A Theory of Global Human Resource Demand. Implications for Comparative Education, Research and Policy

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Introduction

In the recent past, many developing countries still had closed economies. They built economic models to understand national development. These models were constrained to national borders and they considered very few international variables. Educational policies and other type of policies as well were made on the basis of national models of development. Today, most developing countries have opened their economies and international variables are of the most importance for them to understand both their expectations for further development and the right policies to implement.

This article describes some international variables that are affecting developing countries. In doing so, a Theory of Global Human Resource Demand (TGHRD) is build. Then, this article introduces some implications for comparative education, research, and policy. The basis of the TGHRD is the globalization of production (GP) which is driven by MNCs. The need for both profit and competitive advantage propels MNCs to move offshore production processes. In doing so, they generate a human resource demand (HRD) in developing countries. This demand is related to production processes (i.e. assembly, manufacture, R&D), production systems (i.e. Fordism, Toyotism), and production life cycles (i.e. short product life-cycle, large product life-cycle). For countries and corporations, the TGHRD seems to have some implications for comparative education, research, and policy. For example, researchers, politicians, and managers may want to know what educational policies drive a former developing country from being a predominantly assembly plant nation to a mainly R&D center.

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A theory of global human resource demand based on decentralization of technical production processes

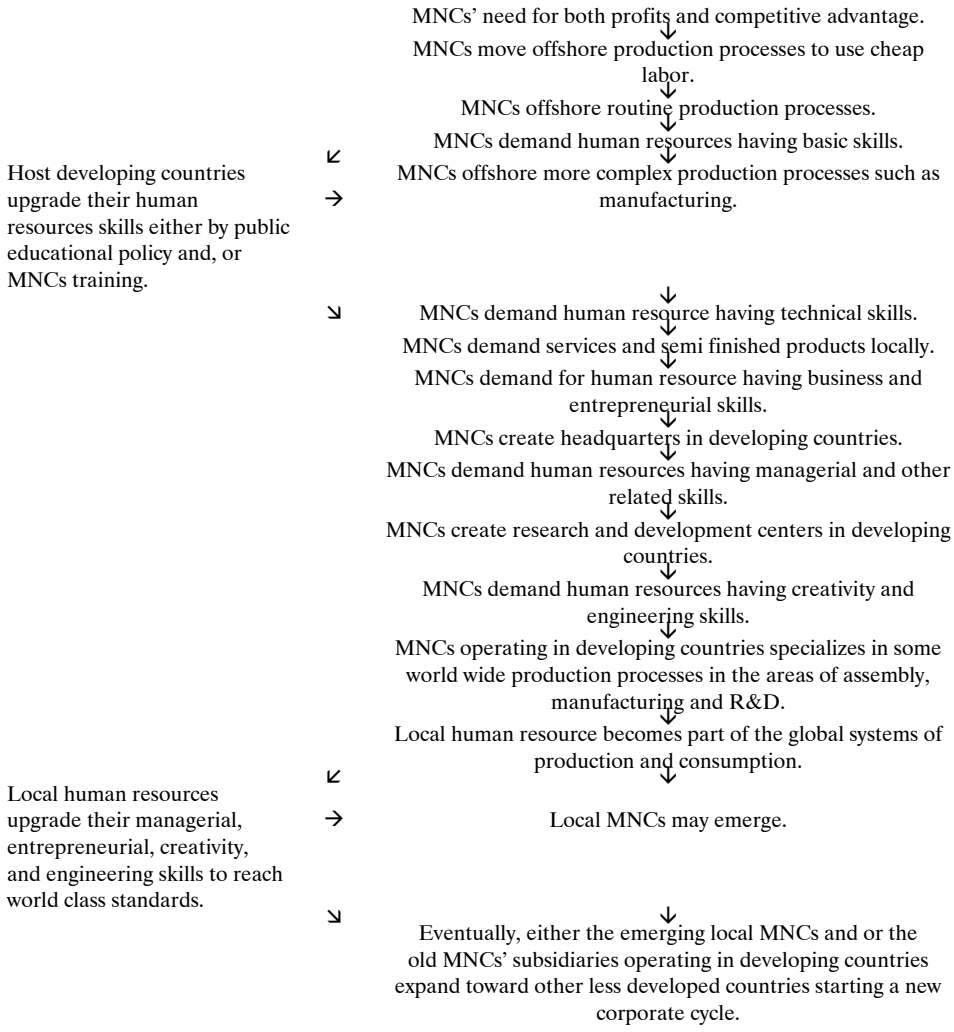
As I said before, the basis of the TGHRD is the globalization of production (GP) which is driven by MNCs. As Figure 1 shows, the TGHRD presents the following pattern. The point of departure is that MNCs needs both increase their profits and improve their competitive advantage. Such a need propels MNCs to move offshore production processes and to use cheap labour from developing countries. At first, MNCs offshore routine production processes and demand human resources having basic skills such as reading, writing, and arithmetic. As host developing countries upgrade the skills of their human resources, MNCs offshore more complex production processes such as manufacturing. As a result, MNCs demand human resource having technical skills. In a third stage, MNCs demand services and semi finished products locally. As a result, MNCs activity generates a demand for human resource having business and entrepreneurial skills. In a fourth stage, MNCs create headquarters in developing countries and demand human resources having managerial and other related skills. In a fifth stage, MNCs create research and development centers in developing countries and demand human resources having creativity and engineering skills. Consequently, innovation also takes place in MNCs operating in developing countries. Over time, MNCs operating in developing countries specializes in some world wide production processes in the areas of assembly, manufacturing and R&D and become an important link within the international chain of production. As soon as (1) local human resources upgrade their entrepreneurial, managerial, creative, engineering, and other skills and (2) they reach world class standards, local MNCs may emerge. Eventually, either the emerging local MNCs and, or the old subsidiaries expand toward other less developed countries starting a new corporate cycle. Moving a plant from one stage to the next usually requires improve its organization, control systems, and equipment, as well as its workers' skills.[1]

