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The role of the State in technological progress

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The starting point for this article is the link between knowledge and the production of goods and services. After an analysis of the characteristics and dynamics of that link, the role of the State in the development of particular lines of technological research is examined.

It is pointed out that in order to define a development strategy which takes into account the technological factor, it is necessary to establish effective specific policies on scientific and technological production in itself and in its political and State dimensions.

The case of Colombia is then analysed. The author holds that in that country science and technology have not received priority attention at the general level or, in particular, in the industrial sector, and he then goes on to review various situations and problems for which technology offers solutions fully in keeping with national development.

Instead of going along with the option of passive adaptation to the international division of labour, a selective position with regard to development and modernization of the economic base is proposed and it is suggested that the role of science and technology in development should be reformulated.

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Introduction

Four decades after the formulation of ECLAC's diagnosis on Latin American economic development, some structural problems of the region not only still exist but have even got worse; furthermore, other factors have appeared on the scene which make it more difficult to "take off" in the economic sense, and at the international level new alignments have taken shape and new economic blocs have appeared. What role can Latin America play in this new international order? Is it true that we are now "on our own", as some analysts suggest? With whom, and with what prospects, can we align ourselves? What are our relative advantages today? What are our greatest obstacles? Against this background, the question that arises is what kind of new model countries like Colombia should adopt to tackle the opening-up process, and what role science and technology should play in it.

I

The links between knowledge and production

In the manufacture of a product, the added value which it incorporates includes an increasingly high component of complex work, due to the use of technologies which call for more highly developed levels of knowledge.

It is widely recognized by experts and leading authorities that an increase in production in absolute terms is not enough to give grounds for considering that the battle for sustained economic growth has been won. The essential thing is to raise productivity through the appropriate incorporation of technological advances in the entrepreneurial sector, since if this is not done, then the low levels of competitiveness will weaken any development policy and make the economic system extremely fragile.

Cutting across ideological frontiers, valuable lessons can be learnt from the experience of perestroika as promoted in the USSR by Gorbachov, who recognized that many of the ills affecting the Soviet economy were due to the slowness with which technological processes were applied, so that they only entered the production apparatus in the long term. "For many years, our policy has been to build

more and more enterprises. The construction of workshops and administrative buildings absorbed enormous sums of money. Meanwhile, however, the enterprises remained at the same technological level" (Gorbachov, 1987). It is worth noting that although the Soviet Union invented the continuous casting of steel, 80% of the production of other countries was carried out with this method, whereas the USSR used it to a very much smaller extent. This situation was summed up concisely by the Soviet leader when he said: "In our country, the road that a scientific discovery has to travel before it enters production is far too long" (Gorbachov, 1987). In the final analysis, it seems to be beyond all doubt that the conveyor belt that connects research with production should operate with a sufficient degree of flexibility in both directions, since otherwise the economy becomes stiff in its joints and the process of seeking new knowledge may be impaired also.

In contrast with the research carried out in most of the developed countries, which is directly related with social and production sectors, in our countries there is a marked separation –if not an impassable gulf– between research and the active sectors of the economy. In the rich countries, the distance between the laboratory and the production line is shorter and shorter; in our country, in contrast, these two sectors are disconnected because of a state of dependence which we have not yet managed to overcome completely. Even though the quality of the research itself may be just as good as that carried out at the international level, the feeble links which exist with the sectors promoting development mean that in our environment the results of scientific activity are still uncertain and there is no shortage of those who believe that our researchers are simply incapable of producing real science and technology.

When we speak of the links between knowledge and production we are recognizing that the university cannot be viewed as a kind of ivory tower where professional researchers speaking unintelligible jargon lay the foundations for a type of scientific culture which the rest of the country must simply consume without question. The university must strengthen its links with the nation and with the political and entrepreneurial leaders from whom it has traditionally been distant, and it must help to overcome mutual misgivings which make it more difficult to put projects into operation and which create a climate of mistrust that hinders the work of research. We cannot continue to permit a university cloistered in an academic world which looks down on both politics and business administration but ends up being crushed by them. Technological innovation and scientific discovery cannot continue to think along lines divorced from the production processes, since the latter are in fact a fruitful field where they can show their effectiveness and fertility. The academic world must overcome its scholastic outlook and its unjustified arrogance and seek meeting points with private and State initiative at both the national and regional levels.

