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# SELECTION OF TECHNIQUES AND MANPOWER ABSORPTION

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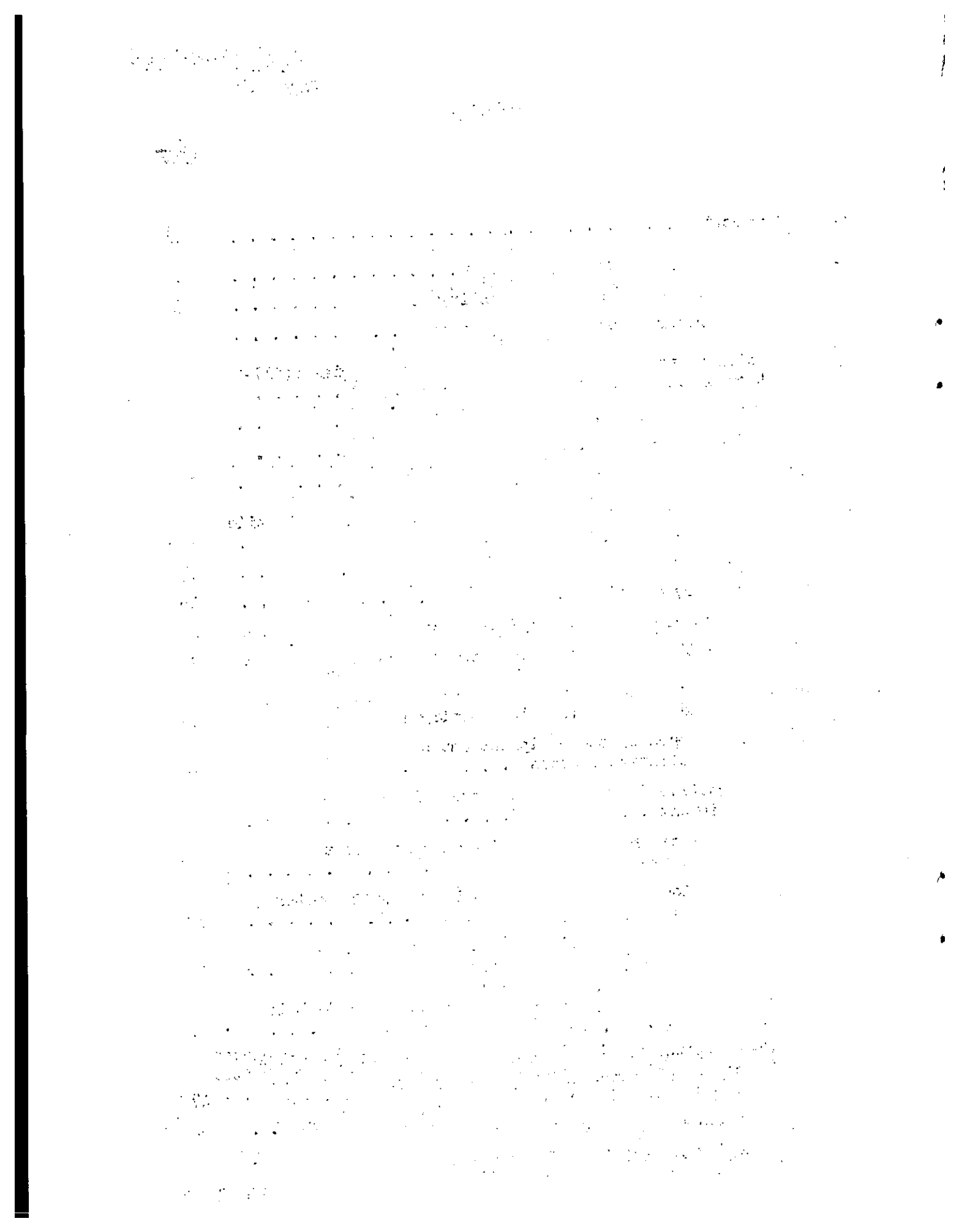

# SELECTION OF TECHNIQUES AND MANPOWER ABSORPTION

## 1. Introduction

The purpose of this document is to examine some problems connected with the selection of techniques and production equipment in Latin American industry, particularly in relation to an investment policy designed to maximize manpower absorption. After a general review of the subject,[1/] the problem of choosing the most suitable production technique for the Brazilian textile industry is analysed on the basis of empirical data from recent ECLA studies.[2/] A description and analysis of some situations that are assumed to be typical of Latin America may be helpful when the question of selecting techniques arises during the preparation of industrial development programmes.

## 2. Technology and factor productivity

An investment policy has three aspects: (a) determination of the total amount of investment, i.e. the proportion of national income to be invested; (b) distribution of total investment among the different sectors of activity and among specific industries; and (c) a technical formula for the combination of productive factors that must be the outcome of investment in the enterprises operating in each sector.

As a complement to the third aspect, an analysis should be made of the efficiency with which enterprises apply the technical formulas or nominal combinations of productive factors that correspond to each sector.

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1/ This account reproduces, with a few slight modifications, part of the document Algunos comentarios sobre los problemas relativos a la productividad en la industria latinoamericana presented by ECLA at the ECLA/ILO Technical Meeting of Experts on Management Development and Productivity in Latin America, held at Santiago in October 1962.

2/ A industria do Brasil: pesquisa sobre as condiçoes de operaçao nos ramos de fiaçao e tecelagem (E/CN.12/623) and The Programming of Traditional Industries: Outline of a Methodology for the Textile Industry (ST/ECLA/CONF.11/L.21).

/Once the

Once the over-all volume of investment has been decided upon, the question of the efficiency with which productive resources are used should be tackled at two levels, i.e. that of the national economy and that of individual enterprises. In the case of the former, the level of factor productivity achieved is directly dependent on the way in which the fields for new investment have been chosen.

As far as enterprises are concerned, the problem is twofold, comprising, on the one hand, the selection of techniques and equipment, and, on the other, the promotion of capital and labour productivity. A policy must be worked out for both factors that would be suitable for the stage actually reached by Latin American Industrial development, and give due importance to programming.

The technical knowledge and forecasting ability needed to determine the best productive combinations transcend the possibilities of a large number of Latin American entrepreneurs. Because of this and various other adverse factors (such as the misleading picture of market conditions frequently given by relative factor prices), productive combinations are apt to exist that use factors at lower levels of productivity than those actually attainable given the resources available in the economy.

These deficiencies in the technical know-how of enterprises become even more marked when technological changes have to be made in response to the demands of accelerated industrial development. The Brazilian machine-tools industry is a case in point. According to the conclusions reached by an ECLA study,3/ the only way in which the industry can hold the market position it has gained, for the next ten years, is to introduce modern techniques on a scale that is obviously far beyond the possibilities offered by its normal evolution, in other words, solely on the basis of entrepreneurial ability.

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3/ The machine-tools industry in Brazil: background material for the programming of its development (E/CN.12/633).

(a) The problem of capital intensity

The importance of capital intensity for industrial development is due to the fact that, as is increasingly acknowledged, the establishment of a clearly defined pattern for economic development entails an equally clear-cut choice of techniques. This problem has two aspects:

(i) Choice of sectors for investment in accordance with their capital intensity (e.g. the textile industry versus the metal-transforming industries); and

(ii) Selection of the production techniques to be used by enterprises once the sectors have been chosen, depending on whether production functions in these particular sectors are such as to offer a choice of several techniques characterized by very different capital intensities (e.g. hand, mechanical, automatic or shuttleless looms in weaving mills).

The fundamental problem for industrial development in Latin America at the present time is the shortage of capital, which has become even more acute with the sharp rise in population growth.4/ At first glance, this is an argument for channelling investment towards the industries that use less capital than labour per unit of output and for the adoption of less capital-intensive methods of production by enterprises.5/

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4/ Problems of definition do not come within the scope of this paper. It should be pointed out, however, that an abundance of labour and shortage of capital mean: (i) as regards labour, that there is a constant margin of unemployed or underemployment in the economy; in other words, that the marginal productivity of employed persons is nil or virtually so, and the social opportunity cost very low; and (ii) as regards capital, that its marginal productivity is usually high, in common with its opportunity cost.

5/ This question, viewed from the standpoint of an underdeveloped economy, has interested ECLA from the very beginning. It was dealt with specifically in chapter III of the study Theoretical and Practical Problems of Economic Growth (E/CN.12/221), published in 1961. Among more recent works of a theoretical nature, mention should be made of A.K. Sen, Choice of Techniques (an aspect of the theory of planned economic development), Oxford, Blackwell, 1960. The United Nations Department of Economic and Social Affairs has also made an extensive study of the subject, and has published several articles on it in its periodical Industrialization and Productivity.

/The preference

The preference for industries or techniques that use more labour than capital is based on the general criterion of the social marginal productivity of the resource in shortest supply, whereby priority should be given to investment that brings about the greatest net increase in output as the result of a marginal increment in a scarce factor. As capital is hard to obtain in Latin America and its rate of return is declining, investment should be directed towards those uses that require the smallest amount of capital per unit of output.

Nevertheless, the techniques at the disposal of the less advanced countries often entail a high capital intensity. What is more, the new procedures that are being invented every day by the enterprises and technological research institutions in the more advanced countries are continually raising the proportion of capital in the relevant productive combinations.

The problem for new countries is their inability to develop at the same pace as the industrialized part of the world. At the time when the developed countries were evolving industrially, this problem did not exist. Their industrial development knew nothing of import substitution or of the transfer of production techniques devised in different economic conditions in other regions. Hence the capital intensity adopted for their production processes was the logical and proper culmination of their ealier line of development.

The particular characteristics of Latin American countries in this respect have been extensively analysed by ECLA. "As a result of technical progress, the optimum density of capital per gainfully employed person has tended to rise continuously in the great industrial countries. Thus, a constant increase in productivity has been achieved which, by raising per capita income and expanding the margin of savings, has facilitated the introduction of new technical methods, thus increasing further the density of capital, the process being repeated successively."6/

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6/ Theoretical and Practical Problems of Economic Growth (E/CN.12/221), 1951, p. 46.

/The application

The application of this process in the developing countries has given rise to the problem that concerns us here. "This process has different aspects in the under-developed countries. Technical improvements do not appear gradually, as they did throughout the course of development of the great centres, nor do they evolve through the successive stages of evolution as did their capital goods. In carrying out their investment programmes, these countries find that they must import the same equipment as is used in countries which have developed over a long period. Thus, equipment which represents a high density of capital per gainfully employed person and which is compatible with the high level of per capita income in the industrial centres, is equally available to the under-developed countries, in which per capita income, and therefore the capacity to save, are evidently lower. In other words, it is theoretically possible for the Latin American countries, considering their relative scarcity of capital and abundance of human labour to have a density of capital lower than that of the more advanced countries, but in view of the nature of the technical process, and its irreversible character, the under-developed countries have a very limited possibility of attaining in fact their optimum density of capital." 7/

Because of the technologically dependent state of the Latina American economies the range of possibilities open to them is rather narrow. On the one hand, they can resort to more antiquated equipment which, because it corresponds to a stage of technology and capital intensity that has already been transcended in the industrial countries, is less automatic and therefore allows a larger amount of labour to be absorbed per unit of output. But as equipment of this kind is usually second-hand, it is especially complex and hazardous to choose. Moreover, its use would be justified only if the techniques it represented were a match for the most modern techniques in efficiency. This is particularly important. The whole economic problem of choosing among alternative techniques is pointless unless the techniques are equally effective when applied to the same production function. If one technique absorbs less capital per unit of output it may be because it corresponds to a production function that is less efficacious than the first (i.e. that would be on the right of the first in a system of co-ordinated axes).

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7/ Theoretical and Practical Problems of Economic Growth, op. cit, pp. 46-47.

/On the

On the other hand, new procedures, techniques and equipment to reduce the input of capital per unit of output could be devised by means of technological research in the less advanced countries that would be properly geared to the economic conditions prevailing there.[8/]

The consequences for Latin American industrial development of the regions's almost complete dependence in technological matters are indicated in the conclusions which were reached by the recent ECLA study on the Brazilian textile industry after its analysis of the problem of replacing obsolete manufacturing equipment.