Figure 2 explains the relationship between educational policies and economic development in the Taiwanese case. The stages of economic development do not agree completely with the stages mentioned in Figure 1 because the Taiwanese case was built from a national perspective. However, Figure 2 shows as follows: 1) assembly plants started the modern industrial development of Taiwan; 2) Taiwanese corporations have become high tech corporations; 3) Taiwan is becoming a major center for international trade and investment in the Asia-Pacific region, 4) Educational policies have been ones of the tools for Taiwanese development.

As Figure 3 shows, no all developing countries have taken advantage of the GP simultaneously. The new industrial economies from South East Asia (Singapore, South Korea, Hong Kong, and Taiwan) were first. Some economies from Latin America (Mexico, Chile, Brazil, Colombia, and Argentina) started taking advantage of GP in

1 Kasra Ferdows, "Making the Most of Foreign Factories", *Harvard Business Review*, marzo-abril 1997, pp. 73-88.

Fig. 1. A Theory of Global Human Resource Demand.



Source.—The author. (This general pattern may have some variations according to specific cases).

the late 1980's. Similarly, other developing countries from South East Asia (India, Malaysia, China, Indonesia, the Philippines, Vietnam, and Thailand) are now being incorporated to the same process as well as the former communist countries.

After decades of resistance against direct foreign investment, many developing nations now seem to be comfortable with it. The GP appears to help governments

Fig. 2. Educational policies and economic development. The Case of Taiwan.

Educational Policy					
-Higher education keeps expanding. -Adjust curriculum in high schools and vocational schools. -Establish technology-oriented four-year college. -Improve educational equality.					1990-93 Skills required: professional mastering foreign languages, finance, transportation, communication, electronic information, technology, and international management.
-Extend compulsory education to 12 years for vocational high school. -Higher & graduate education expands too				1980-89	
-A four-year college-National Institute of Technology begins			1974		
-Vocational education expanded		1970s			
-Compulsory education extended to nine years	1968				
	-Export processing zones	-From exporting agriculture products to export industrial good	Infrastructure. Shipbuilding, steel, petrochemicals, power generation & transportation.	Economic liberalization & technology-oriented development	Toward being an Asia-Pacific trade & investment operation center
	Stages of Economic Development				

Source.—Center for International Private Enterprise (1996).

to reduce unemployment (there are more than 800 million unemployed people in the world[2]). Similarly, GP seems to give MNCs the competitive advantage they need to increase profits. To reduce unemployment many governments are trying to take advantage of the GP openly. They are competing each other to attract jobs from the global economy. They are implementing policies to facilitate the operations of MNCs

2 See International Labor Organization, press release, ILO, Washington, D. C., 6 March 1994; International Labor Organization, *The World Employment Situation, Trends and Prospects,* ILO, Geneva, Switzerland, 1994.

Fig. 3. The decentralization of production processes among countries (assembly, manufacture, and R&D). A base of the TGHRD.

