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TECHNICAL PROGRESS AND SOCIO-ECONOMIC DEVELOPMENT IN LATIN AMERICA: GENERAL ANALYSIS AND RECOMMENDATIONS FOR A TECHNOLOGICAL POLICY

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INTRODUCTION

1. The Economic Commission for Latin America and the problem of technical progress

ECLA's dedication to technical progress, or to science and technology, has its somewhat paradoxical aspects. On the one hand, from its documents and research work it seems clear that the subject has not been one of its main preoccupations. However, on the other hand, there is no doubt that this field is one of the pillars of what is generically called "ECLA thinking".

In fact, since its inception, the institution has identified this aspect as one of the nubs of its concept of the centre-periphery system. In this respect, many opinions can be quoted which, to some extent, have become classic in the economic literature of the region. The following is surely one of the best known and most important:

> "The spread of technical progress from countries where it had its source to the rest of the world has, from the point of view of each generation, been relatively slow and irregular. During the long period which elapsed between the industrial revolution and the First World War, the new methods of production in which technique has constantly found its expression have reached only a small proportion of the world's population.
> "The movement began in the United Kingdom, continued in varying degrees of intensity in Europe, received an extraordinary impulse in the United States and finally reached Japan, which strove to rapidly assimilate Western methods of production. Thus the great industrial centres of the world grew up, while the vast and heterogeneous peripheral areas of the new system shared only to a slight extent in the improvement of productivity." (ECLA, Economic Survey of Latin America, 1949, page 3).

At first sight, the comment on the irregular development and pattern of that important aspect does not reveal all its implications. However, the thesis not only contradicted a previously strongly held assumption, but also broached the examination of the consequences and future implications of this inequality on a series of primary aspects of the problem of development and under-development.

/It is

It is common knowledge that two main currents which appeared and prevailed in the nineteenth century and which still reflect rival views today - what we could call the liberal and the marxist currents - shared the conviction that industrial capitalism would spread urbi et orbi, replicating in outline the central economies. Naturally, both outlooks differed greatly with respect to the social costs of transformation and its later aims, but both, and it is worth repeating, looked to the revolution of production forms and means - in fact, technical progress - to open the way to finding solutions to the material, institutional, and cultural impediments which bog down the pre-capitalist communities, or were won over by the preliminary phases of the evolution of the system.1/

Two World Wars and the major political and social upheavals of the first half of this century broke the illusion created in the nineteenth, and it became clear that, apart from a few exceptions, - almost all of them authentic subsidiaries of the central countries (such as the British Dominions) - one hundred years of laissez-faire, free trade, free movement of capital, and post-Napoleonic international order had not succeeded in imposing that orientation which was supposed to aim at the general and increasing participation in the potential fruits of relentless technological advance. Quite the opposite, it had underlined even more the centre-periphery dichotomy; the traditional functions in the international division of labour remained, and the contrasts in the standards of living and growth dynamics were heightened.

1/ See, for example, the following quotation: "With the rapid improvement of the means of production and with communication made infinitely easier, the bourgeois class is bringing civilization even to the most uncivilized nations. Cheap goods are its heavy artillery with which it brings down all the walls of China and forces the most recalcitrant barbarous xenophobia to capitulate. All nations are forced to adopt, under penalty of passing away, the bourgeois methods of production and are compelled to accept so-called civilization, that is to say to become bourgeois. In brief, it creates a world in its own image and likeness". Marx and Engels, "Communist Manifesto", Editorial Universitaria, Santiago, Chile, 1970.

/In spite

In spite of the evidence, there was no excess of economic analyses or diagnoses of this situation. Convincing proof of this is to be found, to a large extent, in the legal and institutional structure established after the Second World War, the main aim of which was to resuscitate the rules of the game of the pre-war international order and ensure that they were respected. Likewise, in other strongholds, political statements were predominant in which everything turned out to be attributed to the imperialist relations between the centre and the periphery.

The situation was, of course, much more complex and many outstanding individuals contributed to its simplification. A just and correct account of all their efforts is impossible, but it is no boast to say that the basic documents of ECLA and, of course, the personal contribution of Dr. Raúl Prebisch, are part of this effort.2/

2/ See, in particular, ECLA, Economic Survey of Latin America, 1949; Raúl Prebisch, "The Economic Development of Latin America and some of its principal problems", 1949, and "Practical and theoretical problems of economic growth", 1952.

By way of illustration of the heterodoxy of ECLA criteria compared with the traditional school of thought a further quotation is recalled:

"The relatively slow rate at which modern technique has spread throughout the world and the way its benefits are distributed have led to considerable differences in the per capita income and productivity of the various economic regions of the world. There are, of course, natural forces at work which tend gradually to level these differences, though regarded from a historical point of view they are perhaps still too slow. On the other hand, there is a school of thought which believes in the free play of these forces and builds an abstract world wherein the mobility of the factors of production and their free and easy displacement play a decisive role. The premise of these abstract views does not coincide with realities obtaining in the economic world, as they in fact appear to us. This tendency toward the relative levelling of incomes, which would offer similar opportunities for increasing productivity in the different international sectors is, in fact, a fallacy; there is not even an approach to any levelling such as is propounded by these theorists." (ECLA, Economic Survey of Latin America, 1949; op.cit., page 74.)

/A detailed

A detailed examination of the new ideas on the matter under discussion falls outside the scope and aims of this paper. But in connexion with the central idea being developed, an attempt to summarize the ideas of ECLA on technical progress and the operation of the centre-periphery system is indispensable.

As can be appreciated in the quotation reproduced, first, the "varying degrees of intensity" are contrasted with the spread of "Western methods of production", with the "slow and irregular" pace at which this process has been transferred "from the countries where it had its source to the rest of the world". From this, therefore, derives (contrary to the assumption made in the nineteenth century) the tendency for progress to be concentrated in the advanced pole, with the result that "the vast and heterogenous peripheral areas of the new system shared only to a slight extent in the improvement of productivity". In brief, concentration, on the one hand; marginalization (relative or absolute) on the other.3/

To what should this development be attributed? To two factors principally. On the one hand, to the different structural profiles predominating in the Centre and at the Periphery. The features of industrialized economies are diversification of their productive machinery, their internal integration, their relative homogeneity, their specialization in manufactures in world trade, and their status as international investors and creditors - all of which leads to high levels of income and a high capacity to accumulate and create science and technology.4/

3/ For an up-to-date review of this subject, see ECLA, Economic Survey of Latin America, 1971, United Nations publication, Sales Nº: 73.II.G.1, Part I.

4/ These economic features at most claim to summarize what the central countries are like, and do not in any way claim to give reasons for their being so - for such a purpose other aspects would have to be taken into consideration, which in many cases played a more decisive role than the strictly economic ones. Neither is there necessarily any direct or causal relation between the two sets of features, the basic ones and those which appear to result. Of course, there are mutual and circular links between them. In the final analysis, this is the so-called "virtuous circle of wealth".

/It would

It would be superfluous to sketch the counter argument of the realities of the periphery. Let it suffice to mention that, given the national or regional peculiarities, characteristics are completely different, and in extreme cases are the opposite.

Further, the pattern of relations between the two spheres is determined mainly by their respective functions in the international division of labour.

Neither is it possible or necessary to dwell any further on the subject. Let us bear in mind only the basic thesis on the deterioration in the terms of trade in the economies exporting primary products.5/ This argues, as is known, that this machinery enables the central countries to appropriate a variable share of the gains in productivity in the exports from the periphery.6/

It is important to note that the structural contrasts and the consequences of the different forms of specialization in the international economy (e.g., the deterioration in the terms of trade) are complementary but different facets of the existence and operation of the centre-periphery system. In other words, the

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5/ For an analysis of the problem in the light of the recent increases in the prices of primary products, see ECLA, Economic Survey of Latin America, 1973, E/CN.52/974, Santiago, Chile, July 1974, Part I.

6/ On this, see, among others: R. Prebisch, "Economic Development in Latin America and some of its principal problems", op.cit., page 4 and subsequent pages.
With respect to the relative significance of this means of imposing a levy vis-à-vis financial transfers in the form of foreign investments (a matter which has given rise to several discussions), the following calculation included in the Economic Survey of Latin America, 1971, chapter 2, should be noted. Comparing the losses resulting from the worsening of the terms of trade in the five-year period 1966-1970 with the corresponding payments in respect of profits and interests on direct investment, it can be seen that the former were in the region of 3 400 million dollars whereas the latter only amounted to 1 600 million dollars in the same period.

/concentration of

concentration of technical progress (and its fruits) in the central economies and the relative marginalization of the periphery in this respect, stem primarily from the difference in the structural profiles already mentioned. The behaviour of relative prices accentuates and strengthens the tendency of the two spheres of the system to differ, and widens the gap between them, but it is not the principal cause of the situation.7/

The purpose of this brief account is not to call attention to the concern and general involvement of intellectual activity at ECLA in matters connected with technical progress. The purpose is a more practical one related to the aims of this paper. What this is attempting to show is that the analyses and discussions on science and technology, at least vis-à-vis the problems and tasks of economic and social development, cannot be separated from the overall context and the functioning and relations of the centre-periphery system. Only in this way is it possible to see the deep roots of the so-called "technological gap" which will be discussed further on, and also to understand that the allied problem of the concentration of technical progress in the central economies and the relative marginalization of the periphery can only be solved in so far as it is possible to change the structural bases and contrasts which give rise to this problem, as well as the type of relationships which exist between the two spheres.

7/ Putting the problem in more polemic terms it could be argued with justification that the exploitation of the periphery (involved in the trends of price relationships, including transfers in the form of investment) is secondary among the factors which determine the dynamism and growth of the central economies and their difference with respect to the periphery. To justify this it would suffice to compare the volume of internally generated investment with the earnings from the above mentioned sources. However, from the standpoint of the periphery, the levy or transfer in these forms may be crucial in respect of its possibilities of accumulation, the more so, if one takes into account its dependence on external sources for capital goods and foreign exchange.

(a) A further look at the issue in the context of the industrialization of the periphery and new international links

There is no doubt that the general approach to the matter must be formulated in the light of the important changes brought about by the diversification of the productive machinery in the post-war decades, particularly in the relatively more developed Latin American economies. There are several principal aspects which require our attention.

First, there is no doubt that within these economies there is visible evidence of the spread of technical progress, which covers all the sectors, mainly industry, private and public services connected with this activity, and to a lesser extent agriculture. Thus the pattern established in the "outward-directed" phase in which the improvements in the levels of productivity had been confined to the so-called exporter-importer complex was transformed, creating a context of "technological dualism" the intensity of which varied in relation to national conditions.8/

8/ On this, ECLA wrote, for example: "... new production methods tend to be adopted in activities connected in one way or another with the exportation of foodstuffs and raw materials rather than in other activities. In the performance of this function as a primary producer which is actually the function of Latin America, there was from the beginning a strict selection of aptitudes. Vast regions were coupled to the world economic system while others no less large and generally more densely populated ones, up to the present time remained outside the system...Thus in Latin America there remain extensive regions, with relatively large populations, in which the methods of working the land, and consequently the standard of living of the people, are essentially pre-capitalist". (ECLA, Economic Survey of Latin America, 1949, op.cit., page 4).

/Secondly, although

Secondly, although this trend, in its inital stages (grosso modo up to the beginning or middle of the 1950s), continued without greater participation of foreign capital and initiative within the restrictive framework of national markets, it is clear that those aspects changed in subsequent periods, particularly from the second half of the 1960s onwards.

On the one hand, the presence and role of foreign investment increased, and became of primary importance in the new diversification of the productive system and particularly in the more dynamic activities of the industrial spectrum and complementary financial and commercial services. This caused a decisive bias with respect to the traditional fields of entrepreneurship: exports of primary goods and the provision of services.

On the other hand, the foreign sector of many of these economies widened and became more complex, either because of the previously mentioned factor, or because the growth and credits provided by the central countries helped to increase the flow of exports and imports, or because the exports of manufactures began to rise somewhat, or, finally, because regional and subregional agreements helped to overcome what, in the past, ECLA called industrialization in watertight compartments. This was called, in some of the more dynamic experiences, the "internationalization" process of the Latin American economies.

It would be absurd to deny the importance of this and other associated mutations, all the more so in the face of the major criticisms as regards the disadvantages and limitations of the old system of international relations. While before there was strong opposition to foreign capital for industrial development and for investment in activities in the domestic market, the opposite was now clearly the case, and not only for the manufacture of cosmetics or mineral water. While in the past the absence of adequate means of channelling technological progress from the central economies to this part of the periphery was a source of complaint, now, mainly through international enterprises, a transmission belt seems to have been established which has considerably improved the situation. Further examples could be quoted in this respect.

/However, the

However, the recognition and evaluation of these changes does not cancel but rather reinforces the need for a critical reappraisal of the new situation, to ensure that the old patterns are not reimposed out of their historical context, and that they reflect the reality of the last decade.

Concern with the intensity, quality and conditions of the transfer of technical progress, and the clearly unsatisfactory state of affairs with regard to national or regional creation and adaptation of science and technology, is evidence of the fact that the changes recorded fell far short of satisfying Latin American aspirations in this respect. This is dealt with in other parts of the present document and in other papers submitted at the Mexico Conference.9/ For this reason we did not dwell on these aspects, although they are taken up in the following discussion.

What is of prime concern here are the criticisms on the scope and tendencies of the spread of technical progress which this new stage of productive diversification has brought in its train, as well as its social implications.

Getting to the heart of the matter, the fact is that in recent times doubts have increased with respect to the capacity of the process to extend to the whole body economic and, in this way, to produce an integrated and homogeneous system which would establish conditions for the effective and equitable participation of the large majority of the population.

In fact, without going so far as to deny the changes mentioned previously, it seems clear that the extension of domestic gains in productivity was limited mainly to certain metropolitan or urban areas, to specific regions, and to all private and public enterprises which form the so-called "modern stratum" of these economies.

9/ See Joseph Hodara, "Latin American experience in the promotion of scientific and technological development", Draft, SINT-74/10, July 1974; and ILPES documents.

The background to this basic situation is well known and there is no possibility of reproducting it here in detail.10/ However, the dimensions of the problem are worth bearing in mind. In line with the estimates on the Latin American situation as a whole, the so-called modern stratum or sector probably employs approximately 15 per cent of the active population and generates more than 60 per cent of total production. At the other end of the spectrum of regional productivity would be found the activities of the "primitive" or subsistence stratum, which still absorbs more or less one third of the labour force although its contribution to the product is less than 10 per cent. If we compare the productivities per employed worker we are likely to find that that of the modern sector is approximately six times higher than the average for the whole economy, whereas that of the "primitive" sector is less than one fifth of this avergage. This situation, of course, clearly contrasts with the relatively homogeneous profile of the industrialized economies and also, incidentally, with the under-developed systems, in which a kind of "homogeneity in poverty" stands out.

The emerging situation has meant discarding - at least in the relatively more developed economies and those at an average stage of development - the scheme of technological dualism which might smack of the past, and taking a new approach to a more complex situation of structural heterogeneity. This term as explained in the Economic Survey of Latin America, 1973, refers to situations:

10/ On this subject, see, in particular, ECLA, Economic Survey of Latin America, 1968, United Nations publication, Sales Nº: E.70.II.G.1, chapter I, page 20 et seg; Economic Survey of Latin America, 1969, United Nations publication, Sales Nº: E.71.II.G.1, Part Two, page 26 et seg; Economic Survey of Latin America, 1970, United Nations publication, Sales Nº: E.72.II.G.1, Part Two, page 42 et seg; Latin America and the International Development Strategy: First Regional Appraisal, E/CN.12/947 and Add.1, 1973, Part One; Economic Survey of Latin America, 1973, op.cit., Part Three.

/"... of

"... of wide differences in productivity or "modernity" between as well as within sectors of economic activity, but accompanied by complex ties of interchanges, dominance and dependence within a national socio-economic "structure", as opposed to presumed "dualistic" situations in which two socio-economic structures - "modern" and "traditional" or "primitive" - co-exist in a national territory with only limited interchanges and little influence on each other."11/

Inevitably, as a result of the particular heterogeneity of the productive activities - and although this is not, of course, the only factor which has some incidence on the matter - the fruits of the process tended to be reserved for those having the closest organic ties with the productive and territorial centres

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11/ Dwelling a little on the above definition, "those activities which are considered modern are those which, in general operate with relatively efficient forms of organization, in which the capital investment per person employed and the resulting productivity are comparable or similar to those obtaining in industrialized economies. Activities of this type are found in the various economic sectors as traditionally defined. Thus, for example, in this sense, a big share of export agriculture is modern so too is industry organized in units of a given size, as well as some financial establishments and institutions, etc. At the other end of the scale, the primitive stratum covers subsistence agriculture and numerous urban activities providing goods and services in which productivity is low, and in which there is no mechanization, and fixed capital is insignificant. Between both these extremes there is the intermediate stratum in which technical progress and productivity are average". The following criteria were used in classifying economic activities according to productivity strata: "level of productivity of labour, relative efficiency within the branch, capital intensity, size of enterprise and establishments, the degree of organization and integration, the degree of mechanization and technological level, the level of education and the degree of professional specialization of the labour force, as well as other complementary criteria". ECLA, "Naturaleza de las estimaciones sobre la distribución de la fuerza de trabajo, según estratos de productividad", Santiago, November 1970, pages 3 and 7.

/of the

of the modern stratum.12/ In other words, a partial and selective diffusion of technical progress has produced a new form of concentration of this progress and, what is more important, of its fruits. The relation between these two aspects can be seen very clearly by examining the nature of the goods and services which are given priority in production in the modernized sectors. In general, these tend to satisfy, directly or indirectly the consumption requirements of the higher income groups. By way of illustration, the figures in table 1 show the participation of the various income groups in the consumption of the main goods and services produced. As can be seen, durable consumer goods, as well as basic services (transport and housing), are consumed mainly by the 10 per cent in the highest income bracket. Of course, the Latin American average veils many of the differences prevailing in each country.

Contrasting points of view

In this respect, as is well known, there are two competing central points of view, with all the classic variations and nuances. On the one hand, there are the arguments of those who maintain that the restricted spread of technical progress and its benefits - and the type or style of development involved - do not help to open a way to establishing a homogeneous system to widespread social participation and, particularly, to finding a solution to the problem of the critical poverty of a large section of the population. On the other hand, there are those who think that the solution to the problem depends basically on steady and intense growth. To the extent that such growth can be maintained at sufficiently high rates and for sufficiently long periods those objectives will be attained in the end, as they were in the central economies. This has been called the trickle-down effect.

12/ The so-called urban peripheries or "marginal" populations, which make up what is called "urbanized poverty", form types of non-integrated or partially or precariously integrated enclaves in the urban centres.

/Table 1

Table 1

LATIN AMERICA: a/ SHARE OF THE VARIOUS POPULATION STRATA IN TOTAL CONSUMPTION BY SELECTED CONSUMER ITEMS

(Around 1970)

Consumer items \ Population strata	Poorest 20%	Poorest 50%	20% below the highest 10%	Highest 10%	Total
Food, beverages and tobacco	5	23	29	29	100
Clothing	2	14	32	42	100
Housing b/	2	15	29	44	100
Transport	1	5	25	64	100
Durable goods	1	6	26	61	100
Passenger cars (purchased)	-	1	12	85	100
Houses and apartments (purchased)	2	9	29	54	100
Household furniture	2	5	16	74	100
Electrical and mechanical appliances	1	5	37	50	100
Total	3	15	28	43	100

Source: ECLA estimates on the basis of national surveys.

a/ Estimated average based on information provided by Argentina, Brazil, Colombia, Chile, Mexico, Paraguay, Peru, Honduras and Venezuela.

b/ "Housing" includes: rents, household textile articles, fuel, electricity, gas, water, and household supplies.

/It is

It is not possible to reproduce the whole chain of arguments and counter arguments. As any analysis projected over time, decisive answers are avoided for it is difficult to demonstrate the validity of forecasts of future trends. Such is the case, for example, in respect of the main contention of the first line of thought that, by its very nature, the present growth pattern could not attain the steady and necessary growth rates over the long period required to attain the objectives sought. A similar objection is that the possible flaring up of social tensions would impede progress in this direction or would make it impossible for a suitable period to elapse so that this form of growth could show its full potential.13/ In both cases - as in other similar ones - there is no question of a final veredict.

However, available information justifies the investigation of prospects and reasonable alternatives, at least for the region as a whole, in which, naturally, the situation of a few of its major economies, such as Brazil and Mexico, exercise considerable influence.

This is done in Chapter II of the present document. As can be seen, the simulation exercises carried out leave no doubt with respect to two things: (a) the manifest obstacles which lie in the way of the prevailing pattern of development perpetuating itself, even taking a rather optimistic outlook; and (b) the improbability that the tendency to the concentration of technical progress and its fruits will change.

Similar conclusions stem from the experience of the past decade, particularly in respect of the trends in the distribution of income.

13/ On this question, see remarks contained in the Economic Survey of Latin America, 1973, op.cit., Part III.

/If we

If we adopt the justifiable criterion that there are clear, though not exactly symmetrical relationships between the concentration of technical progress and the more or less polarized structure of income, the changes in the latter would reveal some significant indications of the degree of diffusion of the improvements in productivity.

Table 2 shows some principal data on the question and gives an approximate picture of the changes which occurred between 1960 and 1970 in the participation of the different social groups in the income of the region.

If we look first at the lower half of the distribution pyramid, it is easy to see that practically no change occurred in the participation of the 50 per cent in the lowest income bracket, as well as in that of the sub-groups corresponding to the poorest 30 per cent and the 20 per cent in the immediately higher bracket. On the other hand, however, there have been small absolute increases in each one of the groups, although the group which corresponds to the poorest 30 per cent shows a lower increase than the average (19.7 per cent compared with 27.5 per cent of the total) and a minimal absolute increase (12 dollars per capita in the decade). However, the 20 per cent immediately above shows a percentage improvement higher than average (40 per cent compared with 27.5 per cent) and a per capita increase of 56 dollars in 1970, a figure comparable with that of the whole population, which is 95 dollars.

With respect to this part of the structure, therefore, it can be seen that there is virtual immobility in the income status of the poorest 30 per cent and a small improvement in the 20 per cent in the bracket immediately above, which enabled it to increase its per capita income from 140 dollars to 196 dollars between 1960 and 1970. In any event, it should be noted that this modest increase did not change the fact that on the whole the poorest 50 per cent only managed to maintain its share of total income. Although this enabled it to increase its per capita income by 32.6 per cent, it only meant, in 1970, 30 dollars more per year.