With due allowance for partial reassimilation by the industry itself as a result of market expansion, it was calculated that labour displacement, at the conclusion of a re-equipment programme involving the application of certain techniques giving capital the lowest possible intensity, would be about 40 per cent of existing employment. Although this is inevitable to some extent, it is undoubtedly a drawback in any re-equipment programme for the spinning and weaving industry, where the result of inadequate operating conditions is precisely a big labour surplus. But it is really the special characteristics of the textile industry that are at the root of the matter. In fact the difference between obsolete (i.e. old and technically out of date) and completely modern equipment is not simply a question of higher hourly output with the latter but also of considerably smaller manpower requirements. For instance, in the cotton branch, the difference between a mechanical and an automatic loom[9/] in terms of picks per minute is not more than 35 per cent (from 144 to 190 picks), whereas the respective machine workload for the two kinds increases

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8/ The revival of interest in technological research in Latin America is partly attributable to the shortage of capital. ECLA plans to analyse practical methods of promoting applied technological research for manufacturing industry, including the use of international assistance, and to suggest ways and means for technical institutions in the region to co-operate in the planning and execution of their work.

9/ Both operating with optimum efficiency (80 per cent for the former and 95 per cent for the latter).

/by 556 per

by 556 per unit (from 6 to 40 looms per weaver); this reduces the labour required by 65 per cent (from 7 to 2.5 operatives per 20 looms). In other words, the trend of textile technology is to economize on labour rather than on capital; in this, it is reflecting requirements in the more developed countries, where there is a relative abundance of capital and shortage of manpower.

Studies of spinning equipment design have been made in India with a view to improving the traditional spinning wheels worked by hand without any appreciable rise in costs. But, the equipment used there is so rudimentary that it is patently unsuitable for Latin American conditions, and even in India it is being doubted whether they are economic to operate.10/

(b) Some reservations and limitations

In the brief preceding analysis it was pointed out that in questions of investment selection preference is given as a matter of principle to industries that use relatively little capital. But the practical application of this principle is hedged around by exceptions and limitations. In actual fact, it is only of decisive importance when applied not so much to the channelling of investment for new industries as to the adoption of a substitution policy for antiquated equipment in existing industries. As this problem is connected with the selection of techniques, procedures and equipment within enterprises it will be dealt with in the following chapter. Moreover, it is at the level of enterprises that the optimal combination of capital and manpower becomes one of the salient problems.

There are five main limitations to widespread application of the principle of preference for labour-intensive industries in Latin American industrial development.

In the first place, freedom of choice is limited by the amount of natural resources available. For instance, highly capital-intensive metallurgical industries have to be established in some countries to exploit certain rich mineral deposits.

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10/ See A. K. Sen, Choice of Techniques, op. cit., Appendix D "The Ambar Charkha as a technique of cotton spinning."

/Secondly, national

Secondly, national import substitution policy often entails the local manufacture of products that are slower to assimilate technological advances so that the country can continue to receive technical innovations through the medium of its remaining imports in the form of products that are quicker in developing. Because of this the development of steel production might, for instance, be pushed to the detriment of the metal-transforming industries, although these may use proportionately less capital and more labour.

Thirdly, the bulk of investment decisions are not really taken in isolation but are the outcome of the earlier evolution of other sectors. Given the dense web of inter-industrial relations in modern industrial development, such considerations as the creation of external economies, the promotion of industrial complexes and the development of the production of raw materials needed by established industries manufacturing final goods, etc. will rightly take pride of place in investment policy over the question of the respective proportions of capital and labour.

Fourthly, it has been noted in various Latin American countries that, in programming industrial development, only a relatively small proportion (about 20 per cent) of industrial investment is earmarked for new industries, the major share (80 per cent) going to the natural growth of traditional industries already established in the country.[11/] If the problem of investment selection becomes simply a question of developing new industries, its scope is reduced correspondingly.

Lastly, it has been claimed that the goal of industrial programming in a country with plenty of manpower and little capital need not always be to economize on capital. When, for example, an attempt is made to speed up the rate of capital accumulation by ploughing back profits,

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11/ This seems to be generally borne out by ECLA's experience in countries such as Argentina, Bolivia, Colombia and Peru. See Metodología para la formulación de programas de desarrollo de la industria manufacturera (ST/ECLA/CONF.11/L.2).

a highly capital-intensive technique may give rise to a larger potential surplus of value added not intended for consumption than the surplus that would result from more intensive manpower absorption.[12] This would of course occur only if the propensity to consumption were very high among the labour force and very low among industrialists and capitalists. This criterion was used in India, on one occasion at least, to ascertain the most suitable technological formula from the economic standpoint for equipping the textile industry there.[13]

The foregoing observations should not be taken to mean that the proportions in which capital and labour are combined have no bearing on investment selection in the Latin American countries. Preference for productive combinations in which labour predominates still retains its validity as a general criterion. But the possibilities of adhering to it in practice are restricted by the particular circumstances mentioned.

## 3. Selection of techniques and better entrepreneurial utilization of the factors of production

### (a) Selection of techniques and equipment

The product-capital ratio characteristics of a given industrial sector is not invariable but differs from one enterprise to another within the sector, according to the particular production technique (or equipment) used and the efficiency with which the enterprise combines the factors of production.

Hence, there are great possibilities at the entrepreneurial level in general for formulating a policy of productivity and technical assistance deliberatly designed to economize on capital and to absorb manpower. Two different sets of problems may be distinguised in this respect: (a) the selection of techniques and equipment, and (b) the promotion of capital and labour productivity.

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12/ See World Economic Survey, United Nations Publication, Sales No.: 1962.II.E.1, chapter I.

13/ See A.K. Sen, Choice of Techniques, op. cit., appendix C "Technique for the cotton weaving industry in India", pp.106-110.

Independent action by the entrepreneur solely in the light of the products and factors market is not enough in either case to ensure that the productive resources of the economy will be applied at a high level of productivity. The Latin American entrepreneur needs the backing of a number of advisory and technical assistance services, which could be profitably organized in the form of programmes for specific industrial sectors.

One of the salient characteristics of the present stage of industrial development in Latin America is the relatively low absorption of manpower owing to the new industries. This phenomenon undoubtedly has a number of underlying factors and is only partly due to the unsatisfactory way in which the private entrepreneur chooses his production techniques. For instance, when a Government draws up industrial development programmes and incentive policies, it prefers to concentrate the scanty amount of capital available in major projects (steelmaking, basic chemical products, industrial machinery) which by their very nature do not require a large labour force. This line of action is determined by reasons of national prestige - the need for self-assertion felt by peoples that are newly-emancipated or are embarking upon a process of development - and economic reasons, i.e. that it is easier to encourage a small number of big enterprises than to deal with a whole programme of small or medium-scale projects that would be a drain on the very scarce supply of entrepreneurial skills. Moreover, the highly capital-intensive nature of the capital goods industries, which are gradually being drawn into the import substitution process, also limits the range of choice open to the Latin American entrepreneur. The same effect is produced by the retarded state of the foodstuffs industries and others dealing with agricultural raw materials, which are essentially labour-intensive. Their backward state is due to the relative stagnation of the agricultural sector observable to a greater or lesser extent in nearly all the Latin American countries, and to the unequal distribution of personal income.

The inability of the market price system to reflect the relative shortage or abundance of the factors of production, especially capital and labour, is also conducive in Latin America to the adoption of production methods that are unsuitable for the economy as a whole however convenient they may be for the individual entrepreneur. For example, a certain proportion of the

labour force in a particular country or area may be unemployed but, owing to trade union pressure or social legislation, the wages rates may not be much lower than those that would obtain if there were full employment. Because of its location, a forest may be unexploitable except as a source of raw materials for pulp and paper. But, for various reasons, the timber may cost the same as in other areas where the forests have more than one use. In this and similar fields, the factor prices determined by the workings of the market are not a reliable guide for decisions on productive investment (whether to produce or not, in what sectors and by what methods). Market prices should therefore be adjusted by the introduction of artificially calculated opportunity costs so that a rational distribution of resources can be made. It is difficult, however, to apply this procedure in the case of individual enterprises.

Other factors responsible for the adoption of techniques making for inadequate utilization of capital are more closely connected with entrepreneurial action. There is first, the use of capital-intensive methods as a result of the more or less automatic transfer of techniques developed or employed in the major industrial centres. In some cases, local entrepreneurs, by ordering machinery on the basis of catalogues or incautiously taking the advice of salesmen for international machinery manufacturers (this being still the principal source of industrial technical assistance in Latin America), are adopting combinations of productive factors that are incompatible with Latin American conditions. In other cases it is the foreign entrepreneurs themselves who make mistakes. This is of course understandable enough, since innumerable obstacles beset the adaptation of traditional production techniques, originating in more industrialized countries accustomed to use capital intensively, to the conditions prevailing in the Latin American countries, where the relative shortage of factors takes the opposite form. The foreign capital transferred to Latin America may bring in its train a technique, a tradition of organization or even a routine that lead inexorably to the use of highly automatized production methods giving rise to industries with very little

labour-absorption capacity.[14]

Secondly, there are the instances in which the very conditions of the Latin American countries compel them to adapt an uneconomic method of production. This happens when the less capital-intensive methods involve the employment of more highly skilled labour, as is often the case in the metal-transforming industries. Since there is a great shortage of skilled and semi-skilled labour in Latin America, and above all in the metal-transforming industries, entrepreneurs usually take the line of least resistance and adopt capital-intensive methods that have no economic justification in principle.[15]

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14/ A highly illustrative episode may be mentioned in this connexion. In the ECLA study on operating conditions in the Brazilian spinning and weaving industry, some of whose findings will be analysed later, it was pointed out that it was economically inadvisable to re-equip on a highly mechanized basis. Just before this study was to be released, it was learned that a highly mechanized spinning mill had begun to operate in Brazil, using the very methods that had been condemned (because of the relative factor prices obtaining in Brazil) in the conclusions of the report. In view of what seemed to be a flagrant contradiction between theory and practice, it was decided that a group of ECLA experts should expressly visit the mill. They were able to prove on the grounds of specific data that the mill's operating conditions were anti-economic even when judged by the usual criterion of profitability. It had been established by a foreign firm with long experience in that branch in its own country.

15/ The desire to establish new and complex industries without delay also has the same result. Thus, when the motor vehicle industry was being installed in Brazil, the fact that the Government programmes of incentives set a maximum time-limit of five years (and three years for the manufacture of the engine block) inclined the assemblers and manufacturers of parts and pieces to opt for highly mechanized solutions in order to reduce skilled labour requirements to the minimum and to facilitate the mass transfer from abroad of techniques hitherto virtually unknown in Brazil.

/Thirdly, a

Thirdly, a number of difficulties make it impossible for manufacturing industry to work more than one shift a day; this is tantamount to using a three times as much capital per unit of output as under a three-shift hypothesis. Consequently, highly capital-intensive methods of production are used, not always entirely deliberetely. The difficulties include labour's reluctance to work at night and the legal regulations restricting night work, the scarcity of intermediate and technical cadres and of certain kinds of specialized workers for the additional shifts, and the fact that many enterprises are family concerns which makes it difficult for them to delegate authority because of the splitting upo of supervisory responsibilities that this entails. There are also the frequent imbalances in the composition of entrepreneurial production capacity (as a result of haphazard development in the past or of sweeping changes in either the production or procedures adopted). These give rise to bottlenecks in capacity which can be remedied only by operating the different parts of the equipment for a different number of hours per day, thus making it impossible for three full shifts to be worked on a uniform basis in a number of plants. Lastly - and this may be a key factor in some sectors of industry - the regular operation of a whole plant with three or even two full shifts is impracticable without perfect internal organization - production programming, systematic machine maintenance and preventive check-ups, etc. - which is not often to be found in Latin America.

(b) Better utilization of factors

Once the technique to be employed by an enterprise has been chosen, a comprehensive decision still remains to be taken about its degree of capital utilization.

The product-capital ratio can vary considerably from one enterprise to the next, even though they use the same technique, according to the entrepreneur's ability to exploit the factors of production efficiently. This fact opens up new possibilities for a policy of productivity and technical assistance aimed at improving capital utilization, and should be borne in mind when industrial development programmes are being prepared.

/The preparation

The preparation of sectoral programmes covering different aspects of reorganization and modernization, as part of an over-all industrial development programme, would enable certain capital incentives to be used to bring about the adoption of measures for a simple internal reorganization that would undoubtedly raise the productivity of capital.

