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The Impact of Skills Development on Competitiveness: Empirical Evidence from a Cross-Country Analysis¹

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Abstract: In the past half-century, most countries have emphasized the development of human capital as an instrument for economic growth, sustainable development, and improved global competitiveness. However, limited evidence exists on the link between skills development and a country's competitiveness. This paper examines the contribution and association of skills to a country's competitiveness. The study uses panel data from 84 countries in estimating an empirical model. Skills

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availability, foreign direct investments, secondary education, and technical (engineering) education and training are significant contributors to a country's competitiveness in a technologically changing and demanding world. This dynamic requires institutionalizing high-level technical skills development and on-the-job training programs in various firms that provided company specific and general skills to employees. The study recommends increased participation in secondary education and technically-oriented courses in tertiary education and programs that encourage skills transfer from foreign companies. Foreign direct investment, however, requires a conducive investment environment. Increased collaboration between tertiary institutions and industry is crucial for improved skilled development.

Keywords: human capital; international development; international economic competition.

El impacto del desarrollo de habilidades para la competitividad: Evidencia empírica de una comparación entre países

Resumen: En el último medio siglo, la mayoría de los países enfatizaron el desarrollo del capital humano como un instrumento para el crecimiento económico, el desarrollo sustentable y la mejora de la competitividad global. Sin embargo, existen pruebas limitadas sobre la relación entre el desarrollo de capacidades y la competitividad de un país. Este artículo examina la contribución y la asociación de habilidades para la competitividad de un país. Este estudio utiliza datos de 84 países en la estimación de un modelo empírico. La disponibilidad de habilidades, la inversión extranjera directa, la educación secundaria y técnica (ingeniería), la educación y la formación contribuyen de manera significativa a la competitividad de un país en un mundo con tecnología cambiante y exigente. Esta dinámica requiere la institucionalización de altos niveles de desarrollo de competencias técnicas y programas de capacitación laboral en empresas que proporcionen formación específica y general a los empleados. Este trabajo recomienda aumentar la participación de la educación secundaria, cursos de orientación técnica en la educación superior y programas que fomenten la transferencia de competencias de las empresas extranjeras. La inversión extranjera directa, sin embargo, requiere un entorno propicio para la inversión. Aumento de la colaboración entre instituciones de enseñanza superior y la industria es crucial para el desarrollo de mejoramiento de la capacitación del personal.

Palabras-clave: capital humano; desarrollo internacional; competencia económica internacional.

O impacto do desenvolvimento de habilidades para a competitividade: evidência empírica de um estudo comparado

Resumo: Na segunda metade do século passado, a maioria dos países têm enfatizado o desenvolvimento do capital humano como um instrumento para o crescimento econômico, desenvolvimento sustentável e a melhoria da competitividade global. No entanto, existem poucas evidências sobre a relação entre o desenvolvimento de competências e da competitividade de um país. Este artigo analisa a contribuição e associação de competências para a competitividade de um país. O estudo utiliza dados de um conjunto de 84 países para desenvolver um modelo empírico. A disponibilidade de competências, o investimento estrangeiro direto, o ensino, secundário, e a formação técnica (engenharia) contribuem de forma significativa para a competitividade de um país em um mundo de grandes exigências e mudanças tecnológicas. Essa dinâmica exige a institucionalização de níveis altos de desenvolvimento de competências técnicas e programas de capacitação no lugar de trabalho em empresas que forneceram a seus empregados oportunidades de capacitação em habilidades gerais e específicas para cada empresa. O estudo recomenda maior participação no ensino secundário e em cursos de ensino superior orientados para as áreas tecnológicas, e programas que incentivam a transferência de competências técnicas de empresas estrangeiras. O investimento direto estrangeiro, no entanto, requer um ambiente propício ao investimento. Aumento da colaboração entre instituições de ensino superior e a indústria é fundamental para o melhorar um desenvolvimento qualificado.

palavras-chave: capital humano; desenvolvimento internacional; a concorrência econômica internacional.