Although as a general rule the research projects carried out in universities include among their objectives the application of their results to the solution of some national problem, in spite of the best intentions of the researchers this objective often falls by the wayside. This prevents the integration of the knowledge in question into the development of the country, although of course this also depends on the market and entrepreneurs who still tend to lack confidence in national effort and talent. It is frequently complained in loose terms that the cause of this and other failures is "lack of resources", thereby invoking the paternalism of the State or of the institutions responsible for receiving and processing proposals. While recognizing the marked shortcomings in our means of giving official support to research and the need to institutionalize suitable infrastructure for permitting scientific and technological progress, we feel that this phenomenon needs to be analysed in greater depth, since by uncritically appealing to State paternalism we could easily emerge from foreign dependence only to fall into a state of bureaucratic dependence. Moreover it is quite possible that the desired convergence between production interests and national researchers may not come to fruition if both sides continue to have a dependent mentality which stands in the way of original opportunities for uniting production and knowledge.

II

The role of the State

In respect of research and development activities, the State must adopt a leading role in promoting specific lines of research and technology. This also implies a change of outlook among researchers, in the sense of playing a more active role in seeking mechanisms for putting their projects into effect. Thus, in the first phase, with the aim of establishing general conditions for developing research, active State intervention is needed, particularly when what is involved are advanced technologies that make intensive use of scientific knowledge and its practical application.

As emphasized in a report on the recent evolution of spearhead technologies such as informatics, biotechnology and bioengineering, the public sector has had a distinguished role to play in some stage or other of their development. "The reasons for this role of the government sector are varied and include the following: a) advanced technologies are usually the result of lengthy R&D processes often requiring large-scale financing that only the government can furnish either because of its size or because of the uncertainty and risk associated with such investments; b) some of these technologies are deemed important for national security and therefore the government reserves to itself certain powers to control their development and possible diffusion; c) government action is also usually justified because these new technologies are assigned major potential as catalysts of the growth of specified economic sectors and therefore can play a strategic role in economic development policies" (IDB, 1988, pp. 199-200).

The need to establish a scientific and technological base also implies a need for foreign cooperation. This means opening up the country to various forms of investment, while however using the technologies in a judicious manner, rejecting easy solutions such as dependence and instead forming a body of researchers who are unashamedly scientific entrepreneurs rather than mere new kinds of wage earners. We see the university as a source of new knowledge and a privileged intermediary between knowledge and the groups of innovators who are seeking to expand the frontiers of production. For this reason, academics cannot limit themselves to proposing processes to increase productivity from an abstract standpoint, overlooking special regional and cultural features and political and administrative aspects which are of fundamental importance for furthering the objectives of change. A great effort must be made to shorten the distance between those who are carrying out research and the possible beneficiaries, since research cannot operate on a unilateral basis. What is needed is a suitable environment: an academic culture which generates a suitable environment for the development of research processes, and this involves very heavy investment in human resources. As the President of Venezuela said at a recent ECLAC meeting: "education is clearly the great strategic line along which we must advance, because it is the gateway to research, science and technology" (Pérez, 1990, p. 13).

The university must train integral researchers who are not afraid to tackle the management aspects of production: true scientific and technical cadres with a commitment to their nation, their people and the fundamental changes which must take place in the economic and social structure of our countries. These professionals will act as vehicles for the democratization of knowledge, as intermediaries between technological development and those directly concerned with the production of wealth. There is an urgent need to promote cooperation between the universities and the enterprises by building bridges which will lead to greater facilities for giving life to infant enterprises and technology parks and by creating a project bank to carry out promotional and external relations activities to help identify sources of financing and implementation mechanisms. For this purpose, in both sectors it is necessary to identify possibilities for joint action to facilitate the selection, assimilation and adaptation of scientific and universal knowledge which will help to lay the foundations for our own creative processes. This programme

can only be pushed ahead if there is the fullest knowledge of the realities of the country and a scientific and technological outlook is attained which ensures a smooth road to development and makes it possible to take the necessary political and administrative decisions here and now.

