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# Science, Technology and Development: Stakes of Globalisation

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## Introduction

One of the major phenomena of modern times is undoubtedly the intensification of information flows, capital transfers, company relocations around the world which are induced by growth and the excess capital generated in industrialised countries. As a solution to the crisis-stricken economies of West Europe which, in the aftermath of World War 2, strode to develop by adopting Nation-State as a social, political and economic reference system, this intensification caused the framework to implode and forced upon the rest of the world deregulations whose impacts resulted internally in lifting some obstacles linked to the social working conditions created by State interventionism and externally in weakening the rigidity of the national framework. The international, financial and trade institutions contributed a lot to this process by accelerating the liberalisation of potential outlets and the development of new markets, particularly in developing countries through restructuring, adjustment and liberalisation policies. These countries were thus absorbed into a global dynamics where their purported role was to offer new investment spaces. Indeed, they offer every condition for making bigger profits: abundant labour and lower salaries, barely constraining social security system, availability and closeness of raw materials, lower taxes and even negotiations facilities including possibly complacency and corruption.

According to the dominant neo-liberal discourse, the development of these countries depends on their entry into the market economy: liberalisation would open markets, facilitate productive investments and subsequently help contain poverty. Liberalisation is painted as humanism. The argument for an all-out liberalisation of markets and investment conditions in developing countries was no longer the search for new outlets to prevent devaluation of the excess capital accumulated in developed economies, but rather the desire to pull these countries out of the socio-

political impasse in which they find themselves. The problem in fact does not lie there. Presumably, the collapse of the nation-state economic system in developed countries could even offer some opportunities to developing countries. Don't we have on one side, new outlets-seeking excess capital and on the other a blatant need for capital! Whatever the case may be, the constraining and almost irresistible[1] force of this globalisation is a welcome idea. It is described as a 'terrible machine' (Petrella 1997:17) swaying the world and practically leaving no other alternative. The stake involved for the economies and cultures of Third World countries is being passionately debated. Some see it like a sort of development sesame and others like a serious threat to these countries which if not cautioned will disappear in the universe (Hountondji 1997:24-26).

The fact that science and technology are the key factors of this phenomenon and that the stakes for developing countries are playing out at this level very often goes unnoticed. Indeed, the future will depend on what will have been gained or lost in the areas of science and technology. It is from this perspective that we suggest analysing here the consequences of globalisation on the practice of science and technology in developing countries. What will be the impact, on scientific and technological research in developing countries, of the planetary expansion of multinationals, company relocations and intensification of the flow of scientific and technological knowledge and all their consequences at the structural level? Will all these factors contribute to greater visibility of science and technology? Will they induce a re-appropriation of scientific and technological potentials, a necessary condition for their transformation into development activities? These are some of the questions raised by the globalisation phenomenon in relation to the development of science and technology in developing countries. These questions will be analysed a special focus on the place of technoscience as a key factor of societal development and globalisation.

## Technoscience as a Key Factor of Development[2]

It was not until recently that science actually acquired its current status in the development of industrialised countries (after World War 2). Before then, conventional science operated as a marginal phenomenon. Science usually reported retrospectively on the success of a technique which progressed essentially in an empirical manner. Science did not assist the technician, the latter helped science by devising its experimentation instruments. This was a time when science was resolutely knowledge-oriented. As we all know, the industrial revolution of the 18th and 19th centuries was not exactly the consequence of essentially scientific progress. Science cannot be said to have been decisively involved in the development of agriculture, textiles and transportation, not even in that of the primary industries. For example, the steam engine which importance in the industrial progress is well recognised, the first productions of which became operational around 1710, appeared well ahead of its explanatory theory. Newcomen, Savary and the others were rather craftsmen, blacksmiths, Cartwrights, etc., working empirically to enhance the efficiency of their

machines and the yields thereof. Concurrently, theoretical science continued to develop in disciplines like physics, mathematics, chemistry and biology in particular. At the end of the 19th century, indeed, it helped dissipate many mysteries and was such a capital of knowledge that people were convinced by the idea that they held the secret of the universe. This meant that historically two approaches co-existed: one scientific and the other technological. Both converged in the second half of the last century (Hall 1956).

However, a collusion was initiated at the peak of the industrial revolution between science and technology as a result, in particular, of the work of many engineers who, with a solid scientific and technological background, took advantage of scientific knowledge to expand technological progress. Technology therefore resorted increasingly to scientific knowledge and processes to improve on its own while science became simultaneously strongly dependent on technology for its verification process. Jean Ladrière pertinently observed that this converging evolution was inscribed in the 'operational' nature of science (UNESCO 1977:16). It was the need to experiment its knowledge that led science to become allied with technology. For, science combines knowledge and practice at the time of experimentation and theorisation. Thus, by relying on technology to refine and generalise the use of the instruments and tools of which it prompted the invention, science contributed at the same time to the development of those tools. Telescope, microscope, air pump, etc., which were being used in the 17th century for scientific purposes were improved, generalised and their social practice mainstreamed. This has resulted in some 'sciencisation' of technology and a 'technicisation' of science.[3] Ladrière concluded saying that 'The penetration of *social practice* in its most diverse and central forms by science is therefore not something purely accidental to be ascribed to the enlightened will of a few individuals or groups or to a fortuitous encounter between concerns and methods. It was a historically necessary fact in that it reflected the *law of essence*' (UNESCO 1969:16).