Special attention should be paid to reorganization and re-equipment problems in traditional industries where the paramount objective is better capital utilization. The reasons for this merit a word of explanation. The advanced state of obsolescence of the equipment in many of the industries that were the pioneers of industrial development in Latin America, and the textile industry in particular, means that there is ample scope for mass replacement. The age and outmoded technical characteristics of the machinery have reduced labour productivity to very low levels by any international standard, and obsolescence therefore constitutes a serious barrier to a rise in productivity. But the technical re-equipment that exist in practice all involve a substantial increase in the industry's capital intensity because of the nature of the innovations made in this type of machinery during the last thirty or forty years since its installation, which were meant to economize on labour and not on capital. Hence, re-equipment means that productive combinations that differ considerably from their predecessors will inevitably be introduced into industry, since the intention is to adopt methods that are much more capital-intensive and will immobilize enormous investment funds. As the economy of an under-developed country offers a wide range of choice for channelling investment towards new sectors, the advisability of re-equipping will have to be weighed in each case.

It is not possible to determine by means of a strictly economic analysis to the problems which of all the alternatives available is to be preferred. It is a matter calling for a decision of national economic policy, involving a knowledge of the economic factors and the ability to make a choice in the light of the various fields in which the excention of a re-equipment programme might have repercussions. This includes the policy of sectoral and regional priorities in the allocation of national resources and foreign exchange available for investment purposes.

/(c) The sectoral

(c) The sectoral approach

To sum up, the productive combinations adopted independently by the private entrepeneur seldom result in a satisfactory distribution of resources, for two main reasons:

(i) The enterpreneur often lacks the necessary ability or training to make a rational assessment of the alternatives presented in the light of specific data, and the basic technical and economic information to use for an assessment;

(ii) The market prices of the factors of production are not an accurate reflection of the relative shortage or abundance of each factor, i.e. they are not, strictly speaking, equilibrium prices.

Considering the magnitude and complexity of the task, it is difficult to remedy the entrepeneur's lack of information (or of forecasting ability) over the short or medium term by means of technical assistance or courses for managers at the intermediate and senior levels.

The failure of factor market prices to give a true picture of the situation could be compensated for only by government action of a kind that would be hard to put into effect. This would consist in the application of a body of tax and other incentives or restrictions, not to individual enterprises but to the economy as a whole, for the purpose of establishing conditions that would induce enterprises to adopt productive techniques consistent with a more rational distribution of the productive resources of the economy.

A sectoral approach to problems of planning, productivity and technical assistance would perhaps make it easier to choose suitable productive techniques for the private sector, particularly in the case of traditional industries.

A programme for the reorganization and modernization of an industrial sector consists of an integrated body of measures relating to the different fields of administrative and technical organization of enterprises that would be reciprocal in substance and effects and complementary and self-supporting in their application. The interrelationship between the measures that the enterprise itself has to take and the incentives or benefits that

/depend on

depend on the decision of one or more public agencies enables industries to have a clear and well-defined set of alternatives from which to select production techniques. All that is needed is for the over-all programme of reorganization measures and incentives to be prepared on the basis of a clear and sound appreciation of the problem. Incentives for re-equipment - and where appropriate for the future expansion of operations as well - would be given for the types of equipment representing a technical solution that would be economically compatible with the accounting prices of factors. What would otherwise be the outcome of an unplanned decision on the part of the entrepreneur, is thus obtained more directly through rational action taken in the light of conditions (relative factor prices) that are deliberately modified by a body of indirect economic policy measures, and the difficult problem (not yet satisfactorily solved in any Latin American country) of manipulating a complicated system of incentives and restrictions can thereby be skirted.

On the other hand, the choice of a technical solution (or of a limited number of alternative solutions) that is judged to be suitable for a certain sector also implies over-all technical assistance for the whole group of entrepreneurs in that sector with respect to their lack of basic information, and in ability to form an opinion on the grounds of such information when available.

This problem was dealt with in the ECLA study on the Brazilian textile industry and in the programme for the reorganization and re-equipment of that industry which was subsequently drawn up in Brazil. In order to shed more light on the last two sections of this paper, where previous considerations on the selection of techniques and equipment are applied to the Brazilian textile industry, a brief account is given in section 4 below of operating conditions and existing equipment in the industry, which had an installed capacity of 4.3 million spindles and 132 000 looms in December 1960.

/4. Equipment and

## 4. Equipment and operating conditions in the Brazilian textile industry

### (a) Labour productivity

The broad scope of the survey undertaken (covering 855 establishments) made it possible to present a fairly detailed picture of labour productivity and the unit output of machinery in Brazil's spinning and weaving industry. In order to give a clear idea of the present situation, hypothetical standards have been adopted, representing levels of output that is considered could be reached without much difficulty in the conditions with respect to size of market, level of automatic control and manpower training that generally prevail in Latin America. Thus far these theoretical Latin American standards[16/] are considerably below the average levels prevailing in similar industries in Western Europe, not to mention the United States where the special conditions obtaining make the comparison less significant.

According to the results obtained, which are summarized in table 1, levels of labour productivity are extremely low in comparison with those in other countries, and even in Latin America. In the cotton branch, output per man/hour was 1 995 grammes spin (or 46 per cent of the standard) and 8.18 metres woven (or 19 per cent of the standard). To demonstrate the realistic nature of the comparative standards adopted it will suffice to mention that spinning productivity according to this standard is 4 300 grammes per man/hour, whereas the corresponding figure for the same yarn count is 5 500 grammes in Western Europe and 12 400 grammes in the United States.

In the wool branch, low productivity is reflected in a spinning index of 47 in relation to the Latin American standard while the weaving index is less than 33.

A comparison of other Latin American countries included in table 1 (Chile and Peru) with Brazil shows that indices stand at much the same level, except for the cotton-weaving sector which is in a less satisfactory state in Brazil.

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16/ See A industria do Brasil: pesquisa sobre as condiçoes de operaçao nos ramos de fiaçao e tecelagem op.cit., chapter V.

/Table 1

Table 1

LABOUR PRODUCTIVITY a/

| Fibre and process | Brazil | Chile | Peru | Latin American standard | Japan | European average | United States |
|---|---|---|---|---|---|---|---|
| Cotton spinning | | | | | | | |
| Productivity (grammes) | 1 996 | 1 940 | 1 975 | 4 300 | - | 5 500 | 12 400 |
| Index | 46 | 45 | 46 | 100 | - | 128 | 290 |
| Cotton weaving | | | | | | | |
| Productivity (metres) | 8.18 | 11.60 | 14.33 | 43.00 | 30.40 | - | 78.10 |
| Index | 19 | 27 | 33 | 100 | 71 | - | 181 |
| Wool spinning | | | | | | | |
| Productivity (grammes) | 1 119 | 989 | 1 132 | 2 400 | - | - | - |
| Index | 47 | 41 | 48 | 100 | - | - | - |
| Wool weaving | | | | | | | |
| Productivity (metres) | 2.34 | 2.00 | 2.03 | 7.00 | - | - | - |
| Index | 33 | 29 | 29 | 100 | | | |

a/ The data have been adjusted in terms of a standard yarn count of Ne 17. The method used in making this adjustment is described in chapter V of the ECLA study referred to.

/(b) Machinery output

(b) Machinery output

The findings of the ECLA study indicate that the utilization of existing machinery is equally unsatisfactory. A fairly high proportion of the machinery is used, the coefficients being 90 per cent in the case of machinery and 80 per cent in that of working hours in the spinning branch and 95 and 60 per cent respectively for weaving.[17/] The number of shifts worked in the industry (nearly two, which is the average for the sectors corresponding to different fibres) is also relatively high. But the inadequate utilization of capital in the industry is characterized by the low unit output of the machinery during the time it is actually in operation.

According to the estimates made by ECLA (see table 2), the unit output of machinery in the cotton-spinning mills (14 grammes per spindle/hour) is only 58 per cent of the theoretical standard. Similarly, in the cotton-weaving mills, the unit output of the looms (2.93 metres per loom/hour) is a fraction - 54 per cent - of what could be achieved in Latin American conditions with modern machinery efficiently used. Wool figures are equally unfavourable, amounting to only 38 per cent of the theoretical production standard per spindle/hour in spinning mills and 56 per cent per loom/hour in weaving mills.

As regards wool, a comparison of Brazilian with Chilean and Peruvian industry reveals that machinery utilization coefficients are much the same in all three (that is, they are equally far below the theoretical standard). In the case of cotton, the Brazilian industry's figures are inferior to those of the other two countries in the weaving branch and no comparable statistics are obtainable for cotton spinning.

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17/ The lower ratio of hours worked per loom to the hours available in comparison with the corresponding ratio in spinning mills is partly due to the fact that weaving processes are more intermittent and partly because the looms are at a more advanced stage of obsolescence, as will be seen later.

/Table 2

Table 2

UNIT OUTPUT OF THE MACHINERY a/

(In grammes per spindle/hour for spinning, and in metres per loom/hour for weaving)

| Fibre and process | Brazil | Chile | Peru | Latin American standard |
|---|---|---|---|---|
| Cotton spinning | | | | |
| Unit output (grammes) | 14.0 | - | - | 24 |
| Index | 58 | - | - | 100 |
| Cotton weaving | | | | |
| Unit output (metres) | 2.93 | 4.34 | 4.43 | 5.40 |
| Index | 54 | 80 | 82 | 100 |
| Wool spinning | | | | |
| Unit output (grammes) | 22.0 | 17.0 | 25.5 | 52.5 |
| Index | 42 | 32 | 43 | 100 |
| Wool weaving | | | | |
| Unit output (metres) | 1.98 | 1.96 | 2.00 | 3.5 |
| Index | 56.5 | 56.0 | 57.0 | 100.0 |

a/ The data have been adjusted in terms of a standard yarn count of Ne 17. The method used in making this adjustment is described in chapter V of the ECLA study referred to.

/(c) Obsolescence of

(c) Obsolescence of machinery inventory

The low levels of machine and labour output found are due both to marked deficiencies in internal organization (which include a failure to train the workers properly even to operate the antiquated machinery currently used) and the high degree of obsolescence of the machinery in use.

The detailed analysis of the machinery in the various production stages and for the different fibres processed, in the ECLA study referred to, gives a vivid picture of the unsatisfactory operating conditions prevailing in the industry.

Obsolescence is determined both by the age of the machinery and by its technical features. The classification given in the ECLA study is based on technical and economic criteria set forth in that study (see sections 8 and 9).[18/]

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18/ Up-to-date machinery is that meeting certain minimum technical and output capacity standards fixed for each machine by applying the criteria referred to. Even an old-fashioned machine may be considered as up-to-date if it meets or exceeds the basic standards fixed. This applies, for instance, to old machines that have been reconditioned. On the other hand, a recently-built machine may be considered obsolete if it fails to meet the minimum yield requirements established.

A machine is suitable for reconditioning if it can be so modified as to produce an output that will meet the standards laid down for an up-to-date machine. The possibility of reconditioning a machine can only be shown by a technical examination of the machine itself: obviously no general rule can be laid down to determine which machines can be reconditioned. The over-all estimate of reconditioning requirements given in chapter VIII of the ECLA study was based on the following considerations: (a) an age standard, it being assumed that all machines less than thirty years old could be reconditioned (although this is probably not true, there are machines older than this that may be worth reconditioning, which would offset the over-estimate); (b) the views of textile manufacturers on the possibility of reconditioning many of the machines now in use. Thus the number of machines that could be modified was estimated in accordance with the age criterion and with the views of textile manufacturers, and is consequently likely to be fairly accurate.

An obsolete machine is one that does not meet the minimum standard for an up-to-date machine and which is not suitable for reconditioning because it is over thirty years old.

/The results

The results of classifying the machinery (which was done mile by mile) according to obsolescence and in line with the criterion explained, are summarized in table 3. It can be seen that the inventory of the total spinning and weaving equipment suffers from a high degree of obsolescence. In the cotton sector the classification of the machinery indicates that about 80 per cent of the spindles and nearly 70 per cent of the looms are obsolescent. In wool processing the degree of obsolescence is somewhat less, 48 per cent of the spindles being affected and 62 per cent of the looms. The situation is better in the spinning of artificial and synthetic fibres and flax, but it is equally serious in the weaving of these fibres and in the spinning and weaving of jute. For the various fibres processed by the industry it was found that there was a high degree of obsolescence not only in the production machinery (spindles and looms) but also in other stages of the production process, such as the preparation for spinning, preparation for weaving and, to a lesser extent, fabric finishing.