/Table 2

Table 2

LATIN AMERICA: PER CAPITA INCOME IN DOLLARS AT 1960 PRICES AND CHANGES IN THE SHARE OF THE VARIOUS SOCIO-ECONOMIC STRATA IN THE TOTAL INCOME OF THE REGION

	Share in the total income of each group		Per capita income in dollars at 1960 prices a/		Increase in per capita income	
	1960	1970	1960	1970	Percentages	Dollars at 1960 prices
Poorest 30 per cent	5.3	5.0	61	73	19.7	12
Next 20 per cent	8.1	8.9	140	196	40.0	56
Poorest 50 per cent	13.4	13.9	92	122	32.6	30
Next 20 per cent	14.1	13.9	243	306	25.9	63
The 20 per cent below the highest 10 per cent	24.6	28.0	424	616	45.3	192
Highest 10 per cent	47.9	44.2	1 643	1 945	17.7	292
Highest 5 per cent	33.4	29.9	2 305	2 630	14.1	325
Total	100.0	100.0	345	440	27.5	95

Source: ECLA estimates on the basis of national surveys.

Note: The estimates of the average distribution for Latin America in 1970 are based on information provided by Argentina, Brazil, Colombia, Chile, Mexico, Paraguay, Honduras and Venezuela.

a/ This corresponds to per capita income in dollars at 1960 prices. Taking the internal depreciation of the dollar between 1960 and 1970 to be approximately 32 per cent, it can be said, subject to the pertinent reservations, that the per capita income for the region in 1970, expressed in dollars at that year's prices, would amount to about 580 dollars.

/The changes

The changes seem to be more significant with respect to the 50 per cent making up the upper income brackets. Although the percentage share on the whole did not, of course, show any change, there were more marked changes within the group.

It can be seen, immediately, that there has been an increase in the share corresponding to the 20 per cent immediately below the top 10 per cent, from 24.6 per cent to 28 per cent. This represents the highest increase in per capita income (45.3 per cent compared with the global average of 27.5 per cent), and an absolute increase of 192 dollars in 1970 (compared with 95 for the entire population). Meanwhile, it can be seen that the 20 per cent immediately above the poorest 50 per cent more or less maintained its relative position and showed an absolute increase of only 63 dollars at the end of the period, an amount similar to that received by the group corresponding to the 20 per cent immediately following it in the distribution structure (56 dollars).

On the other hand, what may prove surprising at first sight, both the highest 10 per cent and highest 5 per cent experienced a drop in their share and, similarly, increases in their per capita income are lower than those of the total population (17.7 per cent and 14.1 per cent respectively, compared with 27.5 per cent). However, this fact loses much of its significance if it is remembered that the absolute changes in income meant an increase of 292 and 325 dollars for each of these groups, compared with the average improvement of 95 dollars, and with the 30 dollars which were received by the poorest 50 per cent and the extra 12 dollars received by the 30 per cent at the base of the pyramid.14/

14/ In this case, the absolute increase of the highest 10 per cent is almost 31 per cent of the total. The 20 per cent immediately below this 10 per cent accounts for 40 per cent of the total, i.e., both these groups account for more than 70 per cent. However, the respective share of the poorest 50 per cent is a little less than 16 per cent. As can be seen, these differences are of fundamental importance for the structure of demand and the corresponding allocation of productive resources.

/In any

In any event, in an overall appraisal, the variations mentioned show a certain lack of concentration at the apex which, though relative, is not without significance and clearly favours the 20 per cent immediately below the highest 10 per cent, without modifying the marked absolute advantages of the highest income groups.

This is not the place to go into a detailed analysis of the nature and implications of these mutations.15/ What is important in this discussion is to show that the new variety of development has had very little effect on income levels and, by extension, on the living conditions of a large part of the population, particularly the poorest third.

2. Contradictions, responsibilities and possibilities of technical progress

The foregoing leads us to a number of moot questions regarding the significance, responsibilities and possibilities of technical progress in economical and social development.

As has already been seen from ECLA's earliest studies, few approaches to the process of development fail to draw attention to its vital role, especially if considered in its widest sense which includes progress in organization and in training and management.

However, current opinion also reflects a more critical and somewhat doubtful view of its social significance.

This ambivalent attitude is no doubt inspired by the realization of the contradictions that are inherent in the development of scientific and technological potential. The relationship between this and the destructive arts of wars and conflicts is of course the first and increasingly alarming reason

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15/ As regards the concomitant changes related to the structure of employment, see Economic Survey of Latin America, 1973, op. cit., Part III.

for such suspicions. There are others, however, that are not so patent and dramatic but are recognized to be of enormous importance for the future of mankind, such as its repercussions on the environment and quality of life, the distortions of an "economy of waste" and the futuristic (and pessimistic) picture of a cybernetic society.

So far, these views have naturally mainly been prevalent in industrialized countries. The countries on the periphery, on the other hand, continue to adopt a much more optimistic and uncritical attitude towards the significance and contribution of technical progress. The reasons for this are also obvious, since they are the reflection of a lower level of development and of the obviously attractive image that the central economies continue to project for most people.

It is easy to see, however, that countries such as ours have already suffered some of the harmful effects of technological progress, such as the extraction on a massive scale, and sometimes the disappearance, of non-renewable natural resources; other consequences, such as urban congestion and all its implications, are still at an early stage. Although still in their adolescence in terms of modern techniques, these countries suffer from many of the adult complaints of the industrial or post-industrial civilizations, as they are sometimes called.

The main point of this critical reappraisal should be to avoid any kind of technological or technocratic "fetishism" by which it is assumed that the major problems challenges and tasks of social development can be resolved only, or to a very large extent, by means of a greater injection of transferred or created technical progress - modifying the volume of resources allocated to research and development, improving the terms of acquisition and servicing or establishing an appropriate institutional framework. These are all legitimate and desirable objectives but, although necessary, they are not sufficient in the long run.

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At the same time, it would be equally or more mistaken to suggest, as some do, that technical progress per se is responsible for the shortcomings and problems of both industrialized and developing economies.

It is neither the one nor the other; neither the philosopher's stone nor the root cause of all contemporary ills. This of course does not mean that it is not decisive in the general course of events or an influence on the appearance or accentuation of many serious problems.

In fact, leaving such considerations aside, it is becoming increasingly clear that the whole matter depends on the social and institutional framework in which technical progress takes place; that is to say, that the fundamental issue is for what, for whom and how the potential for technological progress is employed and mobilized.

The experience of Latin America referred to above is a case in point.

As has been seen, the increased intensity and spread of improvements in productivity did not do away with, and occasionally actually accentuated, some of the old problems of regional evolution: for example, inter-sectoral and intra-sectoral disparities, urban-rural and regional imbalances, unequal distribution of income, shortage of employment opportunities and transitory or structural tendencies towards external disequilibrium.

However, this state of affairs can obviously not be attributed solely or principally to scientific and technological absorption, although it is probable that the latter contributed to some degree and in some way to it. Several analytical studies by ECLA, it might be mentioned, long ago drew attention to a number of basic incongruities of the transfer of technology with the situation prevailing in these adolescent economies.16/

16/ Regarding these incongruencies of modern productive techniques with levels of income and savings, note the following: "When the great modern industrial centres were in a position comparable to that of present-day peripheral areas, and the per capita income in these centres was relatively low, productive (cont.)

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16/ (cont.) technique also required only a relatively small capital investment per man. Careful study shows that savings are neither great nor small of themselves, but only in relation to the density of capital, determined by technical progress. In this sense, savings in Latin America are, on the whole, very small in comparison with the requirements of modern technique. Certainly in the early stages of the Industrial Revolution of the great centres, voluntary savings were not very great either, but neither did technique at that time require the large capital coefficient per man needed nowadays. Technical improvements were only brought into use as increases in productivity, income and savings made them economically possible and practical. In other words, one must go back several decades, if not a whole century, to find per capita incomes equivalent to those generally obtaining in Latin American countries nowadays.

"In that period, capitalist technique was still in the first stages of its development, whereas now it manifests itself in a high degree of capitalization, not easily within the reach of the scanty savings that can be put aside out of the low incomes prevalent in Latin America. It follows, therefore, that the later modern technique is introduced into a peripheral country, the sharper will be the contrasts between its low total income and the large amounts of capital necessary to increase this income rapidly; so that, had similar contrasts appeared in the development of the great centres, they would have been less sharp than those observed now.

"Consequently, countries which have recently begun their industrial development have, on the one hand, the advantage of finding a degree of technique in the great centres which required time and sacrifice to acquire; but on the other hand, they encounter all the disadvantages inherent in lagging behind in the course of evolution." (ECLA, Economic Survey of Latin America, 1949, op. cit., page 63.)

With regard to the relationship between technical progress and the supply of manpower, consider the following: "The diffusion of modern productive technique thus gives rise to a paradox. Countries having an abundant labour force and a scarcity of capital are faced with a form of productive technique of which one of its predominant traits, especially in the United States, is the saving of as much labour as possible, by means of increasing the capital outlay per worker. Undoubtedly technical progress also seeks to increase the volume of production per unit of capital, whilst reducing the amount of labour required. However, though these two aims call for increasing capital investment per gainfully employed person, and though in the abstract they may be considered separately, technical development has linked them in such a way that, as a rule, it would be impossible to break down investments into the part which is aimed at increasing production per unit of capital and that which is directed towards saving labour ... In view of the fact that these aims have been achieved (cont.)

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As already mentioned, the reason for this lies in the styles of growth pursued or selected by the countries, which have established the pattern and destination of technical progress. In other words, an implicit or explicit strategy for allocating resources has been reflected in another strategy for assimilating and utilizing technological progress.

16/ (cont.) simultaneously and considering the indivisibility of equipment, in which technical progress is embodied, the combinations adopted in the economy of a highly industrialized country, with a high per capita capital density, cannot be undone arbitrarily and transformed into other combinations which conform more closely to prevailing conditions in a less developed country, where per capita capital density is much lower." (Raúl Prebisch, "Theoretical and Practical Problems of Economic Growth", op. cit., pages 48 to 49).

Regarding the contradictions arising from the requirements of productive technique and the size of the markets, the following point has been made: "Another important consequence of the disparity between the degree of growth of income and that of productive technique is the low level of demand which generally characterizes the greater part of the Latin American populations, despite their numerical size. Not only does lack of capital or of skill in managing it stand in the way of the adoption of advanced methods of technique but, in addition, low demand makes it impossible to reap the benefits of mass production. Industrial development in the great centres cannot have been hindered by limitations of this kind. There, the originally low income coincided with production on a correspondingly small scale. This scale grew in time, as greater productivity raised incomes and, with them, demand, which in turn absorbed the larger, better and more varied production.

"The situation is very different in the countries which are now adopting modern industrial technique. Here demand is low because productivity is low; this is so because weak demand in its turn impedes, along with other factors, the utilization of more advanced technique." (ECLA, Economic Survey of Latin America, 1949, op. cit., pages 63 - 64).

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This is not the place to unravel all the complicated historical, economic and socio-political factors behind the choice or pursuit of a stretegy. We are, in any case, a long way from finding a satisfactory theory or hypothesis on the matter.17/

However, this fundamental idea makes it easier to discuss the "responsibilities" of technical progress at a most suitable level. For example, it could be argued that technological policy or absorption has (or has not) entirely fulfilled its function in respect of the intensity, cost or rationality of measures taken within the social context, but it would certainly be a mistake to blame it for the problems identified or for the lack of attention to, or consistency with, community objectives that are not to be found or do not receive priority attention in national development strategies.

From this standpoint, therefore, the alternative technological policies would be quite clear. So long as the style of development remains the same, they should, as far as is essential, be adjusted to it and fulfill the tasks set as efficiently as possible. If, on the other hand, they are intended to operate in another manner

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17/ Of course, the mere suggestion that income is very badly distributed glosses over the fact that this situation was also a prime factor in the experience of the industrialized economies, in addition to the fact that this concentration of income is to some extent a consequence of the situation that accompanies the assimilation of technical progress. The analysis will have to take into account other particular aspects of so-called "peripheral capitalism", such as the backwardness of the agricultural sector that has gone hand in hand almost everywhere with the retention of a large segment of the population, and the contradiction between the pattern of consumption of a wealthy industrialized society that spreads only to a limited part of the population, the allocation of resources that this implies and the fact that average income or that of most of the population is low.

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and in terms of other objectives, it is a sine qua non that these new objectives should be specified in a new economic and social strategy.

In both cases, it could be maintained that technical progress is a dependent variable. However, the term is not very satisfactory in that it suggests a passive or reflective phenomenon. In fact, it is neither the one nor the other, for the simple reason that there are reciprocal influences between the style of development and the technology - even though the former may be the dominant element. Just as it can quite rightly be said that the forms of technical progress have contributed "to some degree" and "in some way" to the presence and even the accentuation of certain key problems of Latin American growth, it can also be argued that it could help to attenuate them and bring about another pattern of development.

The matter must, in any case, be looked at from the standpoint of the circumstances and preoccupations of Latin American economic policy. Whatever the emphasis, orientation and political and institutional framework that goes with it, an increasing concern is being felt in Latin America with problems that have either not been resolved or have been created by the dominant styles of development. This is apparent from public statements, in action plans and in discussions among influential circles. At the external level, it is clearly reflected in the International Development Strategy and in the appraisal of the Second United Nations Development Decade.

From the standpoint of this document, the positive guidelines that derive from this critical re-appraisal are quite clear. The centripetal forces encouraging the concentration of technical progress and of its benefits must be replaced by a sustained incentive to spread outwards, tending towards the homogenization of the productive system towards a marked attenuation of desequilibria between regions and between the urban and rural areas, towards internal integration, towards new, less precarious and more fruitful external relationships and, finally and above all, towards a better distribution of income.

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This being so - whatever one's views or forecasts regarding the action that would eventually be taken as a result of these preoccupations - it is obvious that technological policy should not wait passively for the complete definition of a new approach to development but should already start establishing the basis of its own reorganization.

For this, it is essential to make a critical analysis of certain fashionable attitudes in Latin America. The following chapter attempts to do this. It is also essential to give a broad outline of alternatives for the future according to the style of development adopted by the region. This is dealt with in Chapter II. Finally, a rough outline is needed of a technological policy that reflects the awaited new directions and responsibilities. An attempt at such an outline will be found in Chapter III.

Chapter I

DIAGNOSES OF THE TECHNOLOGICAL PROBLEM

There has been a substantial increase in the rate of importation of new techniques, notably linked to industrialization and urbanization, in Latin America since World War II in comparison with earlier eras. The flow has been mainly in the form of foreign equipment, product designs, technical assistance, contracts with foreign firms, and direct private foreign investment.

Industrialization strategies that virtually all Latin American countries pursued with varying degrees of intensity in this period, initially viewed this sort of acceleration of technological importing as one of the key benefits from industrialization. The implicit assumption was that as economies industrialize they pass more or less spontaneously through succesive phases of rising technological capability which allegedly replicate the experiences of successful late-industrializing economies of Europe, North America and, more recently, Japan.

That is to say, there would be a progressive movement from a Phase I, where copying foreign technologies is the rule, to a Phase II, in which producing units develop an enhanced capability for creatively modifying the imported technology, to a Phase III, in which the late-industrializer becomes a technological innovator on a sufficiently wide scale to engage in mutual international trading of techniques with other advanced economies.

This optimistic perspective has now given way to widespread concern that Latin American countries, despite a substantial advance in industrialization, show little sign of moving out of Phase I, technological dependency. This is not to say that there has been no flexibility in the selection and use of imported technology, but rather that flexibility has been limited mainly to simpler adaptations of the following sort:

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(i) many firms in adding new imported product lines and processes have imported second-hand equipment;

(ii) auxiliary aspects of production, notably materials handling, are "demechanized", that is, made more labour using than is the norm in advanced economies from whom the central processes are imported;

(iii) over time some machine shops, initially established to repair foreign equipment, have moved on to producing replacement parts and simpler equipment items locally. The larger of these have subsequently moved on to producing more complex equipment, but under foreign license;

(iv) poorer or more uneven quality of some local materials have forced firms in some instances to make trouble-shooting type adjustments in the central processes in order to minimize lost time from breakdowns;

(v) some smaller firms have become adept at pirating foreign-designed products for local production.

None of these or other adjustment efforts have, however, generated a significant movement by firms toward local product innovation or sustained process redesigning to better fit local labour and resource supplies.

Concern that Latin American economies remain mired in Phase I has been greatly sharpened by concurrent disappointments over other socio-economic trends. Reference has already been made to the unsatisfactory structure of the changes in income distribution. Similar criticisms extend to other aspects, such as employment, the effects on the balance of payments, increasing dependence on foreign industrial investment, and the brain drain.

Awareness that technological defects have contributed to the development of those problems is also being manifested in other ways. Conferences on Latin American science, technology and development, the formation of CONACYTS, technology documentation centres and a growing volume of critical books and articles on the matter attest to this recognition. There is not, however, general agreement on a diagnosis as to what are the main sources of the defects in Latin American

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technology nor on how these defects contribute to the above mentioned socio-economic problems. Hence there is also no consensus on strategies for making technology an effective instrument for achieving more equitable, sustained and broad-based social and economic improvement.

This document attempts to sketch such a general diagnosis. Its purposes are: to identify and critically appraise the major competing views on technological strategies current in Latin America; to offer a tentative view on an appropriate strategy; and to distinguish areas where immediate policy planning and implementation could be effective, from those where more difficult socio-economic policy shifts are a prerequisite for effective implementation.

Three broad views on what is wrong with Latin America's technological performance and how to improve it can be identified. We call these, for short, the technological gap approach, the relative price distortion approach, and the lack of indigenous creativity view. Adherents of each of these views usually accept that there are elements of validity in other two, but believe their own perception of what is wrong and what can be done about it is the most comprehensive and relevant. The diagnosis in the present document recognizes the partial validity of the technological gap and relative price distortion views, but contends that at heart the problem is not simply a lack of knowledge and experience but also the socio-economic forces that filter new technological knowledge into the economy in such ways as to unduly retard the development of indigenous technological creativity. An effective long-run technology strategy for Latin American countries will therefore have to focus strongly on means for overcoming these retarding forces, rather than merely on means for disseminating technological information.

1. The technological gap approach

In this approach Phase I is viewed as appropriate for Latin American countries under existing circumstances. The approach recognizes that the socio-economic trends noted above represent very serious problems, but it believes that the main technological source

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of these problems is the inadequate rate of transfer of best-practice foreign technologies to the region. In its reading of the situation, modern activities in Latin America are still quite young and inexperienced. Their main needs are for much greater exposure to imported technology and organization, and more production and marketing experience. Its reading of the economic history of earlier successful late-industrializers is that a long gestation period during which reliance was chiefly on foreign technology, was an essential prerequisite for establishing the conditions for passing on to Phase II of indigenous technological creativity. However, since the demographic explosion, rural-urban migration rates, and aspirations for individual material improvements in Latin America today are more intense than in the earlier experiences elsewhere, national technology policies are needed, their main thrust being to accelerate the importing and diffusion of modern technology and organizational methods.

Specific policy proposals emphasize, therefore, the creation of documentation centres, technical assistance institutes, the expansion of science and engineering curricula in universities, etc. Concurrently, firms should be encouraged to expand their technological assistance and licensing contracts with foreign firms, and a favourable climate should be created to attract foreign investment in high technology activities. These measures to increase the inflow and dissemination of technological information, should be accompanied by measures to help finance the adoption of new equipment, particularly by small- and medium-size firms. In addition, since the international market for technology has strong monopoly elements, the state should oversee the specifications of the foreign contracts so as to improve the "technological terms of trade".

A basic difficulty with the technological gap approach is that it is analytically very vague in its implied advice on technological choice. Even making the concept of a gap operational is very difficult. For example, if one adheres to the neo-classical school of analysis, it is the interest/wage ratio that determines which of an array of technological alternatives is best for a given economy. Since the interest/wage ratio will be higher in low wage than in high wage

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economies, it follows from this line of analysis that the latest techniques of advanced countries need not be superior to other techniques used by less developed countries. The weaknesses of neo-classical analysis of the technological choice problem is discussed in detail below. But its virtue is that it does recognize that the question of choice of techniques cannot be settled on the basis of purely technological criteria, but requires socio-economic ones; namely, which technique yields the highest socio-economic payoff and for whom.

The technological gap approach must thus be linked to an analysis of the relative socio-economic benefits of different techniques. Most of the proponents of gap analysis undoubtedly have such linkages in mind, but they have left them vague and underdeveloped and this has tended to reduce the use of the concept in Latin America to rather ambiguous rhetoric. For example, it is clear that Servan-Schreiber's Le Defi Americain was concerned with restoring Europe to parity in world power and influence with the United States by strengthening Europe's ability to develop, finance and manage high technology activities. Whatever one may think of the desirability of this politico-economic objective it does at least give form and definition to Servan-Schreiber's "technological gap".

What is the implicit concern behind the use in Latin America of the gap concept? Surely, it cannot be similar to Servan-Schreiber's, since Latin America is not likely to aspire realistically to world pre-eminence in power and influence in the near future.

Presumably, then the gaps in Latin American usage are defined by other implicit links between technological progress and social objectives, notably the goal of accelerating the region's social and economic development. But because the analysis of the links has been left underdeveloped two critical areas of ambiguity still surround the gap approach even under this assumption.

One area concerns who are to be the main Latin American beneficiaries of the improved technological process. In analyzing possible styles of development, a basic distinction can be made

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between (i) a development effort that concentrates on expanding the modern economic sector, in the hope that this will gradually absorb the entire labour force; and (ii) a style which would concentrate development efforts more directly on the backward areas of the economy in order to advance their technological capability and progressively eliminate the productivity and income gulf between the modern sector and the backward areas of the economy. For each alternative a set of technological gaps can be reasonably well defined. In the modern sector based style the prime gaps would be between, say, equipment and organization of the petrochemical or motor car industries in Latin America and that of the same industry in the centre countries. In the case of the backward sector style, the prime gap would be between, say, the minifundia or artesanal techniques and those of high yielding small farms and workshops in centre countries. The concept technological gap, per se, clearly does not identify which of the gaps should be given top priority by Latin American technology policy. One of the major objectives of this paper is to explore the socio-economic implications and the feasability of the two alternative styles and to suggest implications for improving technology policy in Latin America.