Since World War II, with the advent of 'big science'[4] and the emergence of large-scale industrial research in which science and technology are jointly used in enhancing and inventing their products, they have become altogether a 'system' in that they maintain 'a mutual double dependence relationship and are intertwined in a double feedback process' (Ladmiral 1973:IX). This is the system today referred to as technoscience, as it becomes the real development infrastructure of modern societies and all the more so because it has become inextricably linked to power. While knowing before acting was merely an ambition at the birth of modern science with Bacon, Descartes, etc., nobody would argue today that the unique goal of science is the quest for knowledge and that any pragmatic and utilitarian deviation is done to free mankind from any burden that would prevent him/her from fully dedicating himself/herself to this search for knowledge, as Poincaré (1905) did at the start of last century. The expression 'knowledge is power' by Bacon has never been so relevant. Science, as inextricably linked to technology, has thus become a real power which determines the fate of mankind and societies (Roqueplo 1973:30).[5]

This further justifies the serious consideration dedicated to science by the industry, the army, politics, etc. Of course, it also raises some serious problems which are however proportionate to the deep changes it has introduced in the life of mankind.[6] People living at the turn of this century are bending beneath the weight of the artefacts of technoscience which has 'gradually acquired a decisive influence on what makes up culture in its broadest sense that is, whatever imparts its specific features to the life of a historical community' (Ladrière 1977:41).

Science is considered here from this systemic standpoint as the 'system of science and technology' (Paty 1995) in its implications for the economy and society. Science is thus understood, not only as the set of knowledge produced by the mind, but also as a decisive element in the production line which is necessarily linked to technology and entails fundamental implications for society. This is known as the science 'technology' 'industry' society Ring.

**Technoscience as a Key Factor of Globalisation**

It is commonplace to argue that surplus capital from agricultural revolution was behind the industrial revolution of the 18th and 19th centuries. The capital generated by agriculture, the resulting food security (and subsequently population growth) and the freed labour force as a result of mechanisation considerably boosted the nascent industry,[7] particularly steel manufacturing and textile.

Technoscience is to globalisation what agriculture was to industrial revolution. It is the excess capital generated by the big multinationals that was behind this far-reaching phenomenon. While these multinationals have global 'control' (Clairmont 1997) and cover naturally all sectors of activities, we are more interested here in the fact that most of them make an overwhelming use of the results of scientific and technological research in pharmacy, agriculture, mechanics and electronics, communications, etc. Science and technology-oriented sectors, which are practically at the forefront of development, are behind this growth and have allowed these societies to accumulate such a huge amount of capital.

The collapse of the national framework is therefore nothing more than one of the consequences of this development. The logic of openness is natural altogether in this sense: this is the dynamics of birth giving. And political and ideological decisions on liberalisation are just instruments to facilitate such an openness. While explaining the factors of globalisation, Samir Amin (1996) wrote: 'Crisis is manifested in the fact that, in given income distribution structures, the profits yielded by production find no sufficient outlets in the profitable investments that are likely to develop production capacities. Crisis management consists then in finding 'other outlets' for this floating excess capital so as to avoid their massive and sudden devaluation as it happened in the 1930s. (...) The recipe is the same for all. (...) The liberalisation of international capital transfers, the adoption of floating exchange rates, high interest rates, the deficit in the American trade balance, Third World external indebtedness and privatisation constitute together a perfectly rational policy offering these hot monies the outlet of making headlong rush into speculative finan-

cial investments to pre-empt the same old danger: massive and sudden devaluation of excess capital'.[8]

First, the developments in science, information and communication technologies and transportation are key factors in the expansion and acceleration of this phenomenon. In fact, the planetary village concept reflects this fastness in communication and people's movements. Satellite connections, computer communication networks which have reached, thanks to the Internet, breathtaking speed are the vectors of the phenomenon. Thanks to the developments in communication, transactions which would have taken months to complete just a few decades ago are now done in real time. Victory over space and distance has never been so close. It is therefore the possibilities offered by scientific and technological progress in communication and transportation that determine the current scope of economic globalisation.

The hypostasis of the essentially economic and monetary elements has often overshadowed these genuine factors: infrastructure as such has been neglected in most cases for economic and political superstructures. The interrogation as to the structural origin of these companies' wealth is raised only occasionally. Analysts tend to gloss over economic and financial considerations. And this neglect does have an impact on the development strategies and models applied here and there in developing countries because they place key development factors in the second position and promote super-structural elements instead. An evidence of this is the place given by structural adjustment and similar programmes to education and scientific and technological research in developing countries, understood as the capacity of a people to find solutions to their problems. In these programmes, education and scientific and technological research occupy but a footnote space for social considerations. The application of such models can only lead to dead-ends.