/Table 3

Table 3

BRASIL: OBSOLESCENCE OF MACHINERY

(Percentage of total)

| Fibre processed and type of machinery | Up-to-date machinery | Obsolete machinery | | Total (Units) |
|---|---|---|---|---|
| | | Suitable for reconditioning | Not suitable for reconditioning | |
| Cotton sector | | | | |
| Spinning machines | 20.8 | 41.8 | 37.4 | 2 894 782 |
| Looms | 31.5 | 17.5 | 51.0 | 71 013 |
| Wool sector | | | | |
| Spinning machines | 51.9 | 10.0 | 38.1 | 241 085 |
| Looms | 37.8 | 27.9 | 34.3 | 4 296 |
| Synthetic fibre sector | | | | |
| Spinning machines | 81.2 | 5.8 | 13.0 | 52 908 |
| Looms | 21.6 | 55.3 | 23.1 | 14 493 |
| Jute sector | | | | |
| Spinning machines | 17.6 | - | 82.4 | 42 968 |
| Looms | 12.2 | - | 87.7 | 3 484 |
| Flax sector | | | | |
| Spinning machines | 53.8 | - | 46.2 | 26 614 |
| Looms | 36.7 | 57.2 | 6.1 | 1 335 |

/This marked

This marked obsolescence in the machine inventory of Brazil's spinning and weaving industry is the result of conditions of long standing in the industry, which militate against a systematic policy of replacement of machinery. The ECLA study does not analyse these conditions, but is confined to assessing the existing situation and studying the incidence of the machinery obsolescence in the low levels of machinery output and labour productivity. Despite the inherent difficulties of attemps at measurement in this field, an estimate made for the cotton industry, which is the major sector within Brazil's textile industry, shows that of the over-all operational deficiency, about one-third is due to the obsolescence of the machinery, and the remaining two-thirds to inefficient use of the existing machinery (regardless of its age and technical characteristics) because of inefficient internal organization.[19] The general term "internal organization"

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19/ The technique or production charts and operational deficiency coefficients, which is explained in detail in the last chapter of the ECLA study, on methodology, made possible this over-all approximate measurement.

The over-all operational deficiency is the difference between the present operational level and that which should exist in the future on the assumption that all the machinery is brought up to date and that it operates at the level of efficiency corresponding to the criteria explained in that chapter. The existing deficiency of the machinery represents the difference between the present operations level and the level that could be attained if the existing machinery operated with the degree of efficiency theoretically possible in the light of its present degree of up-to-dateness. The effect of the obsolescence of the machinery was given by finding the difference between these two deficiency coefficients, and relating it to the over-all operational deficiency coefficient. For the calculation of these coefficients in practice, a sample of twenty-five spinning mills, representing a total of 550 000 spindles, was selected from the most representative of the plants with obsolete machinery. This selection was based on the composition of the equipment in these plants (a small proportion of up-to-date machinery, with the rest consisting of requipment that would have to be reconditioned or replaced) their size (from 10 000 spindles or less to 50 000, the largest group having between 10 000 and 20 000 spindles), and their productivity levels, which covered the range from the lowest to the highest.

/covers physical

covers physical elements such as production flows, the distribution of the volume of work, and plant layout, and human elements, such as efficient management and manpower training.

(d) Use of the machinery and labour productivity

This section sets forth a number of comments, taken from the conclusions of the ECLA study referred to, on the relations between the use of the machinery and labour productivity.

Firstly, attention should be drawn to the nature of the technology of the textile industry, which permits a marked economy in manpower (and which is relatively neutral with respect to capital). As shown in earlier parts of the present section, the unit output reported in cotton-weaving mills represented 54 per cent of the standard adopted, and productivity amounted to only about 20 per cent of the standard concerned. This extremely low productivity in weaving is apparently largely due to the use of a high proportion of mechanical looms.[20/] It was observed that with automatic looms unit output rose by 8 per cent and productivity by 125 per cent (excluding the effect of other factors).

In the wool weaving mills unit output represented 57 per cent of the standard, while productivity was no more than 33 per cent of the comparison interval used. As for cotton, there are great benefits to be derived from the use of automatic instead of mechanical looms, but they relate mainly to economy of manpower, since the increases in unit output and in labour productivity that can be obtained amount to 56.5 and 132 per cent respectively. Lastly, it is a fact that any scheme for machinery modernization must, to some extent, be of a type that economizes manpower, because of the nature of the technology available.

Secondly, some results of the ECLA study appear to reveal a trend, at least in the larger plants, to obtain an increase in labour productivity

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20/ Of all looms operating in 1960, 77 per cent were mechanical and 23 per cent automatic. In the State of São Paulo, however, where the bulk of the industry is concentrated, these proportions were about 70 and 30 per cent, respectively.

/at the

at the cost of a less efficient use of the machinery, which would undoubtedly represent a mistaken policy from the standpoint of the economy as a whole.

Generally speaking productivity increases with the size of the mill, whereas for unit output the converse is true, although the effect is less marked. This difference between the effect of mill size on the use of the machinery and its effect on labour productivity implies that full use is not being made of the machinery in the larger plants, apart from the use of labour. This is probably because factors relating to organization and internal administration have a greater effect on the use of the machinery, and that beyond a certain point these factors tend to be adversely affected by increase in mill size. There may be other contributing causes. Traditional accounting systems can more easily reveal inadequate use of manpower than under-utilization of the available machinery; the cost of each machine per unit of output is often recorded solely on the basis of time/machine used, and not time /machine available. Consequently the under-utilization of a certain kind of machinery (regardless of the efficiency with which it is used when it is operating) can more easily be left out of account than the under-utilization of manpower, and this results in the imbalance between unit output and labour productivity referred to above.

This phenomenon was observed directly in the larger plants, which have modern machinery and set very high workloads with the aim of achieving high labour productivity. These workloads, although they succeed in increasing the average productivity of the operative, may lead to reduced efficiency of the machinery if it cannot be properly tended because the labour force is not adequately trained. In this connexion it is interesting to note that the workloads of the largest plants are more than four times those in the smallest plants.[21/]

Thirdly, there is the problem of the scattering of productivity rates among the individual establishments considered. Analysis of the variations in productivity in cotton-spinning mills indicates that:

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21/ See table 26 in chapter V of the ECLA study.

(i) Productivity in the individual mills considered ranges from less than 500 grammes per man/hour to over 6 000 grammes, whereas the average for all the mills taken together is about 2 000 grammes;

(ii) In almost two-thirds of the mills (63.9 per cent) productivity is less than 2 000 grammes per man/hour, a level more or less the same as the average for Brazil as a whole, so that only 36.1 per cent of these plants exceed that average;

(iii) About half the mills studied have a productivity of between 1 000 and 2 000 grammes per man/hour;

(iv) Only 4.3 per cent of all these mills have a productivity rate that equals or exceed the standard of 4 300 grammes per man/hour;

(v) The plants representing the highest productivity rate, which exceeds 6 000 grammes per man/hour, are in Minas Gerais, and the highest individual rate recorded is 6 155 grammes, which exceeds the standard by 44 per cent.

It is interesting to note that the plants whose productivity is higher than the standard rate belong to the following size groups: 10 000 to 19 999 spindles, four plants; 20 000 to 49 999 spindles, three plants; over 50 000 spindles, two plants.

The highest productivity rates per mill were recorded in the medium-sized plants, of 10 000 to 20 000 spindles, whereas the highest average productivity per size group was in the spinning mills of over 50 000 spindles. The explanation lies in the lower degree of scattering of productivity rates in this group of plants than in the other groups, and also in the relatively high productivity levels in all the spinning mills in this group.

To sum up, the great range of labour productivity rates in the individual mills studied, and the existence of a number of spinning mills with rates higher than the reference standard adopted (of which the average for Brazil represents less than 50 per cent), shows the feasibility of a programme to reorganize the industry for the purpose of introducing generally working methods and processes that are already fully applied in a number of mills.

Lastly, the great range of productivity rates in the individual establishments studied makes it possible to pinpoint the causative factors.

/A multiple

A multiple correlation analysis of this question has been made, whose results are briefly summarized below.[22/]

In the cotton-spinning sector it was possible to determine the effect of the obsolescence of the machinery and the size of establishment on the labour productivity rates. The obsolescence of the machinery is measured by an index of obsolescence specially calculated by a process of weighting the percentages of obsolescence of each category of equipment in the mill and the degree of this obsolescence (obsolete machinery, machinery that can be reconditioned and up-to-date machinery).

The results obtained indicate that for all the establishments together only 14.4 per cent of the variations in productivity is due to obsolescence or size. It is possible that the diversification of production (number of different yarn counts produced at the same time), about which insufficient information is available, may be the cause of an additional proportion of these variations. However, it is probable that the greater proportion cannot be explained statistically, that is, it is due to factors directly related to mill organization and management.

Some more detailed examples help to confirm the great importance of the organizational and administrative factors in determining productivity rates. Thus, for example, in spinning mills producing yarn of count 10, it is observed that plants of a similar size (between 2 000 and 3 000 spindles) where the degree of obsolescence is the same (100 per cent) productivity ranges from ranks of 1 to 3 (268 and 708 grammes per man/hour, respectively). Relatively modern plants of larger size have higher productivity rates covering a smaller range. However, the most modern mills, which are small, do not have the highest rates in this group.

With respect to yarn of count 16, out of fourteen spinning mills that which holds second place for productivity has an obsolescence of 100 per cent and has 2 400 spindles. On the other hand a spinning mill in the same group with 2 100 spindles and the same degree of obsolescence has a lower

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22/ These results will be included in the revised version of the ECLA study (now in preparation), in a new chapter.

/productivity rate

productivity rate representing only about 25 per cent of the rate at the first mill. The most modern plant, with an obsolescence of only 18 per cent, stands in the fourth place as regards productivity.

For yarn counts 22 and 30 there is also a discrepancy between the productivity rates and the degree of obsolescence (and size), although it is less sharp. For yarn counts of 40 and above the effect is more marked, and productivity rates range from 967 to 4 520 grammes, or almost from 1 to 5, with very similar degrees of obsolescence. Furthermore, the lowest labour productivity rate was found in a plant with 87 000 spindles and the highest in a plant with 39 000 spindles.

The foregoing examples corroborate the low correlation observed between productivity, size and the up-to-dateness of the machinery, and point clearly to the importance of the organizational and administrative factors.

Similar data could be given for weaving, but those given for spinning seem to make the situation clear enough.

## 5. The problem of selecting techniques and equipment in the reorganization of the textile industry in Brazil

### (a) Obsolescence of the equipment and organizational and administrative factors

The conclusions reached in the previous section reveal the inefficiency of operating conditions in the Brazilian spinning and weaving industry. The machinery is too old and is technically out of date. Moreover production capacity is not being properly used as indicated by the low indices of unit output and the comparison of these indices with standards that can be attained in certain conditions. Labour productivity is equally low, which reflects lack of training, poor internal organization and bad distribution of the volume of work, as well as low output resulting from the high proportion of obsolete equipment.

The obsolescence of the machinery is undoubtedly one of the most obvious factors in the situation observed, and there may thus be a tendency to identify it as the main cause of the low level of the output indices.

However, as seen in the previous section, organizational and

administrative factors, although their effect cannot be measured entirely objectively, must constitute an essential element of any co-ordinated effort to improve the industry's operating conditions. The formulation of an integrated programme of reorganization and modernization such as the Brazilian programme now under study, that includes measures both for the provision of new equipment and for reorganization, and is aimed at specific productivity targets to be attained within a definite period (the doubling of the levels now recorded) through a concentrated effort for five years, will make it possible to deal with this two-fold aspect of the problem.

The foregoing comments show the complexity of the situation found in the Brazilian textile industry, and thus the need to make a careful analysis of the problem of providing new equipment, since this may involve tying up an appreciable amount of capital, which is a scarce factor.

(b) Alternative formulas for the provision of new equipment

In practice the consideration of a re-equipment programme is not limited by the existence of a given technology or type of machinery, since a number of alternatives are available that represent successive degrees of automation and capital intensity per unit of output. Of these alternatives, that chosen should be the one that corresponds most closely to existing conditions in the country where the industry is to operate, including the relative costs of the factors of production, the availability of financial resources, and certain circumstances of an institutional nature.

There is no doubt that re-equipment of the textile industry would be an important factor in raising the level of physical productivity. However, at the same time the charges for interest on investment and amortization of the machinery would rise considerably. Thus it is necessary to analyse of how the increase in amortization and interest resulting from re-equipment would influence costs, and to ascertain whether the rise in productivity would offset this increase by a corresponding reduction in the costs of labour and other inputs. Moreover the economic justification for a re-equipment programme, based on the various technological formulas available,

/should be

should be measured in the light of other criteria, in particular the product/capital ratio.

In this analysis three possible approaches will be considered in relation to the equipment problem.