Source.—The author.

in local settings. In fact, some social researchers have started comparative studies to figure out the policies governments implement to attract MNCs.[3]

Other researchers and institutions have realized that competition for world's jobs is becoming competition between educational systems.[4] They are comparing educational systems to know which of them are doing better and why.[5] In a world of trade agreements that tie governments' hands regarding many economic decisions,[6] educational policies are becoming more important than ever before.

In conclusion, the GP is generating a human resource demand in developing countries and educational research and policy is making the difference. Skill demand is related to the technical production processes that are decentralized from developed to developing countries. As it will be seen next, skill demand is also related to (1) the changing production systems used by MNCs world wide and (2) the implications of the product life cycle.

Changing production systems and skills[7]

TNCs seem to be using the new production systems in developing countries among other regions of the globe. The new production systems require new worker skills.

3 David Bailey, George Harte, and Roger Sugden, *Transnationals and Governments. Recent policies in Japan, France, Germany, the United States and Britain*, Routledge, London, 1994.
4 *The Economist*, 29 March 1997, p. 15.
5 *Ibid*., p. 16.
6 Jeremy Rifkin, *The End of Work. The Decline of the Global Labor Force and the Dawn of the Post-Market Era,* G. P. Putnam's Sons, New York, p. 237.
7 For a more detailed analysis of the relationship between production systems and skills, see Romero-Morett, M. G. *Education & the new productive skills for global competition. The Mexican case*, Ph.D. diss., SUNY, Buffalo, NY, 1997.

Team work, multicultural skills, solving problem skills, listening and communication skills, worker's empowerment, self supervisory and self managerial skills are among the new competencies demanded by the new production systems. Even international agencies are trying to disseminate the new managerial techniques related to the new production systems. The new managerial techniques, as opposed to the traditional system called Fordism - Taylorism (Scientific Management), include strategic management, just-in-time-production, total quality management, teamwork, managerial decentralization, numerically flexible labour force, and functionally flexible labor force. These production systems are called High Production Systems (HPPS).[8]

Kaplinsky & Posthuma[9] concluded that Japanese manufacturing methods are expanding toward Latin American business and they are now part of the managerial language. MacDuffie & Krafcik[10] explain that some skills are related to the new production systems. For example, in the Just-in-time production systems workers have to be able to identify quality problems as they appear on the line because there is almost no stock of surplus parts and very little space to put vehicles needing repair. Managerial decentralization, which is another characteristic of the new production system, require for workers to solve problems by themselves or in groups. Therefore, they need to master analytical skills to identify the root cause of problems.

Table 1 explains, first that production systems and skills are related each other. Second, it describes that some production systems requires more and different skills than others. For example, while Fordism production system demands very narrowly skilled workers, Toyotism production system requires multi-skilled, polyvalent workers operate in teams. It is not only that Toyotism demands more skills for workers today, it requires different skills too. For example, it demands skills that were exclusively required for managers in the past.

Changing product life cycle and skill demand

Table 2 explains how skills and the product life-cycle theory are related each other because corporations need different human skills at different moments of the product life-cycle. According to this theory, the product life has the following phases—new, growth, and mature. For the new phase scientific and engineering skills are highly important, managerial skills are moderately important, and semi-skilled and unskilled labor is lowly important. For the growth phase, managerial skills are highly important, scientific and engineering skills are moderately important, and semi-skilled and unskilled labor is moderately important. Finally, for the mature phase, semi-skilled and unskilled labor is highly important, scientific, engineering, and managerial skills are lowly important.

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8 M. Waters, *Globalization*, Routledge, London, 1995.

9 R. Kaplinsky, and A. Posthuma, *Easternization. The Spread of Japanese Management Techniques to Developing Countries,* Frank Cass, England, 1994, p. 141.

10 J. P. MacDuffie, and J. K. Krafcik, "Integrating Technology and Human Resources for High-Performance Manufacturing: Evidence from the International Auto Industry," In *Transforming Organizations,* edited by T. A. Kochan and M. Useem, Oxford University Press, New York, 1992.

Table 1. The Relation Between Production Systems and Skills.

Production Systems	Characteristics Production Systems	Characteristics Human resource demand.
Craft production	Simple, but flexible tools and equipment using unstandardized components.	Highly skilled workers in most aspects of production.
Fordism-Taylorism (Mass production)	Complex, but rigid, single-purpose machinery using standardized components. Heavy time and cost penalty involved in switching to new products.	Very narrowly skilled professional workers design products but production itself performed by unskilled/ semi-skilled interchangeable workers. Each perform a very simple task repetitively and in a predefined time and sequence.
Toyotism (Lean production)	Highly flexible method of production using modular component systems. Relative easy to switch to new products.	Multi-skilled, polyvalent workers operate in teams. Responsibilities include several manufacturing operations plus responsibility for simple maintenance and repair.