## Effects of Globalisation: Dead-end of Science and Technology in Developing Countries

The effects of globalisation on the development of science and technology in developing countries can be tentatively analysed at three levels: first, in terms of easy access to scientific information; secondly, in terms of the consequences arising from the establishment of multinationals; and lastly, in terms of the implications of structural adjustment policies for orientations and scientific institutions. At each of these levels, science and technology seem to have come to a dead-end: by opening to 'mainstream science', they have become externalised and contribute more to the development of the societies who have the structures and resources to operationalise them. In so doing, they got cut off from local development concerns. With the establishment of multinationals and the implementation of structural adjustment policies, science and technology have become the forgotten ones in the development process, marginalised and reduced to sheer bureaucracy.

### *Globalisation, Knowledge Chains and Development*

Globalisation is celebrated as a panacea because it ends the isolation of developing countries by giving them more accessibility to communication media and scientific information. Because of their significantly lower cost, compared to traditional communication media, information highways constitute the main driving force. It is now possible to look for information everywhere around the world regardless of geographical distance because editing modes, catalogues and databases can now be instantly accessed, thanks to the Internet. The world Internet expansion increased from 2.4 per cent of world population to 6.7 per cent. In Africa, in particular, it went from 0.04 to 0.4 (UNDP:36).[9] It is thus an inexhaustible source of scientific data made available to the researchers of developing countries. Data that would have taken months to reach at a prohibitively expensive cost for ordinary researchers are now very cheaply accessible.

But the criteria with which to evaluate the contribution of this broader accessibility to development-related scientific information can be defined only based on the link between research and its technological, industrial, cultural and social implications. Indeed, in which direction will scientific and technological research develop? Is the social fabric prepared to take hold of them and transform them into innovations and development activities? There lies the real issue!

Here is the danger: the easier the access to scientific data, the more productive research becomes and the more it becomes marginalised and elitist in relation to the socio-economic and industrial fabric which is yet inapt to grasp the results. Then, science in developing countries will develop to contribute more to the central 'science system' with relative effects locally. As pointed out in the *2001 World Human Development Report*, 'The investments of developing countries have come to a point where they are subsidising the economies of industrialised countries. Indeed, many are the holders of prestigious degrees who emigrate despite the fact that their countries of origin devoted very considerable resources to the training of national educated labour'. (UNDP 2001:5).[10] Emigration in this case is not simply physical. Researchers who remain in their countries also experience a kind of mental emigration, judging from the focus of their research since they are not producing for their society but rather in relation to externally-defined objectives and themes.

Indeed, there is a real schism between the societies who have been able to control science and technology and who happen to be mostly countries overseas, and those who still use them marginally. The scientific and technological development map drawn by *World Human Development Report* shows gigantic disparities. 'New product concept and development which very often derive from systematic investments in development research are something occurring almost solely in the OECD countries and a handful of developing countries in Asia and Latin America' (UNDP 2001:39). In fact, representing 14 per cent of world population, the 29 countries forming OECD, with 2.4 per cent of their average GDP devoted to development research, concentrate 86 per cent of the 836,000 patent applications deposited

around the world in 1998 and 437,000 of world published scientific and technical articles.

In practice, the effects of globalisation will translate into broader accessibility and increased dependency of product consumption on technoscience, as a result in part of the research conducted worldwide but which would have materialised in contexts more prepared to grasp it and transform it into innovations. This is also confirmed by the strong growth of the telecom sector (UNDP 2001:31) as it outpaces traditional sectors like electricity, potable water, land line …)

In most developing countries, science still operates marginally. But in absolute terms, the level reached might be higher than the one attained in the 19th century by developed countries. Many Third World scientists have made major contributions to cutting edge science (Paty 1992:17), though their own society could not benefit much from them. Both in terms of the themes, outcomes and validation, scientific research in developing countries is extroverted. As such, it is of a 'colonial' nature in that the recognition, validation and operationnalisation of its results depend on the Centre. Research themes are defined in relation to the practice in developed countries where people have a clearer understanding of the application potentials which are even updated every day. This choice of themes is certainly conditioned by the validation criteria and venues.