The second main area of ambiguity is what are to be the main sources of the gap closing technology under either style.

There is probably general agreement among different proponents of gap closing, that since strong indigenous technical creativity is the hallmark of a technologically advanced society, the development of such a capability should also be an objective of technology policy.

Such agreement, however, leaves policy questions concerning degree of emphasis and timing unclarified. One view is that the main emphasis for some time to come should be on augmenting the inflow of foreign technology. To do this technological licensing agreements should be encouraged and the climate for foreign investment made more favourable. In time this would provide the knowledge and experiential base for entry into Phase II. The alternative is to try to hasten development of a capacity for indigenous creativity by various carrot and stick policies, the stick being used to force a gradual decline in reliance on foreign technology and investment

This document is critical of the first alternative for the following reasons. The first is that many Latin American industries are not comparative infants to the region and their technological sluggishness cannot therefore be attributed primarily to inexperience. For example, the first and second largest factory textile industries of Latin America, those of Brazil and Mexico, were first established with imported equipment and technical assistance over a hundred-and-twenty years ago, predating Japan's first textile factories by two to three decades. Yet today these Latin American industries remain almost as dependent on foreign sources for basic equipment, new processes and products, and technical assistance as in their incepience. Whatever the reasons for this failure to generate the equipment backward linkages, technical creativity and organization dynamism that the "mother" industry of the industrial revolution was able to sett off in successful late-industrializers like the United States, Japan and France, inexperience can hardly be an important part of the explanation.

Secondly, the diagnosis misreads the economic history of successful late-industrializers. Their Phase I was neither very deep nor very prolonged. Indigenous technological creativity emerged quite early in their industrialization. Some of the 19th century Latin American textile mills were erected with imported United States equipment and technical assistance which had already captured part of the equipment market from the pioneering British. Japan has reached first rank among world industrial powers, while assiduously excluding private foreign investment throughout its industrial upsurge. These experiences may not be directly transferable to another era and to different institutional settings, but neither is it justified to base national technology policies on a fictitious reading of the earlier experiences of successful late-industrializers.

Finally, the diagnosis disregards powerful "systems-maintaining" forces in the contemporary relationship between the high-income centre and the countries of the periphery. Neither modern technology nor the range of modern consumer goods are static in the centre countries. Excessive rates of inflow of new consumption styles via the

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"demonstration effect", combined with technological borrowing to satisfy the demand for new consumables, can result in the peripheric economy largely exhausting its physical and human investment capital in meeting the changing demands of a thin and only slowly expanding modern strata through continual technological imitation. Apart from the dubious ethics of such a development strategy, the resulting gulf separating that strata from the low-income mass of the society may not be bridgeable by "trickling down" within a politically feasable time span.

These criticisms clearly imply that passage from Phase I to Phase II is not a spontaneous and inevitable phenomenon, but must be nurtured by technological policies explicitly oriented toward generating a capacity for technological creativity. The next section presents the historic case for this. That necessity and the parallel necessity for policy innovations to adjust to differences in external economic and technological environments confronting late-developers in each historic epoch, is analyzed in detail. Following this historic analysis the same general issues are discussed from an economic-theoretic perspective, using a critique of neo-classical production and demand theory as the point of departure.

2. The case for indigenous creativity - an historical perspective

The case for indigenous creativity is currently being advanced in Latin America from a variety of perspectives. The more extreme versions virtually reject that there are social benefits from importing foreign technology, seemingly favouring a policy of technological autarchy for the region as the antidote to excessive technological dependency.

This would be counter-productive for at least two reasons. One is that there will always be a considerable amount of potential social utility from economizing on resources by exploiting knowledge developed elsewhere. It is rather pointless for the region to concentrate creative efforts on, in effect, reinventing the wheel or the electric motor. Secondly, one has to begin realistic analysis and policy changes by taking the existing structures of production and

/consumption attitudes

consumption attitudes as points of departure. Both are deep-rooted, not merely in income and power relationships, but also in market dynamics and popular aspirations that are not easily changed. Neither the appropriate creative capacity nor the conciencia for accepting policies directed at product simplification and a slowing down of the rate of inflow of modern varieties, can be achieved overnight. One of the benefits of serious micro-studies of the dynamic mechanisms sustaining Latin American structural heterogeneity and technological dependence could be to help enlarge popular awareness that various institutional changes are pre-requisites for a more socially equitable application of technology in many critical areas. A second benefit would be to identify openings within the existing socio-economic structures through which application of technological knowledge in a socially beneficial way could be instituted more immediately.

A partial contribution to developing the requisite conciencia is to demolish the comforting historic myths that help sustain the acceptance of technological dependence. One of these is that all late-industrializing countries, past and present, pass through quite similar sequences of socio-economic experiences on the way to full modernity. The second is that a long period of generalized dependence on imported technology and equipment, what we have called Phase I, has been part of the experience of all successful late-industrializers in the past. The first of these propositions is more misleading than helpful; the second has virtually no historic validity.

The idea that economic development dynamics are basically replicative, a succession of similar stages on the road to full modernity, had wide support in the early post-war literature on social and economic development. This was understandable. The subject had burst on the scene as a major international "problem" related to colonial independence movements, the Cold War, and rising social aspirations and pressures within the Third World. The notion that the past can help predict the future was ready at hand, and was seized upon eagerly by development analysts.

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Unfortunately, the past is not an open book. Countries not only embark on late development with different initial cultural, institutional and natural resources configurations, but even more important for development analysis, each new generation of late developers also finds itself in an international environment with a rather different configuration of technologies, foreign trade, transport and communications, productive capacity and military power than its predecessors. In the past two centuries a dominant force impelling changes in the international scene has been the accumulation of scientific and technological knowledge. The initial enthusiasm for replicative development models and stage theories was bound to stumble over this changing reality. Currently, historical analysis of successful late-development experiences tends to emphasize instead the crucial importance of unique institutional innovations that accelerated physical and capital accumulation, and promoted technological diffusion.

The innovations are unique in two senses. They adapt many inherited features that are special to each country, and they are creative responses to the changing opportunities and constraints emanating from the altered external environment that each generation of late developing countries confronts. The successful developers were neither mere copiers of foreign institutions, nor did they permit themselves to be swept along passively by socio-economic and technological currents emanating from abroad. There is, of course, no assurance that the requisite responses will always emerge. But this merely accords with one of the few obvious lessons of history, that there is no inevitability about development. Despite the impressive international accumulation of science, technology and productive power, there are relatively few cases of peripheral economies transforming themselves into fully developed, technologically advanced centre countries.

This is not to deny the partial validity of the macro-patterns and regularities common to socio-economic development which the earlier replicative models helped to elucidate. In the process of developing,

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the share of industrial output does rise relative to that of agriculture; the share of household expenditure on food does fall with rising household income; population does become more urbanized; death rates do fall before birth rates; fertility rates do decline as the population becomes predominantly urbanized, etc. But these macro-regularities are more in the nature of results than causes of development. They are not the strategic dynamic forces that impel development and on which effective strategies for accelerating the process can be based. No strategic "take-offs" and flights into sustained growth can be predicted from them.

To illustrate we examine briefly some key interrelated aspects of technological creativity from an historic perspective. To do this the development experience of the past two centuries is divided somewhat arbitrarily into three time spans: Period I, from around 1770 to around 1860; Period II, from around 1860 to World War I, and Period III, from World War I to the present. The interrelated aspects considered are: the sources of technological creativity, economies of scale, the dynamics of industrial demand, marketing structures, and the financial requirements for industrial investment. The intellectual agents of technological creativity are also broadly classified as follows: basic scientists, applied scientists, formally trained engineers and technicians, amateur inventors and artisans, i.e. job-trained skilled workers and technicians.1/

(a) Late industrialization in the period 1770-1860

For Period I, there is rather general consensus among economic historians that commercially applied inventions and improvements in Great Britain, Western Europe and the United States originated mainly with job-trained skilled workers and technicians. This group drew very little on either formal engineering recipes or on specific concepts emanating from basic or applied science. The intellectual gulf between the theoretical and practical layers of technological endeavour reflected the limited practicality of formal scientific and

1/ For a more detailed treatment of the various aspects and related documentation, see David Felix, "Technological dualism in late industrializers: on theory, history and policy", The Journal of Economic History, vol. XXXIV, March 1974, pp. 194-238.

engineering rules in this era. This was partly because, despite notable advances in the natural sciences and mathematics, the intermediate links between basic theory and usable technological prescriptions via applied science and engineering were as yet underdeveloped. It was also, partly, because at the practical end, machine building capability of the period, despite notable advances, was still too crude to approximate the machine tolerances, heat resistance and other requirements for applying mathematicized engineering rules to productive processes.

There were, of course, some initial bridges over the gulf. Although the theory of chemical synthesis was still working out of its phlogiston phase, chemical taxonomy was a rich source of information about materials and their properties. Physicians, whose formal training included chemistry, were a source of helpful chemical advice to industrial firms seeking alternative materials to solve technical problems. Another bridge was the amateur inventor, some of whom were obsessed by ideas emanating from a broad knowledge of contemporary science, although many others were haunted by notions emanating from more fanciful sources. The amateur inventor has always been more venturesome than the practical artisan, or in later periods, the R & D laboratory director. His failure rate is therefore always extremely high, but he has contributed important break-throughs; relatively more in Period I than in later periods when the rising cost of technological search began to price him out of more and more segments of the technological gamut. Finally, civil and military engineering became professionalized and mathematicized in this period, more rapidly in late industrializing West European countries than in Great Britain, and began to supply increasingly important design inputs to public works and military hardware. In general, by the end of Period I the bridges between science and technology were becoming more numerous and the gulf was narrowing.

Great Britain was of course the main innovator of factory technology, machine tools, and transportation and transport equipment, but later industrializing continental countries and the United States

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in this period were far from mere copiers. Quite early in their industrialization they began developing their own machine building and designing capability and to adjust techniques to local materials, labour skils and demand peculiarities. Great Britain, with its earlier start and longer period of accumulation of industrial capital, pioneered in advancing economies of scale in a number of major areas, such as textiles, chemical works, iron smelting, mining and beer. But the United States soon pioneered in the fabricating of metal products using interchangeable parts, in wood working tools, and in assembly line techniques for meat packing and the production of wood products; while France led in quality textile products and charcoal iron smelting technology.

Special factors contributed to the early entry by late industrializers into Phase II of indigenous techonological creativity, and even to an incipient entry into Phase III of technological exporting. One was that it was not until the 1840s that Great Britain repealed the last of its restrictive laws against the export of machinery. Prior to that time the diffusion of British technology had been a semi-clandestine affair. European countries offered lucrative contracts to attract British artisans to build equipment and train local workers in priority areas. Governments of industrializing countries also sent missions to Great Britain to report on British industrial techniques, while more informal industrial spying was still another transfer channel. There was, however, little in the nature of direct foreign investment by Britain until the railroad age of the mid-19th century, when British contractors for a time played an important role in designing and building continental railways. In the more successful late industrializers the role was soon taken over by local engineers, railroad contractors and equipment firms, so that by the latter part of the 19th century British contractors and railroad equipment exporters had shifted the locus of their foreign efforts to to the Empire, Eastern Europe, Asia and Latin America. The effort was now combined with loan and equity financing of the railroad projects. In fact, overseas railroad investment became the major component of British foreign investment during the latter's heyday, 1870-1914.

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A second special factor allowing early entry into Phases II and III was the rich artisan base of the late industrializing countries of Period I. Since machine building and the finishing phases of industrial products were still primarily workshop activities, artisans of continental Europe and the United States were able, after a span of experience in operating the new equipment, to move to the higher technological phases of reproducing and then to modifying the equipment components and processes.

However, demand factors also played a major role in stimulating indigenous technological creativity. In the first place, the major locus of demand for industrial products through most of this period, was, in contrast to present-day Latin America, the rural sector. It was not merely that the industrializing countries of Period I began with most of their population still engaged partly or wholly in agriculture, but also that agriculture had in each case embarked on technical progress and productivity growth. The French economist, Paul Bairoch, even claims as a statistical regularity that in the case of both Great Britain and the late industrializing countries of the period, an agricultural revolution began a generation or two before their industrial revolution.2/

The term revolution may be a bit strong for the rate of progress in the continental countries, but there is no doubt that a progressing agriculture in each of the countries was providing a growing market for industrial output. The main demand for iron and iron products prior to the railroad age came from agriculture, and included not simply a static array of traditional iron artifacts, but successively improved plows, harrows, mowers, threshers, and hand tools, much of which are of local design to fit different soil conditions, crops, etc.

Stimulus to creativity came also from the expanding consumer demand for differentiated products. In contrast to later periods, the international component of the demonstration effect on consumption was still embryonic, limited mainly to the aristocratic strata of

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2/ Paul Bairoch, Agriculture and the Industrial Revolution (London, 1969).

European society. Moreover, factory technology was still to crude to produce fine finished products suitable for the tastes of even the bourgeois classes, who at first took their canons of refined taste from the aristocracy, but later deviated toward the intricate grotesqueries that have become indelibly associated with the Victorian era. Thus, in contrast to Latin America today, the expanding demand of the higher income strata for differentiated products was filled by the artisan workshop.

Even the international demonstration effect favoured the workshop; e.g., the production of chinoiserie for the aristocracy came to be mainly import substituted by local potters and furniture makers. In general, the chief locus of product differentiation competition was the workshop, which had the craft skills to produce fine finished products, not the factory which did not, and which could only undercut through lower cost production that sub-sector of artisanry producing intermediate materials and semi-finished goods. Thus, while the factory displaced the artisan workshop in some areas, the high income elasticity of demand of the upper income strata favoured the expansion of artisan workshops in quality consumer manufactures.

There were notable differences, however, between consumer demand patterns of the European industrializers and the United States. In the former, as is the case in Latin America today, the market for industrial consumer goods was overwhelmingly the upper 20-30 per cent of households, although a much larger share of these households were rural than is the case in Latin America. In the United States a similar concentration of consumer demand was to be found only in the South, where slave plantation agriculture gave latifundista characteristics to income distribution and consumer demand. For the majority of the United States population that lived outside the South, the penetration of industrial consumer goods was much deeper, reflecting a more equitable distribution of land and relatively high wages. Consumer tastes tended to be more plebeian, favouring industrial ventures in mass production of shoes, sewing machines and other household artifacts. By the end of the Period I,

/the United

the United States had emerged as the undisputed leader in applying factory techniques to finished consumer goods.

The fixed capital share of industrial investment was very small in the early decades of the British industrial revolution. Bairoch estimates that in late 18th century Great Britain, the value of capital per worker in agriculture (including the value of land) was nine times that of industry. Equity financing of the early industrial ventures could thus be fairly readily supplied from agricultural or mercantile sources via family connexions or partnerships. For the later industrializing countries of Period I, the financial entry barriers rose, reflecting the progressive increase of mechanization and of minimum efficient scale, although Bairoch estimates that even in these countries the value of capital per worker remained higher for agriculture than for industry through Period I.

To compensate for the rising industrial financing requirements and greater entrepreneurial risk, the later industrializing countries embarked on a number of policy and institutional deviations from the British model. Their trade policies were moderately protectionist, to shelter "infant industries" from the full blast of British competition until the infants reached adulthood. The main rationale was that learning by doing would gradually lead to more efficient production via improved labour and managerial skills and improvements in techniques. It is interesting to note that the major economic theoreticians of this period made no explicit separation in their analysis of economic growth between capital accumulation and technical progress. The reason was not that they believed the technology of their times was static - on the contrary they were keenly aware that the "state of the arts" was advancing rather rapidly - but that they thought of accumulation and improvements in the state of the arts as inseparably interrelated. Their view implies a "learning by doing" explanation of technical progress, which for Period I, when most new technology derived from the ingenuity of artisans and job-trained technicians, was realistic.

/The other

The other institutional deviations and policy innovations of the late industrializers were of three major types. One was state transport planning combined with either direct ownership or subsidization of national railroad networks, as contrasted with the pioneering British pattern of private, piecemeal construction. A second was the formation of private industrial banks to supply equity financing and long-term credits, particularly for large-scale industrial ventures. These banks, similar to the Mexican financieras of recent years, were pioneered by the French, but spread rapidly to other continental countries. A third was more concerted efforts to finance the spread of basic education, higher technical training, and, in some countries, advanced scientific and engineering research and training institutes. The late industrializers were generally well ahead of Great Britain in providing popular education and formal scientific and technical training. Their load, however, brought only minor immediate benefits for their indigenous skills and technical creativity, the main payoff coming Period II.

(b) Contrasts with recent industrialization in Latin America

These key features of the late industrializing experiences of Period I differ substantially from the more recent industrialization pattern of Latin American countries. The latter cannot be considered to be broadly repeating the earlier experiences; the deviations are too pronounced.

In the first place, the sustained Phase I technological dependency characterizing the Latin American experience was not a feature of the late industrializers of Period I. They passed quicly to indigenous creativity, this ability reflecting both the richness of their artisan skills and the relative unsophistication of technology in Period I. Secondly, "best practice" technology in this period required less fixed capital per worker and was much less scale intensive than today, so that the private financial barriers against adopting such technology were also far lower. Thirdly, in contrast to most industrializing Latin American countries a technically progressing agriculture provided a very considerable part of the demand for

/wood products

wood products, refined metals, tools and equipment, while the demand for machines to equip factories and workshops was also mainly serviced locally by artisan type workshops. Both broad types of demand provided fertile seedbeds for indigenous creativity. Fourthly, in contrast to Latin America, the composition of the growing demand of the upper income strata for differentiated consumer goods in Period I was much less influenced by foreign canons of taste and status than has been Latin American demand, and was largely met by local artisan creativity.

These differences in technological experience help to explain why structural heterogeneity has been more pronounced in most industrializing Latin American countries, than it was for the Period I late industrializers. With agriculture progressing in closer step with industry than has been the case in most Latin American countries, the relative urban-rural per capita income differences in the Period I countries never reached the extremes prevalent in much of Latin America. In the Period I countries, and expanding artisan sector strongly reinforced the large factory sector in absorbing rural emigrants, so that the industrial share of employment tended, in contrast to the typical Latin American experience, to rise pari passu with the share of industrial output. Finally, despite some well-publicized cases of artisan activities agonizingly resisting their demise before advancing factory competition by wage cuts, the more common situation was for intra-industry wage differentials between small and large enterprises in the Period I countries to be negligible. Workshops could survive and expand on the basis of a favourable demand for equipment and differentiated consumer products, whereas in Latin America the artisan type firm operates mainly in the income inelastic range of products and survives mainly by paying lower wages and evading taxes and social security payments more vigorously than the large firm.

One other contrast is worth noting. By the second half of the 19th century the international demonstration effect in ideas brought the Listian development strategies of the late industrializers of

Period I to the attention of some development-conscious Latin Americans.3/ Political efforts to get such strategies adopted, however, largely failed prior to the Great Depression, with some partial exceptions such as industrial tariff protection in Brazil and expanded popular education programmes in Argentina. When Latin American countries entered the railroad age in the latter-half of the 19th century, they largely ignored the transport planning of Period I late industrializers, opting instead for the disarticulated early British approach. Thus when, during the Great Depression, many Latin American countries belatedly began adopting a broader range of Listian development policies, the declining importance of learning-by-doing among the 20th century modes of technological progress, the disarticulated transport systems and the greatly increased financial barriers to entry in modern industries, provided a much stonier seedbed for late industrialization. The prolonged lag in adopting Listian developmentalism had made the countries late-late industrializers, for whom mere Listianism no longer sufficed, as is indicated by the contortions of import substitution industrialization in the region.

(c) Industrialization during the period 1860-1914

Turning to Period II, broadly 1860-1914, one observes the following relevant changes.

The sources of technical progress shifted increasingly to higher cognitive levels. Formal engineering and applied science began to assume strategic importance in a number of "high technology areas of Period II, notably, chemistry, pharmaceuticals, metallurgy and electric energy. As a result, invention in the high technology areas became more institutionalized, with full-time professionals, industrial research and testing labs, and with stronger intellectual linkages to universities and basic scientific research. Large German

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3/ The concept of state transport planning as well as "infant industries" and the consequent need for protection are often associated with the German economist F. List (1789-1846).

/firms were

firms were the pioneers in these developments, reaping belated benefits from the emphasis of 19th century German development strategy on expanding scientific and technical education.

Serial production of standardized tools and equipment and mass production of a widening range of consumer goods also characterized Period II. In these product areas United States firms usually led in devising new ways of standardizing components, designing large specialized machines, and reorganizing the flows of parts, materials and work tasks on the factory floor. The "American method", in turn, came to be widely adopted by Europeans, including the British. Making possible these developments were broad advances in the tensile strength and heat resistance of structural materials, improvements in power conversion, switching, more accurate machine tools, etc. These innovations were essential for overcoming successive bottlenecks to further mechanization and the extension of economies of large scale.

Mass production was the driving force behind the revolutionary changes in marketing and in the locus of product differentiation competition, which was another major feature of Period II. At the beginning of the period, industrial goods were still being distributed via two main channels. For standardized products, independent wholesaling firms served as intermediaries, buying from the factory and reselling to traders further down the distribution chain to the final user. The arrangement reduced working capital needs of the producer at the cost of an uneven flow of orders from wholesalers and relative anonymity for his product. The wholesaler, for whom a quick turnover of his heterogenous stock of goods was strategic, saw no profit in singling out the products of particular producers for expensive market promotion. The differentiated workshop products - equipment and consumer specialities - were, on the other hand, produced often to customer order, and even the limited production for stock, was often sold directly to the final user. All this changed dramatically in the course of Period II under the impetus of the spread of mass production techniques.

/Growing economies

Growing economies of mass production meant proportionately higher fixed expenses and hence sharply rising unit costs when operating below capacity. In order to sustain output runs while minimizing inventory accumulation, mass producers began by-passing independent wholesalers and to market directly on a scale commensurate with their output capacity. Brand names, mass advertising, and the creation of distributional appendages, including on occasion captive retail outlets, featured the marketing revolution. The combining of large-scale production with mass marketing also originated from below, some large wholesalers and retail chains retaliating by establishing captive production facilities. By the end of Period II the independent general wholesaler was fading from the scene in the industrially-advanced economies.