Source: Adapted from P. Dicken, Global Shift. The internationalization of economic activity. 2d ed., The Guilford Press, New York, 1992.

Table 2. The relationship between product cycle and skill demand.

Skills demanded	Product cycle phase		
	New	Growth	Mature
Managerial skills	Moderate importance	High importance	Low importance
Scientific and engineering skills	High importance	Moderate importance	Low importance
Semi-skilled and unskilled labor	Low importance	Moderate importance	High importance

Source.—S. Hirsch, "The United States electronics industry in international trade," In L. T. Wells, *The Product Life Cycle and International Trade*, Harvard Business School, Boston, 1972, pp. 39-54, Chart 1, p. 41.

However, competitive market pressures and changing market demand are shortening product life. In other words, new products are either introduced or improved faster now than before.[11] As a result, continual improvement is needed and creative and innovative skills demanded.

11 Marshall L. Fisher, "What Is the Right Supply Chain for Your Product?", *Harvard Business Review*, March-April, 1997, pp. 105-116.

Conclusion

As a conclusion Table 2 shows some of the implications for comparative education, research, and policies of the TGHRD. Research implications are, for example, to investigate the skills that workers need in order to do and to improve the production processes and the production systems they perform and use. Similarly, policy implications are, for example, how governments and corporations working together may improve

Table 2. The TGHRD and some implications for comparative research and policy.

Skills related to…	Skills related to..	Implications for research	Implications for policies
Production processes	Assembly Manufacture R&D	-Do different educational policies have placed countries at a different stage of development? -What are the skills that can make countries & corporations succeed in their current stage of development? -What are the skills needed by countries and corporations to upgrade their current stage of development?	-How can governments and corporations improve the teaching of the skills needed to upgrade their current stage of development? -Should Third World technical schools still focus on old type occupations exclusively? -Should Third World technical schools focus on production processes instead?
Production systems	Fordism, Toyotism, Lean Production, High performance production systems…	-Are different skills related to different production systems? -What are the skills that workers need to master the most productive production systems?	-Should Third World technical school focus on skills related to production systems too? -Should the teaching of production systems related skills be part of corporate training exclusively? -How can governments and corporations improve the teaching of the skills related to the most productive production systems?
Product life cycles.	Short, large,	-What are the skills that workers need to enhance their innovative capabilities?	-How can schools and corporations enhance students' and workers' innovative capabilities?

Source: The author.

the skills workers demand to perform well the production processes they do and the production systems they use.

A Theory of Global Human Resource Demand Explained

The GP is now a source for corporations to obtain competitive advantage. In this sense, globalization is no longer just a trend to develop markets all over the world, it is a significant means for MNCs to obtain competitive advantage.[12] Similarly, superior manufacturers now considered that a foreign factory can be a potent strategic asset.[13] Similarly, it has been suggested that MNCs no longer exhibit any important loyalty to any particular national government for all practical purposes. Instead, MNCs have become (or are in the process of becoming) entities unto themselves, dependent only on being assured of a continual supply of highly skilled, technically well trained professionals and technicians.[14]

The need for profits and for gaining a competitive advantage among competitors drives MNCs to move offshore production processes and to use cheap labor from developing countries. At first, MNCs move offshore routine production processes and demand human resources having basic skills. For example, Hewlett-Packard's factory in Singapore was built in 1970 to produce simple labor intensive components at a low cost. It is now one of HP's global centers for the design, development, and manufacture of a number of critical products and components, including keyboards and inkjet printers.[15] Similarly, MNCs that started operating in Malaysia demanded, first, a large number of unskilled workers who were mostly manageable women. They were sought for their manual dexterity and 'docile' personalities. Little training was necessary as these tasks could be learned in less than two weeks.[16] Similarly, at a first stage MNCs operating in Mexico were exclusively involve in routine jobs and demanded workers having no more than basic skills. They were engaged in assembly work. They involved labor-intensive operations exclusively. They used low tech equipment. They used blue collar workers up to 98 percent of the labor force. All manager, engineers, and trouble-shooting technicians were Americans sent from the parent companies in the

12 J. C. Guez, "Systems integration for the international company," In *Information technology in a global business environment*, edited by C. Deans and J. Jurison, Boyd & Fraser Publishing Company, Danvers, Ma., 1996.