Introduction

Skills development is an important element in a country's human capital development, improved competitiveness, and sustainable economic growth and development (World Bank, 2004a). It enables countries to compete effectively in manufacturing and services exports (Gemmell, 1996; Lall, 1999, 2000), and to move into higher growth paths (Kimenyi, Manda, & Mwabu, 2002). Availability, acquisition and application of appropriate knowledge and skills to specific firm activities enhance competitiveness of enterprises, industries, workforce and economy at large through their effects on labor productivity (Lall, 1999; Tilak, 2002). Availability of relevant skills in particular contributes to production of quality, high technology and cheap outputs, while giving the firm a competitive edge both nationally and internationally.

The ability to effectively compete in liberalized markets largely depends on extent to which countries incorporate new skills into the production processes within the fast changing technological advancements. Technological progress and globalization characterized by rapid and flexible shifts in the productive and innovative activities, all call for high level skills and improvement of workforce skills at all levels, supported with comparative advantage and strong systems of industrial organization and management (Lall, 1999). It is apparent that the proposition of comparative advantage in developing economies has lately changed from the traditional base of primary resources and cheap labor to manufactured products and services that incorporate higher skills and technological inputs (Lall, 2000). Indeed, even in activities where developing countries still have comparative advantage in terms of low wages, globalization and technological change patterns impose demand for a skilled labor force.

The current shift from conventional competitiveness characterized by low cost inputs to new dimensions of competitiveness driven by quality, flexibility, design, reliability and networking requires new forms of enterprise management and organizational skills, capable of setting up new production systems, different production structures, information flows, and responsibilities. Key features of skills formation for this enhanced competitiveness include communication skills; broader skills characterized with team work and frequent rotation, problem solving skills; quality improvement, health and safety; and capabilities in linking human resource policies with remuneration systems (peoples' skills) (Low, 1998). These skills are acquired through organized training, on-the-job experience, or problem solving through experience.

As indicated above, the World Bank (2004a) identifies five integrated blocks for improved competitiveness at industry level. These include physical infrastructure, business environment, trade and investment facilitation, human capital, and financial services. When combined, these factors lead to sustainable job creation, increased exports, and value added produced domestically. Within this framework, human capital consists of the labor force, which provides countries with services ranging from health care, education, administration and security (Cohen, 2002). With technological and various other advancements, the demand for skilled workers has been growing and continues to grow. Skills related features that influence competitiveness include levels of knowledge, skills and innovation on the employees, mechanisms for skill updating, information technologies, quality of human capital, and level of investment in education and training in the country.

For instance, in Asian countries interest in the high technology products and key industries in microelectronics, biotechnology, production of new firm products, science industries, civil education, telecommunication, robotics and machine tools, and computer hardware and software led to heavy public and private investments in relevant fields of education and skills training (Lall, 1999). The employers in less developed economies have limited influence on appropriate education policies and systems to promote the acquisition of relevant knowledge and skills geared to business needs

and the ability to use them. For most developing economies, strong linkages are lacking between private sector and secondary and tertiary education institutions, on one hand, and training and labor markets, on the other (Dar, 2000; Fluitman and Alberts, 2000; Lall, 1999).

Further, skills needs tend to change rapidly due to globalization and technological dynamics among other factors. Wignaraja (2005) observes that the economic realities brought about by globalization (liberalization and dynamic markets, constantly changing customer preference, new structures of production and work, among others) are leading to a rethinking of production and competitiveness. The views of productivity have recently shifted from the traditional thinking of efficiency (that is in terms of amount of outputs in relation to input costs and quantities) to viewing productivity and competitiveness as efficiency and effectiveness (how enterprises create and offer customers quality and relevant value to meet the needs for timeliness, utility, esteem service, among other attributes). In their lucid analysis of education technology and growth, Goldin and Katz (2008) indicate that human capital investment in the early twentieth century in America enabled the country to gain an edge in education, technology, and human capital and helped reduce inequalities at the time. Low levels of education and training prevent a nation from achieving the technological frontier requisite for sustainable development and taking full advantage of the global economy. It is therefore vital that less developed economies endow their citizens with at least a secondary school education for effective participation in the global economy. Since quality and relevance of skills availability has a direct impact on firms' and the economy's competitiveness, the workforce has to embrace innovativeness to ensure skills attained are adaptable to changing work environment and are able to boost competitiveness.