In consumer goods, many of these efforts were initially directed at intermediate segments of the income hierarchy, including, for items like margerine, cigarettes, beer, canned foods, shoes and clothing, many low-skilled worker families. Production in European industrial countries by the end of the 19th century was beginning to follow the United States pattern, of penetrating markets below the higher income strata. However, in order to exploit economies of scale in marketing and the rising sophistication of factory techniques, mass producers soon began also to widen their product lines and to engage increasingly in product differentiation competition aimed at capturing the higher income market from the specialist workshops.

The marketing revolution was associated, therefore, with equally dramatic changes in industry market structures. Concentration ratios rose as the large producers pursued aggressive price cutting and other "cut-throat" strategies to take over or drive out smaller competitors. The financial barriers to entry or survival of small firms became more and more serious for to the rising capital requirement for producing at competitive costs was now added the substantial

/capital needed

capital needed to market effectively. Inexorably, the workshop was being displaced from its main strongholds, machine building and product differentiation, by the large scale producer. More and more of the things the workshop could do, the factory could do as well and cheaper. By the end of Period II the market for handcraft consumer products in industrially-advanced societies was being reduced to a limited snob market, for cognoscenti who took pleasure from the interesting imperfections of handcrafted goods that distinguished them from the monotonous regularity of machine made equivalents.

With these revolutionary changes, the centre-periphery division emerged more sharply. At the centre was a group of technologically creative, capital-rich industrialized economies; at the periphery a larger array of technologically dependent, capital-importing economies. By the beginning of the 20th century, foreign investment was incorporating an increasing proportion of direct investment in petroleum, plantations, food processing and public utilities in the peripheral countries, except for the last, chiefly to supply centre economy demand. Concurrently, the mass marketing strategies of centre country industrial firms was intensifying the international demonstration effect on peripheric consumer demand. In Period II this demand was met by exports. While industrial firms of the centre countries were beginning to place subsidiary plants, as well as sales agencies, in each others' markets, they limited investment in peripheral countries to sales agencies. The transnational industrial enterprise was still in its incipience; communications and transport barriers made efficient control difficult and subsidiary plants were for the most part placed only in wealthy neighbouring countries.

Nevertheless, the present day oligopolistic industry structures had been largely erected in national markets by World War I, and various forms of non-price competition characterizing oligopolistic rivalry were being tested in the home markets. Underestimation of the expansionary dynamics of oligopolistic competition and a failure to foresee the growing impact of new, if still incipient, modes of

/transport and

transport and communications on these dynamics, accounted for the notions prevalent in Latin America and elsewhere a few decades ago about the permanent improbability of foreign industrial investment descending on the periphery.

(d) Successful late-late industrialization in Period II: the Japanese case

For late-late industrializers, innovative modifications of Listianism were required to meet the changing international technological and market environment of Period II. Japan's experience demonstrates one set of successful responses to the new environment by a late-late industrializing market economy. Significant for Latin America today are not the specific Japanese policies, which were neither socially optimal then nor would be as effective now in the changed international environment. Rather it is that the policies brought early attainment of technological creativity and adequate defenses against the international demonstration effect, both of which were strategic for Japanese development and are still strategic for Latin America in today's international environment.

The particular modalities of Japanese development strategy were strongly affected by two special factors: the "Unequal Treaties", imposed on Japan in 1858 by a concert of European powers and the United States, and remaining in force until 1911, and militarism, whose impact on development strategy was magnified by the nationalist reaction to western imperialism, of which the Unequal Treaties were a manifestation.4/ The imposed trade liberalization of the Unequal Treaties is cited by some writers as the decisive factor in Japan's successful development, because allegedly it exposed Japan from the

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4/ The Unequal Treaties forced Japan to open its ports to trade placed a 5 per cent maximum on Japanese import duties, and provided for consular courts and other extra-territorial privileges for European and American nationals in Japan. The signing of the Treaties was preceded by shows of force by United States and European naval squadrons and an intense diplomatic campaign of threat and cajolery by the western powers. The treaties were unilaterally abrogated by Japan in 1911. For a detailed account of the events leading to the reluctant Japanese acquiescence to the Treaties, see W.G. Bessley, The Meiji Restoration (Stanford University Press, 1973), Chapters 2-4.

/beginning of

beginning of its modern development to international competition and forced it to fine tune technological choices to relative factor prices. This is largely misleading. The Unequal Treaties did prevent Japan from indulging in autarchical levels of tariff protection, Latin American style, and forced it to be more selective. But the serendipitous effect of the treaties was mainly to push the Japanese to develop more innovative control mechanisms, in order to get around the treaty restrictions, protect the home market and subsidize import substitution and exports. The military logistic factor in Japanese development strategy, which intensified after World War I, accentuated efforts to develop iron and steel, shipbuilding and the heavy equipment industries. But it also accounted for some of the harsher features of the development effort; in particular it retarded the penetration of modern goods and services to the mass of the population.5/

Nevertheless, by imaginative policy and institutional innovation the late-late industrializing Japanese did manage in a general way to replicate the dynamics of successful late-industrialization of Period I. Crucial features include the following.

From the beginning of the Meiji period, an intensive effort was made to pass from Phase I of general technological dependency to Phase II of indigenous creativity. To quote from a recent summary of the Meiji era:

"Approximately fifty years of fervent attempts by the Japanese government and private industrialists to catch up with the Western powers at least succeeded in transplanting into Japan diverse manufacturing technologies as well as scientific and technical knowledge embodied in engineering and scientific disciplines. Since it took the Japanese government from 1858 until 1911 to regain its rights to determine import duties, the government's main weapons for developing Japanese manufacturing industries were limited to direct subsidies, legal sanctions to discourage the use of imported parts and machines, and more important, the building up of the general technological level of the nation through general and specialized

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5/ Cf. William Lockwood, The Economic Development of Japan 1868-1938: Growth and Structural Change (London, 1955).

/education. Also

education. Also, the government played a direct role in transferring selected manufacturing technologies to Japan by its rapid replacement of foreign engineers and other trained foreigners with Japanese nationals." 6/

Facilitating the selectivity of the technological effort were the factors that greatly limited the impact of the international demonstration effect on consumption preferences. In its long isolation from western influences, Japan had developed a rich cultural tradition with deeply-embedded customs and consumer styles. These continued to dominate Japanese household preferences, including those of the higher income strata until well into the post-World War II era, and only in the past two decades have become subordinated to western styles. The tenacity of the older preferences was reinforced by deliberate policies to retard the adoption of modern consumer sales promotion devices. Of particular importance were restrictions on the entry of foregin marketing agencies and the complete exclusion of direct foreign investment. The exclusion was possible, despite the Unequal Treaties, because western economic expansion of the mid-19th century focused on developing export markets (its interest in direct foreign investment came much later) and the foreign promulgators of the Unequal Treaties did not provide for foreign investment rights. The Japanese authorities seized on the oversight to reject wholesale subsequent petitions from foreign investors. This policy has been cautiously modified only in the past decade, as Japanese firms themselves began to engage in foreign direct investment, in favour of reciprocal investment arrangements with the other centre countries.

The high income elasticity of demand for product differentiation was thus largely serviced by the artisan sector. Prestige consumption items continued to be mainly of traditional design even after World War II. A comprehensive household expenditute survey made in 1955 showed that half of urban household expenditures were on items

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6/ Toshi Tsurami, Japanese Efforts to Master Manufacturing Technologies. ICH 14 G 45 (Boston, Mass., Intercollegiate Clearing House, 1970) p. 30.

already produced and consumed during the pre-Meiji era. The workshop through most of the early industrialization effort remained, therefore, the chief locus of consumer product differentiation competitions. Income elasticity of demand for its products favoured the growth of the workshop sectors, facilitating its capacity to absorb rural labour, modify and improve products and processes, and raise productivity. Not until after World War I did wage differences between small and large firms begin to diverge. This Japanese pattern, in other words, resembled that of the late-industrializers of Period I, although the social and policy mechanisms that generated the replication were rather different.

Another noteworthy feature of the Japanese experience was its respectable rate of expansion of agricultural output and productivity. The productivity growth reflected innovative peasant efforts, supplemented by government technical assistance in crop selection and in developing new varieties, and by modest improvements of tools and implements. Agricultural growth had two major positive effects on industrial development. It recreated some of the market interfacing between agriculture and industry that was so prominent a feature of Period I industrialization, and it also made agriculture a significant source of capital, which was channeled to industry and other sectors, partly through land taxation, partly through private accumulation channels.

Finally, there were the Japanese innovations in the financing and control of large-scale production and export marketing. Pioneering government plants were used early in the Meiji period to test risky waters for reluctant private entrepreneurs, although permanent government ownership was limited to areas of high military-logistic importance. The most interesting innovation in large scale organization was, however, the controversial Zaibatsu. The growth of this handful of giant conglomerates, combining banks, international marketing agencies, shipping lines and factories, was facilitated by government subsidies. The Zaibatsu provided finance, export orders,

/quality control

quality control, and foreign commercial and technological intelligence to a stable of nominally independent but captive industrial clients in textiles and other exporting industries.

The arrangements had the interesting side effect of minimizing opportunities for the captive firms to pursue domestic product differentiation competition. Husbanded by the Zaibatsu, the firms exchanged intimate information on costs, trouble-shooting solutions, and process and product innovations with a startling lack of concern for the canons of discretion common to oligopolistic competitors elsewhere.

The links between the Zaibatsu and the government ministries were also remarkably intimate. It was through these informal links, rather than through formal laws and decrees that the government imposed its changing economic priorities to the private industrial sector. The links were used to control the order of establishment of new industrial activities, to promote exporting, and to mobilize industrial and university talent for crash efforts to solve high priority technological problems. The arrangements allowed the Japanese government to pursue a selective strategy of allocating the nations's limited talent, foreign exchange, and domestic financial resources to building up design capability and economies of scale, concentrating first on a small number of activities, and expanding the range sequentially as resources and skills accumulated; that is, to replicate by other means the dynamics of industry widening characterizing Period I late-industrializers.7/

Many of these special features of Japan's earlier industrial effort are now being liberalized. Consumption styles are becoming westernized, and small-scale industry is declining in relative

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7/ The Japanese pattern of automobilization stands in sharp contrast to the Latin American pattern. Pioneering efforts to produce Japanese trucks date back to the early 1920's. The production of passenger cars, however, was delayed until the 1950's, when Japanese firms entered production on a rapidly expanding scale, with adequate design capability, financing and plant size to become in a few years major competitors in international markets.

/importance, as

importance, as is Japanese dualism. Japan is reaching equality with older centre countries in per capita income and technological capacity, and is entering Phase III technological exporting. But much of the old structure of controls still remains. Despite attempts by the United States occupation authorities after World War II to dismantle the Zaibatsu, strong informal links between large industry and government continue to guide post-war economic policy. Foreign businessmen encountering these subtle obstacles refer bitterly to the arrangements as Japan Inc.

Apart from the obvious fact that Japan is now approaching full modernity, with its special set of headaches, a number of macro-economic contrasts between Japan during its earlier transition and Latin American industrializers today merit noting. In general, Japanese dualism was never as severe as in today's Latin American industrializers. Urban-rural and interregional differences in per capita income, and wage differentials between small and large enterprises, seem never to have been as great in Japan. Even during its period of rapid demographic growth, Japanese underemployment was less and the labour force participation rate higher than in most Latin American industrializers. Finally, and basic in accounting for the lesser heterogeneity, Japan generated higher rates of capital formation and avoided falling into the extreme state of technological dependency that characterizes the modern Latin American sectors.

(e) Trends in the international industrial and technological environment since World War I

Period III, from World War I to the present, has involved changes in the international environment which are very generally known, and need not be discussed in detail here. There are three trends however, which have been of key importance from the present point of view, and need to be kept in mind.

First, radically new transport and electronic communications technologies that were only in their beginning at the close of Period II have come to full flower in Period III. These developments have enormously increased the speed and reduced the cost of mass dissemination of images and ideas. Aided by accompanying developments

/in advertising

in advertising, public relations and marketing techniques, they have extended the market horizons of the large multi-national firm to encompass the globe.

Second, these transport and communications advances, combined with equally revolutionary advances in electronic data processing devices and the accompanying managerial "software", have greatly enlarged the capacity of large enterprises to direct widely dispersed operations around the globe.

Finally, close intellectual linkages between science and technology, which had emerged in a few high technology areas of Period II, are now encompassing a widening range of "traditional" as well as new productive activities: agriculture and food processing as well as petrochemicals and nuclear energy. There is now a notable professionalization of technological search in the various activities. In the private sector it has become increasingly centered in formal R & D divisions of large firms. This has accelerated both the output of new and differentiated products, and also the speed with which economies of scale have been extended. It has further raised financial barriers to entry in oligopolistic markets.

These three lines of development have led to the internationalization of oligopolistic competition. The internationalization trend was slowed for a time by the Great Depression and World War II, but burst out in full force in the decades after World War II. United States firms took a long initial lead over their war-damaged European and Japanese rivals, but the lead began to narrow in the 1960s. Future depressions may again slow the expansionary dynamics, but reversal does not seem likely.

Present day policies aimed at stimulating the advance of creative technology in the internal economy must keep this carefully in mind. This is the international economic and technological environment in which such policies must be designed to function.

3. A critical analysis of the relative price distortions approach

In this view the main source of the inappropriate technology problem is that Latin American countries have pursued economic and social development strategies which have unduly cheapened the cost of capital in relation to labour costs. Overvalued exchange rates, tax and credit subsidies, and overly protective tariffs against competitive imports have "artificially" lowered the cost of capital to investors, while trade unionism and various conquistas sociales have raised the cost of hiring labour, at least to the larger enterprises. Capital-intensive activities have thus been encouraged, labour-using ones discouraged, and within individual activities, an unduly depressed ratio of capital to labour costs has encouraged firms to import more capital-intensive technological equipment than they would have had "socially correct" relative factor prices determined technological choice.

To be effective, technology policies must therefore be closely linked to economic policies to bring relative prices in the factor markets closer to "true" scarcity price ratios. That is, the technology policies proper are similar to those advocated by the technological gap approach: the creation of entities for the faster entry and diffusion of technological information, plus measures to strengthen bargaining over the "technological terms of trade". But if these are to facilitate the selection of more socially appropriate techniques they should be complemented with trade liberalization measures and a reduction of foreign exchange, credit, and tax biases favouring investment in modern equipment rather than labour, and a curbing of conquistas sociales and of wage pressures from the unionized sectors of the labour force. The main thrust is less dirigiste than is the technological gap approach, the emphasis being less on new forms of financial subsidies linked to industry rationalization, and more on increasing market competition. Apart from correcting the price "distortions", such competition would also pressure enterprises toward greater efficiency; i.e., it would force them to be more cost-conscious, aggresive and technologically alert. alet.

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This view has also some valid points, notably its recognition that effective technology policy cannot merely focus on increasing information flows, but must also be linked with economic policies that remove decision biases which distort technological choice. The basic weakness of the relative price approach is that it grossly oversimplifies the technological choice matrix. There are two general aspects of this over-simplification. First, on the cost side, the assumption that there are readily available alternatives which use more labour and become more profitable with lower relative wage costs is of doubtful validity. Second, dynamic demand considerations often make other aspects more important than relative capital and labour costs in the choice of techniques.

(a) Relative capital-labour costs in the choice of technique

The neo-classical production function, which provides much of the analytic underpinnings of the relative price approach, implies that there is typically a wide range of techniques per activity, each incorporating different combinations of labour and physical capital, which can be purchased fully embodies in commercially-tested blue prints or equipment, with each alternative being a least-cost choice for some specified ratio of factor prices. This is misleading. Such a fully developed range is often quite small in modern activities. What is more accurate is that there is usually a much wider range of partially developed alternatives, which the growing subtlety of science and technology keeps enlarging. But to bring these partially developed ideas and models to economic fruition requires creative effort. At the least it requires testing various recombinations of components of already known technologies. Often it also requires more venturesome efforts at exploration and innovation to overcome obstacles hindering practical application.

Advanced economies develop those portions of the potential range which hold forth profitable expectations, given their particular concatenations of natural resources, human skills, stock of plant and equipment, size of domestic markets, consumption styles, import and export prospects, military ambitions, etc. Since there is variance

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as regards these conditions between the centre countries, the gamut of developed technologies for direct borrowing by Latin American countries is wider than would be the case were technological innovation concentrated in one country. This is, however, of only marginal benefit to Latin America, since the per capita income levels, market size and input availabilities of the centre countries as a group are far different from those of the technologically dependent peripheral countries. Correcting relative price "distortions" will affect income distribution and the level and composition of demand in peripheral countries. This doubtlessly will change their mix of imported technologies in some degree. It is unlikely, however, to make the revised mix "optimal" in terms of reasonable socio-economic welfare criteria, since such "optimal" technology is not directly importable for a great many activities but has to be developed by creative efforts guided by these welfare criteria.

Consideration of the orientation of technological research in the centre countries shows more specifically the limited extent to which relative price changes can be expected to lead to an easy switch to more labour intensive techniques. The belief that such techniques are readily available rests in part on the implicit assumption that technological change in the centre countries has been guided to a major extent by the desire to use more capital and less labour because of the prevailing high relative cost of labour. The new techniques would then be more economical only, or mainly, because of the prevailing relative prices in the centre countries; the older techniques would still be more profitable to use if wage costs were relatively low. An analysis of available data does not support this view.

It is useful first to note some empirical evidence. A recent comprehensive analysis of capital and labour coefficients for the US economy between 1947 and 1958 divided the economy into 76 interdependant activities, using input-output analysis. In almost all of the activities the capital and labour cost per unit of output, measured in constant prices, was lower in 1958 than in 1947, indicating

/significant technological

significant technological innovation. But extensive simulation experiments with a very wide range of alternative interest/wage ratios failed to eliminate the superiority (lower unit cost) of the 1958 technologies in virtually all the activities. In other words, the innovative changes of American firms in this period were not introduced only because of relatively high wage costs.8/

The major reason why technology does not closely follow changes in the interest/wage ratio in centre economies is that other factors frequently dominate the innovational effort. In some cases, particularly in natural resource processing activities, raw materials problems dominate the innovation search. In the US input-output study just referred to, for example, the few cases in which the unit capital plus labour costs using 1958 processes were higher than for 1947 processes, usually involved natural resource exhaustion. In such cases high labour costs become a secondary consideration.

A more general factor relates to economies of scale. There are a number of well-known physical and probability principles that cause unit costs to fall with increases in plant capacity. Indeed, some of these principles extend to multiple plant operations and to marketing, finance and administration as well as to production. The extent to which potential scale economies can be profitably exploited is limited at any point in time by three major constraints:

i) The size of the market for the product;

ii) Bottlenecks in the production process that limit further scaling up; e.g. reaching the current limits to the tensile strength of key structural materials, the absence of mechanized alternatives for the hand finishing or fitting phases of production, etc.

iii) Limits to the ability to finance large-scale plants and the auxiliary marketing requirements.

8/ Ann Carter, Structural Change in the American Economy, Harvard University Press, 1970, Chapters 8-12.

/The first

The first and third constraints are usually not dominant in the centre countries. The domestic markets of the large countries usually suffice to absorb the output of a number of plants or firms at current minimum efficient scale, while smaller countries can get the requisite volumes of demand through a larger admixture of exporting. Most centre country industries will also have one or more firms in each of an array of activities large enough to generate the requisite financing for such large-scale production and marketing.

This means that the second constraint, technical bottlenecks, is the chief short-term limitation to extending economies of scale. It follows that innovation efforts to overcome the technical bottlenecks is an obvious strategy for large firms to pursue, since success is often crowned by a double payoff. There is the reduction of unit costs, and there is also the ratcheting upward of the financial barriers to new competitive entry and to imitation by smaller firms already in the industry. The latter consideration, the consequence of the greater financial outlays required to build and operate at the higher minimum efficient scale, is of particular importance in oligopolistic industries, the common habitat of large firms in market economies.

The importance of this aspect of innovative behaviour has been rising since the latter half of the 19th century, and a recent quantitative survey of economies of scale in various branches of British industry testifies to its paramount importance today. It reports that in around 80 per cent of the activities surveyed, the minimum efficient scale of plant rose markedly since the end of World War II, notably in continuous process activities (chemicals, metal refining, cement, etc.) and in engineering activities (electronic, electrical and metal products).9/

9/ C.F.Pratten, Economies of Scale in Manufacturing Industry, Cambridge University Press, 1971.

/Further analysis

Further analysis of this survey data shows that in virtually all activities with sizeable scale economies, scaling up of plant results in a decline of both capital and labour costs per unit of output. In the continuous process activities the percentage decline of unit labour costs usually exceeds the percentage decline of unit capital costs, so that the capital-labour ratio rises with scaling up. But the reverse tends to be the case in the engineering type activities, where the capital-labour ration often falls with scaling up.10/ The important point to note here is that if firms could offset both wage pressures and reduce unit capital costs by scaling up, then whether the capital-labour ratio rises or falls in the course of scaling up becomes a matter of second order importance.

For technology-importing peripheral economies these scale dynamics have major analytic and policy significance. It is often assumed that large-scale plants and high capital-labour ratios go together, but the above data and analysis of scale dynamics indicate that this is often not the case and why. For example, the large automotive and electronic complexes in centre countries rank fairly low as regards capital-labour ratios. This is small comfort for a peripheral economy whose home market and ability to concentrate productive and managerial resources are inadequate for large-scale enterprises. It can try to operate on a more modest scale. This will usually raise the capital-labour ratio in engineering type industries and lower it in continuous process industries. But in either case the output-labour and output-capital ratios will be lower than for efficient sized plants.11/ Even if management were equivalent in capability to that of rival centre country complexes unit costs would still be higher in the small plants, except for those whose capital-labour ratios are so low that the lower wages of the peripheral economy compensate for the scale deficiency.

10/ David Felix, "Technological dualism in late industrializers: On theory, history and policy", op.cit., p. 194-238

11/ For Latin American evidence on this see Mario M. Cortes, Technological Absorption and Unemployment: A Comparative Analysis, Washington University, unpublished Ph.D. dissertation, 1973.

/More typically

More typically, the array of under-scale plants will require ample import protection and other subsidization as well as low wages to survive, the more so if managerial efficiency is also less than in the rival centre complexes.

Reducing relative price "distortions" by lowering tariffs and subsidies will no doubt force a higher level of managerial performance. But this will not resolve the other aspects of inefficiency. It will not provide a wider range of imported technological alternatives for offsetting the diseconomies of small scale. Neither is the increased import competition likely to create a favourable market environment for more rapid capital accumulation and growth of firms. Pushed still harder and the liberalization would indeed knock out the inefficient firms. It is unlikely, however, that the advocates of such policy can provide a convincing estimate of how much of the industrial sector and its employment would survive the shock treatment.