More radically, there are several levels of research validation. The first level is the choice of research themes and their institutional acceptance, to the extent where this institutional acceptance conditions funding without which there cannot be serious research. Obviously, researchers are not completely free. The work of Waast and Gaillard has clearly demonstrated that researchers from developing countries, most of whom were trained in developed countries, tend to continue work within the same bounds of research themes and training once they return to their home country. That way, they guarantee their international exposure, opening prospects for funding and getting published. The second level is 'editorial dependence' particularly having the achieved results published in the specialised journals of 'mainstream science' (Waast 1996a) and climaxes with the award of scientific prizes. However, by generalising publication of scientific results to include databases, LDCs admittedly received the smallest or no share. LDCs are practically absent from the main databases of developed countries (ISI, Francis, BiblioSHS) (Harbo 1999-2000:115-127). The third level, an operational and economic one, is the practical uses of the results, implying meeting patent requirements. No doubt, the gap broadens at this level. The stakes of development research also play out at this level since patents define the copyrights of a technological invention and its likely induced wealth. Concerning technological inventions and copyrights of such inventions, about twenty nine countries monopolise the future. Even if the research contributing to these patents is produced by the global science system as a whole, only a few countries own it, as a result of their capacities to transform research into technological innovations.

All these validation criteria are exogenous in relation to the Third World. The major specialised journals are found in developed countries, the best scientific prizes are awarded there and they offer enough operationnalisation possibilities, leading possibly to the acquisition of patents. Thus, themes can be defined only in relation to those conditions. Yet, the interweaving of scientific and technological research with socio-economic fabric and its underlying problems, needs and priorities is one clear variable. Research funding is not neutral. It is conditioned by this close relationship and by the idea that society is made by its own development. Thus, the billions of dollars spent on atomic and nuclear physics since World War 2 have a link to the Cold War and to the 'atom diplomacy' that has become international practice. More billions of dollars went into spatial research following the same logic. This is not because there were no priority research sectors whose results could be far more beneficial in terms of improving the living conditions of mankind in general. It is quite the opposite! Little research is done on scourges like malaria which are affecting Third World countries (whose population weight is well-known in relation to the whole planet) in alarming proportions. Research is therefore all the more developed in a given area if it is associated with the ideological, industrial, military and economic circuit. The orientation of scientific and technological research is inevitably political and economic.

The real problem stems from the fact that developed country needs do not necessarily correspond to the LDCs'. The situation is even more complicated because being still at the stage of agricultural revolution, LDCs must at the same time follow through their externalist education and research programmes, the most advanced science and technology. These programmes are thus carbon copies in content of developed countries' models, resulting inevitably in a disconnection between the educational system, scientific and technological research and the social fabric, yet unprepared to benefit from their result or even understand them. Scientific and technological research is marginalised in developing countries as a result of this uncomfortable situation of straddling two worlds. On one side, part of the society has attained a relatively high consumption level and on the other, the great majority is still confronted with problems of food security.

Fears are that one will increasingly witness the development of a research cut off from its deployment conditions and the results of which can only be beneficial to those countries that have adequate structures to use them. Jean-Jacques Salomon rightly remarked that the answer to the question 'What is the impact on development of a science policy essentially devoted to fundamental research' is: 'zero!' (Salomon 1196b). In fact, he added, 'fundamental research produces information available to the international scientific community. Who can benefit from this? It is those who can transform knowledge and information into an immediate technical know-how at the service of economic and industrial concerns or the health sector'. Of course, there are a few possibilities of operationnalising some of the results in various scientific fields (agriculture,[11] medicine, computer science, for instance) but these are yet to create the synergy that would produce the bandwagon effect.

However, it is important to note that the reverse of the approach asking developing countries, 'instead of trying to reproduce the feats of an Einstein' to concentrate on solving the most urgent problems, especially survival, hunger, unemployment ..., is not at all viable. Gaillard asked in this connection whether 'the future of developing countries lies with new technologies in which a limited number of them like Brazil or the Republic of Korea have engaged or, on the contrary, with development research in agriculture, an activity from which over three-quarters of African and Asian populations are earning a living?' (Gaillard 1989:21). In our view, there is no better way to perpetuate dependence than to limit oneself, as Ahmad Jalali put it, to 'subsistence research' (Jalali 2000:303-306), to the research seeking to satisfy the most primitive needs and lacking the necessary leverage to boost development. To be occupied solely with immediate needs in a competitive environment certainly amounts to opting to lag behind. Japan is often cited as an example of a country which first concerned itself with solving immediate problems, oblivious of the fact that this country's success precisely stems from its ability to '*anticipate*' and to take the lead in advanced technology. Speaking of Japan, Allen further noted that: 'The officials of the ministry of international trade and industry (MITI) and their associates from major companies contended that a concentration of labour-intensive activities would doom Japan to poverty and to an everlasting economic inferiority; that it should concentrate its efforts on creating a type of industrial structure characteristic of western developed countries' (Allen 1983:104). Whereas anticipating strictly means cutting oneself off from daily routine to attend to the problems of tomorrow and finding their solutions. Inversely, if the abstract distance is completely cut off from real conditions, research will also run open.