Within the context of the current global financial crisis, higher levels of training and skills development could cushion countries, especially poor countries against the effects of the economic meltdown. Training and skills development help enhance human capital and coping mechanisms against shocks (both internal and external). More specifically, the impact of the current financial crisis on developing countries could be mitigated by using technological innovation as a driver for economic growth. In essence, economic growth is the transformation of scientific and technological knowledge into goods and service. Thus by promoting skills development, economies could strengthen their capabilities to mitigate against the negative consequences of the global crises while ensuring innovative ways of managing relationships between financial sectors, technology, poverty reduction, and sustainable development.

However, there is limited empirical work that has been done in developing countries to establish the status of skills needs, availability and their implications on competitiveness. Thus it is important that issues on skills development are addressed. The purpose of this study therefore is to examine the contribution and association of skills to a country's competitiveness and the implications such contribution and association may have on competitiveness.

Theoretical Literature

Human capital theory is used to explain the importance and linkages between skills and competitiveness. The underlying preposition of the theory is that education and training are investments that produce returns in the future (Quiggin, 1999). Skills have strong effects on economic growth and other productivity attributes that make both countries and production units (firms) in which the labor force is working more productive and competitive. Thus like education, training empowers human capital with quality skills that can produce benefits in terms of future earnings accruing to workforce. The model attempts to show strong linkages between education and training, labor markets and economic growth. Thus any policy measures aimed at reducing education

and training spending at whichever level limits skills training or leads to deficiencies in skills development while reducing future national income, productivity and competitiveness (Quiggin, 1999; World Bank, 2004a).

In other versions of the human capital models, knowledge, information, and skills are critical through their contribution to increased productivity and hence, *ceteris paribus*, to higher earnings and productivity (Quiggin, 1999). Thus, for a country to attain higher levels of economic growth and competitiveness, it must expand investment in education and training up to a point where the rate of return on additional spending is equal to the general rate of return on capital. Education and skills training are also associated with other private and social benefits. Education is associated with better health status of the population, transmission of cultural values, more intelligent political participation such as in voting, and reduced criminal behavior, and that investment in education and employable skills training yields greater returns as compared to physical investment. All these factors have important implication to a country's overall competitiveness (United Nations Development Program [UNDP], 2005).

There are also a number of studies cited by Quiggin (1999) showing that education can have a positive effect on productivity and that higher education levels significantly contribute to willingness and ability of labor force to adopt new technologies. Education and training endows individuals with skills that are critical for improving competitiveness in African economies through improved productivity (Wignaraja, 2005). Within the standard labor supply and demand theory (Quiggin, 1999), a country with large number of educated people is expected to have a lower skills premium. However, in most developing economies, despite the increasing number of educated labor force, the labor premiums are considerably high, yielding low competitiveness leverage (World Bank, 2004a).

Further, on distributional effects, the model holds that where technological progress tends to increase demand for skilled labor and reduce demand for unskilled labor, a rise in average education levels is necessary to keep the returns to education stable and therefore reduce emergence of higher income inequalities (Quiggin, 1999). Indeed, countries that have embraced the importance of skills development through improved skills training and availability in the labor market and firms are to a large extent characterized by lower income inequalities and higher competitive edge (UNDP, 2005; World Bank, 2004a).

Skills Needs

With new-skills needs created by globalization, a quest for enhanced competitiveness, and changes in information technologies, there is a requirement for high level skills (greater technological, organizational, and managerial skills) regardless of the development level of the country (Lall, 1999). This should also be supported with an enabling environment and supportive policy since firms develop competitive capabilities by responding to market signals that are determined by factor markets and institutions. Other complementary skills needed in the modern production units include developing different attitudes towards work, new work relations, and new management systems skills.

There is also increasing demand for not only up-skills needs but also multi-skills needs. For instance there is apparent increasing demand for professionals and technicians in both developed and developing countries, due to their analytical, cognitive and behavioral skills that enable them to adapt sophisticated technology with ease (Lall, 2000). On the other hand, firms will prefer employees with multiple sets of skills, such as individuals with specialized professional expertise combined with business and management skills and capable of producing higher quality products.

