THE CHANGING NATURE OF INNOVATION AND ITS IMPLICATIONS FOR DIFFERENT TYPES OF DEVELOPING COUNTRIES

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Introduction

When discussing the implications of the changing nature of innovation for developing countries, it is tempting to talk about the radical nature, the paradigm shift of new scientific breakthroughs or technological inventions. From a science and technology perspective, such changes appear to offer new windows of opportunity for economic development or even better might eradicate at once world poverty, diseases and decades of lack of development in most less developed countries. I have, I admit, often been part of such contributions[2] emphasizing the economic and social promises new technologies could deliver and the potential they represented for backward countries for catching-up growth, even leap-frogging. Today though, I would argue though that the debate is less about such relatively "technologically determined" visions on development typical of the 80's, than on the radical nature, one might even say the paradigm shift in social change and economic development at the world level itself.

As I will try to argue in these couple of pages, while these changes in social change and economic development are undoubtedly still closely related to particular technological breakthroughs, and in particular to those in the area of information and communication technologies (ICT), their impact on development is, as if it were, today of a second order nature. It is no longer the direct impact of the transfer of such industrial technologies on economic development which is at the centre of the debate but rather the broader organisational, economic and social embedding of such technologies in a development environment, their social construction, the way they unleash or block particular specific development and growth opportunities: in short a truly "endogenous" innovation process. That process is in all likelihood much more complex in a developing country context than in a developed country one. As has become recognized in the endogenous growth literature[3], the innovation policy challenge with its characteristic Schumpeter mark 1 versus mark 2 features is closely associated with levels of development. In the high income, developed country context the innovation policy challenge seems increasingly directed towards questions about the sustainability of processes of "creative destruction" within environments that give increasingly premiums to insiders, to security and risk aversiveness, and to the maintenance of income and wealth. In an emerging, developing country context, by contrast, the challenge appears directed towards the more traditional,

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[2] See amongst others Soete (1979), Freeman et al (1982), Perez and Soete (1988).

[3] This view of the philosophy and aims of innovation policies differing amongst countries according to their level of development, reminiscent of many of the arguments of the old infant industry type arguments has now become very popular in the endogenous growth literature. See Aghion and Howitt (2005).

"backing winners", industrial science and technology policies bringing also to the forefront many of the features made explicit in Martin Bell's and Francisco Sagasti's analyses of the S&T Systems, and in particular the importance of engineering and design skills and accumulating "experience". Finally there are those poor countries characterized by "disarticulated" knowledge systems, well described in Martin Bell's contribution and where the endogenous innovation policy challenge is most complex of all and involves a much broader array of building innovation system links and bridges.

Science, Technology and Industrialisation: technological experience accumulation

The industrial S&T system is well described in Martin Bell's contribution. It highlights alongside industrial R&D, the importance of experimental development work, design, and engineering experience. While I agree with Martin that too much emphasis has been given to industrial R&D, it should of course been recognized that what became characteristic of industrial technology production method was, as Christopher Freeman has explained in detail, the activity of industrial R&D, its scientific content and the extent of professional specialisation accompanying it. It is this sort of professional work which became and still is recorded in the official, internationally harmonized R&D statistics. As Martin Bell discusses in detail and was actually already acknowledged in the early days of defining what was to become the Frascati Manual definition of "R&D", the industrial R&D statistics were first and foremost a reflection of the professionalisation of R&D activities. In many manufacturing firms the "technical" or "engineering" departments or "OR" sections contribute far more to the technical improvement of an existing process than the formal R&D department, more narrowly defined. But the emergence of the particular R&D function was what came to be most closely identified with the emergence and growth of the industrial society.

As historians have argued this industrial research "revolution" was not just a question of change in scale. It also involved a fundamental change in the relationship between society on the one hand and technology and science on the other. The expression "technology", with its connotation of a more formal and systematic body of learning, only came into general use when the techniques of production reached a stage of complexity where traditional methods no longer sufficed. The older, more primitive arts and crafts technologies continued to exist side by side with the new "technology". But the way in which more scientific techniques would be used in producing, distributing and transporting goods led to a gradual shift in the ordering of industries alongside their "technology" intensity. Thus, typical for most Western industrial societies of the 20th Century, there were now high-technology intensive industries, having as major sectoral characteristic the heavy, own, sector-internal R&D investments and low-technology intensive, more craft techniques based industries, with very little own R&D efforts. And while in many policy debate, industrial dynamism became as a result somewhat naively associated with just the dominance in a country's industrial structure of the presence of high-technology intensive sectors, the more sophisticated sectoral studies on the particular features of inter-sectoral technology flows, from Pavitt (1984) to Malerba (2004), brought back to the forefront many of the unmeasured, indirect sources of technical progress in the analysis.