III

Phases in scientific and technological development

In order to move on from the general intention of promoting a form of development supported by science and technology to the actual implementation of such development it is necessary to carry out a collective diagnostic exercise and review processes and achievements in order to determine exactly what changes should be sought both at the domestic and at the political and State levels. Although there is general agreement that it is a matter of urgency to establish a scientific and technological project for Colombia, for example, and although we do not hesitate to assign to universities and other research centres a key role in the formulation of that project, the difficulties arise when it is necessary to define the various steps that must be taken: it is then that it is essential not to fall into the trap of seeking utopias or making general declarations: instead, it is necessary to establish policies and formulate plans which will win the confidence of the various sectors of the nation.

Before examining the need to reformulate our own development model, it is necessary to make a summary outline, within a new political context, of what has happened in recent decades in the developed countries. In those countries, science and technology have been incorporated into industry and into urban life styles through a process in which three phases may be distinguished:

i) In the first phase, from the end of the Second World War (1945) until 1960, scientific and technological policy was dominated by considerations of so-called national security and military power. Prestige was attached to research in physics, nuclear physics, and space sciences. In that period –more exactly in the mid 1950s– J. D. Bernal (1954) coined the term "scientific revolution". Ten years later, the concept began to win wide dissemination with the publication (in Czech) of "Civilization at the crossroads", by Richta Radovan, followed by another study by the same author, "The scientific revolution and the options for the revolution of today": a work which unites the aspects concerned with science, technology, economic development, labour, artistic and educational considerations, systems of direction and organization, and ecological and social matters (Corona Triviño, 1989).

ii) The second phase, from 1960 to 1973, was the era of the space race, the end of the decolonization of Asia and Africa (national liberation movements), and the emergence of Japan as an economic power. There was an optimistic and hopeful attitude to science and technology, which were given a very special place in economic growth. The scientific and technical revolution embraced a whole series of principles: automation, which involves cybernetics and opens up the way to computerized control centres; chemicalization, whereby matter itself is continuously transformed by its own laws; the application of biotechnological processes which involve the use of microorganisms for the transformation of matter, and the use of renewable sources of energy and nuclear and solar energy to satisfy the new needs in this field. These changes are based on a process of qualitative change in which science comes before technology and the latter comes before production. Consequently, science becomes a prerequisite for technical and productive progress: that is to say, it becomes a component of the productive forces of society.

iii) The beginning of the third phase may be set in the 1970s, having as its background the events of May 1968 in France, the Cultural Revolution in China, the end of the Vietnam war, the consoli-

dation of the Organization of Petroleum Exporting Countries (OPEC), the definitive establishment of Japan as a leading industrial power, and the economic decline of the Western countries. As from the early 1970s, there were clear signs of the exhaustion of the capitalist development model in both the developed and the underdeveloped countries. The Welfare State entered into crisis, and with it its Keynesian-Fordist axis. It received its coup de grâce with the oil crisis of the mid-1970s, brought on by OPEC's pressure to raise oil prices (a situation which suggested the need for a fundamental rethinking of the whole situation).

We shall now analyse the process which gave rise to this last phase and the way in which the world is linking up with a new paradigm in which science and technology must be the main actors.

State interventionism, which arose as a response to the crisis of the 1930s, based its actions on the monetary and fiscal policies advocated by J. M. Keynes as fundamental elements for overcoming the crisis. By virtue of the principle of effective demand, this approach gave rise to the view that the State should operate as an active economic agent whose functions included helping to maintain levels of income such that, through the corresponding demand, they would induce sustained growth of the economy.

In order to implement this approach, institutions and economic policies appeared on the scene whose object was to protect or raise wages (social security, minimum wages, etc.). This was the response at the macroeconomic level.

At the entrepreneurial level, Taylorism-Fordism was responsible for linking the production relations with the macroeconomic elements. This gave rise to a regulatory apparatus which operated as a unitary whole within the framework of the international division of labour and later of the *New Deal*.