Consequently, the education system for developing countries as well should continually put systems in place that allow flexible and regular skills development and upgrading to meet the constantly changing skills needs, and it should give cognizance to the fact that basic formal education is necessary but not sufficient for efficiently using technologies.

Otherwise, these (developing) countries' competitive edge is highly vulnerable to easy entry, technological change, and market dynamics. Currently, even low-technology, labor-intensive industries such as garment industries now demand technical, managerial, design, logistical, and communication skills (Lall, 2000; World Bank, 2004a). Further desire for competitiveness requires that countries shift from simple operational skills to advanced innovative skills (Lall, 1999). Such skills deepening is necessary for any country or firm to achieve a meaningful competitive edge. For a country to achieve improved development, it must address the need for new and advanced skills relevant to the production functions. For instance, developing economies are characterized by simple technologies, and there is overemphasis on improving literacy rates. On the other hand, industrialized countries with deep industrial structures commonly have excellent quality schooling; industrial training; and relatively higher populations of university-trained managers, engineers and scientists.

Types of Skills Formation

Skill formation arises from formal education, vocational training, in-firm (enterprise) training, outside the firm training, and on-the-job learning (Lall, 2000). While basic schooling and literacy may be necessary to absorb simple industrial technologies, advanced schooling and tertiary education are potentially critical for knowledge acquisition and modern skills advancement. On-the-job training, a distinct form of skills formation, is perceived to be more effective and economical since employers are more informed about skills needed at firm level and expertise and resources required to train in emerging skills needs.

On-the-job training is also an important complement of new investment in technology, plant equipment and organisation methods. For instance, Singapore, which is widely regarded as one of the most competitive countries in the world, has a large number of skilled workers supported with all-inclusive training strategy. Singapore ranked 7th with Growth Competitiveness Index (GCI) of 5.56 out of a maximum of 7 in 2004 (World Bank, 2004a). In Africa, for instance, countries such as Kenya had a competitiveness index of 3.45, ranking 78 out of the 104 countries during the same period. Skills provision is integrated within its industrial policy, and enterprises play a pivotal role in determining nature and content of training in various sectors. However, despite the demonstrated productivity effects (Lall, 2000), many firms particularly in most developing economies do not provide on-the-job training, perhaps due to the cost implications.

There are three types of vocational training systems relevant to development of technical skills (Lall, 1999, 2000). These include a cooperative system, an enterprise-based system, and a state-driven system. Under cooperative systems, skills development is a tripartite task undertaken by employers, employees, and government. For instance in Germany, employers offer apprenticeships in all sectors with the active involvement of Chambers of Industry and Commerce in registering apprenticeships and setting qualification standards. Employers cover half of the cost of training in public vocational schools while apprentices contribute by taking lower wages compared to market rates.

Enterprise training, commonly practiced in Japan, involves massive on-the-firm skills training to long-term employees. The state-driven skills formation system involves government providing the fast-changing skills needed in both public and private sectors, for instance in Korea.

Any training strategy a country takes is a function of social, economic, and institutional settings and a rate at which a country is readily able to adjust to globalisation and liberalisation forces. For example, a number of Asian countries have recently recorded high levels of productivity and competitiveness and have at the same time prioritized skills development in the long-term development agenda. Apart from infrastructure development, stable socio-political conditions, and overall macroeconomic efficiency, Singapore's increasing competitiveness has been associated with an educated and skilled labor force (Low, 1998). The country's employment and occupational structures are skewed to more professional skilled development, strong tripartite partnerships involving government, the private sector, and the labor force. High-level training and skills upgrading and retraining strategies are well developed while the universities and polytechnics are committed to the production of higher levels of tertiary education and skills development. Towards addressing the problem of skills deficiencies, the country has a deliberate policy through a foreign workers levy and quota system to restrain the importation of unskilled and low skilled labor while encouraging repatriation of highly skilled citizens studying abroad.

However, relatively few developing countries are investing in education structures that provide basic prerequisite skills for competitiveness (Lall, 1999), despite the fact that almost all countries have opened their economies to global competition and are striving to gain competitive edge in trade and in attracting foreign direct investments.

