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Globalization and the Least Developed Countries: Issues in Technology

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GLOBALIZATION AND THE LEAST DEVELOPED COUNTRIES: ISSUES IN TECHNOLOGY[1]

∞ Introduction

This paper considers the importance of technological progress for economic growth and sustainable human development in the Least Developed Countries (LDCs). It argues that the promotion of technological change will most effectively contribute to these objectives if it forms part of a broader strategy which is aimed at developing productive capacities and expanding employment. The paper discusses the processes of *technological learning*, through which the capability to use and improve technologies is put in place, together with *technological innovation*, through which appropriate new technologies are used to deliver new or improved products to markets. Based on its analysis of the weaknesses of technological capabilities in LDCs, the paper recommends ways in which LDCs can put in place and implement policies that are supportive of technological progress in LDCs. It also identifies the appropriate international support measures necessary to enable this. In respect of domestic policy, a distinction is made between promoting technological progress in agricultural and non-agricultural products, while the importance of targeted ODA, appropriate intellectual property rights (IPR) regimes, and South-South cooperation are emphasized in terms of international support.

∞ Technological progress, economic growth and poverty reduction

Sustained economic growth and substantial poverty reduction in the LDCs requires the development of productive capacities – physical, human and institutional – in a manner which enables the working population to become more fully and productively employed. National productive capacities develop through the closely related processes of capital accumulation and technological progress.

There is widespread agreement on the importance of technological progress for economic growth[2]. Technological change increases the productivity of land, labour and capital, reducing costs of production and improving the quality of outputs. The ability to be internationally competitive also depends on having up-to-date technology. In open economies this is not only necessary for export development but is also vital for domestic production which serves local markets. As most LDCs have undertaken fast and deep trade liberalisation since the early 1990s, technological progress has become vital for their competitiveness and economic viability.

Economic growth is likely to reduce poverty if more labour-intensive technologies are adopted, since this means that more people will participate in the benefits of growth. Poverty reduction will also occur if technological progress is associated with structural change and the negative employment effects of technological progress for some sectors are more than offset by positive effects in other parts of the economy. If technological progress leads to a reduction in demand for labour in some sectors, this will not worsen overall unemployment – or the prospects for poverty reduction – if it is at the same time leading to the introduction of jobs in new or growing sectors of the economy. Balanced technological development between tradable and non-tradable activities and between agricultural and non-agricultural activities is thus crucial. The promotion of

[1] This issues paper was prepared for the Ministerial Conference "Making Globalization Work for the LDCs", Istanbul, Turkey, July 9-11, 2007 by the Division for Africa, Least Developed Countries and Special Programmes (ALDC) United Nations Conference on Trade and Development (UNCTAD) Geneva, Switzerland. The paper is based on UNCTAD (2007 forthcoming) and it includes important inputs from the Inclusive Globalization Cluster of the Poverty Group in UNDP's Bureau for Development Policy. Comments were provided by staff in the Office of Development Studies and Executive Office of UNDP. Issues raised by UNDP Country Offices have also been included, as appropriate.

[2] Neoclassical theory, new endogenous growth theories, and evolutionary growth theories which draw inspiration from Schumpeter all emphasize this.

technological change will therefore best support sustained economic growth and poverty reduction if it is part of a broader strategy to develop productive capacities and expand productive employment opportunities.

☙ The importance of technological learning and innovation

Effective policy design to promote technological progress requires a good understanding of how technological change occurs. In this regard, the assumptions about technological change which are made in formal neoclassical and endogenous growth theories are less relevant than empirical and analytical insights from a close study of processes of technological change.

Technological change in LDCs occurs primarily by *learning* the technologies that already exist in more advanced economies and not by pushing the knowledge frontier further. Neoclassical and endogenous growth theories view this as a transfer of technology in which access to foreign technology automatically follows from openness to trade and foreign investment, and access is equivalent to effective use. However, empirical studies show that in practice the acquisition, diffusion and improvement of foreign technologies requires considerable effort by firms. Much knowledge is tacit, and firms work in an environment of uncertainty with imperfect information. Time, effort and costly investments are required to learn to use technology efficiently.

Nevertheless, technological learning is critical for technological change. Technological learning can be defined as the development of capabilities to use and improve technologies. It encompasses:

- **Core competences**, which are the routine knowledge, skills and information to operate established facilities or use existing agricultural land including production management, quality control, repair and maintenance of physical capital and marketing.
- **Dynamic capabilities**, which refer to the ability to build and reconfigure competences to increase productivity, competitiveness and profitability and to address a changing external environment in terms of supply and demand conditions.