This scheme, which gave rise to the import substitution model in Latin America –applied perhaps most forcefully in Colombia– fulfilled its objectives for a time, but then gradually began to act as an obstacle to the formation of the driving element of the whole system: that is to say, capital.

There were various reasons why this scheme ceased to be organically functional. The international division of labour which arose after the Second World War was very different from the preceding one. The developing countries ceased to be exclusively exporters of raw materials and began to export also manufactures incorporating some content of technology. Furthermore, there was the emergence of highly technified and very competitive economies such as those of Japan and, to a lesser extent, other Southeast Asian countries.

The crisis in the economic leadership of the United States, particularly in the production of high technology, the generation of employment and investment in productive activities, also contributed to the gradual erosion of the prevailing scheme and the formation of new power megablocs: the United States and Canada; Japan and the "Asian tigers", and the European Common Market with a unified Germany and the possible cooptation of the former USSR.

The new technologies –biotechnology, microelectronics, agronics, etc.– were also factors of disintegration, especially of Fordism, assailed by "porosities" and "rigidities" which hindered the accumulation process.

The new model aims to recover the rate of capital accumulation and strengthen the capital/labour ratio within an environment where the process of technical innovation is increasingly rapid, generates new processes and products, and demands greater flexibility on the production line. In this context, technological innovation plays an important role: indeed, competitiveness is based on it.

In the mid-1970s, the first institutions for fostering infant enterprises with a technological basis and total quality programmes began to operate, and there was a general spread within big enterprises of processes of technological research and development largely financed, according to A. Eischner, with price rises made possible through the oligopolistic position of those megaenterprises.

The generation of big economies of scale was based on the globalization of the economy, which, backed up by a new division of labour, sought to apply the model on a world scale.

The systematic use of science in the pursuit of greater well-being for society began in the 1950s when –as already noted in our description of the first phase– elements of international competition emerged (the space race, informatics). In terms of what the history of human progress calls the march of time, authors such as Daniel Bell and Alvin Toffler summarized economic and social evolution in the manner shown in table 1.

Table 1

ECONOMIC AND SOCIAL EVOLUTION

	First wave or pre-industrial society	Second wave or industrial society	Third wave or information-based society
Key resource	Land	Machinery	Knowledge
Dominant sector of economy	Agriculture	Industry	Services
Social groups	Peasants/landowners	Workers/entrepreneurs	Consumers/technocrats
Dominant technologies	Agriculture	Energy and processes	Informatics, telematics, robotics, biotechnology, new materials
Era in history	30th century BC to 18th century AD	18th century AD to 1950	1950 onwards
Economic development	Linear, moderate	Exponential, conflictive	Asymptotic, balanced

Source: Daniel Bell and Alvin Toffler.

Although in the early 1970s the economic crisis gave rise to a certain disenchantment regarding science and technology, this attitude changed in the 1980s, when the countries which had made big investments in technological research and development obtained excellent results which were reflected in high and sustained economic growth, technological advances that gave them a leading position, a big expansion in their share of international trade, and increases in the value added in their products.

IV

The situation in Colombia

Colombia has not given priority attention to science and technology. This is clear from the conclusions of the mission on science and technology which analysed this topic.[1] Expenditure on science and technology as a proportion of total central government expenditure was 1.29% in 1980 and 1.37% in 1988, while over the same period, as a percentage of the gross domestic product, it went up from 0.16% to 0.19%. These figures are substantially inferior to those of other Latin American countries such as Brazil, Mexico, Chile or Argentina, where they are two or three times higher.

The picture is even more discouraging if we look at the evolution of the industrial sector. The model adopted, which was based on import substitution, did lead to the development of industry, but at the same time it heightened the agricultural export and protectionist structure. This permitted the emergence of a type of industry characterized by a high degree of fragmentation of production and high levels of idle capacity (FONADE/DNP/MEN/Universidad Autónoma de Colombia, 1990, p. 32).