Trade, human capital, and competitiveness

Though the focus of our analysis is on human capital and competitiveness, the policy environment within which human capital is developed is important as it dictates the types, levels, pace, and the interactions of the human capital with other parameters in a country. As noted by Lall (1999), with the liberalization of trade and investment, even the traditionally non-traded activities will be exposed to international competition, hence calling for a change to improve their competitiveness. It is possible, in the short term, to enhance competitiveness based on unskilled low paid labor—as is the case in Bangladesh or Mauritius garment industry (International Labour Organization, 1998). However, this does not diminish the value of human capital as wages will finally rise and hence call for a change in technology if the competitive edge is to be maintained.

Governments influence the investment climate through the impact of their policies on the business costs, risks, and barriers to competition facing firms (World Bank, 2004b). Favorable investment climate will spur trade. Regardless of the levels of human capital, variations in investment climates can also reshape competitiveness. Government taxation policies influence the costs of doing business and therefore the scope of investment opportunities that can lead to competitiveness. While some tax regime could hinder expansion in trading, governments also have important roles in providing public goods, supporting the provision of infrastructure, and addressing market failures (World Bank, 2004b).

Firms' judgments about the future are critical, and hence a firm's investment decisions should be forward-looking. Though a firm may have the right mix of human capital, investment risks do exist, such as uncertain responses by customers and competitors. The way a firm assesses such risks and corresponding mitigation strategies will influence its competitive advantage. On the other hand, governments have a duty in maintaining a stable and secure environment, including protection of property rights. As argued in the World Bank Report 2005, policy uncertainty, macroeconomic instability, and arbitrary regulation can also cloud opportunities and chill incentives to invest.

From a business point of view, firms prefer to face less competition. Barriers to competition that benefit certain firms and consumers also deny trading opportunities and raise costs for other firms and consumers. They can also act as growth inhibitors for the protected firms as the urgency to be innovative and increase productivity is absent. Governments' policies influence trade barriers directly through market regulation and their response to anticompetitive behavior by firms (Tamkin, Giles, Campbell, & Hillage, 2004). In Poland, competitive pressure has been reported to be significant by 90% of firms compared to 40% of firms in Georgia (Hoekman & Saggi, 2004; World Bank, 2004b).

Other issues that may affect competitiveness include macro-economic performance. For instance, the United States and in fact many other developed countries are experiencing an economic recession that has led to labor redundancy and decreased firm productivity. This is despite their high levels of human capital. The recession has not discriminated among countries by level of human capital but by how well the country cushions itself against the recession.

Skills availability is central to economic competitiveness and growth potential for any country. Data on comparative analysis of human capital indexes across countries (UNDP, 2005) indicate that over the last two decades, developing economies have experienced considerable underinvestment in human capital development, especially technical and other tertiary levels, and this underinvestment has had a negative impact on the growth potential of productive sectors in the countries. Other indicators include low transition rates between education levels, low and declining tertiary education enrollments especially in technical subjects, and declining quality of industrial training. All these factors constrain developing economies from competing effectively in the global market. For instance, according to recent World Bank studies on Kenyan firms, skills levels and capital productivity have not improved when compared to the mid-1990s (World Bank, 2004a). In other sub-Saharan Africa countries, the situation could be worse given that the quality of skills development and technical training is relatively higher in Kenya compared to several other sub-Saharan countries.

Table 1 shows some selected competitiveness indicators for some developed and developing countries. As shown in the table, developed countries (the United States, United Kingdom, and Japan) have a higher global competitiveness index (GCI). African countries (Kenya and Tanzania) have a much lower GCI. Again, African countries are not performing very well in terms of producing high technology exports compared to countries like Malaysia, the U.S., the U.K., Korea, or Japan. Thus, as developing countries evaluate their strategies for sustainable growth and improved competitiveness, skills development is equally critical among other factors.