The effective acquisition of foreign technologies depends on the development of these competences and capabilities. It is important that research and development (R&D) is an integral part of these capabilities since it is insufficient in its own. For example, design and engineering capabilities are particularly important for upgrading facilities or establishing new ones.

In contrast to technological learning, *technological innovation* occurs when enterprises apply knowledge commercially and introduce new products on the market or make significant technological improvements in existing products and processes. Innovation occurs when an enterprise introduces a product, process or method which is new to them; even if it is not new to the country or to the world.

The enterprise – firm or farm – is the locus of innovation and technological learning. But firms and farms are embedded within a broader set of institutions which play a major role in these processes. In advanced countries, national innovation systems have been established to promote R&D and link it more effectively to processes of innovation. In LDCs, what matters most are the *domestic knowledge systems* which enable (or constrain) the creation, accumulation, use and sharing of knowledge.

Technological innovation in industrial clusters is of critical importance in determining rates of economic growth. Industrial policy activity typically takes place in large clusters of stable and densely concentrated firms, as opposed to, for example, agricultural production, which is typically highly decentralized among many small farming units. From this perspective, technological innovation in industrial policy is a potentially significant process for the LDCs to the extent that positive spillovers from industrial policy and innovation are crucial for

growth and dynamism in the agricultural sector, just like in the very early crucial stages of development agricultural surpluses have been crucial for industrialization[3].

☙ Weaknesses in the technological capabilities of LDCs

The level of development of technological capabilities in LDCs is very weak. Most workers in LDCs have to earn their living using only their labour, with rudimentary tools and equipment, little education and training, weak access to financial services, and poor infrastructure. As a result labour productivity is low and there is widespread underemployment. This is the basic cause of persistent and extreme mass poverty in the LDCs. As a result, the development of productive capacities, including in particular policies to promote technological learning and innovation, need to be put at the heart of efforts to promote sustained economic growth and poverty reduction in the LDCs.

An expanding literature has suggested a number of ways for assessing technological capabilities in developing countries:

- **UNDP's Technology Achievement Index** classifies countries as leaders, potential leaders, dynamic adopters and marginalized countries, with all the LDCs for which there is data falling in the last category[4].
- **UNIDO's Competitive Industrial Performance Index** assigns 'low' rankings to LDCs. Apart from Bangladesh and Nepal; the rankings of LDCs were falling[5].
- **RAND's Scientific Capacity Index[6]** classifies countries into scientifically advanced, scientifically proficient, scientifically developing and scientifically lagging countries. Of the 33 LDCs in the sample all except Benin are in the scientifically lagging category.
- **UNCTAD's Innovation Capability Index[7]** also assigns 'low' rankings to LDCs. Moreover for half the LDCs their "innovation capability", relative to the rest of the world, was worse in 2001 than in 1995.
- The **World Bank's Knowledge Assessment Methodology[8]** also underlines the weak performance of the LDCs with respect to technological capabilities.

There are vast differences in performance between the LDCs and other country groups. The widest disparity is in the number of researchers per million population and patent applications granted by the US patent office per million people. The Index also indicates that the LDCs not only have inadequate access to information and communication technology (ICT) infrastructure such as computers and the internet but also to more simpler forms of communication such as radios, televisions, newspapers and telephones. Rwanda's National Information and Communications Infrastructure (NICI) offers an approach to such challenges – including measures to improve affordability, reliability and access to ICT – yet significant resources need to be channelled into its realisation[9]. While current development efforts in the context of technology focus on the promotion of ICT, it is important to emphasize that efforts to strengthen technological capabilities must go well beyond this.

The weak technological capabilities of LDCs are reinforced by limited technology transfer to LDCs and limited absorptive capacities in LDCs. Firm-level surveys show that new machinery and equipment is identified as the most importance channel of technology acquisition by LDC firms[10]. However, in real per capita terms, machinery

[3] Malhotra, 2006, p. 12.
[4] UNDP, 2001, pp.46-51.
[5] UNIDO, 2002, pp. 41-48.
[6] Wagner et al., 2001.
[7] UNCTAD 2005a, pp. 111-116.
[8] Chen and Dahlman, 2005.
[9] UNDP Rwanda Country Office.
[10] See for example the Investment Climate Surveys of the World Bank: http://iresearch.worldbank.org/ics/Help/basicInfo.htm, Knell 2006; Traeger et al. 2007.

and equipment imports into LDCs during 2000-2003 were at almost the same level as in 1980. Moreover, in 2003, real capital goods imports were about $10 per capita (in 1990 US$), which was seven times lower than real capital goods imports of other developing countries in that year[11].