From industrial R&D to innovation: a paradigm shift?

As acknowledged by many innovation studies scholars and economists (David, Foray, Gibbons, Metcalfe) a major shift in one's understanding of the relationships between research, innovation and socio-economic development took place during over the 80's and 90's, partly as a result of the emergence of new information and communication technologies. The perception of the nature of innovation process changed significantly. One could argue that today innovation capability is seen less in terms of the ability to discover new technological principles, than in the ability to exploit systematically the effects produced by new combinations and use of pieces in the existing stock of knowledge (David and Foray, 2002). The new model implies more routine use of the technological base allowing for innovation without the need for particular leaps in science and technology, sometimes referred to as "innovation without research". It requires though a systematic access to the state-of-the-art technologies; whereby industries introduce procedures for the dissemination of information regarding the stock of technologies available, so that individual innovators can draw much more directly upon the work of other innovators. This mode of knowledge generation -- based on the recombination and re-use of known practices -- raises more information-search problems and is more directly confronted with the problems of impediments to accessing the existing stock of information that are created by intellectual property right laws.

In short, traditional R&D-based technological progress, still very much dominant in many industrial sectors ranging from the chemical and pharmaceutical industries to motor vehicles, semiconductors and electronic consumer goods has been characterized by the S&T system's ability to organise technological improvements along clear agreed-upon criteria and a continuous ability to evaluate progress. At the same time a crucial part of the engineering research consisted, as Richard Nelson put it, "of the ability to hold in place": to replicate at a larger industrial scale and to imitate experiments carried out in the research laboratory environment. As a result it involved first and foremost a cumulative process of technological progress: a continuous learning from natural and deliberate experiments.

The more recent mode of technological progress more associated with the knowledge paradigm and the service economy, with as extreme form the attempts at ICT-based efficiency improvements in e.g. the financial and insurance sectors, the wholesale and retail sectors, health, education, government services, business management and administration, is much more based on flexibility and confronted with intrinsic difficulties in replication. Learning from previous experiences or from other sectors is difficult and sometimes even misleading. Evaluation is difficult because of changing external environments: over time, among sectors, across locations. It will often be impossible to separate out specific context variables from real causes and effects. Technological progress will in other words be much more of the trial and error base yet without as in the life sciences providing "hard" data, which can be scientifically analysed and interpreted. The result is that technological progress will be less predictable, more uncertain and ultimately more closely associated with entrepreneurial risk taking.

Attempts at reducing such risks might involve, as Von Hippel (2004) has argued, a much greater importance given to users, already in the research process itself.

Innovation for development

The implications of this new mode of technological progress for development are rather striking. First and foremost they bring to the forefront the crucial importance of endogenous innovation processes in developing country situations. In the old industrial S&T model, the focus within a context of development was quite naturally on technology transfer and imitation, whereby the latter was more or less viewed as the opposite of innovation allowing for a sudden and rapid catching up process being accompanied by the systematic copying or where necessary the adoption of appropriate technologies from developed countries to developing countries. In the new mode every innovation is to some extent unique with respect to its application. It is the re-use and re-combinations of sometimes routine, sometimes novel pieces of knowledge which is of particular importance. Hence international access to knowledge is crucial as are recombination skills.

It brings me to a number of specific L-20 recommendations which are broadly in line with the focus in Martin Bell's paper, and the recommendations of Geoff Oldham, and Sandy Thomas.

a) Global A2K: crucial for developing ánd developed countries

Let me actually start with the European, developed country side of the need for A2K.

The national focus on the need for investments in knowledge accumulation in developed countries (US, EU, Japan, as exemplified in the case of the EU by the so-called Barcelona 3% target) is not just at odds with the global decision making about knowledge investments of multinational firms, it appears also to ignore the increasingly global nature of long term sustainable problems likely to affect directly the future welfare of those developed countries[4]. The European framework programmes (FPs) e.g. were designed at a time when strengthening the international competitiveness of particular European high-tech firms and sectors was considered essential for Europe's long term welfare. It led to the strengthening of a number of industrial firms/sectors some of which became successful at the world level, others that failed dramatically. Today most EU research programmes benefit as much firms of European or foreign origin, as long as they are located in Europe. The same holds for universities and other public research institutes. Elsewhere (Soete, 1997), I have pointed to the inherent knowledge "diversion" and European "cocooning" implications of such a European research networking strategy.