Table 1
Selected competitiveness indicators

Country	High tech exports (% of merchandise) 1998–2003	Secondary enrollment (%) 1999–03	Global competitiveness index 2001–04	GDP growth (%) 2000–2005	Foreign direct investments (% gross capital formation) 1999–2003
Kenya	5.1	31	3.3	2.5	2
Malaysia	58	69	4.81	5.2	14
South Africa	6.6	87	4.68	3.4	8
U.S.	32.7	93	5.88	2.7	7
U.K.	30.1	164	5.3	2.7	7
S. Korea	31.1	93	4.99	5.4	2
Japan	25.9	102	5.26	1.3	1
India	4.7	49	3.96	5.7	2
Tanzania	2.5	5.8	3.43	6.4	15

Indicators are averaged over the time period. Sources: Global Competitiveness Report and World Development Indicators, various issues.

Empirical Literature

The human capital theory provides the theoretical underpinning to linkages between education, training, skills needs, and labor availability, on the one hand, and a firm's or country's productivity and competitiveness, on the other. Competitiveness depends on the level of knowledge emergence and its application to production. To this end, creativity is essential for moving into and being competitive in the knowledge based production limits for increased productivity. This requires a systematic approach to human capital development for the emergence of such workers and ensuring that education and skills training systems produce a creative workforce.

Human capital is important for economic growth through its contribution to labor productivity and has been observed to be one of the underlying factors for high and sustainable economic growth and competitiveness levels currently experienced by a number of Asian countries (Temple, 2001). For instance, education is a key input to the research sector, which generates the new products and ideas that underlie technical progress. Economies with a higher quality of education are likely to experience a more rapid growth in the introduction of new and quality goods and productive processes that enable them to attain a competitive edge. This is the basic underlying argument in the endogenous growth model that holds that a large part of economic growth is determined by technological progress, which is mainly influenced by the levels and quality of education and skills training of the workforce (Barkham, Gudgin, Hart, & Hanvey, 1996).

Empirical studies (Barkham et al., 1996; World Bank, 1993) show that there is a strong positive relationship between high primary, secondary and tertiary enrollment rates and rapid economic growth. High standards of education and training among the workforce comprise a key element in attracting foreign investments, and at the firm level, enterprises owned and managed by well-educated entrepreneurs tend to grow faster than their counterparts. To a large extent this is associated with the fact that better educated entrepreneurs are more likely than others to implement business strategies such as conducting research and introducing improved products, which are necessary for overall growth of firms and a country in general. Further, better educated and skilled workers are less likely than others to be unemployed, tend to earn more in employment, and also are likely to receive more on-the-job training. Thus, education and training contributes to improved

labor productivity and effectiveness, improving the country's overall economic performance and competitiveness. The opposite holds true. That is, countries that lack educated and well-trained workforce are likely to experience skill deficiencies, leading to low firm profitability and competitiveness.

Lall (1999) estimated a regression function of high technology exports to examine the effects of foreign direct investment and skills as captured through the Harbison Myers Index (HMI) measure of secondary and tertiary school enrollment.² He provided evidence that skills and foreign direct investments (FDI) have a positive and significant impact on the per-capita value of high technology exports, one important measure of a country's competitiveness. Other important factors contributing to competitiveness include technological upgrading and investment in research and development. However, Lall's study did not capture fixed (country specific) and time effects. The study we are reporting here attempts to control for fixed effects as it analyzes the impact of skills among other factors on competitiveness.

Method

This study analyses the contribution of skills development to a country's competitiveness using panel data on 84 developing countries for the period 1999–2003. The data was obtained from available international datasets including Human Development Report (2005), UNESCO, Global Competitiveness Reports, and the World Indicators Datasets. Education and training are taken as the main avenues for skill acquisition and skill stock in any given country. This study borrows from the framework for analysis used by Lall (1999). However, our analysis is limited to aggregated human-capital measures, and because of data limits we do not control for business organizations and firm efficiency as advocated by Lall (1999).

Data

High technology exports. The dependent variable is the level of high technology exports as a percentage of manufactured merchandise, used here and in Lall (1999) as a measure of an individual country's competitiveness. The ability to compete in free markets depends on the ability to incorporate new technologies into manufacturing services for sustained growth.

Harbison Myers Index. The skills level is captured through the Harbison Myers Index (HMI), which is the sum of secondary enrollment and tertiary enrollment (times five) both enrollments as a percentage of age group (Lall, 1999). The tertiary enrollment is multiplied by five due to the weight placed at tertiary level in skills development.