The prevalence of scale economies casts serious doubt on the efficacy or relative price correction as a major strategy for inducing a more appropriate choice of technology. But these scale economies also reinforce the case for promoting indigenous technological creativity. For scale economies are not invariant to the range and designs of products produced by a given plant complex. Especially in engineering type processes, the size of the plant complex and rate of output required to minimize unit costs in centre countries is positively correlated with the following product characteristics:

(i) The width of the range of differentiated models of the basic product line.

(ii) The length of the profitable life of the model run.

(iii) The extent to which the models incorporate complex features intended to augment marketability rather than basic function.

The first two relationships to scale have to do mainly with market characteristics and the competitive strategies of industrial firms. Widening the range of differentiated models often requires additional production lines. New models involve outlays on designing

/and testing

and testing and on start-up costs (retooling, etc.) for putting the model into production. Thus the shorter the life of the model run, the larger must be the output capacity of the plant in order to spread these costs.

In centre countries, product differentiation strategies leading to a widening range of models and shorter-lived product runs have characterized 20th century industrial competition, most notably in consumer and capital goods. In Latin America the smaller size of the market for scale-intensive products has forced firms generally to limit the range of models and to extend the model life relative to firms of the centre countries. But the oligopolistic structure of Latin American industries and the eagerness of Latin American middle- and upper-income households for new consumer goods and foreign designs, pushes in the opposite direction, toward increasing the diseconomies of small scale and the import intensity of production of the modern industrial sector.

The complexity of model designs, on the other hand, touches directly on the need for indigenous technical creativity, as well as on the constraints imposed by market characteristics. To illustrate, economies of scale for a United States model passenger car or light truck, 1960s vintage, was approximately as follows. In final assembly, unit costs for different plant capacities sloped downward moderately until about the 120,000 units production per annum. For engine and drive train forging, machining and assemblying, the unit costs declined much more steeply up to an output of around 240,000 units per annum, assuming an engine model change very 7 years. In the case of body stampings the downward slope was in between the two, but extended to an annual output of 600,000 units, assuming partial changes in body design each year and a complete redesign every five years. In 1967, a given US model built by subsidiaries of a major United States automotive firm in Argentina and Brazil, with around 85-99 per cent

/direct local

direct local content and annual output runs in each country or around 30,000 units, incurred the following percentage increases per unit over costs for equivalent production phases in the United States.12/

Final assembly	15 - 40 per cent
Engine and drive train components and assembly	30 - 300 per cent
Body stampings	80 - 100 per cent
Amortization and other capital charges	200 - 330 per cent
Total cost difference	71 - 154 per cent

Lengthening the model life would clearly reduce the cost disadvantage of small scale, mainly by reducing item 4). But simplifying the design would reduce the cost disadvantages further. The intricate contour lines of the United States models require complicated tool and die work, very heavy presses and high tensile, uniform quality cold rolled sheet steel, all related to styling rather than function. Economies from design simplification in this phase are enormous, and would also permit a substantial scaling-down of plant and equipment. Tooling costs for small presses to bend sheet metal into lesser contortions run from 5 to 10 per cent of the costs of the heavy die presses needed in the above example to contour sheet metal,13/ with additional savings from less machining and from the use of lower quality sheet metal. Equipment economizing could also be obtained from not contouring windshield and rear glass panels. Substantial additional economizing on forging and machining facilities is obtainable if engines were reduced in horse-power and power-driven accesories cut back, the consumer utility loss this time being in convenience but not in basic function. Saving of fuel from lighter engines, lesser foreign exchange outlays from using lower-grade

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12/ Jack Baranson, Automotive Industries in Developing Countries, IBRD, World Bank staff occasional papers, Nº 8, Johns Hopkins Press, 1969, Table 4.

13/ Jack Baranson, op.cit., p. 71.

/sheet metal

sheet metal and fewer special steels, and economizing of road construction costs by building vehicles with tighter suspensions and higher road clearance, indicate that the resource economizing would spill over to many other areas.

This is a fairly obvious illustration. The introduction of simplified models like the Citroneta and VW Beatle indicates that some international automotive companies are fairly quick to supply such models for middle-income segments of the Latin American middle classes. Nor is the illustration meant to imply that automotive redesigning is necessarily the place to begin developing indigenous technology for overcoming the economy of scale hurdle. However, the wide range of automotive models of varying complexity and luxury produced or imported in Latin America makes the illustration particularly apt for introducing the final major flaw in the relative price approach - its grossly inadequate theory of consumer demand.

(b) The importance of consumer demand and the demonstration effect in the choice of technique

The theory of consumer demand that underlies the relative price approach is notoriously too static to provide adequate analytic support for the relative price approach. Formally, the theory analyzes the hypothetical behaviour of the "rational" consumer, that is, one with a stable and internally consistent preference ranking for the items of a pre-determined and unchanging range of goods and services. The objective of the consumer, who is assumed to know accurately the properties of the various goods in the range, is to maximize his satisfaction from consumption, subject to the limitation that his income usually is too small to allow him to consume all he would really like. Should the relative prices of the goods change, the consumer will adjust his purchases, generally substituting more of the goods whose relative prices have fallen for those whose prices have risen, the elasticity of his response to price changes varying for the different goods in accordance with the differing intensities of his preference for them. Similarly, if his income rises, he will

/increase his

increase his purchases of most goods in his consumption basket, but in different proportions, so that his income elasticity of demand will also vary as between different goods.

In a community, the decision by some consumers to alter their purchases of some goods, will usually alter the relative prices of goods and hence the consumption decisions and satisfactions of other members of the community. But except for this third party impact on relative prices through market demand, the welfare obtained from consumption by each individual or household is assumed to be unaffected by what or how much others consume. There are assumed to be no positive or negative "neighbourhood" or non-market price impact (pollution, emulation or band-wagon effects, etc.) through which one consumer by his pattern of consumption can damage or benefit another. With these assumptions it follows that an economy with free functioning competitive markets will maximize consumer welfare in the short term; that is, with the overall productive capacity of that economy taken as given.

Among economic theorists there is mounting criticism of the limited explanatory power of this highly restrictive static schema. For our purposes, technology policy, the chief defect of the theory is its inability to explain consumer behaviour toward one of the major phenomena of modern times: the increasingly rapid rate of entry of new goods and new variants of exisitng goods in the consumer market. This basic defect, in turn, undermines other of the premises and welfare conclusions of the theory.

According to annual surveys by McGraw-Hill, US firms in the early 1960s devoted 48 per cent of their R & D expenditures to creating new products, another 41 per cent to improving existing product lines, and only 11 per cent to improving production processes.14/ Many of the new and improved products were capital goods

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14/ Cited in W. Eric Gustafson, "Research and development, new products, and productivity change" American Economic Review, Vol. LII (May, 1962).

/or intermediate

or intermediate materials, and thus represented, indirectly, process improvements for the user firm. But a large proportion were consumer goods. Once again, the data go contrary to the factor biased technical change hypothesis. U.S. firms were not even devoting a very large part of their R & D to improving their own processes, whether to adjust it to changes in the interest/wage ratio or whatever; they were devoting most of it to product differentiation to either capturing temporary monopoly positions by reaching the market with new products and product variants ahead of their competitors, or undercutting their competitors' temporary monopolies by developing salable imitations.

This sort of behaviour is known to be peculiarly characteristic of oligopolistic industries, in which firms rarely engage in open price competition, but compete through product differentiation in its various dimensions. Much of private R & D outlays in the US and other centre economies represent, then an extension of product differentiation competition, motivated by the same market control objectives as are expenditures on advertising, packaging, consumer finance and other marketing devices.

To assess market prospect for new consumer products, to advise firms on how to increase the effectiveness of their advertising, and on how to entice consumers to new goods through packaging, brand name selecting and market segmenting, a whole new body of applied marketing theory has emerged in recent years, primarily as a branch of social psychology rather than economics. In this theorizing, the consumer is an individual with far more plastic preferences than is the self-reliant rational consumer of economic consumer demand theory. His ability to compare qualities and prices of different goods is quite limited, as are also his time and means for enlarging his limited knowledge. To fill the gap he relies heavily on emulation of peer groups and on familiar trademarks. He responds to status and sexual symbols in advertising and product styling, and, his buying habits are subject to impulses and caprices.

/He is

He is still held in by a purchasing power constraint, his income and borrowing capacity, hence relative prices are not unimportant for him. Some of his preferences are indeed deep rooted; notably in the area of food. But within his overall income constraint, much of his changing consumption patterns cannot be explained by the static theory of consumer demand. In empirical demand studies by economists this shows up in the frequent statistical insignificance or "wrong" sign of the price variable in the econometric demand equations.

It is a short step analytically from dynamic analysis of consumer behaviour of the socio-psychological sort, to the famous "international demonstration effect" common to discussions of the changing consumption patterns of the modern sectors in Latin America. From casual observation it is apparent that these patterns have been following the changing patterns of the centre countries, and that the time lag in the imitation process has been shortening over the post-war period. What still needs to be sorted out more precisely is how much of the rate of inflow of new and differentiated goods and consumption styles reflects an income effect and how much reflects shifts in preferences that are largely independent of income changes.

That the income constraint is important is indicated by the heavy emphasis in the marketing strategies of most large consumer-goods producers in Latin America on "skimming the cream" from the market; i.e., directing their product lines and promotional strategies at the wealthiest 20 to 30 per cent or so of consumers. Except for Argentina and Uruguay, the penetration of very few modern sector goods, apart from some processed foods and textiles, filters down much below this strata of households, other than via the sale of second-hand goods and cast-offs.15/

15/ The percentage of metropolitan families in the market is often higher, but as is shown in a recent ECLA study, the average household income of all urban income groupings in the major Latin American cities, from the lowest 20 per cent of families on up, is also significantly higher in absolute terms than equivalent strata in provincial cities and towns and the countryside. "Income distribution in selected major cities of Latin America and in their respective countries" Economic Bulletin for Latin America, Vol. XVIII, 1973, pp. 13-45.

/The changing

The changing composition of consumption of the higher income strata is, however, also in the domain of the international demonstration effect. Unfortunately, this domain has not been explored in much detail thus far. Household expenditure surveys as conventionally structured go only a small way toward elucidating the effect. This is partly because their samples are cross-sectional rather than across time, but also because they tend to aggregate goods into broad types, thus blurring analysis of even the cross-sectional change of the product mixes within each category. Some enlightenment is provided by such surveys, such as that motorcar owing families in Latin America tend to spend a higher percentage of their income on the purchase, care and feeding of their vehicles than in most centre countries. But much more detailed evidence remains to be gathered and analysed in order to capture the dynamics of the demonstration effect.

Moreover, the income constraint ought not to be taken as pre-determined and independent of the demonstration effect. A loosely stated hypothesis in the economic development literature asserts that the appearance of modern goods has an incentive effect, stimulating individual efforts to save and earn more income for the purpose of acquiring the goods. Increased individual productive effort is, however, only one way to increase one's income. Often it may not even be the most effective way, if the institutional environment is adverse. One's income and access to credit can also be increased by exercising market or political power, or by cutting the corners of legality. Since the ability to effectively exercise such power is very unequally distributed, a high rate of inflow of new "incentive goods" via an intensification of the demonstration effect can well lead to a further concentration of income. That is, individuals and groups may wield their market power, their influence on government expenditure, and their tax-evading skills more intensely in order to generate the additional income needed to satisfy their new consumption aspirations.

/This corollary

This corollary of the "incentive goods" hypothesis has a degree of prima facie plausibility in Latin America, and may well contribute to the special intensity and persistence of inflation in the region.16/ It also implies that contrary to the usual specifications of statistical demand equations, income may be in part the dependent variable and consumer demand partly the independent variable. This likely interdependence of the key variables makes it even more difficult to assess quantitatively the extent of the demonstration effect. However, the following partial pieces of evidence on household savings behaviour, offer some quantitative clues which suggests both the importance of the effect and areas for further research on its impact.

1962 household income-expenditure survey data for Venezuela show that in the major cities only families earning 2,000 bolívares per month and up had positive savings. In small towns, however, positive savings began with family incomes of 500 bolívares and in rural areas with family incomes of 400 bolívares. Only 22 per cent of rural and small town families spent more than their income, whereas in Caracas the proportion was 80 per cent and in other major Venezuelan cities it was 67 per cent. Rural and small town families as a whole save 10 per cent of their income while in Caracas aggregate household savings rate was -16.5 per cent, and in other major cities, -10 per cent.

Brazilian data for 1961-1962 show a similar pattern. São Paulo families began to save at a family income level three times higher than the income at which families in Belem began to save. As a result, only 3 per cent of all São Paulo families were net savers, whereas nearly 70 per cent of Belem families saved part of their income.17/

16/ Markos Mamalakis, The Theory of Sectoral Clashes, Development Centre Reprint Nº 9, University of Wisconsin, Milwaukee, 1970.

17/ ECLA, "Income distribution in selected major cities of Latin America and in their respective countries", op.cit. p.43. Expenditure includes the acquisition of motor cars.

/The implications

The implications for societal welfare of an intensified demonstration effect are, therefore, more problematic than is implied by the economic theory of consumer demand. In fact, the impacts of the changing consumer styles are generating concerns at both ends of the demonstration effect channel, although the issues involved differ in the very afluent centre countries from those of the periphery.

The problems of very affluent societies like the United States and Sweden are more psychic in nature, related to a questioning whether much additional utility obtains any longer for the affluent, i.e. families of the upper 20-30 per cent income strata of such countries, from adding to their consumer stocks, beyond the passing pleasures of acquisition.

Initially consumer durables and various "convenience goods" were time-saving for the household, and this, plus shorter working hours, gave the household more leisure time. But with continued accumulation of consumer capital the time saving gets offset by the increasing amounts of leisure time absorbed in stock keeping maintenance, and in troubling decisions about when and how to use the growing stocks. Individual items in the stocks, moreover, depreciate rapidly as status symbols, since their acquisition usually spreads over the community, while the insistent messages from the market place to purchase new status items mount exponentially. The harried leisure classes faced with an increasing sense of inadequate leisure time, feel compelled to dispense with older time-consuming modes of enjoying leisure. Life styles change at a more rapid pace, and the pursuit of leisure consumption becomes more frenetic and unsatisfying. The ecological movement, dropping out of the "rat race" by the middle-aged, the "counter-culture" of the young, are inchoate manifestations of a growing malaise among the international consumption style setters, the affluent sectors of the centre countries. This could purport some major qualitative changes in the future content of international demonstration effect on the imitative Latin American consumers, perhaps even a slowing of the pace.

/At the

At the receiving end, the periphery countries, the current problems with the demonstration effect are of a quite different order. In the first place, there is much less reason for the higher income strata to become ridden with self-doubt about the utility to them of their acquired modern life style. Household durables, the private motor car, and other modern conveniences are still time-liberating for the Latin American buyer. And as long as an income gulf limits such goods to a minority of the households, the status value of modern acquisitions also depreciate more slowly than in the centre countries. It would, therefore, be unrealistic to expect anti-materialistic emanations from abroad to generate the same eager response from the upper income Latin American strata as have the materialistic emanations. In general, the avidity for modern goods in Latin America remains broadly rational from the private point of view. One cannot, therefore, place much reliance on the possibility that future changes in the international demonstration effect will, like a hidden hand, spontaneously bring about a more socially optimal pattern of consumer preferences in the region.

With no significant changes in the existing market structure and industrial policies prevalent in Latin America, the changing demand patterns of the middle and upper income groups will continue to dominate the changing pattern of production of the modern sector, apart from exports. The large domestically-owned firms will continue finding it more profitable and less risky to replenish temporary monopoly positions in their oligopolistic markets by importing their new product designs and processes, since these come complete with technical assistance and even prestigious trademarks and marketing help. They will resist, again for quite rational reasons from the private point of view, attempts to force them to do their own R & D. Investing in R & D would be a large added business expense, with much lower probability of profitable returns from the outlay than if the same sums were used for new foreign licensing agreements.

/Multinational

Multinational subsidiaries will resist for a somewhat different set of reasons. Within the multinational organization, the capability of doing effective R & D is obviously very high, but it is centered in the headquarters country. In the late 1960s, United States multinationals spent 97.4 per cent of their R & D in the United States; the 2.6 per cent performed abroad being done almost entirely by transport equipment firms and chiefly in Western Europe and Canada.18/

Production subsidiaries in peripheral economies, are, to the multinational company, mainly marketing by other means. The subsidiaries are typically set up at first in order to hurdle obstacles against gaining or keeping access to the local market via direct exporting of products. They continue to serve mainly as a funnel for extending the profitable life of successive products developed at headquarters for the centre country market by producing them later in the peripheral countries. Were the peripheral market to grow to some critical size, at that point there is little doubt that multinationals would begin to find it more profitable to forego some of the quasi-rents on their centre type products, and to modify them for peripheral market characteristics. United States multinationals already do some of this for their European markets, although this has not yet happened on any significant scale, as regards the peripheral country markets. But even if such efforts were to become an important part of a revised strategy of multinationals, there is little reason to doubt that the R & D would still be conducted in headquarters country facilities where talent and experience is already well-developed, and the top corporate managers on hand to regulate the effort.

18/ Data from McGraw Hill "Survey of business plans for research and development expenditures, 1967-1970" (May 1967), as summarized in Constantine V. Vaitsos, "Income distribution, welfare considerations and transnational enterprises" (presented at the Bellagio Conference on the Multinational Enterprise and Economic Analysis, September 1972).

/The demonstration

The demonstration effect seems thus to be an integral part of a complex systems-maintenance mechanism that keeps dependent peripheral economies from breaking out of Phase I technological dependency. The same mechanism also sharply restrains the rate of trickling down of modern consumption goods to the lower 70 per cent of the population. The mechanism of systems maintenance functions in the following four ways:

(i) Technological choice in the modern sector is governed by the processing requirements of the succession of new goods, and the processes, in turn, incorporate the labour saving and scale economy trends of process technology in the centre countries. Hence it sharply limits the growth of labour absorptive capacity of the modern sector in the peripheral countries.

(ii) The private utility of key modern goods, e.g., the motor car or the TV receiver, are heavily dependent on sizeable complementary public expenditures on expressways, tunnels, underground parking, telecommunications, etc. Given the political power of the higher income strata, a major share of public works expenditures tend to be devoted to maintaining the private utility of such consumer durables. The widespread incidence of abysmal housing, inadequate rural clinics, schools and water works in the majority of Latin American countries does not mobilize public resources with nearly the alacrity and dedication as does traffic congestion.

(iii) The negative impact of the demonstration effect on household savings ratios indicated earlier, and its probable stimulus to tax evasion, limits at the macro-level the rate of domestically financed capital formation to GNP. Hence it helps sustain one of the critical obstacles to maintaining rates of economic growth high enough to compensate for the limited employment effect of the modern sector.

(iv) The rapid rate of introduction of new and differentiated products augments the demand for industrial imports to equip and supply the new lines of production. New products tend to form successive links of a domestic product substitution chain; e.g. the

/succession from

succession from cotton and wool textiles, to rayon, to various synthetics, to new weaves and finishes; or from radio to radio-phonograph combinations, to black-white TV receivers, to coloured TV, to tape recorders, with accompanying shifts from vacuum tubes through various generations of solid state substitutes and other component improvements. New products tend initially to have fewer domestic backward linkages and hence a much higher import content per unit of output than the older product which they partially displace in the domestic market. New products based on foreign designs and processes, usually raise the import intensity of the overall product category. As home demand for the new products spread, opportunities for local substitution of the imported components tend to be exploited and the import content falls. The fall however, will then be offset by the introduction of still newer versions of the general product category with their initially high import content. Thus, whether the import coefficient of the product category rises or falls secularly depends critically on whether the pace of new product introduction outruns or falls short of the pace of import substitution of backward linkages.

The new products, moreover, tend to be more technologically complex and to be based much more on new materials developed abroad than are the older generation products. Hence efforts to keep pace with new backward linkages run into increasing obstacles, notably scale and skill deficiencies. The import content curve then begins to rise for the product category. The same dynamic substitutions obtain also between product categories, so that the import/output ratio of the entire modern sector also begins to rise. In all industrializing Latin American countries the import/full capacity output ratio began to turn up in the 1950s. The actual ratio rose at a slower rate primarily because balance-of-payments difficulties frequently forced governments into restrictive fiscal-monetary efforts, during which domestic demand fell and excess capacity rose. Thus,

/an intensifying

an intensifying demonstration effect underlies perhaps the major obstacle to sustaining high economic growth rates in the modern sector: the tendency for import requirements to grow faster than the capacity to import during periods of rapid growth.19/

(c) An appraisal of the relative price distortion approach

The main virtue of the approach is that it does emphasize what the technological gap approach largely disregards: that the inappropriate choice of technology in Latin American countries reflects market forces that bias entrepreneurial decisions in a socially suboptimal direction, rather than merely an inadequate inflow and dissemination of technological information from abroad. The critical deficiency of the relative price distortion approach is its underlying theoretical model. The model is based on institutional and behavioural assumptions that abstract from such central real world phenomena as uneven capacities to generate technology between countries, increasing economies of scale, uncertainty and uneven financial constraints on accumulation between small and large firms, oligopolistic competition, and plastic consumer preferences. It is nevertheless the basic model which guides the prescriptions for optimizing technological borrowing by eliminating relative price distortions, even though the model provides no analysis of either the complex of forces, other than relatative prices, that govern technological progress in the centre countries, nor of the socio-psychological forces, other than relative prices and incomes, that influence consumer choice in the countries of the periphery.

Considerable emphasis has been given here to analyzing the relative factor price distortion approach for two special reasons. The first is that corrective proposals for the technology problems of Latin American countries originating abroad have centred heavily

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19/ For supporting quantitative evidence from post-war Argentina, see David Felix, "The dilemma of import substitution", in G.F. Popanek, ed., Development Policy: Theory and Practice, Harvard University Press, 1968.