The first involves no appreciable replacement of the equipment, the main emphasis being on the introduction of administrative and organizational reforms aimed at expanded output through an increase in labour productivity and in the unit output of the existing machinery. As already stated, the low standards of internal organization and machine output justify consideration of this first formula, at least in principle.

This hypothesis will be analysed later, mainly for purposes of comparison, since in all probability, as the machinery has had such heavy wear and tear, the increase in unit output that would be theoretically feasible could not in fact be attained in most of the mills. In addition it must be remembered that it is extremely difficult in practice to succeed in introducing administrative and organizational reforms without parallel changes in the equipment used.

The second technological alternative open to the Brazilian textile industry is based partly on partial re-equipment with modern machines of the conventional type, like those used in average mills in most countries in Western Europe, and partly on the reconditioning of the existing machinery in so far as this is an economically and technically sound proposition.

The third possibility is re-equipment with machinery with a high degree of automatic control and a high production capacity, such as that now manufactured by several international firms and used in the best textile mills in Europe and the United States. In this case the machinery and equipment would still be of the conventional type, suitable for the traditional processes of the textile industry, but at a level of technology and automation considerably higher than that proposed in the second alternative.

Yet another possibility, which could constitute a fourth course, would consist in the use of new and highly simplified cotton spinning processes that would entail radical changes in production systems. However, these

/processes are

processes are still at the experimental stage (although they are already being applied on an industrial scale in a small number of pioneer establishments in the most industrially developed countries), and it would be necessary to wait a few years until the new technology has been properly tried out and this equipment is readily obtainable on the world market. Another consideration is that Brazilian labour used to working with processes that are already out-of-date, could not, without a period of transition, switch to methods that require successively fewer, but highly-skilled, workers. At present, moreover, these processes are only worth considering in countries where wages are very high and labour is scarce. In the light of these circumstances this formula was rejected as an alternative method of replacing equipment.

Of the three approaches described for an equipment modernization plan, the first, in essence, maintains the existing machine inventory, and is confined to the introduction of improvements in internal organization and other matters that are extraneous to the machinery but affect its performance.

The two remaining alternatives differ as regards the level of automation of the machinery, but both represent the conventional technological standards of today. The first involves the introduction of entirely modern and highly automatic machinery only to replace those existing items of machinery and equipment that in view of their age (over thirty years) and characteristics (below certain minimum levels of up-to-dateness established for each individual machine)[23/] are obsolete and cannot be economically reconditioned. All the equipment that can be reconditioned (so as to attain or surpass the minimum levels of unit output) is included in this alternative as such. Since a relatively high proportion of the customary equipment could be reconditioned in accordance with the criteria established, this first re-equipment formula represents substantially lower capitalization than the second alternative, which involves the replacement, by completely modern conventional machinery, even of equipment that could be reconditioned.

To provide a basis for comparison between the cost analysis for each

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23/ See chapter X (Methodological Concepts) of the ECLA study.

/of these

of these alternatives, the existing situation was also studied, as regards characteristics of equipment, machinery yields and labour productivity.

There follows an analysis of the economic results, in relation to the existing situation, of modernization according to the three following hypotheses:

(i) Increased efficiency and productivity without major changes in the machinery used (hypothesis I).

(ii) Modernization of equipment at a moderate cost by using machinery that is economic to operate, without being the most modern obtainable, and reconditioning the machinery whenever this would be an economically and technically sound proposition (hypothesis II).

(iii) Modernization through the total replacement of the existing equipment by the machines available on the world market with the highest degree of automatic control and production capacity used at present within the conventional technology (hypothesis III).

These three alternatives are based on a hypothesis that the present productivity rates can be doubled by the end of the reorganization programme of which the re-equipment forms a part.

(c) Analysis of the part cost of production for the various re-equipment formulas

For the purpose of this analysis a cotton spinning and weaving mill was selected that was as representative as possible of the industry as a whole in terms of its equipment and of the levels of unit output and productivity. Nevertheless, in order to make the evaluation as conservative as possible a mill was selected whose spinning section did not include a single up-to-date machine, and only a small proportion of machinery that could be reconditioned, the main equipment consisting of obsolete machinery due for replacement. Thus the estimated cost of renewing the equipment would be somewhat higher than what might be regarded as the average for the industry, since few of the mills studied did not have in their spinning section some machines, however few, that could be considered up-to-date.

/In the

In the weaving section, on the other hand, there were some up-to-date machines (40 filling spools and 100 modern automatic looms).[24/]

The data on the cost of labour and machinery in the alternative hypotheses for modernization and re-equipment, taken together with the cost of raw materials, make it possible to establish what may be termed the "part cost of production" of one metre of fabric, and to observe how this varies with these hypotheses. A complete estimate of the cost of production would, of course, have to take into account other cost factors that could not be considered, such as the cost of power and fuel, maintenance, and general overhead and administrative costs. However, the part cost, which covers labour, machinery (amortization and interest) and raw materials, undoubtedly represents about three-quarters of the total cost of a grey fabric, hence these data can be used as an important criterion for the critical appraisal of the reorganization and re-equipment hypotheses considered.

If the part cost of a metre of fabric in the existing situation is taken as the basis of comparison (see table 4), the following observations may be made:

(i) Of the various reorganization and re-equipment formulas considered, that which results in the sharpest reduction in the part cost (index 78.6) is the formula involving re-equipment with reconditioning and replacement of machinery (hypothesis II) with three shifts. Even if the third shift were excluded, it would still give the lowest part cost (84.6).

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24/ This mill has 22 100 spindles and a daily output of 5 680 kg of carded cotton yarn of count Ne 20; it employs 352 operatives in two shifts with a productivity rate the same as the Brazilian average of 2 010 grammes per man/hour. The weaving section consists of 450 looms, with 350 workers in two shifts, and a daily output of 22 333 metres of a fabric with 20 picks a centimetre, 110 grammes per metre in weigh and 90 centimetres wide. The productivity rate of the weaving section, too, is the same as the Brazilian average, a little over 8 metres per man/hour. (See chapter VII of the ECLA study, which gives a detailed account of how the various components of the "part cost" are calculated.)

/ (ii) The third

(ii) The third hypothesis, re-equipment involving a more intense capitalization, gives a higher part cost than hypothesis II, with either two or three shifts (indices 92.4 and 82.2 respectively), despite the sharp increase in productivity that would result. This is due, of course, to an incidence of capital costs that more than offsets the increase in productivity, because of the relative prices of labour and capital now prevailing in Brazil.

(iii) Hypothesis I, involving better use of the existing machinery, gives an appreciable reduction in part cost compared with the present situation. The number of shifts (indices 87.1 and 87.3 respectively) does not appear to affect this comparison, because of the relatively small incidence of capital charges in the part cost in the industry's existing situation.

(iv) The comparison between hypotheses I and II, reorganization without renewal, re-equipment, and re-equipment with moderately up-to-date machinery, shows an appreciable difference (87.3 as compared with 78.6) only for three shifts. Double-shift operation does not seem to provide sufficient margin to allow the increase in productivity to offset the capital costs involved in the high level of investment required by hypothesis II.

(v) It should be noted that the data in table 4 are intended to provide a basis for assessing the general average level of the spinning and weaving industry; they do not exclude the possibility that situations very different from those outlined in the table may exist in particular mills.

Comparison of the relative advantages of the different re-equipment formulas must take account of some other very important factors, although they may be difficult to quantify, either because of their qualitative nature or because they are not explicitly shown in the part-cost comparison referred to previously.

(i) The modernization of the machinery would result in a considerable increase in labour productivity and a parallel increase in unit wage, which in the spinning mills, as already indicated, would be 100 per cent

/Table 4

Table 4

PART COST OF A METRE OF COTTON FABRIC a/ IN A COTTON SPINNING AND WEAVING MILL ACCORDING TO VARIOUS RE-EQUIPMENT HYPOTHESES

(Cruzeiros)

| | Existing situation | | Hypothesis I | | Hypothesis II | | Hypothesis III | |
|---|---|---|---|---|---|---|---|---|
| | Two shifts | Three shifts | Two shifts | Three shifts | Two shifts | Three shifts | Two shifts | Three shifts |
| Cost of the cotton | 132.50 | 132.50 | 132.50 | 132.50 | 132.50 | 132.50 | 132.50 | 132.50 |
| With 21.4 per cent wastage | 160.00 | 160.00 | 160.00 | 160.00 | - | - | - | - |
| With 13 per cent wastage | - | - | - | - | 150.00 | 150.00 | 150.00 | 150.00 |
| Value of the cotton in one metre | 17.92 | 17.92 | 17.92 | 17.92 | 16.80 | 16.80 | 16.80 | 16.80 |
| Value of labour per metre | | | | | | | | |
| Spinning | 4.18 | 4.64 | 3.51 | 3.90 | 2.45 | 2.72 | 1.19 | 1.31 |
| Weaving | 9.17 | 10.19 | 6.38 | 7.09 | 2.01 | 2.23 | 1.43 | 1.44 |
| Value of amortization and interest on capital per metre | | | | | | | | |
| Spinning | 1.77 | 1.28 | 1.50 | 1.08 | 5.01 | 3.65 | 5.72 | 4.15 |
| Weaving | 3.16 | 2.29 | 2.21 | 1.61 | 4.36 | 3.07 | 8.31 | 6.04 |
| Total part cost | 36.20 | 36.32 | 31.52 | 31.60 | 30.63 | 28.47 | 33.45 | 29.74 |
| Indices | 100.00 | 100.30 | 87.10 | 87.30 | 84.60 | 78.60 | 92.40 | 82.20 |

Source: ECLA (E/CN.12/623)

a/ Fabric of 110 grammes per metre and 90 centimetres wide, of yarn count Ne. 20.

/(productivity) and

(productivity) and 16 per cent (unit wage) for hypothesis II, and 250 and 33 per cent, respectively, for hypothesis III. In the weaving mills the increases would be even sharper. At present wages in the textile industry are among the lowest in all the transforming industries; the average wage amounts to only the minimum legal wage, or very little more, and this is in fact due to the low labour productivity that prevails.

(ii) Modern machinery would also make for a better-quality product, from the yarn, which would be more regular, cleaner and stronger, to the finishing, which would include new processes developed in recent years and provide better and more attractive goods, with advantages both for domestic consumption and export.

(iii) The use of fewer machines would bring about a reduction in maintenance costs and in the capital tied up in stocks of parts and accessories. Maintenance costs would also be reduced because the time required for maintaining new machines is less than that needed for old and often worn-out equipment. Lastly, there would be a reduction in the risk of mechanical breakdowns, which cost hours of production.

(iv) The reduction of the number of machines would reduce total consumption of motive power and fuel.

(v) With respect to hypothesis I, under which use of the existing machinery operating in substantially improved conditions of internal organization would give output indices not very different from those resulting, according to table 5, from hypothesis II, it should be noted that this proposition is open to some doubt. In fact the dilapidated state of the machine inventory now in operation makes it very uncertain that this machinery could really operate at the theoretically attainable level of efficiency which served as the basis for calculating the output under hypothesis I.

(vi) In view of what has been said in the preceding paragaph, it is even less likely that the existing machinery could be used systematically for a third daily shift, without reconditioning or replacement. This means that certain additional advantages, deriving from the lower incidence of overheads and administrative costs in the unit cost of production, that can be obtained with three shifts, are in practice only attainable under hypotheses II and III.

/Table 5

Table 5

COEFFICIENTS FOR THE ECONOMIC ANALYSIS OF RE-EQUIPMENT

| Coefficients | Present situation | | Hypothesis I | | Hypothesis II | | Hypothesis III | |
|---|---|---|---|---|---|---|---|---|
| | Two shifts | Three shifts | Two shifts | Three shifts | Two shifts | Three shifts | Two shifts | Three shifts |
| Spinning | | | | | | | | |
| Product-capital ratio | 1.8 | 2.4 | 2.1 | 2.9 | 0.7 | 0.9 | 0.6 | 0.8 |
| Value added per operative (cruzeiros/kg) | 628 | 576 | 739 | 682 | 1 322 | 1 213 | 3 173 | 2 899 |
| Ditto - index | 100 | 92 | 118 | 109 | 211 | 193 | 505 | 462 |
| Weaving | | | | | | | | |
| Product-capital ratio | 4.9 | 6.7 | 6.9 | 9.5 | 3.6 | 4.9 | 1.9 | 2.6 |
| Value added/operative (cruzeiro/m) | 1 420 | 1 300 | 2 033 | 1 864 | 7 545 | 6 872 | 12 261 | 11 224 |
| Ditto - index | 100 | 92 | 143 | 131 | 531 | 484 | 863 | 790 |
| Reinvestable surplus per unit of capital (Cr.1 000/Cr.1 000) | 3.6 | 4.9 | 5.4 | 7.3 | 3.4 | 4.7 | 3.0 | 4.1 |
| Integrated mill | | | | | | | | |
| Product-capital ratio | 3.7 | 5.1 | 4.9 | 6.8 | 2.0 | 2.0 | 1.3 | 1.9 |
| Value added/operative (cruzeiro/year) | 65 514 | 59 973 | 92 960 | 85 237 | 188 475 | 172 283 | 401 533 | 365 606 |
| Ditto - index | 100 | 92 | 142 | 130 | 288 | 263 | 613 | 558 |

Source: ECLA.