13 Kasra Ferdows, op. cit., p. 88.

14 R. B. Reich, *The Work of Nations: Preparing ourselves for 21st. Century,* Vintage Books, New York, 1992.

15 Ferdows, *op. cit.*

16 See V. Lin, "Women electronics workers in Southeast Asia: the emergence of a working class," In *Global restructuring and territorial development*, edited by J. Henderson and M. Castells, Sage, London, 1987; J. Ariffin, "Industrialization, female labour migration, and the changing pattern of Malay women's labour force participation -an analysis of interrelationships and implications," Paper presented at the Seminar on Population and Sectoral Development, Cameron Highlands, Malaysia, 2-5 January, 1981.

United States to run the plants on the border. About 90 to 95 percent of direct labor were single females with very low educational backgrounds.[17]

Further, the International Business Machine at Guadalajara plant (IBMG) started by rebuilding electric typewriters 25 years ago and demanding low skill workers mostly. Even today IBMG makes routine production processes that require one professional per 15 blue collar workers. The same is true for the Hewlett Packard plant at Guadalajara, Mexico which just started doing assembly work of computers according to Roberto Gonzalez, R&D project manager.[18] Even, local suppliers which are doing production processes for IBMG may employ one engineer per 20 blue collar workers.[19]

Over time MNCs operating in developing countries change in terms of the technology they use, the human skills they demand, and the production processes they make. For example, Pang, and Lim[20] show that MNCs, by introducing high tech industries in the Asian NICs, conformed a strong demand for mostly male scientists, engineers and technicians, as well as for unskilled or semi-skilled female production operators who are primarily machine-tenders. Moreover, they say that the supply of scientists, engineers and technicians have increased as a result of the different kinds of production processes that have been introducing over time, from the assembly line to high tech product design, while the demand for unskilled female workers have declined, both in absolute and relative terms.

Pang, and Lim[21] have also shown that high tech industry has clearly increased the skills and technological capacity of the local labor force in the NICs. Unskilled workers, for example, have progressed from simple manual operations to tending of sophisticated computerized machinery and equipment, for which literacy and "numeracy" are more important. More skilled jobs have been created and scientific and technical personnel trained.

From the Henderson's (1989) study,[22] which analyses some determinants that have made Hong Kong a regional "core" of semiconductor production, it is possible to conclude that both processes—upgrading human skills and upgrading production processes—are related. For instance, he mentioned three reasons which allowed Hong Kong becoming the regional "core" of semiconductor production. First, the ability of Hong Kong to deliver highly skilled technical and engineering labor force at a cost far below that in developed countries. Second, the availability of skilled manpower, and third, the capability of the Hong Kong education system to provide high quality engineers and technicians who are the sine qua non of advanced testing facilities and

17 E. George, "What Does the Future Hold for the Maquiladora Industry?", In *The Maquiladora Industry: Economic Solution or Problem?*, edited by K. Fatemi, Praeger, New York, 1990.
18 Roberto González, Interview with the author, 1996.
19 Alfonso Alva, Interview with the author, 1996.
20 E. F. Pang, and L. Y. C. Lim, "High tech and labour in the Asian NICs," *Labor and Society* 14, 1989, pp. 43-58.
21 *Ibid*.
22 J. Henderson, "Labour and state policy in the technological development of the Hong Kong electronics industry," *Labour and Society* 14, 1989.

design centers. In other words, because Hong Kong upgraded its manpower capabilities, the US semiconductor firms have upgraded their operations there.

Also MNCs are evolving in South East developing countries. According to the Salih, and Young's (1989) study[23] on MNCs operating in Malaysia, in a second stage chips became more complicated and the technical equipment as well. Then, young women who have completed at least basic secondary schooling were preferred. Dexterity was increasingly being replaced with judgmental skills and sophisticated competencies to deal with the machines. Further, there was a change in the overall structure of employment by occupational and skills categories. There was a trend toward declining direct labor, and more absorption of skilled labor, especially of technicians and engineers.

MNCs operating in Mexico are having similar evolution. For example, George[24] found that in 1988 maquilas in Juarez and Chihuahua had changed. The labor force was different almost all technicians and engineers were Mexican, along with an increasing number of managers. He also identified what he called second-generation of MNCs' subsidiaries, which 'extended the old dimension of routine assembly of mature products to attempting state-of-the art production.