/on relative

on relative price corrections; for example, the summary volume of the recent set of studies of industrialization in various peripheral countries by the OECD.20/

The second is that in Latin America, even many critics of the market liberalization solutions, when they resort on occasion to economic analysis to buttress their case, tend to fall back on arguments implicitly drawn from the same normative model as are the views they are criticizing. We have in mind in particular, the static treatment of monopoly as a major distorting force, leading to overly simplified policy proposals for eliminating monopoly distortions, including even quick price "fixes" to reduce monopoly rents. Monopoly power is indeed endemic in Latin American economies. Its roots are, however, not merely in highly concentrated ownership of physical and financial assets, but also in various dynamic factors related to market demand, technological change and capital accumulation. A deeper understanding of these dynamic factors is a sine qua non if the technological and accumulation capacities of Latin American countries are to be guided toward a more equitable social and economic development than has been the experience to date. The critical commentary on the relative price distortion approach is intended to provide preliminary guidelines for the detailed micro-analysis of these dynamic factors that still remains largely to be done.

But it is clear that measures to change prevailing relative prices - to reduce labour costs in relation to the cost of capital and equipment - combined with competitive pressures to force firms to be more efficient, are alone unlikely to result in widespread adoption of more appropriate forms of technology. Alternative techniques which use more labour, and which would become more profitable if labour costs were reduced in relative terms, are often not readily available.

20/ I.M.D. Little, M. Scott and T. Seitovsky, Industry and Trade in Developing Countries: A Comparative Study (London, 1970).

/Further, the

Further, the dynamics of consumer demand are often of greater importance to the firm when choosing products and techniques than are relative factor prices. Changes in relative prices may be required but they will need to be supplemented by other, and probably more basic, measures if a sustained shift toward the development and use of a more appropriate technology is to be succesfully promoted.

Chapter II

SOME NUMERICAL EXERCISES: ORDERS OF MAGNITUDE TO BE CONSIDERED IN THE ORIENTATION OF TECHNOLOGY POLICY

The historical analysis in the preceding chapter shows that in those countries which have been successful in the effort at late industrialization, technological creativity has emerged at a relatively early stage. The types of technology in use in the most advanced countries have changed rapidly with the passing of time, and the more general external economic and political environment has also been different in different periods. In these changing circumstances one of the key factors to success has been the ability to adapt to the conditions of the time, and to evolve new policies conducive to the early establishment of suitable forms of technological creativity. This leads to the conclusion that successful industrialization in Latin America will also require an adaptation of policies and institutions, designed to stimulate the development of the forms of technological creativity judged most appropriate in the environment of today.

The critical analysis of important currents of thought regarding technological problems - what have been referred to as the technological gap and the relative price distortion approaches - reinforces this view. In the present-day world economy it is not likely to be sufficient to encourage the use of advanced techniques from the centre countries, with the expectation that with time and some assistance this will lead to internal technological creativity. The new techniques are likely to continue to be brought in from abroad and to be of a sort not well suited to the conditions of the region. Stronger and more immediate measures will be required to produce technological creativity of the sort required.

/1. Present-day

1. Present-day conditions and the dilemma to be faced

A major question in all this is "What sort of technology is required in the conditions of today?" Perhaps the principal "condition" to be noted is that, as has become increasingly clear, the patterns of development generally followed in Latin America (and the technology which has been used) have spread their benefits very unevenly; there has been no obvious or rapid integration of the entire economy. This situation, and the problems it poses, has been discussed in the Introduction to this document; and various aspects have been analyzed in detail in Chapter I. It is one of the central problems which an adequate sort of creative technology will have to confront.

The present chapter illustrates this problem through the use of a relatively simple numerical exercise. This helps to make more explicit the dilemma involved and to assign approximate orders of magnitude. Also, a simulation experiment projects these magnitudes to the end of the century to give an idea of what trends might be expected with different assumptions. It is well to emphasize at once that these projections are not predictions; they only show what would happen given the assumptions used in the exercise.

It is useful first to look at the problem in the most general terms, to regard "technology" in the widest sense as the total of all those aspects of economic organization which determine the volume of goods and services available to a community. This total can be conveniently estimated by the use of the gross product figures, which can then give an approximate idea of the present overall level of technology in Latin America and how it might evolve. Corresponding figures for the centre countries are given to provide a standard for comparison. In 1970 the per capita gross product of Latin America as a whole was US$ 540, while for the developed market economies as a whole the figure was US$ 2,960. The figures for major Western European countries such as France or West Germany are very similar to this latter average, although there are of course, centre countries both at somewhat higher and at somewhat lower

/levels.1/ The

levels.1/ The average figure can therefore be taken as representing a high level of technology, but one in general use in a number of countries. In these most general terms then, the average level of technology in Latin America in 1970 was rather less than one-fifth that of the advanced centre countries.

This makes clear the magnitude of the inequality which must result if technology is used to try to more or less reproduce the production pattern of the centre countries - a production which is geared to income levels far above the Latin American average. The extent to which this sort of inequality has been introduced into the production structure of the region has already been discussed, both in the Introduction and in Chapter I. It makes clear that an appropriate technological policy should be at least as concerned with the type of product to be made, and the general development pattern to be followed, as with selecting the most appropriate way to produce a specific item.

This is the existing situation. It needs also to be asked how fast this "gap" might reasonably be expected to close. Since technological policy will inevitably bear full fruit only over a considerable period of time, what sort of future pattern would it be appropriate to aim at? The general order of magnitude involved, and how much the "gap" can be narrowed with different assumptions can be readily determined by the use of a series of relatively simple simulation experiments.

The central difficulty can be shown at once by presenting a calculation based on rather favourable assumption about future economic advance in the region. The main assumptions and results of this calculation are as follows:

1/ The figures are taken from the United Nations, Yearbook of National Accounts Statistics 1971, Vol. III, Table 1A. They are in current 1970 dollars and conversions have been made at prevailing exchange rates.

/Gross product

	Gross product per capita in 1970	Average annual rate of increase 1970-2000			Gross product per capita in 2000
		Gross product	Population	Gross product per capita	
Developed country	2 960	3.0	0.5	2.5	6 210
Latin America	540	7.0	2.4	4.5	2 025

If Latin America is able to sustain a rapid increase in per capita production levels, the total income per capita at the end of the century will be nearly 70 per cent of the present day average in the centre countries. But even assuming per capita income increase much more rapidly in Latin America than in the centre countries throughout this thirty year period, the average in these countries would still be triple the Latin American figure at the end of the century. For Latin America to reach full parity in this sense income per capita would have to increase at an average annual rate of 8.5 per cent during these thirty years, which in turn would require an annual increase in the gross product of slightly more than 11 per cent.

These results do not follow from the use of pessimistic assumptions in the calculations. For the developed countries it has been assumed that population will increase at an average annual rate of 0.5 per cent to the end of the century. In most of the Western European centre countries population growth has already slowed to this figure, and if anything the rate of population increase in the next several decades will probably be less than that shown. With the population increase assumed, the gross product will have to increase at a rate of only 3.0 per cent per annum to achieve the specified increase in per capita incomes. In the recent past the gross product in the centre countries has increased at higher

/rates, and

rates, and projections into the future generally also foresee rather higher rates of growth. The rate of growth in per capita incomes shown for the centre countries is therefore a conservative figure; it does not require even the continuation of recent past performance.

The assumptions used for Latin America are by contrast more likely to prove optimistic. The projected annual rate of growth of the population (2.4 per cent) is well below the present rate for the region (2.9 per cent), and also below most expectations about the average rate likely to prevail over the 1970-2000 period. Given the youthful age structure of the population, a sharp decline in age specific birth rates would be required for the annual increase to average no more than 2.4 per cent over the period. Even so, the projected increase in per capita incomes requires an average annual increase in the gross product of 7 per cent - compared to only 3 per cent in the centre countries.

This is well above what the region has been able to achieve in past periods - during the 1960's, for example, the gross product increased at an average annual rate of 5.4 per cent. Still, in recent years very high growth rates have begun to seem increasingly possible, and a 7 per cent figure may not appear startlingly high. It needs to be emphasized however, that a 7 per cent <u>average</u> annual increase in the gross product over a 30 year period would be a startling achievement. By the end of the century total production would be 7 1/2 times that of 1970, so that the economy known today would be only a minor element in that to be built. In little more than a single generation an entirely new and vastly larger economic structure would have to be created - taking Latin America as a whole this new structure would be nearly half again as large as the 1970 economies of all of the countries of Western Europe combined. The economic achievement of Western Europe since the end of the Second World War, itself nearly a 30 year period, is generally regarded as very impressive. If the economies of Latin America were to expand at a 7 per cent rate to the end of the century the achievement would be very much more substantial: starting from a

/smaller base

smaller base, the absolute increase in the volume of production would be much greater. Somewhat more will be said about specific difficulties encountered in achieving very high growth rates later in this chapter.

There is a clear conclusion to be drawn from this exercise: it is not possible to "catch up" with the advanced industrial countries in the foreseeable future, and for the region as a whole any policy aimed at that goal is illusory. This means that a technological policy aimed at keeping pace with the latest product designs and innovations in the centre countries is also an illusion. These products and processes will be developed for populations with much higher average income levels than those which will prevail in the region. If they are introduced it can only be for a minority of the population, and the disparities in income which now exist will be continued.

A more realistic policy goal might be to aim at achieving the current high Western European levels of technology and living standards by around the end of the century, which would in itself be an enormous achievement and advance. This would mean that the production pattern and techniques already known would be the approximate objective. New product designs and innovations would be regarded critically and only introduced if they were clearly suitable to the needs of the region or offered some special advantage. Creative internal technology would mostly be concerned with better adaptation of existing techniques, and with spreading the use of these techniques more widely through the economy.

While these are the realistic prospects for Latin America viewed as a whole, it needs to be noted that there is considerable diversity within the region and so scope for variation among national goals. An idea of the potential range can be given by making the same projection for a high income country, such as Argentina, and for one of the several smaller countries of the region where the per capita gross product in 1970 was only around US$ 300. The figures are as follows:

/Gross product

	Gross product per capita		
	1974	Annual rate of increase 1970-2000	2000
Developed country	2 960	2.5	6 210
Argentina	1 050	4.5	3 930
Low income country	300	4.5	1 125

If a higher income country such as Argentina can increase per capita incomes at the rate of 4.5 per cent per annum they can be raised to well above the current Western European level by the end of the century, and to nearly two-thirds the level these countries are themselves projected to have at that time. Further, in the specific case of Argentina, the rate of population increase is well below that in most countries so that a total growth rate of 5.5 per cent to 6.0 per cent would probably suffice for this purpose (compared to 7.0 per cent required for the region as a whole). If a really rapid rate of growth could be sustained, "catching up" with the centre countries would be a more feasible goal for a high income country such as Argentina. In this case technological policy could appropriately be more heavily oriented toward keeping abreast of the latest developments in the centre countries, as there would be a greater expectation that these developments could be suitably adapted for use by the bulk of the population.

For the poorer countries of the region however, even achieving the present level of the advanced countries does not appear to be a realistic goal within these time limits. Rates of population increase are typically high in these countries so that the projected per capita figure could well require a total growth rate somewhat higher even than the 7 per cent cited earlier. Achieving, by the end of the century, a oer caouta gross product 40-50 per cent of

the present West European level might be a more appropriate goal for these countries. This would require even greater care in designing an appropriate technological policy.

This general point of what is feasible during the next several decades is most clearly seen when discussed in terms of the entire population to be provided for. Also, per capita output figures are important to keep in mind when considering the type of goods produced; and it is worth stressing again that the selection of the goods to be produced should itself be considered an important aspect of technological choice. But other aspects of the level of technology are better related to employment rather than to the population as a whole, and so it is convenient at this point to shift the basis of the discussion to the labour force.

The general future prospect can also be expressed in these terms. Calculations similar to those above, but in terms of production per member of the labour force are as follows (figures are again in U.S. dollars):

	Production per member of the labour force in 1970	Rate of increase	Production per member of the labour force in 2000
Developed country	6 920	2.5	14 510
Latin America	1 735	4.0	5 627
Argentina	2 880	4.0	9 340
Low income country	970	4.0	3 146

/The general

The general conclusions are the same, although there is some difference in the relative magnitude of the figures.2/

Thus far the discussion has been in terms of average productivity, but one of the key characteristics of the Latin American economy is the existence of an important, high productivity, modern sector, while the bulk of the labour force is still engaged in activities where productivity levels are moderate to low. Although in average terms the level of technology and the standard of living are well below those of Western Europe (and are likely to remain so), it is still possible to pursue a policy of trying to "catch up", and this is in effect the policy which has generally been followed. Modern type products and production methods are taken over more or less intact from the advanced countries; these are generally designed for use by populations with high income levels, and advanced techniques are available for their production; those who produce and consume these goods (and their associated services) become something of a closed and limited group in the economy. The major implications of this process, particularly with respect to the distribution of income, have already been discussed in the Introduction;

2/ When expressed in these terms the gap between Latin America and the developed countries is less in 1970, since in Latin America the labour force is only about 31 per cent of the population while in countries such as France or West Germany the figure is around 42 per cent. This largely reflects the differences in age structure resulting from the higher birth rate: an average worker in Latin America has a relatively high productivity, but also has more dependents to support. At the same time, the labour force is likely to increase at an average rate of around 3 per cent annum for the rest of this century; a decline in the rate of population increase will only begin to affect the labour force figures after about a 15 year lag, and a declining birth rate would probably lead to higher participation rates for women. Thus a 7 per cent aggregate growth rate would mean an increase in productivity per member of the labour force of only 4 per cent. Again for Argentina the situation is different from most of the region: the participation rate is already higher (36.5 per cent) and the labour force will probably increase at less than 1.5 per cent per annum so that a lower growth rate is implied by the 4 per cent rate of productivity increase.

/and some

and some important elements of the process itself, relating more specifically to the choice of technology, have been analyzed in Chapter I. All that needs to the emphasized here are the likely consequences of continuing a policy of this sort.

Although fully adequate data on productivity levels for different groups are not available, the situation can be illustrated in approximate terms. For this purpose the economy can be divided into three large groups as follows:

(a) A modern sector which we will assume employs about 20 per cent of the labour force with productivity levels about three-quarters the economy-wide average in countries such as France or West Germany. With these assumptions the modern sector accounts for about 60 per cent of total production.

(b) An intermediate sector which occupies about half the labour force and where productivity levels are rather less than one-quarter those of the modern sector. This sector accounts for somewhat more than one-third of total production.

(c) A "subsistence" 3/ sector where 30 per cent of the labour force is engaged in activities with very low productivity levels and which therefore accounts for a minimal part of total production (around 5 per cent).

3/ This term is used to describe that substantial part of the population engaged in occupations in which productivity and incomes are very low. It does not imply that such occupations are outside the market economy; on the contrary, the marginal type urban services which occupy a major proportion of this group are an integral part of the urban money economy. In so far as it is interpreted literally it should instead be taken to mean that incomes of this group are not much more than what is needed to subsist. The term is not completely satisfactory but on the whole seems preferible to others (the "primitive" sector, for example) which have been used.

/This is

This is the existing reality: a top group with productivity and income levels not too far below those of many of the advanced industrial countries, and whose members can therefore reasonably aim at the kind of consumption patter prevailing in those countries; while the bulk of the population is much poorer and for the most part can only watch the process from outside.4/

The possibilities for the orientation of future growth revolve, in this sense, around the extent to which investment and technological advance are (i) to continue to be concentrated on the introduction of ever new goods and processes in the modern sector, allowing this sector to advance in line with developments in the centre countries; or (ii) are to be directed primarily toward incorporating those who have thus far participated only very partially, or even remained entirely outside the system. The possibilities, and the inherent conflict in existing circumstances can be easily illustrated.

2. Concentrating investment and technology in the modern sector

As one possibility, suppose that the basic development strategy is to concentrate on modern type production, with the expectation that sustained rapid growth will progressively absorb the rest of the labour force until the economy is fully integrated at the level of the modern sector. A few of the newer trends in the centre

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4/ Although the figures used in the calculations, and the assumptions involved, are only rough approximations to simplify the discussion, they are in line with available estimates for the region. With respect to productivity, numerical estimates made by ECLA show that the modern sector, more strictly defined, accounted for 12.4 per cent of total employment and 53.3 per cent of the gross product toward the end of the 1960's. Estimates of the relative size and productivity levels of the intermediate and "subsistence" sectors were similar to those shown here. Estimates of the distribution of income in the region show that the top 20 per cent receive about 60 per cent of total income and the poorest 30 per cent only around 5 per cent. There is not a perfect correlation between income and productivity of course, but the different estimates do indicate that this is approximately the extent of concentration which exists in the region.

/countries are

countries are discouraged, and some measures are taken to improve techniques in the non-modern areas, but these aspects are secondary to the main effort. The general development strategy, and the focus of technological policy, is on keeping the modern sector competitive and expanding its size as rapidly as possible.

In numerical terms the following assumptions would coincide with a strategy of this sort. Productivity in the modern sector would advance in line with that in the centre countries, at a rate of 2.5 per cent per annum. This means that productivity in the modern sector would remain at about three-quarters the economy wide average of a typical centre country. Productivity in the intermediate and "subsistence" sectors would be maintained relative to that of the modern sector; that is, productivity in these areas too would increase at a 2.5 per cent rate. To the extent that the economy-wide growth rate permitted, investment would be used to upgrade individual members of the labour force, some passing from the "subsistence" to the intermediate sector and others from the intermediate to the modern sector.

It is worth noting that these are fairly moderate assumptions. Productivity (and income) levels in the intermediate and "subsistence" sectors advance in line with those of the modern sector - and this has not always been the case in the past. More important perhaps, productivity in the modern sector does not advance any closer to the levels of the centre countries. A more aggressive policy could well push for full competitiveness with the centre countries, particularly to be able to compete in world markets, and this would further reduce the absorptive capacity of the modern sector.

Suppose then that with this strategy it is possible to achieve a prolonged period of steady and rapid growth - 7 per cent per annum in aggregate terms or 4.2 per cent per annum in terms of average productivity per member of the labour force. From 1970 to the end of the century the composition and productivity of the labour force would then change as follows (figures for a developed country and the average figures for the region are repeated for easy comparison):

/Production per

	Production per member of the labour force (1970 dollars)		Percentage of the total labour force occupied	
	1970	2000	1970	2000
Developed country	6 920	14 510	100	100
Latin America	1 735	5 960	100	100
Modern sector	5 200	10 900	20	45
Intermediate sector	1 240	2 600	50	35
"Subsistence" sector	250	525	30	20

The modern sector could advance greatly in these conditions. Not only would productivity levels within the sector somewhat more than double, but the proportion of the total labour force engaged in the sector would rise from 20 per cent to about 45 per cent at the end of the century. Even so, well over half the labour force would still remain outside the modern sector after 30 years, with an important proportion remaining in the "subsistence" sector. This majority of the labour force would still be engaged in activities where productivity was sharply lower than in the modern sector so that the disparities in income levels would almost certainly continue to be very large.

This example illustrates the attractions, as well as the shortcomings of growth centered on the modern sector. It is perfectly possible for a part of the population to follow the consumption patterns of the developed countries; and if a rapid growth can be maintained additional segments of the population can be incorporated at an increasing rate. Indeed, if the rate of population increase should decline substantially, and the rapid growth continue for a further 30 years or so (beyond the year 2000), there would be good prospects of integrating the entire population into the modern sector. That is, favourable population trends and

/a steady

a steady and rapid rate of expansion would in fact hold out the prospect of "catching up" with the advanced countries about one-third of the way into the next century.

It needs to be emphasized that the absorption power of the modern sector depends heavily on the achievement of a rapid increase in the overall level of productivity (which in turn depends mostly on the total growth rate). If, instead of the 4.2 per cent increase per annum assumed above, the calculations are made at progressively lower rates the results are as follows:

Annual percentage increase in average productivity	Percentage composition of the labour force in 2000		
	Modern sector	Intermediate sector	"Subsistence" sector
4.2	45	35	20
3.2	29	46	25
2.5	20	50	30

The percentage absorbed by the modern sector falls rapidly with a decline in the overall growth rate, and should productivity increase at the lowest rate shown there would be no change at all in the structure of the labour force over the 30 year period. Incomes within each sector would increase at the rate of 2.5 per cent a year, but there would be no reduction in the disparities between the different sectors; the great bulk of the labour force would remain in the intermediate and "subsistence" areas with productivity (and income) levels sharply below those of the modern sector. The modern sector would continue to provide highly attractive new goods to a minority, but this minority would remain a constant, rather than an expanding, proportion of the whole.

/Nor should

Nor should it be thought that this lowest figure involves overly pessimistic assumptions. If there is no substantial decline in the birth rate during the next 10-15 years, or even if this occurs but is accompanied by higher female participation rates, the labour force will expand at around 3 per cent per annum, on average, to the end of the century. If the aggregate growth rate should average 5.5 per cent per annum, average productivity would then increase at a yearly rate of about 2.5 per cent. For the period 1960-1970, for the region as a whole, the gross product increased at 5.4 per cent and in per capita terms at 2.4 per cent per annum. The minimum rate shown only implies future achievements similar to those of the recent past. The higher rates on which most of the discussion is based imply substantial improvements over past performance.

This makes clear the risk, and the major shortcoming, of a policy which concentrates investment and technological capacity in the modern sector. The risk is that if the economic performance is only moderately good the modern sector will remain an enclave, with the great bulk of the population continuing in activities with sharply lower productivity (and income) levels. The major shortcoming is that even a spectacular economic performance will require well over half a century to integrate the entire labour force into a modern sector which advances in line with developments in the centre countries.

Since achieving a high rate of economic growth is of such central importance to the success of a technology policy oriented toward the modern sector, it is advisable to examine, even if only very briefly, the economic feasibility of accelerated growth for the region. In very general terms this has already been done; here the question can be approached via two major, but more specific, components of the economy. The first is via investment requirements and the ability to finance these requirements. Since the projected rapid growth rate is about 30 per cent higher than that for the 1960's, this means that investment, as a percentage of the gross

product, would probably have to increase substantially. A sharp increase could be avoided only if the capital/output ratio could be correspondingly reduced, and this is unlikely with growth, and investment, concentrated on the modern sector.

If the investment coefficient does rise substantially then this increase will have to be financed, either by an increase in the internal savings ratio or by an increased inflow of foreign capital. A large increase in the internal savings ratio is difficult to achieve with a modern biased growth pattern. The importance of the demonstration effect, product differentiation with its frequent model changes, and the continuing flow of new goods are all aspects of modern industrial society which exert pressure for spending; and so tend to depress potential savings ratios. This aspect has already been discussed in more detail in Chapter I. The alternative is an increased inflow of foreign capital, and the probability seems high that this would be a feature of rapid modern oriented growth. Recent Brazilian experience tends to confirm this expectation.