/(vii) Lastly,

(vii) Lastly, the hypotheses that involve both reconditioning and replacement of machinery provide the possibility of using for future mill expansion the space freed by the removal of an appreciable number of units, which could represent a substantial reduction in future costs of investment in buildings.

(d) Application of the product capital ratio and other criteria

Economic analysis of the advisability of re-equipment, and of the different ways of doing this, should be based not only on the part cost of a typical fabric but on other criteria as well. The values represented by the following coefficients for each case or technological formula are considered below:

(i) Product-capital ratio

(ii) Value added per worker

(iii) Surplus of value added available for reinvestment, per unit of equipment.

The third coefficient was only determined for weaving. The others were determined for spinning, and for weaving in an integrated mill engaged in both spinning and weaving.

The analysis should be carried out by stages. First, a comparison should be made of the formulas which involve reconditioning of the equipment (I and II) in order to determine the technical guidelines on which such reconditioning should be based, considered as if it were an investment for the start of a new sector.

Secondly, consideration should be given to the formula for improving present conditions without additional investment (hypothesis I). The feasibility of a purely administrative reorganization of this kind is, however, seriously limited by a number of factors. These factors will be taken up later in the analysis, both with respect to present conditions, and to hypothesis I based on three work shifts, except where they relate to the impossibility of using the present machinery.

Lastly, the formula of re-equipment provisionally adopted should be compared with the hypothesis of an improvement in present conditions without replacing obsolete machinery.

/With respect

With respect to spinning, the product-capital ratio under any hypothesis shows a much greater use of capital (25 to 30 per cent) at the three-shift than at the two-shift level. Hence, the formula of three work shifts must, in principle, be a sine qua non of any reorganization formula involving additional investment. The reduction in the value added per worker resulting from the introduction of the third shift seems insignificant compared with the better use of the capital thus obtained.

The higher capitalization of hypothesis III compared with hypothesis II does not reflect a more economical use of capital but quite the opposite. The product-capital ratio drops, but not very much, on the basis of the formula of re-equipment with improvement of the machinery. Since hypothesis III presupposes a much greater increase in investment compared with the previous hypothesis, the latter seems clearly to be the preferable solution from the standpoint of use of capital, even though the value added per operative is much higher in the formula based on greater automation.

What remains to be examined is how present conditions can be improved without additional investment. If, for the reasons mentioned earlier, only the two-shift operation is considered, it will be noted that better use is made both of capital and labour, although the improvement is relatively slight. The main attraction of this formula seems, therefore, to lie in the fact that it does not require additional investment.

A comparison between the formula of administrative improvements under present conditions and the hypothesis of a moderate re-equipment (hypothesis II) shows most interesting results worthy of careful attention. It should be borne in mind that the comparison is made between hypothesis I with two shifts and hypothesis II with three shifts). The product-capital ratio, in the case of such re-equipment, would drop to less than half (from 2.1 to 0.9) while the value added per worker would increase by 60 per cent. Considering the relative lack of capital and abundance of labour, the comparison militates against re-equipment, particularly if it is considered that the comparison is made between one amount of capital (even though at a level of use different from the present level) and another amount of capital to which would have to be added an appreciable amount of additional investment.

/Since, for

Since, for the reasons mentioned earlier, a reorganization without additional investment is hardly feasible in practice, it would be more realistic to compare hypothesis II with the present situation. In this case, the position would be very different. The product-capital ratio would also drop by half (1.8 to 0.9) while the value added per operative would virtually double.

The situation revealed by an analysis of the corresponding coefficients in weaving is similar, in its main features, to the one described above. A three-shift operation is implicit in the idea of re-equipment, and when the two technical formulas constituting a greater or lesser increase in mechanization are considered, this re-equipment should represent the formula involving a smaller investment both global and per unit of output. The difference in the product-capital ratio (that is to say, in the economic use of capital) between hypotheses II and III is nearly 50 per cent (from 4.9 to 2.6), which shows that any increase in mechanization is anti-economic, because of the relative factor prices in Brazil. Productivity naturally rises much more sharply with increased mechanization (although falling short of a 100 per cent increase) but this fact does not seem enough to offset the reduced use of capital and the large amount of additional investment required.

Reorganization without additional investment would, as far as weaving is concerned, result in reduced use of capital and labour. However, a comparison between this hypothesis (I) and that of moderate re-equipment (II) shows the same reduction in the use of capital (product-capital ratio) from 6.9 to 4.9. However, the rise in the value added per capita is more marked, increasing nearly four times.

In the case of weaving, the surplus value added susceptible of being reinvested, which can here be calculated, introduces an element of moderation in the earlier conclusions. This surplus, which in some circumstances may be as important a criterion as the product-capital ratio, is the value added per capita. It is higher in hypothesis II than in hypothesis III, and this again shows the anti-economic nature of unduly capital-intensive re-equipment. However, in hypothesis II (three shifts) it is still higher than under present conditions (two shifts) and remains below that resulting from the formula of reorganization without additional investment (although by a relatively small margin).

/...

That part of the table showing the coefficients related to integrated manufacturing, which includes spinning and weaving, is naturally close to the previously mentioned figures.

Certain conclusions can be drawn from the above analysis, although not with the same degree of accuracy in all cases. First, the idea of re-equipment involving a high degree of modernization - at or even above the level of hypothesis III - should be categorically rejected.

It will probably be a fairly long time before the relative prices of factors in Brazil - reflecting a very different market position - change sufficiently to invalidate this conclusion.

Secondly, whenever present conditions can be improved without additional investment, hypothesis I, even at the two-shift level, is clearly preferable to the massive mobilization of investment funds needed to carry out the re-equipment in hypothesis II (three shifts). In practice, it seems that the disadvantage shown by the economic analysis of this re-equipment would be greater in spinning than in weaving. As will be explained later, the problem arises from the fact that the operation of a weaving mill according to improved patterns requires a quality of yarn which is difficult to achieve in mills in which most of the equipment is obsolete. A quality factor is thus introduced here which may severely restrict freedom of choice among the alternatives offered in theory.

Thirdly, if hypothesis I is found to be unfeasible, or if administrative improvements under existing conditions cannot be carried out in certain cases, the comparative position of hypothesis II, providing for moderate re-equipment, would improve considerably, particularly with respect to weaving. In this case, a decisive factor in laying down the best approach to the reorganization and modernization of the textile industry might be the consideration of qualitative, institutional, market and other factors which, by their very nature, cannot be expressed in figures, and will be dealt with later.

(e) Re-equipment, expansion of the market and use of manpower

In this section the probable effects of a re-equipment programme on the use of manpower in the spinning and weaving industry will be examined, bearing in mind the evolution of apparent consumption and the higher yield of the operations which should result from the application of a re-equipment programme.

/Any programme

Any programme providing for the replacement of obsolete, low-yielding equipment by more modern machinery with a higher unit output, tends in general to absorb less manpower. The re-equipment considered here, in spite of the fact that its target is a level of output much lower than the output of the United States and Japanese textile industries, may result in a considerable displacement of manpower. It will depend largely on how it is carried out, since under certain conditions its unfavourable effect on the volume of manpower absorbed by the industry may be lessened.

In the interests of greater clarity, the position will be described in schematic form.

(1) The reorganization of the industry and its re-equipment - and not the latter alone - reduce the employment of manpower in mills in two different ways. On the one hand, modern machines have a higher unite output than obsolete equipment and therefore fewer modern machines will be needed to maintain the same rate of output. On the other hand, modern machines have a higher degree of automation, which means that a single operative can handle a larger number of units at the same time.

(2) A quantitative evaluation of the displacement of manpower which a re-equipment programme such as is provided for in hypothesis II (see the previous section) would produce in the Brazilian spinning and weaving industry is very difficult to make because the displacement would derive from innumerable specific situations; not only will the degree of obsolescence of textiles mills vary considerably, but the extent to which equipment substitution is undertaken will depend upon decisions in each mill, and this makes any over-all quantitative estimate hazardous. Hence, the only purpose of the considerations set out below is to provide some indication of the possible extent of the problem. The considerations are limited to the cotton and wool sectors (which together represent about 83 per cent of the manpower employed in the industry).

(3) Assuming that all the mills are in a situation similar to the average for the industry, the total number of cotton spindles will drop by 40 per cent, whereas the number of looms will decrease by 43 per cent.

/With respect

With respect to wool, the reduction will be 42 per cent for spindles and 40 per cent for looms respectively. On this basis, the future inventory of machinery would be approximately equal to 60 per cent of the present figure as far as the number of machines is concerned. Nevertheless, according to the re-equipment programme considered, there will be a surplus of up-to-date machinery over and above requirements for two-shift operations, and this surplus will vary from one fibre to another and may even be nil in some cases.[25/] If the appropriate correction is made, the future inventory of machinery will be about 63 per cent of the present figure in spinning mills and 67.5 per cent in weaving mills (5 and 12 per cent respectively of the 60 per cent of the machinery remaining in the future).

(4) With respect to the workloads, the differences calculated between the present and future position, on the basis of re-equipment hypothesis II, are as follows:

| | Present situation | Future situation | Difference in percentage |
|---|---|---|---|
| Cotton spinning (operatives per 1 000 spindles) | 7.0 | 5.0 | 28.5 |
| Cotton fabric (operatives 20 looms) | 7.0 | 2.5 | 64.0 |
| Wool yarn (operatives per 1 000 spindles) | 20.0 | 14.0 | 30.0 |
| Wool fabric (operatives per 20 looms) | 16.6 | 6.6 | 60.0 |

It may thus be considered that in spinning mills, in general, the reduction of manpower resulting from re-equipment will be about 30 per cent, while amounting to 60 per cent in weaving mills, for each work shift. It should be borne in mind that these reductions relate to employed manpower in the basic situation and that the total figure will only be reached at the end of the programme, when the effect of all the measures to improve the internal operation of mills will have been felt.

(5) The manpower necessary for an output equal to the present figure (on a two-shift basis, as at present) would be as follows at the end of the reorganization programme:

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25/ See chapter VIII of the ECLA study.

Spinning: 70 per cent of the manpower x 60 per cent machinery =
40 per cent of the manpower currently employed.

Weaving: 40 per cent of the manpower x 67.5 per cent machinery =
27 per cent of the manpower currently employed.

This means that to operate a number of up-to-date machines equal to 63 per cent and 67.5 of the present inventory respectively, at more or less twice the present levels of unit output per machine and manpower productivity, 44 per cent of the present manpower employed in spinning and 27 per cent in weaving will suffice.

(6) However, the above is based on a total output equal to the present figure, whereas during the execution of a re-equipment programme internal consumption is likely to expand so as to require use of the same machinery in a third shift. Expansion of total output, which will be made possible by the introduction of a third shift (working six hours) would be 37.5 per cent, and this would correspond to the apparent increase in consumption up to 1966 or 1967.

(7) The manpower increase resulting from the introduction of a third full shift (i.e. working with all the machines available) is 50 per cent of the manpower used for two shifts (as at present). Thus, the total manpower required to work three shifts would be as follows:

Spinning: 44 per cent of the present manpower +22 per cent =
66 per cent of the present manpower.

Weaving: 27 per cent of the present manpower + 13.5 per cent =
40.5 per cent of the present manpower.

Thus, the reorganization and re-equipment programme will, after it has been completed, produce a reduction in the manpower used in cotton and wool spinning of about 33 per cent of the manpower now employed in this branch of the industry. The reduction in employment which this implies will be greater in weaving, amounting to 59.5 per cent of the present level.

As spinning mills currently employ 53 per cent of their manpower in the cotton and wool sectors, the average reduction of employment for

/the combined

the combined total of spinning and weaving mills would be approximately 45 per cent of the present level. This calculation, as said before, is not a strict calculation since, by reason of its aggregate nature, the variations from one enterprise to another, which may alter the final results, are eliminated. Moreover, it is assumed as a hypothesis that the position with respect to the other fibres will be similar to the position for cotton and wool.