Science is not ready-made and cannot be simply transposed; neither does it suffice to reproduce the research themes developed in developed countries or even make groundbreaking discoveries if specific conditions are not met, in particular, the existence of 'national scientific communities and well-established educational structures […] apt to absorb the shocks of economic globalism and put international knowledge flows to their advantage' (Gaillard 1998). Otherwise, research institutions will operate, as Jean-Jacques Salomon put it, like an ultra-modern tower in the middle of a multitude of traditional villages' (Salomon 1992:388) and completely cut off from the society and the production system. In this sense, the Internet, in most of the developing countries of the South, is much more consumption than an information producing-system. Globalisation does, at that level, a sort of levelling from the top which will further widen the gap between the North and the South on one hand, and among Third World social strata on the other. While it is good for one to benefit from advanced technical communication equipments, there is also need at the same time to be involved with a global research dynamics in order to be able to exploit the massive information inflows from communication networks, to benefit from research funding and to have research validated. The need to fit into this global dynamics controlled by developed countries conditions research themes and

subsequently put them on the margin of society, as a result of development gap and differences in problems and needs.

### *Expansion of Multinationals and Development of an Endogenous Science System*

Let's now address one of the expressions of this globalisation, that is, the expansion of multinationals worldwide and the associated relocations. From hearsay, developing countries were going to integrate the global economy by liberalising their economic system and facilitating foreign investments. With these company expansion and relocations, one would have expected revived funding for development research activities on the new sites, implying greater technological innovation capacity and enhanced education in general. But the conditions of relocations do not seem to pursue these expectations. Relocations, as they currently unfold, have essentially involved production sectors by banking on the comparative advantages of unskilled labour. In this sense, their impact on the level of education and innovation cannot be positive, even though it translates into relatively better living conditions. It is therefore being naive first to ignore that these multinationals are seeking labour-intensive countries with lower salary scales where they can make maximum profits and pay the least taxes and secondly, to believe that they could bring about any genuine development. Far from providing a breeding ground for the development of scientific research in LDCs, the installation of multinationals is more likely to become a hindrance for various reasons.

First, instead of a veritable technology transfer, these company expansion and relocations entail, in their wake, a transfer of readily consumable technological products. This creates an illusion of endogenous development. Indeed, whether these products are mounted and assembled in developing countries does not fundamentally change the situation because basic technology has not been integrated in the entire socio-economic fabric. It is therefore wrong to count the number of TV sets or computers in a country, even if assembled on the spot, as a development index if that country is reduced to a simple consumer and cannot develop research to appropriate the underlying technology.

By liberalising to facilitate access to technological import, globalisation rather contributes to a sort of innovative potentials congestion since a technological import will only show solutions. It works like a magic box without inducing re-appropriation of technology, which is a must. Globalisation is therefore trying to kind of standardise needs and solutions by simply transposing the problems and solutions of developed countries into LDCs. The latter can see their context-specific problems coexist alongside the problems created by the importation of West European culture and technology. This co-existence creates another type of LDCs-specific problems best expressed by the separation between the urban and rural areas. So, the coercive force of imported solutions develops a spirit of receptivity, finally inhibiting innovation capacities. This translates into a common belief according to which 'Whites have invented everything'.

Secondly, globalisation accentuates the 'specialisation' of economies or the international division of labour set in place since colonial times. For, multinationals are only willing to install or relocate to LDCs the mechanical or manufacturing production sectors which require intensive labour but not advanced technology. The rationale is essentially to move, based on lower salary scales and taxes, the production sectors requiring intensive but often unskilled labour. The gains from the comparative advantage offered through the cost of unskilled labour cannot guarantee genuine development without a qualitative jump forward which is necessarily expressed through technological anticipation. It is through this anticipation alone that competitiveness can be guaranteed in a world where rapid breakthroughs in production tools no longer leave room for simple production mechanics. Yet, the advanced technology, financial and service sectors (which are part of what Samir Amin named the monopolies of the West) are the ones making considerable gains. Obviously, the most decisive and sustainable element today is for growth to be based on scientific and technological innovation. The other forms of growth turned out to be short-lived.[12] Developing countries still confine themselves to the basic sectors: agriculture, raw materials, basic and mining industries, etc., which will increasingly depreciate due to the development of substitutes. Commodity and high-tech products markets do not grow at the same pace. It is quite the opposite; commodity market tends to decline or remains relatively stable due to these substitutes. Inversely, monopolised by developed countries, high-tech products market grew at a breathtaking speed and seem to offer endless prospects. This situation is nothing new. Indeed, already in 1949, the UN published a study underscoring the deterioration of commodity prices in relation to those of manufactured goods. Between 1936 and 1938, the deterioration was estimated at 40 per cent. And yet, it was admitted that because of their scarcity (a recurrent theme then) and the possible depletion of natural resources, commodity prices tended to increase. Strangely enough, no commodity has so far been dropped because of depletion but rather because of the substitutes, and more recently, because of synthetic products.

