding the hypothetical nature of the study and the simplifications introduced in the calculations, the estimates are sufficiently reliable for purposes of comparing potential savings.

Table IV-17 compares costs and profits in Kraft pulp mills of the same size (daily capacity of 300 tons) in four regions, producing exclusively for European market.

10/ ECE, Pulp and paper prospects in Western Europe (Munich, 1963); FAO, Prospects for expanding forest products exports from developing countries (1964).

11/ FAO, Geographic comparison of the economies of pulp production, 1963 (mimeographed).

/Table IV-17

Table IV-17

PRODUCTION COSTS AND GROSS PROFITS IN KRAFT PULP MILLS

(Daily capacity: 300 tons)

Location	Net price at mill a/	Direct manufacturing cost	Gross profits on investment
	Dollars per ton		(Percentage)
Northeast of Finland	111.0	68.5	19.6
Southwest coast of Canada	101.5	70.4	15.2
Coast of Tanganyika or Kenya	104.5	45.9	23.8
Southern coast of Chile	99.5	52.9	21.7

a/ Obtained by subtracting freight and insurance charges from the price of the pulp at a European port (c.i.f. Rotterdam). Gross profits on investment are calculated on the basis of the difference between these prices and manufacturing costs.

It will be noted that the mill situated in Chile, despite the higher transport costs resulting from the greater distance from Europe, would have one of the highest profits-investment ratios, solely because of the lower cost of wood. The influence of the cost of wood on the direct manufacturing costs of unbleached Kraft pulp emerges clearly from a comparison of the share by wood in direct manufacturing costs in Finland and Chile, which are at opposite ends of the scale as regards wood prices. In Finland the cost of wood represented 75 per cent of direct manufacturing costs, whereas in Chile it was only 46 per cent.

/Although Europe

Although Europe is expected more easily to satisfy its short-fibre pulp requirements by better utilisation of existing mills in the region, it might be possible to introduce into the European market certain Latin American homogeneous short-fibre pulps, such as eucalytus and bagasse, for which conditions in Brasil and Mexico are very favourable.

Prospects for exporting products with a greater value added, such as a different types of paper, to the more industrialized centres are less encouraging, in view of the fact that the cost of the raw material is not as important as in the manufacture of pulp. Consequently, the adverse factors in Latin America (high capital costs, low productivity and high cost of electric energy) have greater impact.

21. 9. 71