[4] At the same time, and by contrast the national focus on such investments by emerging developing countries, is starting to question the static, "given" nature of their international production and trade specialisation. It is interesting to observe that international trade specialists such as Samuelson have raised questions as to the sustainability of trade welfare gains (for the US economy) given an active, voluntary knowledge accumulation process in emerging economies such as China.

At the same time, the broadening of research priorities areas to include both local as well as global long term issues raises increasingly questions about the European territorial nature of the research being carried out and funded through the FPs. In many research areas, European welfare will in the long term be directly influenced not by the development of local knowledge through the FPs, its international commercial exploitation and intellectual appropriation, but by global access to such knowledge, the development of joint global standards and the rapid world-wide diffusion of such new technologies to other, non-EU countries. One may think of energy saving technologies, research on sustainable development and climate change, health and the spreading of diseases, food safety, security, social sciences and humanities, etc. In all these areas, the limitation of the funding of research to academic, public and private research institutes located in Europe appears contrary to the need for global solutions to safeguard in the long term European welfare.

Somewhat at the opposite spectrum of such trends, the global multinational enterprises have been successful in pressurizing both the EU and the US to strengthen world-wide, the intellectual property regime within which knowledge can now effectively be traded world wide through various so-called TRIPS+ bilaterally enforced trade agreements. This new international IP regime being more or less imposed worldwide by the EU and the US raises many questions about global welfare and access to knowledge particularly for emerging and developing countries. The current IP regime has actually become greatly skewed in favour of protecting private knowledge goods, without taking into account the social costs incurred. As Richard Nelson put it recently: "...while patents are the primary incentive for profit-motivated invention in some key technologies, they are actually causing harm in other areas, including some 'high-tech' industries involved primarily in R&D." [5] In areas such as drugs, bio prospecting and software, questions can be raised whether alternative research funding systems providing less negative externalities for consumers world wide and in particular in developing countries than the current patent system, might not be more appropriate[6].

In short, is it not time for a completely different approach in the developed world to knowledge appropriation recognizing much more the global nature of knowledge accumulation and the importance of access to knowledge for emerging, developing economies, as well as developed countries? From the perspective of what Europe could contribute to world wide welfare it might, I would submit, contain a vision with much

[5] See UNU-INTECH, Experts Urge Reform of International Patent System, At Eve of WIPO Assembly, September 26th, 2005

[6] See e.g. the proposal for a Medical Innovation Prize Fund in the US (HR417), whereby patents would be kept in place until the new drug registration, but then freely copied by generic competitors. As a result the developer of the drug would not control the market, but there would be competitive valuation of the medicine whereby each new drug competes with other new drugs for prize money. The most important changes in the IP paradigm are: the budget for innovation is fixed, the incremental cost to innovators of using the new innovation is zero, and there are no economic incentives to restrict access to the newest technologies.

more political appeal to European citizens than the somewhat Eurocentric perspective of Lisbon.

b) Global A2Brains: inducing "brain exchange"

The mirror picture of A2K is of course A2Brains.

A2Brains has always been an essential feature of development and knowledge transfer. Dramatic shifts have occurred over time both in the aggregate flows of highly skilled labour amongst countries. Many European countries have moved from a situation of emigrating countries to immigrating countries, with Ireland probably as the most extraordinary case. At the same time, the migration of skilled labour from developing countries to developed countries has increased significantly. The issue has been referred as the 'brain drain' as well as brain exchange or brain circulation. 'Brain circulation' is defined as the cycle of moving abroad to study, then taking a job abroad, and later returning home to take advantage of the skills acquired abroad to enhance domestic job opportunities. "Brain exchange" is defined as a two-way flow of expertise between a sending country and a receiving country. Where the net flow is heavily biased in one direction, the term "brain drain" has been used.

As Martin Bell notices, the brain drain issue has been analyzed from very different angles, e.g. as 'curse or boon' (Commander, Kangasniemi et al. 2002) or 'winners and losers' (Beine et al. 2002). The earlier literature on the brain drain focused on global welfare being raised by the rational choice of highly skilled emigrants to seek improved incomes abroad (Johnson 1967; Berry and Soligo 1969). In later studies, the effects of brain drain for the development of the sending country can be summarized by two viewpoints. On one hand, from an endogenous growth framework perspective, economists believe that the direct impact of brain drain reduces the economic growth of the sending country (Miyagiwa, 1991, Haque and Kim, 1995, Reichlin and Rustichini, 1998, Hague and Aziz 1999; Wong and Yip 1999, Lowell 2002). Furthermore, they have argued that it reduces the wages of the unskilled population, are likely to increase the wages of remaining skilled workers, and hence will increase inequality. Thus, brain drain acts in this view as a double-edged sword on poverty: increasing the inequality and slowing down economic growth. On the other hand the theories of economic growth (Lucas 1988) focusing on "human capital accumulation" as an important source of economic growth, suggest that the effects of migration prospects on human capital formation (Mountford, 1997, Stark et al., 1998, Vidal, 1998, Beine et al., 2001), may actually foster human capital formation and growth in the sending countries. The possibility of emigrating to higher wage countries may stimulate persons to pursue higher education in the hope of improving their expected wages abroad. This causes sending countries to benefit from skilled emigration because it induces the remaining native population to pursue higher education.