How do you pull out of a 'specialisation' cleverly upheld and maintained by several development theoreticians[13] who see in globalisation a way to perpetuate their careers? Many of them still conceive development as a straight line process. This is why they believe agriculture should be developed first so that the excess from this sector could finance industrial development as was the case in the developed countries. In a nutshell, this amounts to saying that science and technology should be put off and agriculture developed, thus going through the same stages as developed countries did. This vision overlooks a fundamental factor: Western Europe invented its own model by itself during its revolution. It was not under the pressure of a more developed system pouring in its products and results. And even though revolution did not occur in all West European countries at the same time, those that followed it like France and Germany, Sweden and even USA, and benefited from technology transfer from the revolution centre – essentially Netherlands and Italy – were advantaged by the fact that these were relatively not too

advanced and more easily transferable technologies (Bairoch 1971:79). Third World countries are experiencing a different situation altogether because most of the new technologies are the result of important scientific precedences requiring longer and more complicated education which, consequently , are less easily transferable.

Furthermore, these countries are inundated with high-tech products that have been integrated in lifestyles and are now part of the daily environment; so to return at this point to the different stages of West European development – agriculture, textile, mechanical industry, modern industries making massive use of science and technology – in order to make consumption level correspond with production level is something practically impossible. This, to some extent, tends to remind us of the various bartering between USA and the European Union, USA and Japan, USA and China, etc., or even the old GATT negotiations on non-tariff barriers. These countries are aware of the devastating effects that massive importation of a foreign product would provoke on the local industry, especially if the latter is not yet competitive in the area. Most developed countries are seeking to protect or subsidise some sectors of activities so that they can face up to international competition. USA protects its agriculture, subsidises through would-be military/industry contracts many high-tech sectors, including notably aeronautics, while Japan and several other Asian countries are trying to limit access of American products to their markets. It can thus be seen that the liberalisation policy imposed on developing countries is very staunchly resisted in Western Europe, subsequently mitigating its impact. Worse still, this neo-liberal vision is mistaken since the newly industrialised countries including even Japan neither followed this path nor gave in to specialisation. Citing them as an example is wrong, because these countries have understood that they had to bet on either technological innovation or innovation through technology transfer. The South-East Asian 'dragons' often cited as successful liberalisation models followed a different policy altogether. South Korea's case is a good illustration. Instead of disengaging and opening the market, the State limited and even banned industrial imports in sectors where the local industry was striding to establish itself (Perrin 1983) at a time when the IMF imposed, as one of its conditions, that the country opens its markets to foreign products and especially allow multinationals to acquire interest in companies behind its accomplishments.

Obviously, making foreign investments solely in labour-intensive sectors cannot favour development because it does not induce appropriation of science and technology. It is the reverse. By favouring lower salaries, the investments delay skills development and innovative capacity. By employing unskilled labour alone, the companies encourage the brain drain phenomenon. Trained researchers look for a better place with the necessary environment to do their work for the benefit of these companies.

Mostly located in OECD countries, these multinationals will obviously repatriate their generated profits. In fact, these companies can be called transnationals only by their operations and production (Clairmont 1997:16).[14] But in terms of capital and development research, each multinational is associated with the name of a region or

country where the major shareholders and research units are based. The study conducted by the magazine, *Wired* gives a measure of this disequilibrium. While identifying 46 technocities or science parks (innovation centre where synergies are created between technical know-how, capital and opportunities) classified on the basis of the number of seats of investment trusts, research laboratories, universities or similar institutions, the magazine identified 13 in USA, 16 in Europe, 9 in Asia, 2 in South America, 2 in Africa, 2 in Australia, 1 in Canada and 1 in Israel (UNDP 2001:38).

The profits generated therefore belong only to those countries. Even if applied research was to be developed in the units that these multinationals will base in LDCs, it will still benefit the developed countries which are in a better position to grasp their effects. There is an urgent need to develop an endogenous scientific research integrated in the socio-economic fabric. Michel Paty noted that 'Anyway you look at it, it appears that for scientific development to mature, it requires an explicit and effective national science-oriented will' (Paty 1992:11). A national science-oriented will is one way of allowing the creation in these countries of a research level and a scientific community with the capacity to accompany technology transfer and subsequently a real industrial development. Indeed, 'paradoxically, a company or a nation planning to grow mostly through technology transfer must therefore maintain active research laboratories with a view to creating the intellectual exchanges through which such transfer can be beneficial (UNESCO 1969:26).

### *Liberalisation and Scientific Policy Crisis in the LDCs*

Liberalisation, one of the corollaries of globalisation, reduces considerably the State's influencing power over the practical orientation of scientific or even economic policies (French 1998). Having stripped itself of all the competitive profitable sectors with the wholesale privatisations and liberalisations dictated by the international institutions, the State has much more reduced leverage over the definition of scientific policies. Remember that in most OECD countries, the private sector provides funding for 50 to 60 per cent of development research (UNDP 2001:37). By investing in development research, the companies certainly benefit from the fundamental research potential put in place by the state structures. In fact, the state is the only one to invest in fundamental research the sort of venture capital that will allow research institutions, universities and centres to provide local industries with the knowledge potential and the people needed for their development. At present, this potential is dwindling in most countries under structural adjustment, with the decay of universities and research centres. Several research centres have simply been shut down. If you add to that the inclination towards education privatisation and if you bring it to bear on the population, then you obtain the most dramatic consequence of the liberalism policy being implemented in developing countries.