In addition to limited technology transfer, LDCs are less able to absorb new technologies. This is because of weak human resources – low levels of education and high levels of brain drain[12] – and weak and segmented domestic knowledge systems. Domestic knowledge systems, which underpin learning and innovation, are split between traditional and modern technologies. The production activities which create most employment and livelihoods in the LDCs are based on traditional or indigenous knowledge systems. These have great potential as a reservoir of creativity but they are largely de-linked from modern knowledge systems.

Modern knowledge systems also have a number of major weaknesses: (i) there are weak linkages within the system amongst and between different specialized suppliers of knowledge (national laboratories, research institutes, universities, technology transfer agencies, etc.); (ii) knowledge creators are de-linked from local production, and knowledge is created on the basis of a R&D-centred linear model of innovation rather than responding to demand, which in any case is very weak; (iii) the modern knowledge-system has often been donor-driven; and (iv) modern knowledge systems in LDCs are not well-connected with international knowledge systems[13].

The weakness of the knowledge system is reinforced by weaknesses in several other areas, including a weak financial sector (failure to provide credit and enable investment) and an underdeveloped infrastructure (lack of electricity and transport networks). A symptom and result of these weaknesses is the underdevelopment of the private sector and the missing middle in the enterprise structure[14]. During the past decades, the LDCs have found it difficult to develop internationally competitive enterprises and to diversify their productive activities.

The majority of LDCs continue to maintain a very strong specialisation in primary unprocessed commodities, and only a few LDCs have managed to diversify into manufactures at the lower end of the technology scale. As a result, the value added created by the labour force of the LDCs is very low in comparison with the value added created by the labour force of other country groups[15]. The *Least Developed Countries Report 2006* shows that the labour productivity divide between LDCs and other countries is very large. Value-added per worker in 2000-2003 was just 20 per cent of the level in other developing countries and only one percent of the level in developed countries. The productivity gap between LDCs and other developing countries has also widened since 1980. Agricultural labour productivity fell in one-third of the LDCs between1980-1983 and 2000-2003 while non-agricultural labour productivity fell in four-fifths of the LDCs during the same period.

∞ National policies: what should the priorities be?

Successful developing countries have adopted policies to promote technological learning and innovation which are geared towards achieving technological catch-up with more advanced countries. There is no reason why LDC governments should not have the same orientation and seek to achieve the same results. However, policies to promote technological learning and innovation in LDCs need to be appropriate to their level of technological development, economic structure asnd the capabilities of their governments and business sector. Encouraging structure and the capabilities of their governments and business sector. technological learning and innovation requires measures which go beyond what are traditionally identified as science and technology policies.

[11] UNCTAD, 2006, pp. 154-162.
[12] UNCTAD, 2006, pp. 100-104.
[13] UNCTAD 2006, pp. 246-255.
[14] UNCTAD, 2006.
[15] UNCTAD, 2006, pp. 167-182.

In the early stages of catch-up, there is a need for a balanced approach which includes both agricultural and non-agricultural activities, tradables and non-tradables, and foreign direct investment (FDI) and domestic enterprises.

Agriculture and the Green Revolution

For many LDCs, promoting a Green Revolution in basic staples should be a priority. Sustainable agricultural intensification is becoming a necessity in more and more LDCs as the rural population density rises and the opportunities for agricultural growth through expansion of the agricultural land area are becoming exhausted.

From past experience, the first stage in promoting a Green Revolution should be to establish the basics for agricultural productivity growth. These include: investing in rural physical infrastructure, particularly roads and (where appropriate) irrigation systems; establishing adaptive and experimental research stations; investing in and improving agricultural and rural extension services; and where necessary, land reforms. None of these steps, in themselves, are easy.

Getting the agricultural knowledge and information system right is also a key ingredient of establishing the basics. There are three aspects of the knowledge system which can contribute to the huge gap between the actual land and labour productivity levels in LDCs and what is potentially achievable. These are:

- **An extension gap:** which arises when average productivity is far below what could be achieved using the best practices and technology suitable for the specific location.
- **A research gap:** which arises when national applied research programmes have not developed appropriate high-yielding varieties.
- **A science gap:** which arises when adaptive research at the national level is not provided with the basic prototypes from international scientific programmes, such as the Consultative Group on International Agricultural Research (CGIAR).