Indices for science and engineering enrollment in tertiary education. A science enrollment index is the percentage of the population in tertiary total enrollment multiplied by 1000 plus the tertiary enrollment in technical and science subjects multiplied by 5000 (Lall, 1999). The engineering skills index used here is the parallel version with tertiary enrollments in engineering courses instead of enrollment in technical subjects (Lall, 1999: 52). These indices are proxy measures of the levels of technical, science, and engineering skills availability in the respective countries. *A priori*, we assume that the existence of highly-trained managers, scientists, technical, and engineering in a country has a positive impact on the country's competitiveness.

² “[The] Harbison Myers Index is the sum of secondary enrollment and tertiary enrollment times five, both as a percentage of age group” (Lall, 1999, p. 52).

Adjusted gross domestic product per capita. The analysis uses the gross domestic product per capita at purchasing power parity as a proxy measure of resources and a country's capability to finance education and skills development. In summarizing the effects of more open trade on skills development Wood and Ridaò-Cano (1999) point out that one of the factors is the ability of different countries to offer their inhabitants learning opportunities. In addition, high GDP per capita is closely associated with a higher level of exports, especially middle-level and high technology exports (Lall, 1999). Thus, inter-country differences affect learning and skills development opportunities through household and public expenditure effects on education and training.

Net foreign direct investments. Foreign direct investments can contribute to a country's overall productivity both because it is associated with high technology transfers and also in contributing to capital formation in general. Thus, if net foreign direct investments do not contribute to increased capital formation and technology transfer, the effects are likely to be devastating to the economy. However, in some countries, foreign direct investment stocks have been associated with high competitiveness and economy's production of high technology exports.

Model

The framework estimates the effects of skills levels on competitiveness across various countries. Skill levels in a country are measured using the Harbison Myers Index (HMI). The estimated model is specified as:

$$\gamma_{it} = \lambda_i + \delta_t + \beta X_{it} + v_{it}$$

where γ_{it} is the dependent variable, high technology exports as a percentage of manufactured merchandise, λ_i and δ_t are country- and time-specific effects, respectively, v_{it} is an error term representing idiosyncratic shocks or noise, and X_{it} is the vector of the independent variables: Harbison Myers Index, tertiary science and engineering enrollment indices, gross domestic product at purchasing power parity, and net foreign direct investments. Based on the results of a Hausman specification test, a fixed effects model was chosen as the appropriate model. Since the data is only for a five-year time period, the study only estimates a one-way error component model controlling for country-specific effects.

Table 2

Pooled estimated general least-squares results with cross-sectional weights (linear estimation after one-step weighted matrix), with selected fixed effects for countries

Indicator	Statistic
<i>Variable</i>	<i>Coefficient (standard error)</i>
Harbison Myers Index	0.25** (0.08)
Tertiary engineering enrollment index	0.019** (0.039)
Gross domestic product per capita at purchasing power parity	0.34** (0.12)
Foreign direct investments	0.020* (0.009)
Constant	-1.297** (0.369)
<i>Country (selected)</i>	<i>Fixed effect</i>
Kenya	0.52
Malaysia	0.97
South Africa	0.022
United States	0.39
United Kingdom	0.32
Korea	0.46
Japan	0.37
India	0.20
Tanzania	0.45
<i>Summary measures</i>	
R ²	0.99
Adjusted R ²	0.99
Sample years	1999–2003
Total included observations after adjustments	5
Cross sections included	84
Total pool (unbalanced observations)	420

Standard errors in parenthesis; * $p < .05$; ** $p < .01$.

Results and Discussion

Results

The fixed-effects results are based on pooled data for 84 countries and are presented in Table 2. All the factors included in the regression are statistically significant, have positive coefficients, and account for 99% of the variation in competitiveness. The science enrollment index was dropped from the regression due to the small number of observations.

Discussion

According to the results, available skills have a positive and meaningful impact on high technology exports. One can reasonably conclude that skills are essential for the country's

competitiveness, especially in the production of high technology outputs. This suggests that any improvement in high technology exports requires a skilled labor force that has investment in both the secondary and tertiary education levels. One should keep in mind that low foreign investment could be one of the indirect contributing factors for low competitiveness leverage experienced by less developed countries through education.