The public is well familiar with the debates over the efficiency of World Bank and IMF-led policies; both institutions are known to act as the political and ideologi-

cal arm of the multinationals, with the mission of perpetuating the dominant neo-liberal system. Basically, the ultimate goal of these institutions is not to develop LDCs but to create the conditions for the establishment of multinationals. The ensuing form of development is relevant only because it allows markets creation. Therefore, the World Bank or the International Monetary Fund should certainly not be trusted with boosting real development of science and technology in LDCs, not even promoting the structures with the capacity to achieve such development and allowing local appropriation. What has been done so far is quite the opposite: drastic reduction or even cancellation of the education budgets of universities and research centres through the imposition of structural adjustment programmes here and there, even though their usefulness in developing countries is yet to be demonstrated in a system that has hypostasised material consumption and neglected technoscience as a veritable engine of development. Worse still, under the poverty reduction programmes implemented in Highly Indebted Poor Countries (HIPC), it appears as though scientific and technological research could be set aside for, it is being more successfully done elsewhere. Here is the logic behind such an attitude: Why should investment be made in an activity which is comparatively done better elsewhere and whose results can still be generalised through globalisation? Why continue funding research centres whose past performance was very mixed? Why not resolve the immediate problems rather than investing in activities with uncertain results?

**The Specific Case of Africa**

Within the LDCs in general, African research is more marginalised and extrovert. Beyond the reasons often mentioned (brain drain, theoretical nature of research...), we believe that one single fundamental factor appears to constitute the real bottleneck: the absence of real *scientific and technological demand.* Indeed, in African countries, most of the scientific systems were developed after World War 2 or after independence. This development occurred, not in relation to local concerns, but in the spirit of the periphery providing service to the centre. It is true that the orientation of themes focusing on local concerns have been deeply changed to reflect local concerns.

The issue is neither to deny the existence of these problems, a potential research subject nor the relevance of the themes. The issue is the capacity to translate such problems into *scientific and technological demand.* The scientific demand concept presupposes a need where political, intellectual, social, industrial, economic and health concerns intersect... The need can exist or be provoked. But until it is turned into demand, the research concerned with it still remains marginal and extrovert. This is so because scientific and technological research is not simply demand for knowledge, it also demand for wealth. If science and technology cannot produce value-added, they are indeed bound to become marginalised or extrovert (since they are likely to produce it in the medium or long run for other countries).

And yet, what do we notice? When the needs are specifically African, they attract little attention from both African and international policies and are considered a

marginal problem. For the past several decades, the marginal character of pharmaceutical research on malaria has been widely noticed, compared to what international pharmaceutical research is devoting to the other diseases, notably cancer.... This is indeed because malaria is considered a demand for knowledge but not a demand for wealth by global development research.

When the needs involve products and 'civilisation artefacts', technological research is all the more extrovert as common opinion has their eyes riveted on West European solutions and products. It may be argued that as a result of relocations, multinational companies recruit in host countries local researchers who contribute locally or through emigration to the development of such products, but as always, these (internal and external) migrations never appear to lead to local appropriation of development research. The production or reproduction-geared local industry sees no real interest in promoting development research, not only because of the expensive costs of such an exercise, but also because the belief is that solutions exist or can be developed elsewhere. As it appears, innovation and anticipation capacity are wrecked in the production sector. They may develop in the knowledge sectors that contribute more to enriching 'mainstream science'.

**In Conclusion: What Can We Do?**

The prerequisites for the appropriation of science and technology include developing an endogenous industrial fabric with an upstream and downstream integration of scientific and technological research, generalising education, defining scientific policies which are no longer based solely on West European themes and also reflecting local problems. But none of these conditions is likely to be fulfilled at this time of globalisation despite broader access to information media and sources. Such access will no doubt contribute to raising research level and quality in developing countries. But if the appropriation conditions are not met, this intensification of research, regardless of the results, will have little consequence on development in general. Besides, such access will more likely facilitate isolated research than a real synergy-creating one, especially in the absence of veritable institutional and socio-economic dynamics which are likely to boost significant research and encourage the exploitation of its fallouts.

A concept of globalisation, different from the conventional model that preaches economy specialisation and rid off the neo-liberal imperialistic strait jacket might effectively create the conditions of this re-appropriation at the industrial and economic levels.

First, the myth of economism must disappear, particularly in African countries where development, under the pressure of the international institutions, is formulated exclusively in economic and monetary terms as though for a people lacking the invention capability to find solutions to their own problems, development could be achieved solely through economic or monetary policies.