Similarly, the level of skills demanded by MNCs operating in Mexico has been increasing for both direct (blue collar) and indirect (white collar) workers. For example, The proportion of "technical workers", comprised of technicians and engineers, represented 8 per cent of the MNCs subsidiaries workforce in 1979 and 13 per cent in 1988. In the largest Mexican industrial park for assembly plants, which is operated in Cd. Juarez by Grupo Bermudez, the proportion of total employment of technical workers was 26 per cent in 1988.[25]

The adoption of new automated technologies is driven a change in MNCs operating in Mexico. In 1986, a study found that 11 out 35 MNC's subsidiaries in the electronics industry were using programmable equipment.[26] In 1987, Dominguez-Villalobos[27] interviewed 20 large electronic, electrical and automotive plants in Cd. Juarez that accounted for about a quarter of the MNC subsidiaries' employment in that city. Twelve of the plants used a total of 286 micro-electronic machines, about half of which were robots (mainly for assembling electronic components). Computer numerical controlled machines were employed for a variety of activities, including molding, welding, plastic forming and programming.

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23 K., Salih, and M. L. Young, "Changing conditions of labour in the semiconductor industry in Malaysia," *Labour and Society* 14, 1989.

24 George, *op. cit.*, p. 224.

25 N. A. Fuentes, Tito Alegria, Jeffery T. Brannon, Dilmus D. James, and G. William Lucker, "Local sourcing and indirect employment: Multinational enterprises in northern Mexico," *Multinationals and Employment. The Global Economy of the 1990s,* edited by P. Bailey, A. Parisotto, and G. Renshaw International Labour Office, Geneva, 1993.

26 L. Palomares, and L. Mertens, "El surgimiento de un nuevo tipo de trabajador en la industria de alta tecnología: El caso de la electrónica," [The emergence of a new type of worker in the high tech industry: The case of electronics industry]. Análisis Económico, vol. 6, núm. 10, 1987, pp. 31-53.

27 Lilia Dominguez-Villalobos, *Microelectronics-based innovations and employment in Mexico,* World Employment Programme Research, Working Paper No. 208, ILO, Geneva, 1988.

The trend towards more automatization leads to increasing reliance on technicians and engineers in Mexico. Dominguez-Villalobos[28] reports that from 1984 to 1986, employment of engineers increased by 33.2 per cent for eight firms using microelectronic innovations, compared to 3.5 per cent for 12 non-using firms.

Gereffi[29] also explains that MNC's subsidiaries operating in Mexico have changed. He says that there is a vast difference between the subsidiaries export plants along the Mexico-U.S. and the new capital- and technology-intensive firms in the automobile and computer industries that are located further inland in Mexico's northern states. These latter factories use relatively advanced technologies to produce high-quality exports, including components and subassemblies like automotive engines. They pay better wages, hire larger percentages of skilled male workers, and use more domestic inputs that the traditional maquiladora plants that combine minimum wages with piecework and hire mostly unskilled women.

In a third stage, MNCs demand services and semi finished products locally. As results, MNC's activity generates a demand for human resource having business and entrepreneurial skills. For instance, Pang, and Lim[30] affirm that people from Hong Kong, Singapore and Taiwan, who have experienced scientific or managerial personnel employed in foreign-owned high tech firms, have often left them to establish their own successful high tech companies generating a new group of local entrepreneurs.

Pang, and Lim[31] also show that upgraded skills have fostered the economic development of the Asian NICs in several ways. First, scientist and engineers, trained in US institutions have created high tech enterprises that export products to other countries. They have succeeded in a growing number of industries, including high value-added consumer electronics, automobiles, and semiconductors. Second, the upgrading of human skills has allowed the development of high tech companies in Singapore and Hong Kong. Moreover, the same authors affirm that competencies have been a key factor of the Asian NIC's development. For instance, they say that regional growing pool of scientific and engineering manpower has been critical for the success of the computer industry in Taiwan. Scientists and engineers have made it possible for domestically as well as for foreign-owned firms to absorb and adapt new technologies rapidly. More recently, Taiwanese firms have begun to move away from making copies of foreign computers and parts using standard technologies to develop and design new high tech products including customized chips and image scanners.

Similar cases are occurring in Guadalajara. IBMG has developed managerial and entrepreneurial skills locally by developing local providers. IBMG transfers technology and know how to local business to become their local suppliers. Over time they have become suppliers of other MNCs in the same electronics industry of Guadalajara.[32]

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28 *Ibid*.

29 G. Gereffi, "The 'Old' and the 'New' Maquiladora Industries in Mexico. What Is Their Contribution to National Development and North American Integration?" Nuestra Economía, vol. 2, núm. 8, May-August 1991, pp. 39-63.

30 Pang, and Lim, *op. cit*.

31 *Ibid*.