Each of these aspects of the knowledge system needs to be addressed in policies to promote technological learning and innovation. Nevertheless, it is the research and extension gaps which are the key for LDC governments, whilst the science gap is more an issue for their external development partners.

Once the basics for a Green Revolution are established, policies should seek to widen uptake of new technologies. In order to do so, it may be necessary to kick-start markets through government interventions that give farmers access to financial services and seasonal inputs at low risk and low cost. This can be achieved through the use of targeted subsidies and through the work of special agencies which provide a bundle of services. In the past, state commodity marketing boards were the key institutional innovation which provided multiple functions. In practice they had numerous deficiencies. The task which many LDCs now face is to devise new marketing boards which fill the institutional vacuum created by the dismantling of the old boards but embody institutional innovations which deal with the deficiencies of the past.

Non-agricultural policies

Although actions to initiate a Green Revolution should be an important component of technological development efforts in early catch-up, the non-agricultural sector should not be neglected. What will matter are the technology search capabilities which are necessary to identify relevant existing technologies as well as the design and engineering capabilities which will be necessary to establish new facilities and also upgrade products and processes. In short, the key capabilities are:

- **To search for existing technologies** internationally;

- **To generate investment projects** on the basis of this international search (which introduces new activities into a country);
- **To execute these investment projects**;
- **To learn from others** nationally (which encourages the diffusion of best technological practices within a country);
- **To up-grade and improve existing products, processes**, production methods and organisational arrangements already in operational use.

It is business firms that are the basic locus of non-agricultural technological learning and innovation. However, in many LDCs, such business firms are missing or underdeveloped. A priority in LDCs should therefore be the transformation of small and informal activities into organized small-scale enterprises, together with support for small-scale enterprises to grow to become larger firms, which will have a greater potential to develop technological capabilities and innovate. To these ends, it is necessary to strengthen the capabilities of entrepreneurs (management and organization) and the labour force (craft and technical skills, design and engineering skills). In addition, it is also necessary to provide converging affirmative actions such as preferential access to credit, technology and markets. Undertaking innovation is a risky activity. This means that the promotion of technological learning and innovation by domestic firms may require financial incentives[16]. Such incentives can take various forms, including credit subsidies, tax incentives, and matching grants for innovation projects.

Collective entrepreneurship can also be a powerful mechanism for diffusing and upgrading best practices[17]. This can build on existing collective entrepreneurship practices, such as saving and credit rotation associations, or sectoral and territorial groupings of producers and traders who seek economies of scale, for example, by sharing capital equipment. The promotion of collaborative action in the fields of technology, design and marketing is a key issue.

The encouragement of clusters of domestic enterprises as well as the encouragement of stronger linkages between domestic and foreign enterprises is an important field for public policy. Because of the weak development of domestic enterprises in LDCs, FDI is sometimes seen as a means of acquiring technological capabilities[18]. This is possible. However, the evidence suggests that it is not an automatic process.

As important as the linkages between firms are linkages between different economic sectors. These linkages not only help to strengthen supply capacities (through technology and skills transfers), they can also help to stimulate demand (through stronger contracting relationships). While linkages can encourage diversification into new areas, they can also support upgrading in existing areas of specialisation. Efforts should also be made to develop natural resource based production clusters through adding value to natural resources and exploring the possibilities for import substitution with local production of some inputs and equipment and the development of domestic production engineering capabilities.

Finally, it should be stressed that technological learning and innovation will require the co-evolution of improvement in physical infrastructure, human capital and financial systems, along with improved technological capabilities within enterprises and more effective knowledge systems. Moreover, it will also require an adequate macro-economic framework which ensures appropriate macro-economic conditions for sustained technological learning and innovation, as well as the right investment climate. The latter will require an appropriate regulatory framework but will also depend, in particular, on buoyant demand conditions.

[16] Sachs, 2004.
[17] Nadvi and Schmitz, 1999; Oyelaran-Oyeyinka and McCormick, 2007; Pietrobelli, 2007.
[18] UNCTAD, 2005b.

☙ International policies

There are three key areas of international policy which need to be emphasized (i) the use of official development assistance (ODA) to promote technological learning and innovation, (ii) the appropriate modification of international intellectual property rights (IPR) regimes to serve this purpose, and (iii) the contribution of South-South cooperation.