Furthemore, instead of the manufacturing and mass labour sectors alone, multinationals should also establish themselves in sectors requiring some control of

scientific and technological potential that is adapted to local needs. Their installation should be accompanied by development research units working under contract with local research centres. In recent years, African countries have been able to demand that multinationals integrate social and environmental dimensions in their projects. Now, a thought should also be given to integrating development research dimensions to be undertaken in partnership with university institutions or local research centres. Development research is today dominated by the private sector. But particularly in Africa, where the structures of public research have been completely dismantled by structural adjustment policies, political constraints must be imposed on multinational production structures by requiring them to implement a development research component which should be more important than the social one which, so far, have been leading the continent into the vicious circle of assistance.

In this sense, local research would be stimulated, as it will locally benefit from the conditions for development, validation and operationnalisation of its results. Through a retroactive effect, research training programmes will be updated to meet the local demand thus generated. This will offer a double advantage: adapting training and research contents and creating employment opportunities for those trained, and subsequently reducing extraversion and the brain drain.

The creation of transnational research teams should also be reinforced with a view to pooling them together and establishing the scientific communities who are likely to revive development. This old ambition was visibly caught in the intricate problems of state funding and bureaucracy.

The ambitions of China, as reflected in the words of Stephen S. Cohen, can illustrate this point: 'In the sectors of aerospace, fine chemistry, high-tech manufactured goods, transport equipments, pharmaceuticals, telecom, etc. it needs European, Japanese and American large multinational companies. The latter are bound to become the main aids of its trade and industrial policy by playing two key roles: technology transfer and technical know-how in exchange for access to its market...' (Cohen 1998:19). The recent discussions between China and Europe on the concept and production of Airbus 380 did confirm these terms of trade as the Chinese required Europe to base some of the development research units in China.

## Notes

1. 'There is no alternative' is one of the most recurrent expressions when it comes to discussing the relevance of neo-liberal policies. The expression is now even consecrated by the English acronym TINA.
2. For a more detailed presentation of this point, read Ymelé Jean-Pierre. 'La technoscience comme infrastructure de développement des sociétés modernes', in *Informatique Individuelle*, n° 2, March-April, 1995.
3. Read more on the subject in Jean Réné Ladmiral, prefaced by Habermas(1973). A quite explicit explanation of the role of science and technology as the 'primary productive force' is given. p. XI.

4. 'Big science' refers, as Michel Paty puts it, to the 'machinery of high-tech and industry now supportive of progress in the state-of-the-art science of the matter, life and the universe' Read Paty (1996).
5. 'It is also in its power (or rather: in the power that it can confer because it is power by itself) that science can be practically justified; to be convinced, one simply needs to listen to the arguments put forth by the scientists themselves when they are claiming for research credits. If the situation were different, science would not have its current social importance; it would not disturb the forms of our existence; it would be an 'art' among others and would have no more resources than the 'fine arts'.
6. This issue has led to the development of a whole school of thought which sees science, in Castoriadis' words, as a 'hammer without master'. Read on the subject *Les Scientifiques parlent*, under the direction of Albert Jacquard (1987); *Le jaillissement des biotechnologies*, under the direction of P. Darbon et J. Robin (1987). However, our focus here is not to discuss the negative consequences of the domination of culture and nature by science and technology, though developing countries do face this type of problems. From another perspective, we also wish to insist on the fact that it would be dangerous in present times to make a mechanical reproduction of anti-science movements in societies where science is marginal and where primary superstitions are still deeply rooted. Focusing on this theme would certainly provoke more mistrust in science and this, we believe, would seriously jeopardise development. In developed countries, scientific and technological potential has largely reached the critical threshold enabling them to 'sustain' society and to contain anti-science movements, which is not the case in developing countries where that potential is yet to be built up.
7. For more insight into the subject, read Bairoch (1963).
8. Excerpt from a summary of the author's theses entitled 'les défis de la mondialisation', available on the Internet. A slightly different version of this excerpt is found in Amin (1995), p.11. Read also Amin (1996).
9. But this growth is still far from reaching the penetration rate of 50 per cent which is estimated to be the threshold from which computer and Internet benefits are manifested.
10. The report added that it is expected that 100,000 Indians would receive visas to emigrate to USA which would represent for India more than two billions in resource losses.
11. Agriculture and health represent indeed over 80 per cent of African scientific production in the 1980s. But in this area, paradoxically, it is estimated that the low growth of production in Africa was not the result of higher yields that is, science but rather of the expansion of cultivable surface areas while during the same period, three-quarters of the world production growth was attributed to higher yields. Read Gaillard & Waast (1988).
12. According to the reflections series devoted to the development of science, one might distinguish between four types of growth: extensive growth which is achieved by increasing the number of production units; growth through capital accumulation at constant technology, growth by improving the structure and organisation of production relations and growth resulting from technological innovation. The last mode of growth is the only one that cannot be saturated as the results of its own effects. It is therefore indefinitely extensible. Read Unesco (1969).
13. Read, for example, the comparative costs theory by David Ricardo (1817, Chapter VII) for a systematic preliminary analysis of specialisation theory. Read also Assidon (1892).
14. Eight countries possess 96.5 per cent of the first two hundred multinationals and 96 per cent of their turn-over.