GLOBALIZATION, TECHNOLOGY TRANSFER AND SKILL ACCUMULATION IN LOW-INCOME COUNTRIES

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Abstract

Globalization has drastically improved access of technological latecomers to advanced technologies and, to the extent that technological upgrading is important for development, it provides a unique opportunity for low-income countries to raise per capita income. This paper shows that low-income countries as a group have in fact substantially increased the GDP ratio of technology imports over the past few years, but that there are large cross-country discrepancies in technology upgrading within this group. General-purpose technology continues to constitute the bulk of technology imports, while sector-specific technology used for labour-intensive activities has gained in importance. Improved access to technology imports appears not to have improved labour productivity and the demand for skilled labour in many low-income countries. To raise the benefits reaped from globalization, governments might need to make additional efforts towards a simultaneous increase in technology imports and the skill level of the domestic labour force.

Introduction

Both standard neoclassical growth theory and recent endogenous growth theory explain the persistent poverty in developing countries as being partly due to differences in technology between rich and poor countries. Neoclassical theory considers technology as both universally available and applicable, and technological differences as gaps in the endowments of objects, such as factories or roads. By contrast, endogenous growth theory considers that gaps in the endowment of ideas and in the limited capability of developing countries to absorb new knowledge are the main reasons for poverty. The latter implies that development policy should concentrate on the interaction between technology and skills with a view to facilitating the reduction of the idea gap.

One of the main opportunities which globalization – the integration of national economies – is said to offer to developing countries is that they would have better access to the technical advances in developed countries. Integration would help to reduce the technology gap and to raise the level of total factor productivity and per capita income in developing countries. Coe and Helpman (1995), Keller

(1998) and Coe, Helpman and Hoffmaister (1997) – henceforth CHH (1997) – have shown empirically that countries which have imported more from the world's technology leaders have experienced faster growth in total factor productivity. This paper refines the measure which these authors used to proxy technology imports and assesses whether on this refined measure technology transfer to low-income countries have increased over the past few years.

The role of technology adoption in the process of economic development has been a recurrent theme in the economic literature. It highlights that the cross-country distribution of per capita income will move up over time with no change in its range if the distribution of technology adoption is constant over time, i.e. all countries adopt new technology equally. To reduce this range, backward countries will need to upgrade their level of technology faster than the advanced countries. The realization of technological improvements in backward countries is closely interrelated with their educational attainment: their skill supply influences the amount and degree of sophistication of technology which can be adopted and efficiently used, while in turn the amount and sophistication of newly introduced technology impacts on the demand for skills. This means that globalization can ignite a virtuous circle of technological upgrading and skill accumulation in technological latecomers.

It is clear that the interdependence between globalization, technology upgrading and skill accumulation is determined by many factors, and a full specification of these mechanisms is beyond the scope of this paper. The more modest objective of the paper is to concentrate on trade flows as a vehicle for technology transfer to developing countries, and to assess empirically two phenomena which reflect whether or not globalization has ignited a virtuous circle between technology upgrading and skill accumulation: (i) the evolution of machinery and equipment imports and their sectoral bias, and (ii) the change in the demand for skilled labour.

Section I presents a simple framework regarding the interaction between technology upgrading and skill accumulation. Section II assesses technology imports by low-income countries from both developed countries and developing countries with significant domestic research and development (R&D) spending, where the latter group will be called "technologically more advanced developing countries". Section III discusses changes in labour productivity and the demand for skilled labour, and section IV provides some concluding remarks. Throughout the paper, specific emphasis will be placed on low-income countries where, following UNCTAD (2000), this group includes all developing countries with a per capita GDP of under US$ 800 in 1995.

I. TECHNOLOGY AND SKILL ACCUMULATION

The shortage of modern technology is widely assumed to hold down the level of per capita income in low-income countries. But there is little empirical evidence on whether the improved access to modern technology which has come about with globalization has helped alleviate this shortage. It is clear that their improved access to modern technology alone does not guarantee that low-income countries will realize productivity increases. They need the human capital required to absorb and efficiently use modern technology. Moreover, economic policies and institutional arrangements impact on the actual amount of modern technology which low-income countries can import.