ODA for technological learning and innovation

The new approach to development assistance, reflected in poverty reduction strategy papers (PRSPs), has sought to increase national ownership and support the development of home-grown policies. Nevertheless, in practice, the tension between conditionality and ownership has not been resolved. Donors can play an important role in providing financial and technical support for processes of technological learning and innovation where technological progress is identified as a priority concern for governments. There has been a recent increase in support for science, technology and innovation by a number of development partners. However, this has been either geared towards funding centres of research excellence (e.g., academic centres with few links to industry) or it has been focused on a particular objective (e.g., technological innovations to help combat HIV/AIDS. The current approach does not effectively stimulate technological learning and innovation for the economy as a whole.

Moreover, the effectiveness of ODA for agricultural technological learning and innovation has been severely compromised due to the shift in the research priorities of major donors. There is now a need for a rapid increase in ODA for agricultural R&D for the LDCs. Furthermore, it is also essential to provide ODA for non-agricultural R&D in LDCs, which donors have neglected in the poorer countries. Although the agricultural sector is still the major source of employment and livelihood in LDCs, the development of the non-agricultural sector is increasingly important for employment creation and sustainable poverty reduction. Technologies which allow for more efficient energy consumption are also important for these economies. For instance, Senegal has taken a lead in addressing the growing challenges of energy dependent economies in the context of high energy prices through innovative proposals which involve the establishment of a compensation fund.[19] In short, donors should support technological learning and innovation in both the agricultural and non-agricultural sectors, and also help countries acquire more efficient and environmentally-friendly technologies. Aid for technological learning and innovation in the tradables sector should also be a priority focus of Aid-for-Trade.

Intellectual Property Rights (IPR) regimes

In the case of LDCs, learning will principally revolve around absorbing already existing technologies and techniques and adapting these to specific local conditions, i.e., by imitation. Some kind of "reverse engineering" is necessary in all cases of imitation. In this respect, strong IPR protection is likely to hinder rather than facilitate technology transfer and indigenous learning activities in early stages of industrialization. The current IPR regime favours the producers and holders of IPRs, mainly found in developed countries, at the expense of those trying to get access to protected IP content, mainly found in developing countries. This leads to increasing the knowledge asymmetry between the developed and the developing countries.

While successful developing countries in East Asia have pursued active policies aimed at closing the technology and knowledge gap through mechanisms such as reverse engineering and compulsory licences before the current IPR regime came into force the current IPR regime is hindering the process of technological catching up for latecomer developing countries, including the LDCs. While the current IPR regime may be improved in the short-run via (i) fine-tuning and calibrating of norms and standards in line with the LDCs' needs; and/or (ii) enhancing TRIPS flexibilities, these efforts are likely to be insufficient. It is essential that the LDCs have

[19] UNDP Senegal Country Office.

considerably more policy space in the foreseeable future and this will require more than just fine-tuning or tinkering with the existing IPR regimes.

In the short term, it is essential that developed countries effectively implement their obligations under article 66.2 of the TRIPS Agreement by adopting special incentives, such as tax breaks and subsidies, for the transfer of technology, including machinery and equipment to LDCs. Furthermore, it is desirable that development partners of the LDCs take measures to promote technological development in the LDCs in line with the recommendations of the Third Programme of Action for LDCs, which was agreed in Brussels in 2001. For example, Bangladesh has recognized the importance of including measures to facilitate the development of new technologies, attracting FDI conducive to technology transfer and investing in local research and capacity building programs[20].

In the medium to long term, it is important to promote *alternative non-proprietary mechanisms for knowledge governance*. The LDCs, in collaboration with the international community, should explore options such as (i) patent buy-outs, (ii) price discrimination mechanisms, (iii) public-private partnerships, (iv) indirect or direct subsidization of research, (v) open source collective mechanisms, information and knowledge commons, (vi) joint research initiatives, (vii) regional technology sharing consortia, and (viii) joint research ventures and licensing agreements with technology transfer clauses.

South-South cooperation

Given the smaller technological distance of LDCs from other developing countries (as compared with developed countries), technological imports may be particularly important from middle income developing countries. It may be easier therefore to adapt technologies used in countries that are newly industrializing economies. The development of South-South technological links thus needs to be actively pursued.

[20] UNDP Bangladesh Country Office.

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