The results show that the tertiary engineering enrollment index has a positive and significant effect on the levels of high technology exports produced in the countries. The level of human capital development, especially critical engineering skills development and its impact on competitiveness, can also be observed through the number of skilled individuals who have acquired high-level technical skills necessary in the production of high technology products. The skilled manpower could include engineers. Thus, for a country to have a competitive edge, it should be ready to invest substantial resources in tertiary education, especially in high level technical training courses including engineering.

The difficulty in assessing quality may be explained by country-specific contexts. For instance, secondary education constitutes an academic prerequisite and transitional level for enrollment in most tertiary learning institutions that offer skills-oriented courses. To a large extent, production of high technology and or knowledge-intensive outputs require the highest levels of competence, with relevant skills on creative design, innovation, and efficient production technology. The base for most of these skills is mainly a secondary-school education. Unlike in developed economies, secondary education gross and net participation rates in most developing countries are relatively low. However, secondary education is an important base for skilled labor force, members of which can occupy employment niches that draw on advanced skills for enhanced competitiveness.

Gross domestic product per capita at purchasing power parity provides a general proxy for income measure in the estimation. It is used to control for macroeconomic and welfare effects that are expected to have substantial implication on production of high technology outputs and hence competitiveness. The results show a positive and significant relationship between GDP per capita at purchasing power parity and production of high technology products. Higher GDP at purchasing power parity increases households' demand for higher education, including advanced skills development that is required in production of high technology products. Thus, for a country to remain competitive, it should ensure high and stable GDP per capita levels.

The empirical results show that foreign direct investment has a positive and statistically significant impact on competitiveness. Foreign direct investment as a share of any country's overall investment can either have a positive or negative effect on competitiveness depending on how best the resources are utilized for improved production. The levels of foreign direct investment are higher for technologically advanced economies that to a large extent produce high technology and differentiated outputs compared to developing economies. However, in the recent past, most of the developing economies have benefited significantly from foreign investment. For instance in 1997, foreign investment in the leading 10 developing economies (China, Brazil, Mexico, Singapore, Argentina, Chile, Indonesia, Venezuela, Malaysia and Thailand) was estimated at 75.9% (Lall, 1999). Most developing countries still receive low levels of foreign direct investments, especially those in sub-Saharan Africa.

Conclusion

The new technological paradigm imposes demands on the existing narrow base of skills and knowledge on developing countries. These countries will have to develop their skill bases to achieve

sustainable growth and technological advancement. Secondary education and training in high-level technical courses such as engineering are important for a country's competitiveness.

There are a number of issues that emerge from this study, and as a result, we need to rethink skills training policy and the strategy for countries with less developed skills development, develop feasible skills development strategy involving public-private sector partnerships, address issues of producing qualified technical graduates in various fields, develop and sustain linkages between industry and public training institutions, enhance the effectiveness of technical and vocational education and training system, including skills development, and promote the role of the private sector in development of technical, industrial, vocational and technical training and skills curriculum.

Based on the lessons from other countries, particularly the Asian countries that have earned considerable competitive edge in their production sectors, developing economies need to enhance private sector participation in skills development in the formal institutions and technical and vocational education and training. Various mechanisms for enhancing linkages between industry and training institutions include support for apprenticeship, attachment training, relevant curriculum and training programs' development, and sponsorship and private sector/industry participation in training and skills development policy development processes. Finally, it is critical that less developed countries undertake some form of skills inventory to inform sectors of specific skills needs for respective countries. This should also be based on such standards as the International Standard Classification of Occupations (ISCO) giving cognizance to implications of technological developments and globalization issues.

Further, policies for promoting employment, education, and skills development for sustainable economic development should be geared towards qualitative dimensions in terms of higher skills and productivity, compared to quantitative dimensions. Reforms in the education system should focus on expanding and improving the quality of post-primary education, especially science, technical, and engineering courses in technical training institutions, universities, polytechnics, and secondary schools. Other initiatives include the development of science parks and increased resource mobilization in innovation programs, research, and development.

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