32 Luis Toussaint, Interview with the author, 5 May 1996.

In a fourth stage, MNCs create headquarters in developing countries and demand human resources having managerial and other related skills. For example, Salih, and Young[33] affirm that the availability of highly skilled and comparatively cheap technical personnel in Malaysia is an important consideration in MNCs decisions to remain in Penang. Similarly, the high skilled people of Malaysia have allowed decentralization of management control away from head offices in developed countries. Such a trend suggests that in the near future, the MNCs decision making process will not remain in the core economies only. Similarly, Chen[34] (1987) points out that one factor of MNCs decentralization from developed countries is that very often developing nations provide facilities and national technological infrastructure which is upgraded in terms of education, training of engineers and technicians, as well as in terms of higher learning and scientific institutions, and telecommunications and transporting infrastructure.

Similarly, some MNCs placed in Guadalajara perform as decentralized headquarters. As explained by Roberto Gonzalez,[35] a HPG R&D project manager, HPG now has its own business portfolio and has to succeed worldwide in order to survive. In this sense, HPG needs to find business opportunities and market niches to increase its profitability level. HPG investigates customers' needs by doing market research. It studies the technical viability of new products and services, analyzes technical risks, makes cost-benefit analyses, and anticipates the value added of new products and service.

In a fifth stage, MNCs create research and development centers in developing countries and demand human resources having creativity and engineering skills. As a result, innovation also takes place in MNCs operating in developing countries. Recently, Mexican workers have moved from doing world class autos to develop R&D work. For example, Baker[36] informs that Mireya Ruiz, 27, is developing software for IBM in Guadalajara. Her husband, Jorge Ramos, also a programmer, works there, too. Jobs like hers pay high wages for Mexico.

In addition, HP has built a R&D facility in Guadalajara and other companies are following its example. Evolution of HPG from pure manufacturing to hardware design makes HP executives think that computer design will be a "commodity" soon as manufacturing is a "commodity" today.[37] Hewlett-Packard Company's factory is Guadalajara, Mexico, not only assembles computers but also designs computer memory boards.[38] Similarly, General Electric in a join venture with Mabe de Mexico created a new R&D center that stands as a monument to GE's big bet on Mexico. Nearly half of its 148 researchers and engineers have studied at GE's Louisville center. Its research team bristles with advanced degrees, and two-thirds of the researchers are 30

33 Salih, and Young, *op. cit*.
34 E. K. Y. Chen, *Industrial development, foreign direct investment and economic cooperation: A study of the electronics industry in the Asian Pacific,* Paper presented at the Seminar on Economic Cooperation through Foreign Investment among Asian and Pacific Countries, Bangkok, 19-22 May 1987.
35 Roberto Gonzalez, Interview with the author, 6 May 1996.
36 S. Baker, "The Mexican worker," *Business Week*, 16 Oct. 1989, pp. 84-92.
37 R. Gonzalez, and V. de La Mora, *Evolución de HP en México* [Evolution of HP in Mexico], Paper presented at the First Conference of the Electronics Industry, Puerto Vallarta, Mexico, July 1996.
38 Ferdows, *op. cit*., p. 74.

or younger.[39] This is a $7 million research and development center built in Queretaro. With its state-of-art technology and top-notch research, this is the kind of projects that proof that Mexican manufacturers can compete at the highest levels and that NAFTA can work.[40]

Further, Ferdows[41] affirms that 3M's operations in Bangalore, India manufacture and design software. Motorola's workers in Singapore designed and manufactured two popular pagers. And two of the most innovative Alcatel Bell's factories are located in Shanghai.

Over time, MNCs operating in developing countries specializes in some world wide production processes in the areas of assembly, manufacturing and R&D and become an important link within the international chain of production. According to Luis Toussaint,[42] IBM Guadalajara's Human Resources Manager, IBMG have specialized in the manufacturing of both software and actuators (devise that read information from computers hard drives). Actuators can only be produced in pure rooms which are 500 hundred times cleaner than any surgery room. This year IBMG is going to have the largest clean room in the world built at a cost of US$69 million dollars. IBMG also specializes in manufacturing desktop and laptop computers as well as software for other corporations. It can produce and ship software any where in the world in less than 24 hours. IBMG also advises other IBM plants regarding the production processes it masters. For example, other IBM plants consult IBMG regarding operative software and IBMG also sells consulting services related to computer uses for manufacture processing.