Industrial production, for its part, shows high indexes of concentration. These are due to structural characteristics connected with a small domestic market and investment policies which have chan-

[1] See FONADE/DNP/MEN/Universidad Autónoma de Colombia, 1990.

neled surpluses towards the financial accumulation cycle. Thus, although the concentrated industrial sectors have very good indexes of economic performance, in the long run these policies hinder industrial development. Consequently, the oligopolistic enterprises have used their profits and indebtedness to buy existing enterprises rather than to expand their own production capacity.

Over the period 1979-1986, gross production grew in real terms, with recessions in 1973-1975 and 1980-1983. Added value and domestic consumption registered similar behaviour. Labour remuneration grew steadily between 1974 and 1983, but as from the latter year it did so more slowly, and there was also a decline in employment and in the number of establishments. Although some parts of Latin America have a solid industrial base which puts them in a better position than the African countries and extensive areas of Asia (in 1988, exports of manufactures accounted for more than one-third of total exports in Latin America as a whole, while in Brazil and Mexico they amounted to 51.7% and 43.2%, respectively), in countries like Colombia the figure barely reached 16.1%, thus showing their heavy dependence on commodities (ECLAC, 1991).

In general terms, the industrial structure by sectors has not registered substantial changes. In 1986, the composition of production was as follows: non-durable consumer goods, 44.2%; intermediate goods, 43.3%, and metal products and machinery only 12.6%, of which the machinery and equipment branch accounted for 4.7%.

If we examine the links with technology through: i) imports of capital goods; ii) purchases of patented technologies; and iii) technologies put into operation by various enterprises, we see a notable drop in the industrial sector's share in imports of capital goods, from a peak of 50% at the beginning of the 1980s to 40% in 1984.

The share of manufacturing in total payments for technical services went down from 30% at the beginning of the 1980s to only 8% in 1988. The sectors accounting for the biggest shares of these payments were the manufacture of paper and paper products, printing and publishing, which accounted for nearly 35% of payments by industry between 1976 and 1988, followed by the manufacture of chemicals and chemical products derived from petroleum, coal, rubber and plastics, which together represented a little over 10% of total payments during the period.

Payments of royalties, in which industry had an important share, went down considerably during the 1980s. The two sectors which accounted for the biggest shares of these payments were the manufacture of metal products, machinery and equipment (nearly 30% of total payments) and the manufacture of chemical products (nearly 40%).

The reduction in payments for royalties and technical services may be an indication that industry does not make much use of these forms of incorporation of technological innovations, or that because of the restrictions which exist other ways of making such payments are used. In order to analyse the impact of royalties on the industrial sector it is worth noting their share in added value: after having accounted for 1% in 1970, they went down to 0.30% by 1986, which is in line with the decline in payments and confirms the sluggishness of the incorporation of technology.

In its analysis, the mission on science and technology notes that "in contrast, the share accounted for by interest is increasingly important, and in 1986 it was twice the level of 1970. It would appear that a large part of the surplus generated by the sector has been directed towards financial payments rather than expenditure on technological modernization" (FONADE/DNP/MEN/Universidad Nacional de Colombia, 1990).

The behaviour of capital formation confirms the slow growth of the capital stock of the economy. According to this mission, "if we start from the assumption that there is a high degree of correlation between investment and technical change, it may be said that, at least during the last decade, the introduction of new technology in this way has been limited. This situation is particularly critical in the case of the agricultural sector" (*ibid.*).

If, in the case of Colombia, we look at the characteristics corresponding to the third phase, it may be noted that in the industrial sector there have been great changes in the skills of the staff, and greater linkages of professionals and technicians are to be observed, together with more and better specialization of functions. These changes are most evident in the areas of chemicals; chemical, electrical, industrial, mechanical and metallurgical engineering; electronics and informatics, and business administration.

This is a basic element in the process of industrial technological innovation, which in turn is essential for the restructuring of the sector and is the heart and soul of the process of greater economic openness which has been put into effect in Colombia since the beginning of the term of office of the present government.