(8) The reduction in staff is not likely to take place at once, but will probably be gradual as it becomes possible, through adequate training and vigorous internal reorganization measures taken by the mills, to reach optimum workloads without affecting the efficiency of the machinery or the quality of the product, and this may well take two or three years. Similarly, a reorganization and modernization programme in a branch of industry with levels of efficiency and productivity as low as those in the Brazilian spinning and weaving industry must inevitably produce an appreciable reduction in the manpower employed, since the surplus manpower reflects the archaic operating conditions which the programme is intended to abolish. However, there are a few points which show how, in practice, the situation may appear in a less unfavourable light.

(9) First, the introduction of internal reorganization measures and improved methods of work, which will go hand in hand with the substitution of obsolete equipment, may not in practice be fully synchronized in some years (at least in so far as achievement of full results are concerned) with the re-equipment programme. There will thus be a tendency for the indices of manpower reduction given earlier to be mitigated by the effect of the increase in apparent consumption. Secondly, the growth of the market beyond the projected output capacity will require an expansion of that capacity and a corresponding absorption of labour, so that the size of the displacement of manpower will be reduced. This market expansion may, moreover, take place more rapidly than expected if the high gross product growth rates registered in the past are accompanied in the next few years by a more balanced distribution, both between regions and between classes of population. The reduction in the cost of textiles may also have a favourable effect on the consumption of the low-income groups.

/(10) Secondly,

(10) Secondly, staff turn-over, which is a permanent feature of textile mills, represents an average of 10 per cent of the manpower employed in the Brazilian spinning and weaving industry. If, no new staff is recruited to replace those lost through turn-over during the period of adaptation of the operatives to the new machinery, the manpower displaced may perhaps be completely reabsorbed by the industry itself.

6. The selection of techniques and equipment from a dynamic standpoint[26/]

The above analysis illustrates the problem of selecting techniques in the preparation of industrial development programmes, as it relates specifically to the reorganization and modernization of a traditional industry.

The following paragraphs deal with the same problem from a dynamic standpoint, introducing into the consideration of the topic some hypotheses on probable evolution as compared with Europe and the United States.

(a) Some hypotheses on the evolution of textile techniques (cotton spinning) in Brazil compared with the United States and Europe

A few hypotheses are offered below on future technical stages in respect of cotton spinning in Brazil, compared with the progress made in that branch of the industry in more developed countries, in order to be able to determine the course which should be followed by the Brazilian industry to enable it to compete with the industrialized countries.

To this end, a study was made of the behaviour of specific components of the cost of production of one kilogramme of cotton yarn (count 20) in Brazil, Europa and the United States: the components selected were those which lent themselves more readily to an estimate, namely labour, depreciation and the interest on capital invested.

With respect to the stages, it was considered that the present situation in Brazil is as described in the ECLA study on the textile industry in that country,[27/] a situation which is more or less similar to that of Europe in the years before the Second World War.

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26/ This topic is dealt with more fully in "La programación de industrias tradicionales: una metodología para la industria textil (ST/ECLA/CONF. 11/L.23).

27/ See A industria textil do Brasil: Pesquisa sobre as condiçoes de operaçao nos ramos de fiaçao e tecelagem, Limited,(E/CN.12/623).

/The next

The next stage, which is called "stage 1", represents the level which could be reached through the implementation of a programme of reorganization and re-equipment, thus producing a situation such as existed in Europe a few years ago, in the 1955-60 period or thereabouts, representing a level that has already been partly exceeded. It is a standard technical level of the conventional type, using machinery with a normal output of some 20 grammes of yarn (count 20) per spindle-hour.

At present, the cotton spinning industry in Europe is moving beyond that stage as a result of further improvements, and it is estimated that by 1968, when the reorganization of the Brazilian industry will be completed, Europe will already have left stage 1 behind and passed fully into stage 2.

The technical level represented by stage 2, which approximately reflects the present situation of the industry in the United States, is characterized by the use of high output machinery[28/] which may bring output to about 24 grammes of yarn (count 20) per spindle-hour. It is estimated that Brazil will reach that stage by 1977, or ten years after completion of the reorganization which characterizes that country's first stage, a time limit considered sufficient to amortize the investment made.

Stage 2, the features of which have already been described, will thus be the third stage for Brazil and the second stage for Europe, while for the United States the next stage will be complete automation, which will be called stage 3 and is described below.

Experiments are being conducted in various parts of the world, based on the use of partly automatic spinning systems (from the opening of the bales to the drawing slivers and from the drawing slivers to the cone-winder, in the case of direct spinning, so that all that has to be handled is the transport of the drawing sliver tins to the roving frames).

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28/ With "carrousel" fitted opening, directly feeding pneumatic cards producing some 20 kg. of fine yarn per hour, high speed drawers with sliver regulator, roving frames with high capacity spinning bobbins or even direct spinning of the drawing slivers for coarse or medium counts, continual frames of 15 000 RPM with automatic movement of the spinning bobbins, high-speed automatic winders and automatic knotting of yarn.

/These systems

These systems are based on the successive addition of machines similar to those of the standard type, with an output comparable to that of the machines described as typical in stage 1. Thus, an increase in labour output is obtained through a reduction of staff, until a workload of a little less than 1 000 spindles per worker is reached, but without any marked increase in the output of the machinery.

However, further new processes are being developed, based on machines whose output is higher, similar to those in stage 2 except that they are completely automatic and even provide for the elimination of some phases of production now being used.

The output of these machines will be appreciably higher, since they can produce as much as 28 grammes per spindle-hour (based on yarn of count 20) and with workloads so low that 0.5 persons can handle 1 000 spindles, whereas at present the same number of spindles need more than 7 workers in Brazil, 3 in Europe and 2.2 in the United States. Stage 3 is therefore considered the use of these latest automatic high-output systems, without considering those at present being tried out, since it is felt that they have been superseded by the completely automatic systems which will appear on the market very shortly.

Estimates of installation costs should be based on the current price of existing automatic systems since data is lacking on which to make an estimate of the real cost of future methods. However, since the number of machines involved in the automatic process is likely to be less than for the standard process, the future price may well be below the figure selected.

It is generally agreed that the salaries, hours and, above all, the shortage of labour expected in Europe during the next decade will compel the textile industry to adopt completely automatic systems (stage 3). It is estimated that these systems will be in use in Europe in 1977 or thereabouts, and in the United States by 1968; at the moment it is not possible to say when these techniques will be economically applicable in Brazil. It is therefore important to study the effect of the successive stages on costs and the extent to which investments will prove economic, as well as to compare the competitive position in the three areas. As stated earlier, since it is impossible to forecast the future behaviour of all the cost components, particularly the raw material (cotton), the analysis should be confined to labour, depreciation and interest on capital invested.

(i) Labour: this was based on the present average cost per hour of work, including social security payments: 0.35 dollars in Brazil (including the night shift), 0.80 dollars in Europe and 1.70 dollars in the United States. For the succeding stages the cost of labour was estimated on the assumption that it would increase by one-third of the additional profit resulting from greater output, the cost of labour per kilogramme of yarn being obtained by dividing the hourly wage by the amount of yarn produced in one hour of work.

(ii) Depreciation: for Brazil, with respect to the conditions under stage 1 and 2, the figures included in the ECLA report[29/] were used, while for stage 3 depreciation was estimated to be 10 per cent annually on an estimate of 325 dollars per spindle, a figure which includes a 35 per cent increase over the f.o.b. value, to meet the cost of freight, entry and installation. For Europe, the same figures were used minus the 35 per cent increase, although with respect to stage 1 half the amount estimated for the stage was taken to cover the amortizations already effected, future amortizations being estimated at 20 per cent annually in view of the fact that stage 2 would be reached shortly. The same procedure was used for the present position (stage 2) in the United States.

(iii) Interest on capital: 12 per cent was used for Brazil and 6 per cent for Europe and the United States, the percentages being applied to the output which, either in practice or theory, is obtained or can be obtained under optimum conditions of efficiency.

The output of 1 000 spindles - based on 6 600 hours of work annually - was estimated, for the different stages, at 14 kg. (Brazil's present figure), and 20 kg., 24 kg. and 28 kg. for stages 1, 2 and 3 respectively.

The workloads (in terms of the number of workers needed to operate 1 000 spindles, including preparation in the spinning) were also estimated separately for each country or area and each stage. However, with respect to stage 2 in Brazil, the workload adopted is slightly lower than the load in Europe or the United States at the same stage; this was done because of the difficulty which Brazil is likely to experience in training workers and supervisors to the same level as in the other two areas, particularly in

29/ See A industria textil do Brasil.... op.cit. in footnote 27.

view of the relatively low starting point in Brazil. The assumption also reflects the intention to reduce loss of employment to a minimum, since demand is not expected to expand sufficiently to make possible increases in output capacity, and thus the absorption of the manpower displaced by technical advances.

(b) Tentative estimate of cost, investment and yield

The results of the estimates based on the assumptions and hypotheses described are shown in table 6.

The following conclusions can be drawn from the table:

(i) The cost of labour per unit of output is reduced in every case as a result of the increase in output imputable to the use of more advanced techniques, in spite of the provision made in the assumption for substantial increases in hourly wages: in Brazil the ratio between present wages and those in stage 3 is 1 to 4, in Europe it is 1 to 3 and in the United States over 1 to 2.

(ii) On the other hand, the trend of the incidence of investment on unit of output (depreciation) shows a continued rise. In Brazil the increase is perhaps moderate up to and including stage 2, but it rises sharply in the third stage; in fact, while depreciation in stage 2 is slightly over twice the present figure, in stage 3 this cost component is nearly six times the present figure and two and a half times the figure in stage 2.

In Europe, the move from stage 1 to stage 2 means an increase of 33 per cent whereas the depreciation figure in stage 3 implies increases of 200 per cent and 125 per cent over stages 1 and 2 respectively. In the United States the move to stage 3 would mean an increase of over twice the present charge (stage 2) for depreciation.

(iii) Looking at the total of the three cost components, Brazil shows a fairly sharp reduction of about 10 per cent between the present position and stage 2. However, the move from stage 2 to stage 3 shows a doubling of the cost.

In Europe the position is somewhat similar: the cost of stage 2 is nearly 8 per cent over the cost of stage 1, while the cost of stage 3 is 40 per cent more than stage 1, a percentage which is more or less repeated in the case of the United States in the transition from stage 2 to stage 3.

/Table 6

Table 6

PRESENT POSITION AND COMPARATIVE PROJECTION OF SOME TECHNICAL LEVELS IN COTTON SPINNING IN BRAZIL, EUROPE AND THE UNITED STATES

| | Brazil | | | | Europe | | | United States | |
|---|---|---|---|---|---|---|---|---|---|
| | 1962 | Stage 1 1968 | Stage 2 1977 | Stage 3 | Stage 1 1962 | Stage 2 1968 | Stage 3 1977 | Stage 2 1962 | Stage 3 1968 |
| Base output (kgs per 1 000 spindles/hour) | 14 | 20 | 24 | 28 | 20 | 24 | 28 | 24 | 28 |
| Output (grammes per man hour) | 2 000 | 4 300 | 11 200 | 56 000 | 6 500 | 12 500 | 56 000 | 12 500 | 56 000 |
| Hourly wages (in dollars) | 0.35 | 0.450 | 0.65 | 1.50 | 0.80 | 1.10 | 2.40 | 1.70 | 3.60 |
| Cost components used per kg of yarn (in dollars) | | | | | | | | | |
| Labour | 0.175 | 0.094 | 0.06 | 0.03 | 0.140 | 0.09 | 0.043 | 0.120 | 0.060 |
| Depreciation | 0.031 | 0.063 | 0.073 | 0.175 | 0.045 | 0.06 | 0.135 | 0.060 | 0.135 |
| Interest on capital | 0.035 | 0.072 | 0.082 | 0.210 | 0.013 | 0.036 | 0.081 | 0.018 | 0.081 |
| Three component total | 0.241 | 0.229 | 0.215 | 0.415 | 0.198 | 0.186 | 0.259 | 0.198 | 0.276 |
| Estimated present capital (in dollars per 1 000 spindles) | 25 000 | | | | 30 000 | | | 47 500 | |
| Investment (in dollars per 1 000 spindles) | | 85 000 | 135 000 | 325 000 | | 95 000 | 250 000 | | 250 000 |
| Output (kg per 1 000 spindles per year, 6 600 hours a year, three shifts) | 92 400 | 132 000 | 158 400 | 184 800 | 132 000 | 158 400 | 184 800 | 158 400 | 184 800 |
| Index of output per 1 000 spindles | 100 | 143 | 173 | 200 | 100 | 120 | 140 | 100 | 118 |
| Capital-product ratio (dollars per kg/year) | 0.27 | 0.64 | 0.85 | 1.70 | 0.23 | 0.60 | 1.35 | 0.30 | 1.35 |
| Capital-product index | 100 | 237 | 315 | 630 | 100 | 261 | 587 | 100 | 450 |
| Workers per 1 000 spindles in 3 shifts | 22.8 | 15.0 | 7.56 | 1.5 | 9.0 | 6.6 | 1.5 | 6.6 | 1.5 |
| Capital-labour ratio (dollars per worker) | 1 097 | 5 666 | 18 000 | 216 667 | 3 333 | 14 394 | 66 000 | 7 197 | 166 000 |
| Capital-worker index | 100 | 516 | 1 641 | 19 750 | 100 | 433 | 4 980 | 100 | 2 306 |

a/ Output of carded yarn count 20, working with three shifts.

b/ With respect to future salaries, it is assumed that the profit accruing from increased output will be equally divided, one-third each for the worker, the enterprise and the consumer respectively.