The second aggregate way of examining the feasibility of very rapid growth is through the foreign sector. It has been common experience in Latin America, as well as elsewhere, that accelerated growth leads to a more than proportionate rise in imports, and these must be financed, either by rising export earnings or rising inflows of foreign capital. The latter have often provided short term relief, but in the longer term the cost of servicing the capital inflows tends itself to become a major drain on exchange availabilities. Thus rising export earnings become crucial, and the external sector has long been regarded as perhaps the major bottleneck to the achievement of more rapid growth rates.

Some of the difficulties likely to be encountered with a growth and technological policy oriented toward the modern sector can again be placed in perspective by presenting a few numerical estimates. Here too favourable assumption are made throughout the

/exercise; the

exercise; the fact that the difficulties are clearly large, even with optimistic assumptions, indicates just how serious the obstacles are likely to be in this area.

Suppose, first, that a 7 per cent total growth rate could be sustained with exports expanding at the rate of 8.5 per cent per annum. This is likely to be a minimum figure. Modern type growth involves large import requirements and financial payments, and as rapid growth would progressively expand the relative size of the modern area, exchange requirements are certain to increase faster than total production. In the past the gap has tended to be significantly larger than that assumed here and growth has frequently had to be curbed because of insufficient foreign exchange availabilities.

At the moment raw materials provide the bulk of Latin American exports, but there is little prospect that exports of this sort can expand at anything like the projected 8.5 per cent rate. On the demand size, the assumed rate of growth for the centre countries is only 3 per cent per annum, and although an increasing need to import basic commodities as domestic supplies are exhausted will raise demand somewhat, it is not likely to vary much from this 3 per cent figure in volume terms.

On the supply side it is doubtful that Latin America could sustain a very rapid increase in raw materials exports for a prolonged period. The projection implies a more than seven-fold increase in total production in the region by the end of the century, and this will itself involve enormous demands on available materials supplies. Resources will have to be more carefully preserved, and the additional amounts which can be exported are likely to be limited, even if there is adequate external demand.

In this situation relative prices for primary commodities may well show a long-term improvement, but this will no longer be an unmixed advantage to the region; with the rapid industrialization projected, the region will itself become a major consumer and so from this standpoint adversely affected by rising materials costs.

/Taking all

Taking all these considerations into account, exports of primary commodities have been projected to increase at 5 per cent per annum, again probably an optimist assumption.

The difference would have to be accounted for by industrial exports, and it is here that the obstacles are apt to be greatest. Over the 30 year period industrial exports would have to rise to more than 60 times the 1970 level - at an average rate of increase of 15 per cent per annum. They would account for two-thirds of the regions exports at the end of the century. Such an increase would again be difficult from both the demand and from the supply side.

It is the problems of supply that are more generally known - all the difficulties involved in reducing costs, maintaining quality, and devising marketing techniques so as to be able to compete in the world market for industrial products. But when considering an increase in industrial exports of the size suggested, the difficulties faced from the demand side are probably at least as serious.

The problem can be clearly seen by noting the implications for the region's share of total world trade in industrial products. If world trade in industrial products is projected to increase at 5 per cent per annum,5/ this would mean that Latin America's share of this total would rise from 1 per cent in 1970 to 15 per cent at the end of the century. If some increase in the share of other developing regions is also postulated, then the share of the centre countries in world industrial exports would have to drop very sharply. From about 95 per cent of the total in 1970 this would

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5/ This rate of increase is lower than that of the recent past, a reflection of the lower growth rate projected for the centre countries. It has been assumed these countries will grow at the rate of only 3 per cent per annum, and as they account for the great bulk of world trade in industrial products, such trade must also be expected to increase less rapidly than in the past.

/have to

have to fall to 75 per cent or less by the end of the century. That is, for Latin America to achieve an increase in industrial exports of the size required, the centre countries would have to accept a large decline in their own share of such trade; and Latin America would probably also have to be given a preferencial position vis-à-vis the other developing areas.

Relative changes of this magnitude would not necessarily be voluntarily accepted by the rest of the world and it would be difficult to force the changes required. Exports to third markets might be substantially increased if the region could become sufficiently competitive, but the largest markets for industrial exports would continue to be the home markets of the centre countries, and there is no easy way of forcing entry into those markets. Judging from recent experience it seems more likely that the rest of the world would resist rather than passively accept a large scale incursion of this sort into world markets for industrial products.

It is thus difficult to be very optimist about the prospects for the achievement of very rapid modern sector oriented growth in the region as a whole, and so difficult to be enthusiastic about a technology policy concentrated heavily on the modern area. Although there is little doubt that much could be achieved, the proportion of the total population which could be incorporated into the modern sector would probably continue to be disappointing, and great disparities in income levels would probably continue to prevail.

But here again it is necessary to note that what seems unlikely for the region as a whole might be much more possible for a single country. Special conditions in any respect might ease the difficulties, but it needs to be pointed out that with respect to the crucial problem of the external sector this is true in a special sense. It is quite possible that one or two countries could establish themselves as export centers for the region. The restraints of the world market would then be less important as the exports of a single country, even if growing

rapidly, are a smaller factor than when considering exports of the entire region. That the restraints would not be removed is clear from past experience of even small countries in world markets for industrial goods, but they would certainly be less severe.

3. A growth pattern oriented toward the non-modern areas

An exercise similar to that presented above, but dealing with a growth pattern oriented toward the non-modern sectors of the economy, readily illustrates the different nature of the results. Shifting the center of attention away from the modern sector still leaves considerable scope for variation in the exact pattern of growth, and here it will be assumed that a fairly moderate version is followed. This would involve the following central characteristics. New products and processes in the centre countries are screened carefully, and only those judged to be of particular benefit are introduced into the region. But this inflow, combined with internal investment and technological efforts, is enough to permit a continued, if slower, advance of the modern sector itself. In numerical terms it is assumed that productivity in the modern sector rises by about one-quarter, and employment expands so that the sector absorbs 25 per cent of the labour force at the end of the century. The increase in productivity is an average, and would permit sharp rises in some activities while techniques in others remained relatively unchanged. Overall it would permit a modest rise in incomes even for those already incorporated into the modern sector at the beginning of the period.

In the rest of the economy the objective would be first, to absorb all those in the "subsistence" area into the intermediate sector, and second, to raise productivity levels in the intermediate sector as much as possible. Shifting those engaged in "subsistence" type activities elsewhere would reflect the idea that most of these are not very amenable to direct efforts to raise productivity. For example, in the urban areas much of the "subsistence" labour force is engaged in service activities of only marginal value, and more

productive opportunities need to be provided. In the rural areas much of the "subsistence" sector is the result of land holdings which are too small and improvement depends on land reform measures, expanded opportunities for rural artisan type activities, etc. The first aspect would then mean expanding the size of the intermediate sector so as to absorb the "subsistence" area, thus raising income levels of the poorest group in the economy. The second aspect would mean raising productivity (and income) levels in the intermediate sector itself.

The results would of course again depend on how high a rate of overall economic expansion could be achieved. The possibilities can be illustrated with calculations using the same alternative growth rates as before: a 4.2 per cent annual increase in overall productivity (which implies a 7 per cent rate of growth of the gross product), and two progressively lower figures. The results of the calculation are as follows:

	Percentage of labour force occupied		Productivity in 1970	Productivity in 2000 with specified annual increase 1970 to 2000		
	1970	2000		4.2 %	3.2 %	2.5 %
Total economy	100	100	1 735	5 960	4 460	3 640
Modern sector	20	25	5 200	6 500	6 500	6 500
Intermediate sector	50	75	1 240	5 780	3 780	2 690
"Subsistence" sector	30	0	250	-	-	-

In all three variants it is assumed the "subsistence" group is completely absorbed into the intermediate sector by the end of the century. If it were possible to achieve a total growth rate of 7 per cent, productivity in the intermediate sector itself could be raised to quite close to the level prevailing in the modern sector

/- that is,

- that is, by the end of the century the economy could be approaching full homogeneity. With lower rates of growth the advance of the intermediate sector is progressively less, but even in the least favourable of the three possibilities shown productivity in the intermediate sector rises to more than 40 per cent that of the modern sector at the end of the century. This compares with an initial 1970 situation in which productivity in the intermediate sector was less than one-quarter that of the modern sector and a large "subsistence" sector existed with a productivity level less than one-twentieth that of the modern sector.

This makes clear the major advantage of an investment and technology policy oriented toward the non-modern areas of the economy: the great disparities in productivity and income levels which presently characterize the region could be progressively and rather rapidly narrowed. Even if very high aggregate growth rates could not be achieved, very substantial progress could still be made in this direction. The disappointment of ccurse would be that, even though some advance within the modern sector is projected, this is moderate, and productivity levels fall progressively further behind those in the centre countries. By the end of the century they would be only about 60 per cent of the economy-wide average in a typical centre country, and there would no longer be a large group in the region whose living patterns were closely similar to those which would then prevail in the high income countries of the world.

The external sector would be a less serious obstacle to rapid growth if the orientation were of this sort. The production pattern and the technology used would diverge increasingly from those of the centre countries, and so the necessity to import technology, equipment, special materials, etc. from those countries would also be less. There would therefore be less pressure to expand exports to the centre countries. A more basic type of import substitution could occur, and trade could more naturally expand on an intra-regional basis.

/The major

The major obstacles to a rapid growth of this sort are likely to be of an internal nature and do not lend themselves to even crude quantitative exercises. In opting for such a strategy, Latin America would be largely charting a novel course, away from the economic dynamics that have dominated its growth since the mid-19th century. In very general terms, it would be embarking on major policy and institutional changes along either socialistic or, alternatively, some variant of a nationalistic pattern. Even if the popular conciencia needed to support such radical deviation from the past were to spring up quickly, the new strategy would still have to probe its way in a quite different national and international environment from that which confronted any of the foreign examplars.

It would be foolish to reject all further access to foreign technology, hence new selective arrangements would have to be worked out with those major creators and repositories of that technology, the multinational companies. This would obviously be a difficult, painful process. Neither can it be expected that intensive efforts to promote indigenous technological creativity would quickly bear fruit. The capacity of the non-modern areas of the economy to absorb new techniques and organizational improvements is another limiting factor. Translating vague popular enthusiasm for the new strategy into a willingness to accept reduced access to the latest foreign creations is still another, as is also the problem of sustaining work commitment among the managerial and technical classes in the face of such austerity. The development of policy and institutional innovations for solidifying the effort, and the creation of a bureaucracy adequate for the strategy, are other obstacles high on the list. The list could be extended further, but the above illustrates the type of dominant obstacles that an effective strategy of this sort would have to overcome.

It should be noted, however, that with respect to technological policy alone it is likely to prove easier to stimulate creative technological efforts within the region with a development pattern of this sort than if growth continues to be concentrated on the

modern sector. The objectives are clearer, the tendency to follow the latest advance in the centre countries and import the new techniques is replaced by the need to examine conditions in the non-modern areas and devise appropriate techniques for improving these conditions. The scientific, technical, and capital requirements for truly creative technological advance of this sort are bound to be much less onerous than those required to conduct creative research along the lines followed in the centre countries, and which would have to be duplicated if technological creativity with growth centered on the modern sector continues to be the goal.

Even if it is assumed that the difficulties of working out a new pattern of growth are likely to limit the aggregate growth rate to the lowest of the illustrative figures presented above (2.5 per cent per annum in terms of average productivity increase), this would still permit technical progress to significantly improve the material well-being of a much larger proportion of the population than could all out modern-sector-based growth. It would also equip the region, after a period of time, with a richer and more broadly distributed capacity for accelerating productivity increases in subsequent years than would continuing with the current growth strategy.

Chapter III

SOME SUGGESTIONS FOR THE TECHNOLOGICAL POLICY OF LATIN AMERICA IN THE COMING DECADES

The notable emergence in the past decade of policy measures in Latin American countries to modify the costs and content of their technology, has concentrated mainly on three aspects of the region's complex technology problems: improving the "technological terms of trade", expanding the channels for disseminating technological information to local producers and enlarging the cadres of scientists and high-level technical personnel. The basic rational guiding these policies has been the technological gap approach in combination with the view that the semi-monopolistic international market for technology requires countervailing power by the state to strengthen the weak bargaining position of local producers as purchasers of foreign technology. As yet the direct promotion of indigenous creativity as a partial substitute for technological importing, has played a subordinate role in most countries. There are some exceptions, most notably Peru, which with the recent establishment of INTINTEC seems to have shifted its emphasis to promoting domestic industrial innovation, but the Peruvian case is as yet atypical.

The basic implication of the analysis of this document is, however, that a substantial capacity to adapt and create technology is crucial for development strategies that aim for broad-based socio-economic growth. Hence its corrolary is that Latin American technology policy must alter its order of priorities and begin focusing on methods to stimulate that capacity.

It should of course be apparent that quick payoffs from such efforts are unlikely, but rather that the rewards will cumulate over time. Initially, the payoffs will be restrained by inexperience as well as by the long gestation and high failure rates that characterize innovative efforts even in societies with long experience at creating technology. But even more

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basically, the pace of the Latin American effort will be constrained by the socio-economic obstacles analyzed in earlier sections. Nevertheless, the effort need not wait for mass attitudinal conversion and wholesale institutional changes to set the stage. There are openings even within the existing socio-economic setting to start redirecting and amplifying technological strategy, and in so doing, to help favourably to alter the setting.

In identifying such openings, it is useful to distinguish the productive areas where lack of adequate technological information is a key obstacle to improving social productivity, from those in which decision biases of the enterprises are the chief obstacle. In the first areas, institutions that provide direct technical assistance, data banks, and other means of enriching the flow of information could be quite effective. In the second areas, the attempt to supply such information will be largely met with indifference by the potential recipients, since they are already plugged into informational networks suitable for their purposes. The distinction overlaps the division between the public and the private sector, although the nature of the main constraining decision biases differs between the two sectors.

1. Initial openings for technological policies for the private sector

In the private sector, the difference in outlook is basically determined by the position of the firm in its market. Large firms producing for the local market are typically engaged in oligopolistic market strategies. Indeed such firms are the main private channels for importing foreign technology, since their continued participation in product differentiation competition critically depends on replenishing product lines from abroad. Well-established informational channels link them to foreign sources of new technology; to the multinational headquarters in the case of foreign subsidiaries, and to foreign licensors in the case of domestically-owned firms.

Obtaining technology through these channels has two overwhelming advantages for the firm over collaborating in creative technological efforts with local technology institutes. One is that it receives as a package a well-tested process or product accompanied by expert assistance in production layout, trouble-shooting, quality control and marketing, at a more or less predictable unit cost. The second is that the licenses often include exclusive distribution rights in the local market. These advantages greatly lower investment uncertainty for the firm in staying abreast of local oligopolistic competition. If these market characteristics continue to prevail it is hard to see how technological institutes can, by simply offering technological services, establish more than marginal relationships with the large private firms.

The retarding effect on local inventiveness of these alternative channels is illustrated by the Argentine patent data of table 3. In 1949 individual inventors were awarded over half the total patents granted in Argentina. This high percentage was probably a residue of the temporary stimulus to legal inventiveness of World War II when access to imported equipment and technology was abruptly curtailed. By the 1960's, however, the annual number of patents granted to individuals had dropped to little more than half the 1949 figure, and to around 25 per cent of the total number of patents granted by Argentina.1/

The contribution of the individual inventor to post-war Argentina technology declined even more than the declining patent trend indicates. A sample survey of the Argentine inventors, taken the late 1960's, showed that most were part-time amateurs, and that only a small percentage of their patented devices reached commercial application. Very few of these were licensed

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1/ A similar post-war decline is reported in a Chilean survey. See CORFO, La propiedad industrial en Chile y su impacto en el desarrollo industrial (Santiago, September 1970). Mimeo.

/Table 3

Table 3

THE ANNUAL DISTRIBUTION OF PATENTS GRANTED IN ARGENTINA: 1949-1967

Year	Patents to individuals	Percentage of total	Patents to firms						Total annual patents granted
			Granted to firms less than 10 patents		To firms granted more than 10 patents				
			Number granted	Percentage of total patents	Granted to foreign-owned firms	Percentage of total patent	Granted to domestically-owned firms	Percentage of total patents	
1949	2 445	54.6	1 560	34.9	447	10.6	0	0	4 482
1955	2 615	56.5	1 473	31.8	542	11.7	0	0	4 630
1960	1 982	44.6	1 591	35.7	877	19.7	0	0	4 450
1965	1 207	29.3	1 707	42.3	1 213	29.4	0	0	4 127
1967	1 344	23.5	2 075	36.2	2 314	40.4	0	0	6 742

Source: Jorge Katz, Importación de Tecnología. Aprendizaje Local e Industrialización Dependiente. (Buenos Aires, Instituto Torcuato Di Tella, 1971) Chapter 9, p. 28.

or sold, but rather were mainly put into production by the inventors, typically on a small-scale. The small-scale reflected not merely limited access to finance, but also the fact that most of the devices were gadgets with limited markets, or were minor improvements of accessories for moter cars and durable household and commercial goods.2/

Moreover, only a small proportion of the patenting in post-war Argentina by enterprises represented locally developed alternatives. As a signatory of the Paris Convention on Intellectual Property Rights, Argentina had committed itself to protect foreign patentors by permitting them to re-patent locally innovations developed abroad, and thus to control their use in Argentina. The major proportion of the Argentina patents granted to firms were extensions of foreign patents rather than locally developed innovations. As is indicated in table 3, the percentage of patents obtained by foreign firms actively engaged in the repatenting effort (firms receiving 10 or more patent each), rose sharply between 1949 and 1967. The majority of the patented innovations were not used in Argentina during the period covered. Rather they protected the patentor against technological pirating, and gave him a legal bases for hindering efforts to modify or improve his patented processes or products by other Argentine forms.3/

To overcome such adverse relationships requires a closer collaboration between economic and technology policies than has been characteristic of most Latin American countries to-date. In general terms, economic policies would have to go much beyond trying to subsidize R & D by private firms in order to seduce

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2/ Jorge Katz, Importación de tecnología. Aprendizaje local e industrialización dependiente, Instituto Torcuato di Tella, Buenos Aires, 1971, Chapter X.

3/ Jorge Katz, Importación de tecnología. Aprendizaje local e industrialización dependiente, op. cit.

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them into investing in such efforts. The lavishness of the subsidies needed to achieve such seduction would most probably far exceed the social benefits obtained, since the subsidized local technology would merely reduce some of the foreign exchange cost of product substitution chaining. More socially potent results, would at least require the subsidies to be complemented with policies restricting access of large firms to foreign technology, whether through special taxes or other measures, in order to force them, faute de mieux, to engage in local creativity, and to become more interested in using the creations of other local innovators. This would, in turn, raise the need to establish priorities for both technological importing and local R & D subsidies, a difficult task requiring close collaboration between national economic and technological planning agencies. Barring the development of such complementary economic policies, technology policy perse would be well advised to cast its seed on less stony ground than the large firm selling mainly to the internal market.

There is, however, one important exception, industrial exporting, where even the large Latin American firm would be a small, marginal supplier. Its main concerns therefore would not be with product exclusivity and market shares, but with the oppressively large financial costs and risks of exporting to highly competitive markets; e.g., its limited knowledge of foreign market characteristics, the heavy cost of foreign marketing outlets, and the difficulties of staying abreast of the changing designs and cost characterizing export markets. In this area the large firm is less likely to disdain local technological collaboration, especially since the alternative, foreign licensing, usually contains clauses restricting exporting of the licensed product. Technological assistance per se would, however, not go very far in overcoming the reluctance of firms to venture into exporting. Institutional innovations paralleling the various functions performed for Japanese industrial exporting by the Zaibatsu would probably also be required. Among these central functions would be the provision of foreign technological intelligence

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and assistance in creating and adapting products for export. The Zaibatsu-type effort would need to be selective, concentrating the nation's limited resources on more promising ranges of industrial products. As these are likely to encompass mainly less scale and skill intensive products, the industrial exporting effort could be a potentially important alleviant of the pressing employment problem.

The response of the foreign subsidiary, on the other hand, is likely to remain as stony to offers of local technological help in exporting as in production for internal markets. One reason is that for either need, the subsidiary has direct access to a much richer and more experienced collection of R & D talent at company headquarters than is likely to be available in Latin American countries for some decades. The second reason is that exclusivity and capitalizing on monopolies of technological knowledge loom large in the strategies of multinational companies in export as well as domestic marketing. They are, after all, oligopolistic firms on a world scale. Given adequate inducements, they could contribute usefully to product redesigning for both domestic and export markets, but their technological effort would remain centered in headquarters abroad.

Another potentially fertile area of industry for technological collaboration is small and medium enterprise. Such firms are usually too miniscule to worry about market shares and technological exclusivity, and are also too small to interest foreign licensors. Hence they subsist with underscale plants and old equipment through paying lower wages and evading taxes more vigorously than large firms, and, in some cases, by ingenious pirating and copying of modern product designs. Effective technological collaboration would require parallel organizational innovations, e.g. producer co-operatives and special financial institutions to assist the rationalization of production. Models for this can be found in similar efforts of many post-war European countries, notably in France. The technological adaptations need not, indeed should not, be directed toward high technology. Indeed, the intermediate sector could well be the place

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to begin experimenting with product simplification and the descaling for processes. The base for the technological effort could often be older product designs and processes that the centre countries have since replaced with more complex ones. Knowledge about such products and processes is now largely in the public domain, although considerable data collecting would be needed to establish an adequate information base from which to select suitable products and processes for modification to local needs.

Further down the technological ladder, a potentially fruitful area is the "subsistence sector". This sector includes marginal urban activities, but its main base is still rural, in agricultural minifundia and village artisan industries. The two combined in loose economic symbiosis to form the most backward and impoverished part of Latin American society. The "subsistence sector" lacks virtually all the requisite inputs for elevating its productivity and material well-being: lack of access to superior technical information, to skills and finance for exploiting such knowledge, and to group organization for generating the requisite inputs. The "subsistence sector" is both the main repository of rural underemployment and the chief source of the indigestibly rapid flow of migrants to the provincial cities and metropoli of the region. Yet the absolute size of the rural "subsistence sector" keeps increasing at an annual rate of about 1.5 per cent. Apart from efforts complementing agrarian reform in some Latin American countries, the minifundia remains a neglected area for technological policy: in the case of rural artisan industry the neglect is almost total.

