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Development of technological capabilities for building productive capacity in LDCs

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1. Two Modes of Building Productive Capacities in LDCs*

In general, we can conceive of two modes of productive capacity development in LDCs, depending upon whether abundant resource of a country is labor or natural resources. The first happens in mostly manufacturing sector which involves the so-called OEM (own-equipment manufacturing) where LDC firms make products to the foreign buyers's specification under diverse forms of contractural arrangement including FDI (Hobday 2000). The second mode typically involves resource-based (such as mining) sectors which evolves to be an extension and upgrading into backward or forward linkage sectors as a part of the global value chains led usually by foreign companies (Morris et al 2012). What follows is a brief discussion of each mode in sequence.

One of the most conventional modes for developing productive capacity in least developed countries (LDCs) may be through contractural arrangement with foreign countries, in the form of the OEM or FDI. It is a specific form of subcontracting under which a complete, finished product is made to the exact buyer's specifications. Examples of the OEM or FDI-based assembly-type products include consumer electronics, automobiles, and telecommunication equipment. These arrangements are typical of low-income or middle-income countries who tend to specialize in mature industries. From the 1970s to the early 1990s, OEM accounted for a significant share of the electronic exports of Taiwan and Korea, and served to facilitate technological learning (Hobday 2000). An example is textile products where latecomers produce for export markets via an OEM arrangement with firms from advanced countries.

OEM does not simply mean production and job creation in the host countries, but it naturally involves learning and building certain capabilities. Learning with the OEM mode can be discussed in the two stages. During the first and earliest stage of development, the latecomer firms learns skills or operational know-how while they produce the final products according to the foreign-supplied manual on foreign-made plants or production lines. In other words, there is a manual to follow during operation, and tacit knowledge (know-how and skills) is created during the process. Thus, the process can be called skill formation which leads to increase in productivity. This productivity increase through learning by doing is the main sources for the catching-up during this stage. In terms of catching-up patterns, this stage corresponds to path-following catching-up (Lee and Lim 2001). In this stage, being a simple assembly production, the responsibility taken by local or late-comer firms or entrepreneurs for production tend to be small.

The second stage, which can be regarded as an advanced form of the OEM, is to acquire processing technology, such that the late-comer firms now take the responsibility for production. In this stage, the late-comer firms acquire processing technology while they produce goods according to designs provided by foreigners, usually final producers. The designs can be either those of the products or those of production facility or both. In any case, acquisition of processing technology means that the late-comer firms become capable of *setting up their own production facility and takes responsibility for production*. Foreigners provide not only designs but often dispatch personnel to provide technical guidance in setting-up production facility and/or in producing the goods. In terms of the catching pattern, the stage still corresponds to a path-following catching-up as it basically tries to imitate the

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fore-running firms. Thus it can be basically "duplicative imitation" in terms of the framework by L. Kim (1997).

In this mode of OEM based learning-by-doing or exporting, the by-products are job creation and foreign exchange earnings, and the policy tools often include tariffs and undervaluation of currencies that are less sector-specific or horizontal. A desirable structure of tariff may be asymmetric structure, such as higher tariffs for sectors that are being promoted and lower tariffs for imported capital goods. Such asymmetric tariffs increased the world market share of Korean products (Shin and Lee 2012). Other forms of horizontal interventions are needed to build physical infrastructure.

The second mode of linkage development in GVCs aims to build productive capacities in related segments while the LDCs are initially engaged in resource (minerals) –based simple production under the foreign leadership (Morris et al 2012). There have emerged new perspectives which argue that LDCs may escape the resource-curse under certain conditions. In particular, changing strategies of industrial organisation, such as importance of the efficiency of GVCs, have led lead commodity firms to emphasise the virtues of external supply of inputs into their operations, initially from the lowest cost global supplier, but also over time to lowest cost local suppliers. The linkages and upgrading transformation may emerge from lead commodity producers in the commodities sector to input suppliers (backward linkages) and to commodity processors (forward linkages or downstream activities).