The combined role of education and technology for output generation can be expressed in two alternative ways in the production function. First, they can be viewed as multiplicative inputs, which implies that the "marginal productivity" of education – determined by the number of inputs and the current technology – can remain positive even if the technology does not change. A second, and probably more useful, view (Nelson and Phelps, 1966; Lucas, 1993; Young, 1993) argues that education has a positive payoff only if the technology is always improving.

This second view can be formalized building on a model by Nelson and Phelps (1966). The model shows that the rate at which technological latecomers realize technology improvements made in technologically advanced countries is a positive function of their educational attainment (with $*\theta / *h > 0$) and proportional to the gap between the technology level in advanced countries ($T(t)$) and their own ($A(t)$):

$$\frac{A'(t)}{A(t)} = \theta(h) \left[\frac{T(t) - A(t)}{A(t)} \right]$$

Assuming that technology in advanced countries improves exogenously each year by ν per cent, i.e.

$$T(t) = T_0 e^{\nu t}$$

implies that the equilibrium path of potential technological development of a technological latecomer is

$$A(t) = \left[\frac{\theta(h)}{\theta(h) + \nu} \right] T_0 e^{\nu t}$$

Accordingly, the potential level of technology which is employed in a technologically backward country depends on its own educational attainment *h* and the rate of technological progress in the advanced countries which becomes available to the backward countries. A greater supply of human capital will have no effect on the level of output generated with conventional inputs unless new technology is introduced, and skill accumulation will continue only when technical progress is sustained.

The introduction of new technology can stimulate skill accumulation in two ways. First, the technology can be of a more recent vintage without affecting the sectoral composition of production (within-industry effects). Second, assuming the existence of a technology ladder in the production of goods ordered by increasing technical sophistication, the introduction of new technology can stimulate skill accumulation also – and perhaps most importantly – when it leads to a change in the sectoral composition of production by relating to activities which are one rung up on the technology ladder compared to those which already exist in an economy (between-industry effects). Hence, the full impact of technology adoption on skill accumulation depends on the amount of new technology that is introduced and on the degree of change in the structure of production up the technology ladder which the new technology entails.

The introduction of new technology is constrained by barriers to technology adoption. When such constraints are present, the technology inflows which can be realized (ν_F) will be lower than the potential inflows of modern technology (ν).

$$A(t) = \left[\frac{\varphi(h)}{(\varphi(h) + \nu_F)} \right] T_0 e^{\nu_F t}$$

Several factors determine the difference between ν and ν_F. Import rules and restrictions will limit technology imports – one effect of trade integration is the decline of such limits. Natural trade barriers such as geographical distance can reduce technology imports to the extent that geographical distance raises transportation costs of capital equipment, which embodies technology to prohibitive levels. From a microeconomic perspective, high costs for firms to invest in new technology limit its adoption,[1] including a cumbersome legal and regulatory framework or high real interest rates and an unstable exchange rate, which do not enable potential investors to make long-term plans.

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[1] See Parente and Prescott, 1994, for a detailed discussion.

From a macroeconomic perspective, a country's ability to import new technology will be seriously limited if it is subject to a balance-of-payments constraint because it cannot achieve export earnings that fetch the foreign exchange which is required to pay for such imports. The level of the export-earnings requirement is determined by the share of machinery investment which needs to be imported, as well as by the level of aggregate investment and the proportion of investment which is machinery (as distinguished from construction).

But increased trade integration also has a composition effect on the country's production structure. As argued above, this composition effect impacts on the direction of change up or down the technology ladder brought about by the sectoral bias of the new technology. On the import side, an inflow of new technology that raises productivity of all sectors equally will not alter comparative advantage in the framework of standard trade theory. But the opposite will be the case if the inflow of technology was sectorally biased, since for Ricardian reasons this would alter comparative advantage.

On the export side, the composition effect works through two channels that can pull in different directions. The first channel regards the terms of trade: to maximize its export earnings, the country should strive to export those products which are not subject to declining terms of trade. The second channel regards the country's comparative advantage: to maximize its export earnings, the country will need to change its production and export structure towards those sectors in which it has a competitive edge. Concern has often been expressed in this regard because to the extent that manufacturing is higher up on the technology ladder and provides a better growth potential than agriculture, developing countries might experience deindustrialization and lower growth because their comparative advantage is usually not in manufacturing.

Globalization further complicates the composition effect of trade integration. With an increasing number of countries integrating into the world economy, a specific country's comparative advantage