From the point of view of the receiving countries though, skilled migration is always important not just for the growth of their economies but also because of more general benefits like entrepreneurship, the contributions to an increasing demand for goods and

services, attraction of new capital, etc. The foreign environment offers new alternative possibilities for initiative taking and entrepreneurship.

At first sight there is hence a lot to be said for the proposal of Martin Bell for a tax on the employers of highly skilled immigrants. However, there are in my view also possible less finance dependent proposals which might help. Let me quote from a recent contribution form Patrick Weil which summarizes well the French situation, typical for many European continental countries: "French reservations with regard to skilled migration have historical roots: a racist corporatism which was developed in the 1930s which sought to reserve the most valuable professions in society for the French and to restrict access to foreigners reputed to be 'inassimilable'. This corporatism has been replaced today with third-worldism: in the name of development or co-development, it remains difficult for a foreign graduate of a French university to acquire a residence permit, even if he or she already has a job offer from a French company.[7]

This is both incoherent and absurd. Be (s)he African, Asian, South American, from the moment he receives a degree from a European or North American university, a foreign student enters the world market. If he does not want to return home, he will not do it. And if Europe refuses him, he will receive a job offer from the United States, Japan, Canada, or Australia and will be 'lost' both for his country of origin and for the country where he received his training.

It is, however, possible to reform policy on qualified foreign workers without falling into the North American approach: the brain drain, which attracts skilled immigrants who never return home. Foreign graduates seek employment on the European labour market because they wish to gain the resources or the professional experience necessary to launch themselves into a career in their home country. If they later balk at the idea of going home, it is often because they fear losing the cultural, scientific, or entrepreneurial environment necessary to maintain or enhance their skills base. It is essential, therefore, to accompany the liberalisation of the recruitment of the most highly qualified, with a better 'offer' closer to the wishes of these high skilled workers and more respectful – case permitting – of their home countries' interests."

The concrete proposal here would be to issue a "permanent visa" to such highly skilled workers. In the case of The Netherlands and e.g. our own PhD students, I have proposed to offer with the university degree a permanent visum allowing for a voluntary based 'recirculation' – at a rhythm of their own choosing and at which one could accompany and support them rather than blocking them – between their country of origin and their country of training. The current problem for most foreign graduate students coming from developing countries is that after their degree and return back home they are becoming cut off from tacit-based knowledge exchange programmes through the administrative hassle of and restrictive policies with respect to visa applications. Not surprisingly they will, even when motivated to go back, prefer to look for jobs in the developed country and apply for work permits there.

[7] In 2002, 5,851 foreign students obtained a permanent residence permit by transformation of status (6,636 in 2001, of which 2,300 were married to French citizens). Source: Ministry of the Interior, AGDREF.

As Weil (2005) notices: “The right of recirculation has already been created, for example, by a French law of 1998 for the retired worker: after 15 years’ professional activity, a foreign worker has the right to a ‘retirement card’ which allows him or her to circulate freely between his or her country of origin and place of work, without fear of being refused a visa. Thus, he or she can return to live out his or her final years in his or her land of birth in complete security, free to appreciate retirement whilst retaining the opportunity to return to France to visit family and friends or for medical treatment. Seasonal workers could get the benefit of multi-annual permits: they would be guaranteed a permit for the next five or 10 years, if at the end of their season, each year, they return to their country of origin. Last but not least, graduates from European universities could receive the benefit of a permanent visa. It would permit them to return and re-circulate from their country of origin without fear of been unable to leave.

The facilitation of ‘return tickets’ or ‘recirculation’, according to a regime adapted to suit each category of migrants – for highly skilled workers, but also for seasonal workers – will be one of the new tasks for immigration policy in the 21st century[8].”

[8] See: Dana Diminescu, *Visibles mais peu nombreuses, les circulations migratoires roumaines*, Paris: Editions de la Maison des Sciences de l’Homme, 2003.

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