Couple of promising examples are already out there. In the case of Botswana, its rise from low income to middle income country has been possible owing to its diamond sector where local firms have emerged from simple commodity producer to diamond cutting and polishing processor since the 1980s. It has taken a long time and the progress has been very slow until 2005 when there was a big deal between the government and De Beers (global diamond jewelry company) to promote local processing industries. Because 2005 was the year when De Beers‟ 25 year mining license was due for renewal, the government had a great deal of bargaining power. The government insisted that in order for De Beers to renew its mining license for another 25 years it should help Botswana to create a viable and globally-competitive cutting and polishing industry. Until then, De Beers used to say that Botswana had no comparative advantage in processing sector, however, after the new contract, the Government invited the world's leading cutting and polishing companies (16 in total) to establish factories in Botswana and in the process to transfer cutting and polishing skills to local citizens. While the situation in Botswana is much better than before, longer term challenge is to keep moving up the value chain, currently from crude diamond production and cutting & polishing to polished dealing, jewelry manufacturing, and marketing & sales which take up the bigger pie in the chain.

Similar challenge of upgrading exists in the mode starting from OEM. While the OEM is an effective way of catching up at the early stage of economic growth, it is somewhat uncertain as a long-term strategy because foreign vendor firms may move their production orders to other lower-wage production sites (Lee 2005; Lee and Mathews 2013). Currently, a similar trend is underway among flower producers in East Africa as foreign vendor firms buy flowers not only from Kenya but also from neighbouring countries catching up with Kenya. In this respect, OEM firms should prepare longer term plans to transition to original design manufacturing (ODM) and finally to original brand manufacturing (OBM).

ODM firms carry out most of the detailed product design, and the customer firms of ODM companies continue with marketing functions. Meanwhile OBM undertake manufacturing, design of new products, R&D for materials, processing of products, as well as sales and distribution for their own brand. The path from OEM to ODM to OBM has become the standard upgrading process for the latecomer firms. Modified examples of such upgrading in flower firms in Africa would be producing flowers that can last longer, have specific smells, and use less pesticides. All these require innovation. A transition to OBM in the flower industry would require African firms to enter into marketing and set up their own outlets with their own brands in Europe. Such a transition to ODM or OBM is not easy but serves as a narrow path to the middle- or even higher-income status. Another model available for African countries, endowed with rich resources, is a combination of 'black' and 'green' development, where cash from exports of natural resources can be used to finance entry into green industries (Lee and Mathews 2013). In general, transition to the middle-income stage calls for more sector-specific or vertical intervention policies. This is because the country must identify its niche between low-income countries with cost advantages in low-end goods, and high-income countries with quality advantages in high-end goods. For instance, Botswana is trying to find a niche, by targeting a mid-level quality of cutting and polishing, above the small stones produced in China and India, and below the highly specialised stones produced in Belgium and Israel (Morris et al 2012).

At this stage, public policy should focus on two kinds of upgrading: entry into new industries, and upgrading to higher value-segment in existing industries, which is to upgrade the overall industrial structure (Lee and Mathews 2012). Short-cycle, technology-based sectors are candidate niches for latecomers (Lee 2013). The main issue is how to break into medium short-cycle technology-based products or into the higher-valued segment of the existing sectors. Good targets for such an (import substitution) entry are those products that latecomers have to import at higher prices due to oligopolistic market structure, dominated by incumbent countries or firms. A best existing example is China's telephone switch development in the 1980s and 1990s (Lee et al. 2012). The lessons have implications for African countries which produce oil but export it as crude oil without refining it. They can build more oil refineries based on mature or medium short-cycle technologies. The task is possible since the technology needed to build oil refineries is old, mature, and easily available at cost. The process would be similar to the Korean entry into steel-making through a state-owned enterprise in the early 1970s.

2. Role of the Public Sector and International Community in Productive Capacity Development in LDCs

The stage-based mode of productive capacity development described in the above can be further elaborated with focus on the changing roles of government research institutes (GRI) or public research organizations (PRO). The essence of such a latecomer model of productive and technological development is the tripartite cooperation involving government research institutes, private firms, and government ministries (GPG) which played a key role in such countries in the past as Korea (Lee and Mathews 2013).. Under this model the actors have different roles depending on the stage of development. A typical division of labor in the past examples from east Asia was that government research laboratories are in charge of R&D, private firms of undertaking production, and government ministries of marketing in the

form of direct procurement or protection by tariffs and exclusive standards. The case of the telephone switch in Korea and China would be the most typical representation of this model. Under this model, R&D is mainly done by GRIs or public research organs, and private firms are in charge of manufacturing and the government helps marketing through procurement of the domestically-made products.