As in the other areas, technical help would have to come in a package that includes the other inputs. The basic objective should be to reproduce the dynamic interaction between agriculture and rural industry that was the dominant feature of Period I industrialization. In that era, however, the dynamics were sparked by the wealthier and more technologically alert segments of agriculture and industry. By contrast, the Latin American rural "subsistence sector" represents the most impoverished and technologically stagnant part of agriculture

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and industry. The dynamics have, therefore, to be mainly sparked from without, although once the underutilized labour, and the native ingenuity that lie buried under centuries-old layers of poverty, apathy and suspicion, begins to be mobilized, the momentum could begin to be carried forward from within.

Technological progress in this sector does not require sophisticated new techniques, but rather modest but successive improvements of existing techniques in both the minifundia and the artisan industries. In the initial period, the guiding objective should be improvements that the "subsistence sector" could largely reproduce with locally available materials and skills. In this way the initial social cost of minifundia and artisan capital accumulation would be kept low, since the major inputs would be labour time from underemployed labour to produce the materials and equipment; while local ingenuity and enterprise would be stimulated rather than overwhelmed. The technological task requires, therefore, very detailed knowledge of local socio-economic conditions. Organizationally this calls for close collaboration between anthropologists, agricultural economists, engineers and agronomists.

Here is one part of the national technological effort for which the prima facie case for subsidization for some decades is overwhelming. Not only would the social cost of capital accumulation by the "subsistence sector" be far less that the nominal market cost in the early phases, but the social benefits would also far exceed the market value of increased "subsistence sector" output. For the benefits would also include a dampening of the rate of exodus of rural labour and hence of the severe socio-economic costs that the exodus has been generating in urban areas.

Finally, since the "intermediate" and "subsistence" sectors of various Latin American countries have many features in common, there is a strong basis for regional collaboration between national technological efforts, for frequent exchanges of experiences and solutions. This could accelerate the payoffs from these efforts in in each of the countries. Indeed, in these aspects of the strategy,

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many smaller countries of the region could play a major role in the institutional and technological innovating.

Detailed knowledge of similar efforts in other continents could also be useful in guiding the Latin American effort. For example, although the cultural milieu and the guiding ideologies are quite different from Latin America's analyses of the comprehensive attempts of China and Tanzania to replicate Period I type dynamic interactions between peasant agriculture and rural artisanry might well be helpful in formulating the Latin American efforts. There are, however, various limitations, identified in section 3 below, to applying the commune structure in the Latin American rural setting. Institutional innovation rather than direct copying of foreign models is also required for effective radical reformism.

2. Openings for technological policies for the public sector

The decision biases of public sector enterprises and agencies militating against indigenous technological creativity are of a different order than in the private sector. In the public sector they derive from an excessive propensity of high-level Latin American technicians and scientists to take their cues concerning the choice of technology and of scientific research projects from their confrères in the centre countries. As a result, the potential of these cadres for assisting Latin American social and economic development remains seriously underutilized. The general solution lies in greater awareness of the nature and consequences of the decision biases along with policy measures to constrain the exercise of these biases.

Large public sector "dukedoms", such as public works, transportation, and telecommunications ministries, have had a considerable amount of autonomy in choosing designs and equipment for their projects and in obtaining external finance from the World Bank and from centre countries supplying equipment and technical consultation. Since the "dukedoms" are usually headed by engineers and can envelop their decisions in a thick fog of technological

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expertise that tends to overwhelm supervisory financial agencies like the Treasury and Central Bank, and economic supervisory agencies like national planning boards, the "dukedoms" have considerable scope for exercising their professional biases toward modern techniques and equipment as they strive to catch up with "the engineering Jonases" of the centre countries. Supervision is largely limited to budgetary controls that govern the pace with which projects are undertaken and, to some extent, their individual scope, but has had much less influence on the techniques used to carry them out. The "dukedoms" have thus had considerable freedom to opt for labour saving and import intensive techniques in carrying out the approved projects.

Yet civil engineering is one important activity where the potential range of alternative techniques is quite wide. Until the 20th century, civil engineering required the directing of large bodies of men, working with hand tools and a modest amount of specialized heavy equipment. This sort of mass labour handling skill has become obsolete in centre countries, though it is being revived ingeniously in some regions of the underdeveloped world. Labour intensive techniques in earth moving, grading, reforestation, track-laying and other phases of public projects, could play a much greater role in absorbing labour and in minimizing foreign exchange pressures than they have in Latin America in recent years.

Devising workable solutions for the difficult logistics and management problems would not be easy, but the social imperative for Latin American civil engineers to turn their ingenuity in this direction is mounting with each year's increment to underemployment. It may be that even with ingenuity and experience, such techniques would still increase budgetary costs and delay project completion. But to the customer, the Latin American government, the social benefits of higher employment and reduced foreign exchange outlays should compensate for at least a fair elevation of project costs. What is needed is awareness of the possibilities, decisions to experiment along such lines, and tighter controls over the selection of techniques by the supervisory agencies. One of the tasks that national science-

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technology councils could usefully assume would be to serve as advisors to the national planning boards and financial agencies, reviewing the technical aspects of proposed projects for dispensible modernization biases.

A similar function could be performed for telecommunications. The dismal state of Latin American T-V programming - a poor copy of the bad U.S. model - is an object lesson in the social costs of being seduced by the glamour of technological hardware, to the exclusion of adequate consideration of "software" problems, that is, of the uses to which the hardware is put. In most Latin American countries, the government, pursuaded by the argument that television was a potentially powerful instrument for advancing popular education and culture, pioneered in the establishment of the initial television transmitters, which in turn, stimulated the sale of receivers. Government pioneering thus overcame the "critical mass" obstacle to the spread of private transmitters and the entry of commercial television. Concurrently, the financially pressed governments decided that they could no longer afford the programming costs of keeping television within the public sector. The original educational and culltural objectives largely faded away, and within a few years Latin American television was converted into a powerful new sales device for accelerating product differentiation.

Latin American and other Third World countries are now being pressed to invest in communication satellites for extending television to rural areas beyond the range of urban television transmitters. Again the emphasis by enthusiasts in engineering and commercial circles is on the potential educational benefits. A valuable extension of the functions of national science-technology advisory councils could be to help dissolve the technological mystique surrounding such proposals by analysing carefully the "software" implications of these glamour technologies.

The extension of rural telephone networks illustrates a somewhat different aspects of the social cost of the technological hardware bias. The case for providing such service is quite pursuasive: it would

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facilitate emergency communication with isolated districts as well as provide more mundane conveniences to the inhabitants of the districts. But one of the influential proponents of extending such services, the International Telecommunications Union, also advises that the appropriate local equipment should be small automatic centrals, since these would obviate the need to employ voice operators, and since such automatic exchanges are being produced en masse by the major telephone equipment companies, the suppliers of technological expertise to the ITU.4/ As it happens, labour saving is not a current social desideratum under Third World employment conditions, while a voice operator could often perform the task of transmitting emergency messages with greater flexibility than an automatic system. Indeed in isolated districts of centre countries, compatible manual exchanges are still in operation today. The much simpler designs for such exchanges are also now public domain technology. Since the major Latin American countries now produce part of their telephonic equipment, it should be possible for them to adapt these simple manual exchanges and supply them to rural areas of the region at less domestic cost and with considerable foreign exchange savings. An alert national science-technology council could usefully take on the function of exploring cases such as the above for opportunities to economize on social costs, enlarge the range of indigenous technology and augment employment.

The various linkages between science and technology offer still other opportunities for rationalizing decisions of the public sector. Today in the centre countries, while applied science often plays a direct role in generating modern technology, the contributions of basic science remains more distant and diffused. Nevertheless, the distance has been shortening in recent decades. It is easy to cite a number of

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4/ Cf. ACAST, A Latin American Plan of Action for the Application of Science and Technology to Development, United Nations Economic and Social Council, E/CN.12/966 (May, 1973), pp. 178-180, for a presentation of the ITU position. For a critical analysis of ITU's technological biases see Brenda Haddox, "Communications and the Developing World" World Development, Vol. 2 (February, 1974), pp. 61-64.

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important post-war technologic break-throughts that originated rather quickly in earlier advance of basic sciences. For example, solid state physics led to the transistor and micro-circuitry, low temperature chemistry to cryogenics, wave mechanics to micro-wave transmission and laser beams. But such rapid translation of basic scientific advances into usable new technology depends on the existence of richly endowed cadres of applied scientists and engineers plus private and public firms with sophisticated R & D capability to seize upon and develop profitable technological derivations of the scientific advances. As long as the latter are lacking, as is the case in Latin America today outside of medicine, the yield from one of the potentially important social functions of its basic science will continue to be close in zero in Latin America.

Since a sophisticated Latin American R & D capability is some decades away even with optimistic projections as to its rate of development, it follows that a rational science technology strategy should assign a much lower priority to expanding basic sciences in most specialities, and be much more selective in the expansion, than have centre countries. In this regard, the biological sciences are probably the most promising area for special emphasis. Not only does the region have a fair nucleus of medical personnel and facilities to adapt basic advances into practical applications, but the biological sciences could also contribute to the development of an innovative capacity in important areas, such as, agriculture, forestry, and biological pest controls.

To date progress in tropical agriculture and forestry has been limited to some plantation products mainly for export to the centre countries. The basic botanical investigations and agronomical experiments for these were done almost exclusively at the initiative of the centre countries. Thus far, basic and applied scientific research on improving tropical food agriculture and forestry for local consumption has been largely neglected. Yet much of Latin America is tropical, and extending the agricultural frontier in the tropics could bring inmense payoffs in easing the region's employment and balance of payments problems.

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Similarly, the rising price of chemical feed stocks and growing concern over the adverse environmental effects of chemical insecticides, is turning biological research in centre countries toward developing biological pest controls. There is no good reason why researching the plant and insect populations of tropical forests and jungles for biological alternatives to insecticides should be chiefly left to centre country science. This is surely a promising area for Latin American science and technology to innovate in developing environmentally superior exportable alternatives to insecticides.5/

To be sure, other valuable functions of basic science require moderate investment to expand areas of lesser immediate priority. Growing cadres of basic scientists will be needed to instruct applied scientists and technicians, as the universities of the region expand such training. Basic physical scientists are urgently needed to advise governments in such areas of rapidly advancing science and high technology as nuclear energy and communications. Each basic science specialty is also a valuable early warning system, providing advice on new international developments in their speciality that have long run socio-economic potential. When the industrial R & D effort of the region reaches a sufficient size and sophistication, various basic science specialities could also begin to function as important sources of sophisticated scientific information and advice for the R & D efforts. Indeed, one promising area probably merits immediate attention - the development of economic solar energy, for which the climate of much of Mexico, Argentina, Peru, Bolivia and Chile, is more suitable for an economic break-through than are those of the centre countries. Hence this research, which has been given low priority in the centre countries, affords Latin America a unique opportunity to make an important technological contribution to easing the world energy

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5/ For a list of other possibilities, some requiring basic science inputs for ecological or technologic purposes, see Ignacy Sachs, "Population, Technology, Natural Resources and the Environment" in ECLA, Economic Bulletin for Latin America, Vol. XVIII, Nos 1 and 2, 1973, pp. 126-138 (United Nations Publication, Sales No 5.73.II.G.3).

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problem, and to also garner the economic benefits of being a pioneering technology exporter. The R & D problem in this area is mainly one for engineering and applied physics, but inputs from basic physics would probably facilitate the effort.

The need for at least a modest rate of expansion of its basic science establishment poses serious organizational problems for Latin America's science-technology effort. To keep basic scientists "basic" and up-to-date, they need to remain active in research in frequent contact with a minimum critical mass of confrères in order to benefit from the intellectual stimulus and the interdisciplinary assistance commonly needed for sustained creativity. Latin America's chronic scientific brain drain has been in part a reaction of many of its best scientists to inadequate equipment and intellectual isolation. Creating "centres of excellence", universities or institutes that can provide the requisite research equipment and intellectual critical mass, with facilities for frequent access to the centres by less advantageously located scientists, could significantly ease the brain drain problem. This solution has, thus far, proved too administratively difficult or costly to implement even in Argentina, Brazil and Mexico, although each has the basic economic and intellectual resources to maintain an effective national centre. For the small- and middle-sized Latin American countries a national centre is out of reach at this stage of their economic development, and they must seek co-operative solutions: e.g., a subregional "centre of excellence" serving the Andean Bloc; and a more narrowly specialized one serving Central America. The administrative obstacles, political jealousies, and financial problems of creating national centres in the large countries are multiplied for regional centres. Hence finding innovative ways to overcome the national and regional obstacles would be a notable contribution of the science-technology councils of the region to the partial staunching of the brain drain and to the advancement of Latin America's science-technology capability.

/3. Criteria

3. Criteria for selecting between importing and creating technology in the modern sector

Suppose Latin American countries were to begin broad efforts to shift from their modern-sector-based "style of development" to an anti-dualistic development style, and began, therefore, to make the drastic changes of socio-economic policy required to implement the new "style". Implementation require applying policies influencing the choice between importing and creating techniques, and the equipment embodying the alternative techniques, to the modern private sector, as well as to the "easier" sectors discussed above. Economic and technological planners would have, therefore, to devise general criteria for guiding the specific selections.

In very general terms, the planners would still have to strike some balance between reducing technological dualism and augmenting the rate of economic growth as conventionally measured. In the very long run as the economy approached full integration, the two efforts would become complementary and the trade-off problem would fade away, but in the short and medium run - i.e., for some decades - painful choices would have to be made between the relative intensities of the two efforts. Resistance from modern sector consumers, work incentive problems, limits to the growth of bureaucratic efficiency and similar type constraints, would accentuate the trade-off dilemma. But there is a more basic cause for its persistence in dualistic economies, which relates to the fact that both physical and human capital accumulation are needed for broad-based economic growth. A higher rate of economic growth accelerate the economy's potential to accumulate physical capital, whereas an intensification of the anti-dualistic effort - i.e., promoting national creativity and the productivity of the backward sectors - increases human capital accumulation at a faster rate.

Initially, at least, a higher rate of economic growth can be obtained from plans that hew closer to modern-sector-based development line, since the national capacity to create technology, and of the rest of the economy to accumulate physical capital, are initially

small.6/ On the other hand, for a given economic growth rate, more human capital accumulation could be obtained from plans that hew closer to anti-dualistic development line. Essential ingredients for modern sector growth have been imported technology, equipment and intermediate materials. Equally essential for developing the "rest of the economy" would be physical capital inputs, much of which have to come initially from the modern sector. Closely linked to the trade-off between the economic growth rate and the intensity of efforts to reduce dualism are therefore, the choices between importing and creating technology for the modern sector, and between proportioning physical capital to the two sectors.

This suggests a few general guidelines on technological choice for the Latin American modern sector during the initial phases of the anti-dualistic style of development.

(a) In the modern sector, the effort to create technology should initially concentrate on final consumer goods and house building materials, notably on product simplification and increased use of local materials. As these are not direct inputs to other productive activities, the risks and costs of technological experimentation with products and processes would be isolated, rather than magnified by an adverse impact on the cost and quality of other products. Successful results, on the other hand, would create new demands for equipment and materials supplied mainly by the modern sector, with some stimulus also to raw materials production in the "rest of the economy".

6/ The evaluation methods of conventional national income accounting exaggerate the true social gain, by overestimating national economic growth in dualistic economies with considerable production for subsistance and highly projected modern sectors. The value of the subsistance goods and services given up when their production becomes commercialized is underestimated, while monopoly pricing leads to some overestimating of the value of output of the modern sector. It is very doubtful, however, whether correcting for these accounting biases would eliminate trade-off problem.

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An especially valuable feedback from such efforts would be the build up of machine designing capability, an essential characteristic of technologically creative economies. To quote from a Swedish engineer-economist:

> "The engineering industry is less limited by natural resources than most other industries, and human effort, skill and organizational ability are consequently key factors. And it appears that the development efforts within the engineering sector have at least as powerful an influence on overall development and consequently on the per capita incomes as the latter have in stimulating the growth of the sector. So the "proper" level of technological sophistication for a particular locality, or the right degree of capital intensity as opposed to labour intensity, may lose much then of its relevance. The reason for this is that in a sector with rapid organic growth of skills and technology it is not the starting level of technical sophistication or of capital/labour intensity, that counts but the way these factors change over time."7/

(b) On the other hand, intermediate materials widely used by the modern sector, should for that very reason continue to rely on best-practice imported technology in the initial phases. The expanding economies of scale and technological subteties of continuous process technologies, such as in steel, basic chemicals and petrochemicals, and steam electric power production, are difficult enough for Latin America to keep up with. While adapting processes to differences in the composition of indigenous coal, mineral ores, and chemical feedstocks have often accompanied the establishment of plants in these activities, the redesigning has typically been done by foreign design teams. Progressively enlarging the participation of Latin American professionals in design adaptation would probably be the least risky way of developing cadres of local design talent. In this way a local talent base could be built up in time to design processes that extend the range of local raw materials

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7/ Jon Sigurdson, "Technology and Employment in China" World Development, Vol. 2, Nº 3 (March 1974) pp. 75-85. For similar observations concerning machine building capability and economic growth in 19th century industrializers, see Natham Rosenberg, "Technological change in the machine tool industry, 1840-1910", Journal of Economic History, December, 1963, pp. 414-443.

the country is able to exploit economically, while minimizing the effect of the build up on the costs and export competitiveness of the modern sector.

(c) The neglect of the independent inventor, illustrated previously indicates another fruitful opening for building up creativity in the modern sector. Indeed, the ignis fatuus of the typical independent inventor, a financial killing, could even be used to turn his creative efforts toward improving "rest of the economy" techniques. In R & D financing, research costs are typically a small fraction of the cost of developing innovation to marketable levels of reliability, quality and production costs. Thus the costs of D are a much greater deterrent to independent creative efforts than the costs of R.

This suggests two additional functions for national science-technology councils. One is to select from the creations submitted by independent inventors, those that hold promise of being socially valuable within the overall criteria of the anti-dualistic development strategy, and to provide equipment and testing centres for carrying out intermediate stages of product and process development: in especially promising cases financing through the pilot plant stage might be warranted. The second function would be to act as a conduit to government and private finance for bringing to production the creations that pass the intermediate development stages successfully. The availability of such developed creations could also become one of the criterion governing decisions on whether to allow a firm to import a similar technology under license.

(d) Creating channels for supplying design and trouble shooting assistance from the modern to the "rest of the economy" sector should be another important objective. This is one of the major components of the Chinese "walking on two legs" development strategy that has impressed many observers.8/ In this strategy the modern urban sector

8/ E.g., E.L. Wheelwright and Bruce McFarlane, The Chinese Road to Socialism (1970); Sartaj Aziz, "The Chinese approach to rural development" World Development, Vol. 2 Nº 2 (February, 1974), and Jon Sigurdson, "Technology and employment in China", op. cit.

/supplies little

supplies little financial assistance to the rural sector; the flow via taxes seems rather to be the other way. What is supplied is a wide range of technological assistance to the rural communes, including designs for very scaled-down and simplified cement, metal refining, ball-bearing, and chemical fertilizer plants, built mainly with local labour and building materials, and processing local raw materials. Such plants have spread rapidly through the commune system, and play a key role in the successful Chinese recreation of Period I agroindustry dynamics.

The Chinese commune system as such is not directly transferable to Latin American conditions. Cultural and ideological barriers apart, there are two basic economic reasons why Latin American countries could not effectively copy the commune arrangement without major alterations. One is that while China's rural area is much more densely populated than is Latin America's, its road system is much less developed. The Chinese communes are therefore densely populated units usually separated from urban centres by high transport costs. Under these circumstances a network of small commune plants can deliver intermediate materials for local use almost as cheaply as a small number of efficient large scale plants more distantly located.9/ With some possible exceptions in the Andean Altiplane and Mexico, large densely populated rural districts isolated by high transport costs, and convertible into equally self-contained but dynamic subeconomies, do not exist in Latin America. The second is that Latin American modern sectors tend to be relatively larger and the subsistance sectors are usually more lacking in indigenous skills and co-operative traditions, than is the case in China. Finance in Latin America would, therefore, have to flow from the modern to the subsistance sector, rather than the reverse. Similarly, technical and organizational supervision from the modern sector would probably have to be applied more closely, paternalistically, and

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9/ Jon Sigurdson, "Technology and employment in China", op. cit.

/perhaps for

perhaps for a longer period, than was the case in China, before the "primitive" sector is able to develop a strong technological and accumulative momentum of its own.

Now to work out effective linkages between the modern sector and the "rest of the economy", notably with the subsistance sector, is one of the major tasks that would face an anti-dualistic development strategy in Latin America. The Chinese example, merely indicates that it can be done under much more difficult initial circumstances than those that would confront efforts at innovative Latin American solutions; it is not, however, directly importable.

4. Concluding remarks

It should be apparent that the foregoing analysis is in no way a case for technological autarchy, but rather for accelerating Latin America's entry into Phase II as a necessary condition for more equitable socio-economic development. The region under the most realistically optimistic projection about the growth of its indigenous creativity, will continue for some time to be mainly dependent on foreign sources for new technology. Nor does achieving in time a broad capability for technological creativity mean anything other than that Latin America would then be able to participate more effectively in the exchange of technology which has so powerfully facilitated the economic progress of centre countries.

Thus the case for assigning highest priority to developing technological creativity does not imply curtailing parallel efforts to improve the region's "technological terms of trade". Indeed, the bargaining superiority of foreign technology suppliers is not due to a malevolent conspiracy but rests on the fact that they are profit seekers with much more powerful options supporting their bargaining positions than are available to Latin American buyers of technology. Developing indigenous technological options for the buyers can therefore only strengthen the effectiveness of efforts to improve the "technological terms of trade".

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The document has only been able to sketch in general terms the system maintaining forces that have guided Latin America along its highly destorted and socially inequitable modernization path. Some suggestions for technological policy have also been drawn in general terms. Obviously, for specific applications each country will need to analyse in much greater detail its existing obstacles and the potentialities for applying institutional and technological innovations, for which analysis, however, the document we trust provides a useful general framework. Since the countries of the region differ in their levels of skills, natural resources and ideologies, implementation of these broad policy suggestions will vary in pace and content. However, the present endowment of skills and technical talent of even the small Latin American countries should suffice to enable them to begin work along at least some of the general policy lines of the strategy suggested here.