With regard to the agricultural sector, the traditional model of a dual economy has been changed through the strengthening of medium-sized holdings oriented towards modern agriculture. Nevertheless, the increase in agricultural production has been due more to the expansion of the area cultivated than to an increase in yields. The higher yields registered have been due to the greater use of improved seeds and machinery, together with heavy investments in irrigation and land improvements (basically for commercial crops such as oilseeds, cereals and sugar).

In the Colombian agricultural picture, there are two critical elements: land use and land conservation. According to a study made by the Agustín Codazzi Geographical Institute (1987), only 4.6% of the total land area is used for crop farming, 51.5% consists of forests, and 35.1% is used for pastures, which reflects poor management of the land resources. In addition, it is necessary to bear in mind the serious deforestation being suffered by the country, which is only exceeded by that in Brazil and Indonesia.

Raising agricultural production involves not only strengthening the present scientific and technological structure but also eliminating the barriers which exist, including the impossibility of gaining access to land of good quality in good locations, the lack of infrastructural works (irrigation districts) and the oligopolistic prices of agro-chemical inputs. Technological research and development in the sector have been marked by the dissemination of the procedures of the international strategy known as the "Green Revolution".

With regard to spearhead technologies, the advances made in molecular biotechnology and tissue culture open up opportunities, though they also raise some important problems which are a source of increasing concern to the leaders of agricultural research in Third World countries. Some of the applications of genetic engineering which are of particular significance for countries whose agriculture is in a process of development include the improvement of tolerance of drought, nitrogen fixation, improving the efficiency of photosynthesis, and the use of monoclonal antibodies to identify viruses and reorder matter. The applications of tissue cultures include the cleaning up of tissue diseases, the rapid multiplication and *in vitro* storage of clonal material, increased genetic diversity through somatic variation, and the use of other cultures to accelerate the process of genetic improvement, especially in climatic zones where it is only possible to grow one generation per year (Nickel, 1989).

The high cost and degree of private ownership of this type of research raise fears that the developing countries may lag behind the capitalist countries and transnational corporations and will finally have to buy this technology. This fear is accompanied by recent decisions such as that permitting the patenting of genetic engineering material. Only big agricultural research systems which can invest enormous resources in this field could achieve success in it, and even so there are many risks (CTC, 1988).

The big commercial firms may only be interested in crops and animal products which have a big market, so that products aimed at solving the problems of the developing countries, and particularly those of small producers, might not be benefited by biotechnology research processes. Some Latin American countries have set up institutions such as the Centre for Genetic Engineering and Biotechnology in Cuba, the National Institute of Agricultural Technology in Argentina, the Centre for Research into Genetic Engineering and Biotechnology in Mexico, the National Biotechnology Programme in Brazil, and the Institute of Biotechnology in the National University of Colombia. The technological challenge in these areas is difficult, however, since the rapidity of the changes taking place calls for great dynamism of the production apparatus and responsiveness to technological progress in order to improve competitiveness or, at the least, be able to act as rational consumers of technology.

For countries such as Colombia, this is an important challenge which obliges the country to adopt a research strategy and try to ensure that technological innovations help to solve social problems rather than make them worse. Most of the

agricultural areas of the developing countries are in the tropics, and peasant pressures push activities towards the most fragile ecosystems, in marginal conditions for sustained production. This emphasizes the need for the environment to be taken into account in all strategic research.

What is needed in the Latin American countries is for the national research centres to act simultaneously i) in the modern sector, by giving priority in their studies –as some analysts have already proposed– to products with comparative advantages in the export market which must be made still more competitive through the biotechnological revolution, and ii) in the traditional sector, particularly in respect of foodstuffs for domestic consumption.

V

The regional situation

The economic crisis currently being faced by the majority of countries in Latin America, which is made worse by hyperinflation, the rapid advance of urbanization, the increase in the number of people living below the critical poverty line, and an external debt which stands in the way of economic development (plus the lag in scientific and technological progress), calls for the reformulation of the development model.