The above GPG model can be modified as the model of international technology assistance for LDCs. This can involve cooperation between foreign actors (F), local firms (L), and government (G) in the so-called FLG model. A simple idea of this is to put foreign actors (foreign research organizations invited by the donor government or the United Nations) in the place of the GRI/PRO in the GPG model so that foreign actors (cooperating partner) conduct R&D to transfer the results to local (private or state-owned) firms in African countries (stage FLG0). Then, in the next stage or FLPG, foreign partners conduct joint R&D with local R&D organizations or firms. Then, in the third stage, the aid-receiving LDCs is able to conduct R&D locally through private-public partnerships. The final stage is, of course, where all functions are performed by private actors.

The Green Revolution of the 1960s and 1970s and the System of Rice Intensification (SRI) are examples of the FLG model (Lee et al 2014). The Green Revolution involved the introduction of packages of high-yielding varieties of: rice, wheat, and maize; fertilizers; pesticides; new management practices; and irrigation. The packages brought about a dramatic increase in productivity and production. The Green Revolution, initiated with support from the Ford and Rockefeller Foundations and led by Norman Borlaug, is regarded as having saved over a billion people from starvation. Much of the initial research on rice and wheat has already been done in American universities but needed to be adapted to local conditions. This required the creation of new international research institutes, initially the International Maize and Wheat Improvement Center (CIMMYT) in Mexico and the International Rice Research Institute (IRRI) in the Philippines (Juma 2011). These institutions were later brought under the auspices of the Consultative Group on International Agricultural Research (CGIAR). Today the CGIAR is a consortium of 15 research institutes working on agroforestry, biodiversity, dry areas, food policy, fish, forestry, livestock, maize and wheat, potato, rice, semi-arid tropics, tropical agriculture, and water. As part of this international initiative, local authorities expanded roads, improved irrigation systems, and provided electrical power to support farmers to adopt the new technology. International lending was also made available to promote the package. Research collaboration at the international level also led to the birth and expansion of national agricultural research institutes. These centres were to adapt the internationally developed varieties of rice and wheat to local conditions.

In the Indian case, the government played a key role in the diffusion of new seed varieties (Lee et al 2014). The government, with the financial support from the World Bank and technical assistance from the Rockefeller Foundation, established state seed corporations in most major states in the 1960s which led to the creation of the seed industry in India (Juma 2011). SRI was started in the early 1980s after participating groups from 40 countries first assembled in Madagascar in 1983. Then, it rapidly spread to more countries with the assistance of Cornell University. India is regarded as one of the biggest beneficiaries of this initiative.

In certain context and on certain conditions, such as availability of foreign assistance and access to knowledge and funding, the latecomers may try leapfrogging into newly emerging

sectors, such as renewable energies. An example is the use of solar power in desert grasslands rural areas in Jigawa State of Nigeria (Lee and Mathews 2013). Given no water supply in this semi-desert area, a traditional option was to open wells with rope and bucket, hand pumps, or government supplied diesel-powered pumps that work only until they break down or until villagers run out of money to buy the expensive diesel. Now, solar-powered pumps have solved the problem as they are designed to run maintenance-free for eight to ten years or more.

Another example is the O&L Groups in Namibia (Lee et al 2014). Established by Mr. Shilongo, this company started from retail and brewery, and then diversified into dairy and even solar energy. Owing to government support (against a South African company's price dumping to kill this company), they survived, grew big and quickly, with their sales reaching about 4 per cent of GDP of that country. Given that Namibia imports electricity from South Africa and Angola, this company plans to enter more into energy business, including wind power, although they have first to solve the hurdle imposed by grid monopoly by the government.

Some example cases in LDCs are really more about adoption of new technologies than local innovations. But adoption is a beginning or stepping stone for learning and eventual innovation. Without adopting, you cannot learn. Manufacturing in East Asia, such as Samsung and Hyundai Motors in Korea, all started from the adoption of foreign technology for production, learning from using it, finding a way to enhance productivity by mastering production technologies, and finally even acquiring design technology (Lee 2005, Lee 2013a). More recent examples can be found in the renewable energy markets of China, Brazil, and India which involve the transition toward low-carbon economies. Options for LDCs in low-carbon technologies include wind, solar, biogas, and geothermal energy sources. In this case, coordinated initiatives and incentives for early adopters are essential in reducing the risks associated with weak initial markets.

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