(iv) This would seem to indicate that unless present conditions change automatic spinning would not be economic in any area if the f.o.b. cost of 250 dollars[30] per spindle cannot be reduced. However, in view of the labour shortage in some areas, the technique of stage 3 might have to be adopted, in spite of the lower yield, in order to meet demand. Another solution would be to use the output of countries with cheap labour in order thus to make up the deficit in the more developed countries. At any rate, as far as Brazil is concerned, considering the relatively low cost of labour and the higher cost - compared with other areas - of imported machinery, it does not seem possible to say when the introduction of highly automatic techniques will be economically feasible. However, the position might be different if the manufacture of this type of machinery were undertaken under economic conditions.

(v) Comparison of the present cost (three components) shows that in Brazil output is about 22 per cent more expensive than in the other areas; however, when the reorganization and re-equipment programme is completed in 1968, Brazil will compare favourably with the United States, but still unfavourably with Europe.

This comparison might show entirely different results if other inputs forming part of the cost, particularly the raw cotton, which represents between 50 and 70 per cent of the total cost, were included. As stated in the ECLA report,[31] the fact that the raw material is considerably cheaper in Brazil than in the other areas more than offsets the country's unfavourable position compared, say, with the United States, in the matter of operating costs as defined in the present analysis. In 1977 Brazil's position - as early as stage 2 - will have substantially improved in comparison with the previous stage. If Europe remains at the same technical level in 1977 as in 1968, in other words if it is still in stage 2, the 22 per cent cost advantage it held over Brazil in 1968 will decrease by 15 per cent in 1977 as a result of the improvements made in Brazil. On the other hand, if Europe moves into stage 3, providing for a high level of automation, Brazilian costs in 1977 will be considerably lower than the

30/ Estimates based on an actual budget.

31/ "A industria textil do Brasil..." op.cit.

European costs, unless the latter improve considerably as a result of substantial reductions in the cost of machinery estimated for stage 3. This seems to imply that the idea of using automatic spinning methods in Brazil should be discarded.

(vi) Estimated investment per 1 000 spindles in Brazil would reach 85 000 dollars in 1968, or 3.4 times the present investment of 25 000 dollars per 1 000 spindles (representing machinery much of which is automatic).[32/]

While the amount of additional investment needed is considerable, it should be borne in mind that it will produce an upward revaluation of the present capital by 400 per cent in view of the fact that it will convert an obsolete machine inventory into a stock of up-to-date machines. At the same time, this additional investment will make it possible to reduce by 22 per cent the price of the three cost components referred to.

(vii) As the future value of output cannot be forecast, depending as it does upon market conditions, an analysis of the capital-product ratio has been made, the ratio being expressed in terms of volume. This ratio - the input of capital per annual kg of yarn - would amount to 0.27 dollars under present conditions in Brazil, although if it is considered that the same capital will allow output to continue for six more years until 1968, the ratio will be reduced to one-sixth, or 0.045 dollars per kg, allowing for amortization during this period. While the unit input of capital will be 137 per cent higher in 1968 than in 1962, account should be taken of the fact that there will be a 400 per cent revaluation of machinery over its present value with an additional investment of only 250 per cent of the present estimated capital. The additional investment for stage 2 will bring the capital-product ratio up to 0.85 dollar in 1977. If depreciation of this investment is spread over a ten-year period, annual amortization will amount to 0.085 dollars. However, since it is felt that the move to stage 3 after the ten-year period has elapsed will not be economically justified, it may be estimated that the investment estimated for stage 2 will have a useful life of 20 years, thus reducing its annual incidence to 0.0425 dollars per annual kg of yarn, virtually the same figure as was estimated for stage 2. Output will increase by 20 per cent with the same number of

32/ In the aforementioned study on the textile industry in Brazil, the value of this machinery was estimated at one-fifth of its replacement value.

spindles, but if a period of 20 years is considered, demand should increase by 120 per cent, and therefore it may be estimated that output capacity during the same period must be doubled.

At the technical level of stage 1, an output sufficient to meet demand in Brazil, will require 2 400 spindles. Taking a figure of 85 dollars per spindle, the investment factor will then amount to 0.35 dollars per annual kg. On the other hand, if the output required to meet demand is based on components of the technical level needed for stage 2, only 2 000 spindles will be required which, at a unit cost of 135 dollars, shows an investment factor of 0.47 dollars per annual kg of yarn. Considering that part of the equipment used in stage 1 will have to be replaced because it has become obsolete and cannot be used, the investment estimated for stage 2 - reflecting a complete reconditioning of the equipment - is likely to be more economic in the end than a reconditioning of only part of the equipment.

(viii) Implementation of stage 1 in Brazil, expected to be completed in 1968, will raise the capital-worker ratio from 1 097 dollars to 5 666 dollars. This ratio is almost exactly in line with the aforementioned revaluation to be effected in present equipment as a consequence of the expected investment of 85 dollars per spindle needed to move from the present position into stage 1. In fact, it has already been shown how an investment equal to 3.4 times the revaluation would be equal to four times the present value of the machinery. In other words, the increase in the capital-worker ratio is merely apparent. Stage 2, on the other hand, will produce a real increase in the ratio, since the investment per work will increase by over 200 per cent, from 5 666 dollars to 18 000 dollars, particularly as a result of the reduction in the number of operatives, which will be merely half the number needed in stage 1. However, account should be taken of the fact that output will increase by not more than 60 per cent whereas demand will rise by 120 per cent if it is assumed that the same machinery will function for at least 20 years. In this case, the output capacity will have to be doubled and this would completely reabsorb the manpower displaced.

(ix) Implementation of stages 1 and 2 will represent at least a relative reduction of persons employed in the industry if demand grows at an anual rate of only 5 per cent. However, the market can be expected to expand

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at a greater rate through a more rapid development of the domestic market and the opening of foreign markets (Latin American common market, output deficit in international markets or better competitive position with respect to the latter), and this would have a favourable effect on the absorption of labour. Moreover, it should be borne in mind that wages will increase by 90 per cent between the present position and the conditions expected for stage 2, rising from 0.35 dollars to 0.65 dollars per hour in real terms.

(x) With respect to the above, it is reasonable to assume that Brazil will gradually move from the present position to stage 2 in about 20 to 25 years.

(xi) Modernization of the Brazilian textile industry will, of course, raise serious financing problems, particularly in the move from stage 1 (1968) to stage 2 (1977). Investment intensity in this case will be 135 000 dollars per 1 000 spindles and will reflect a complete change of techniques, without any possibility of effecting reductions by modifications in the machinery. The estimated capital for stage 1 may be fully amortized in 10 years. Assuming that profits will be the source of financing in the move from stage 1 to stage 2, the reserves needed will have to amount to some 13.5 dollars per year per installed spindle, without taking into account the expansion of output needed to keep up with the increase in demand. In order to build up these reserves, a most difficult task, particularly in periods of foreign exchange instability, the Government will have to provide suitable tax incentives.

The problem of expanding output capacity may also be tackled by attracting foreign capital. This prospect may have some practical meaning if, in future, shortage of labour and uneconomic conditions of operation in stage 3 (automatic spinning) produce a shortage of output in the more developed countries. Foreign companies would then become interested in establishing mills in countries where operating conditions are such that they can export to their own countries the volume needed to make up the deficit.

/(c) Relative

(c) Relative position of the Brazilian textile industry

Table 7 shows the comparative evolution of the industry in the countries considered, based on analysis of the data mentioned earlier, with particular reference to the relative position of the Brazilian industry.

Brazil's position, compared with the other areas, would be as follows:

(i) Output: Brazil's present output is only 15 per cent of the output in the United States and 33 per cent of that in Europe. In 1968 it will be 8 per cent and 35 per cent, respectively, of United States and European output, while in 1977 Brazil's output will be around 20 per cent of the figure for the other areas.

(ii) Cost: Brazil's present cost is 22 per cent higher than that of the other areas considered. In 1968 it will be 16 per cent below the figure for the United States but will remain at 22 per cent above the cost in Europe. The Brazilian position will then improve up to 1977, when the cost in Brazil will drop to 17 per cent and 22 per cent below the figures for Europe and the United States respectively.

(iii) Capital-product ratio: at present the incidence of capital charges on output is 10 per cent lower in Brazil than in the United States but 12 per cent higher than the estimated figure for Europe. In 1968, the capital-product ratio in Brazil will be slightly higher than in Europe and 6 per cent below the ratio in the United States. In 1977 the Brazilian position will be most favourable: the ratio will be 37.5 per cent below that of the other areas.

(iv) Capital-labour ratio: the ratio for Brazil is lower in all the years considered. At the moment investment per worker in Brazil is less than a third of the figure for Europe and one-sixth that of the United States. In 1977, in spite of a more than 100 per cent increase over the estimated figure for 1968, the ratio in Brazil will be only 12 per cent of the figure estimated for Europe and the United States.

From the above it may be inferred that in 1977, or perhaps even a little earlier, it might be economic for the United States and Europe to take advantage of the favourable conditions in Brazil - and perhaps in other Latin American countries with similar conditions- to produce in those countries the volume needed to make up the deficit created by the increase in their domestic demand.

/Table 7

Table 7

COMPARATIVE EVOLUTION OF THE TEXTILE INDUSTRY IN THE THREE AREAS CONSIDERED, BASED ON A TENTATIVE SCHEDULE

| | Region | 1962 | 1968 | 1977 | ? |
|---|---|---|---|---|---|
| [illegible] (kilogrammes per man/hour) | Brazil | 2 000 | 4 300 | 11 200 | 56 000 |
| | Europe | 6 500 | 12 500 | 56 000 | - |
| | United States | 12 500 | 56 000 | - | |
| Cost per kg. of yarn (dollars per kg. three components) | Brazil | 0.241 | 0.229 | 0.215 | 0.415 |
| | Europe | 0.198 | 0.186 | 0.259 | - |
| | United States | 0.198 | 0.276 | - | - |
| Capital-product ratio (dollars per kg/year) | Brazil | 0.045 | 0.064 | 0.0425 | 0.085 |
| | Europe | 0.038 | 0.060 | 0.068 | -a/ |
| | United States | 0.050 | 0.068 | - | - |
| Capital-labour ratio (dollars per worker) | Brazil | 1 097 | 5 666 | 18 000 | 216 667 |
| | Europe | 3 333 | 14 394 | 166 000 | - |
| | United States | 7 197 | 166 000 | - | - |
| Indices b/ | | | | | |
| Output | Brazil | 100 | 100 | 100 | - |
| | Europe | 225 | 290 | 500 | - |
| | United States | 650 | 1 302 | - | - |
| Cost | Brazil | 100 | 100 | 100 | - |
| | Europe | 82 | 82 | 120 | - |
| | United States | 82 | 120 | - | - |
| Capital-product | Brazil | 100 | 100 | 100 | - |
| | Europe | 84 | 25 | 160 | - |
| | United States | 111 | 106 | - | - |
| Capital-labour | Brazil | 100 | 100 | 100 | - |
| | Europe | 304 | 254 | 922 | - |
| | United States | 656 | 2 930 | - | - |

a/ Including amortization.

b/ Brazil: 100.