According to ECLAC estimates, in 1990 the gross domestic product of the region as a whole went down by 0.5% compared with the year before, when it had in any case only grown by 1.5%. As a result, the per capita product went down for the third year running, sinking back to the levels registered in 1977 and 1983. The growing inflation was on the point of assuming the chronic nature which can lead to hyperinflation: at the end of 1990, the cumulative twelve-month rate of price increases was 8 500% in Nicaragua, 8 300% in Peru, 2 400% in Brazil, 1 800% in Argentina and 130% in Uruguay. In other countries with recent high inflation which are applying stabilization programmes –including Mexico, Ecuador, the Dominican Republic and Colombia– the price rises were between 30% and 75% per year. These figures, which give grounds for concern, erode the purchasing power of wage earners.

In most of the countries of the region, there was no reduction in 1990 in the external sector's effective import capacity, either because exports expanded, because the servicing of the debt was postponed, or because a capital inflow was received.

The region's external debt amounted to US$423 billion, after having gone down slightly the year before because the inability to fulfil debt service commitments led to arrears of US$11 billion, while the devaluation of the dollar also helped. At the end of 1990, the most heavily indebted countries were Brazil, with US$ 121 billion; Mexico, with US$95.9 billion; Argentina, with US$67.5 billion, Venezuela, with US$31 billion; Peru, with US$17.71 billion, and Colombia, with US$17.2 billion (ECLAC, 1990).

Rapid urbanization has been the general rule in the region over the last three decades. At the beginning of the 1960s, 51.2% of Latin Americans lived in rural areas, but by 1990 the proportion had gone down to 30%. The remaining 70% live in urban centres, which continue to grow and give rise to dramatic processes of urban chaos. These changes have caused great modifications in the food system, in the preferences and habits of consumers, in the development of agro-industry, and in the increase in informal economic activities which compete with those carried on in the formal sector, but without paying taxes or giving any form of labour stability (the typical "black" economy). Urban unemployment increased in all the countries of the region except Chile (where it went down from 20.0% in 1982 to 6.6% in 1990) and Mexico (where it eased from 4.2% to 2.8% over the same period). In Colombia, such unemployment rose from 9.1% to 10.2%.

Quite apart from population growth itself, urban dwellers are increasingly concentrated in very large conglomerates. In 1950, there were ten

cities with 5 million inhabitants or more, whereas in 1990 there were 33 metropolitan areas with 5 million inhabitants or more, 15 with 10 million or more, and six with 15 million or more. Generally speaking, they display problems of "urban crisis", since their size makes any kind of rational ordering difficult. The most serious feature of the problem is that "cities in the world's poorer countries are fast filling up the ranks of the world's largest cities", and this represents a break in the historical connection between the size of cities and their degree of economic and social development, since this size no longer reflects an industrialization process which attracts new city dwellers, but phenomena of another nature based on the "tertiarization" of the economy. Some 58 of the world's 100 largest metropolitan areas are in developing countries, and the slums and shantytowns of the developing world are growing twice as fast as cities as a whole. "Estimates in 1987 put the proportion of city populations living in slums or squatter settlements above 30% for many developing country cities. In some cases the bulk of the city's population lives in slums: 70% for Casablanca, 67% for Calcutta, 60% for Bogota and Kinshasa, and 42% for Mexico City" (Population Crisis Committee, 1990). This increases the deficits of dwellings, public services and community equipment, as well as noise and environmental pollution: in short, it makes poverty still worse.

In the case of the Latin American region, including of course Colombia, it is necessary to distinguish between two great economic options which involve in turn two great options in science and technology policy: either we accept the neoliberal model which advocates passive adaptation to the new international division of labour, or we establish as a prerequisite the formulation of a nationalist policy for development and modernization of the economic base. This latter option calls for promotion of the agricultural and industrial sectors through expansion of the domestic market and the development of technological innovation in order to make good the areas where we are lagging behind, creating or consolidating in secondary and higher education a scientific base which favours national research and development capacity in strategic areas and spearhead sectors of technology. For this purpose, it is necessary to reformulate the role to be played by science and technology in the development of the country and to indicate clearly what their links should be with the educational system, particularly at the higher and postgraduate levels, where the supply of graduates must be guided not so much by the spontaneous demand of the market as by the strategic needs of the country.

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