HP's factory in Singapore, which started producing simple labor intensive components at a low cost, has acquired considerable expertise and has specialized as a HP's global center for the design, development, and manufacture of portable printers for markets worldwide.[43] Ferdows affirms that foreign plants specialization is good for a MNC's strategy[44] but it is also good for foreign factory's survival.

As local human resources upgrade their entrepreneurial, managerial, creativity, and engineering skills to the point to reach world class standards, local MNCs may emerge. Eventually, either the emerging local MNCs or/and the old MNC's subsidiaries operating in developing countries expand toward other less developed countries starting a new corporate cycle. Pang, and Lim[45] registered that both foreign and local high tech firms in the Asian NIC's have adjusted to rising market wages by relocating labor-intensive operations to neighboring low-wage countries (e.g., Thailand, Malaysia, the Philippines, China), while keeping for them the better paid jobs that requires

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39 T. Smart, P. Engardio, and G. Smith, "GE's Brave New World," *Business Week*, 8 Nov. 1993, pp. 64-70.
40 Smart *et al*., *op. cit.*
41 Ferdows, *op. cit*., p. 74.
42 Toussaint, *op. cit*.
43 Ferdows, *op. cit*., p. 73.
44 *Ibid*., p. 87.
45 Pang, and Lim, *op. cit*.

upgraded skills to make research and design activities. For example, HP's factory in Singapore increased its profits and competitiveness by developing a pool of Asian suppliers.[46]

There is much evidence regarding decentralization of high technology production processes from developed countries to the Asian NICS and from these countries to the less developed nations in the Southeast Asia. About this regard, Castells[47] affirms that the process of high tech production process decentralization has gone beyond the Asian NICS to the other economies in the Southeast Asia fostering the regional economic development. There is also much evidence that proves that this kind of decentralization has been caused by the upgrading of people's skills through education and training.

Implications for Research and Policy

It has been a government task to set policies to support national economic development. However, state policies set by national governments have been loosing strength as a result of international trade agreements. For example, many monetary and fiscal policies are already set in international trade agreements such as NAFTA and the Masdrich European Community Agreement. Worse, state policies are also loosing ground as a result of national economies exposure to international economic fluctuations. In short, in the context of today's global economy few state policies are able to affect local economic development as they did before. One of them is educational policy. Therefore, government educational policies should be supporting the following concerns.

Human resource in corporations

Nations should be aware of the importance of human resources for local corporations to get further stages of development. Researchers may want to investigate the stage of development of every local industry using the TGHRD as framework. In this way, researchers will determine what industries are either in the assembly, manufacture or R&D stage. Then, researchers may want to speculate how human resource demand will growth on the following bases. First, what industries will be upgraded to the next stage. Second, what industries will be downgraded. Third, what industries will remain and growth in the same stage. Educational policy should be set accordingly current and future human resource demand.

46 Ferdows, *op. cit.*, p. 81.
47 M. Castells, "The internationalization of the economy and the current technological revolution," *Labour and Society* 14, 1989.

Human Resource. The New Wealth of Nations

Nations are also more aware of the importance of having skillful human resources to improve attract jobs from the global economy. Similarly, access to skillful human resource has become more important for MNCs' location than access to any other type of resources. Researchers may want to develop a regional geography of national human resources, including their skills, their costs, their productivity, training and educational centers, and R&D facilities. An inventory as such will be an invaluable resource for MNCs to settle down plants locally.

Focus

Researchers may want to compare the skill supply and demand between technical schools, colleges, and universities on the one side and MNCs on the other side. They may also want to compare skill demand between both MNCs and local business. Finally, they may want to compare the skill demand from specific types of workers, production processes, production cycles, and production systems.

Instruments

Further research may also focus on developing new research instruments. New research instruments may improve the assessment of skill supply and demand. New research instruments may include standardized questionnaires, interviews, and tests. These tests should be able to measure different types of skills, such as competencies related to specific types of workers, production processes, production cycles, and production systems.

Skills

Publications of books, journals, and articles related to skills and competencies are growing quickly. They include new skill frameworks, new skill paradigms, and new skill lists. Some of them are based on organizational theory while other skill classifications have diverse foundations. However, few of them have a scientific base. Future researchers may want to study scientifically the theoretic foundations of skill classification to provide a consist framework to understand what a skill is and why it is demanded.

Skill teaching and training

Teaching skills is not the same as teaching content. Teaching skills for the new workplace is different from teaching other kinds of knowledge. Therefore, future researchers may want to investigate specific techniques to teach and train the new productive skills demanded by the modern corporation. Skill based education also has implica-

tion for curriculum theory. Researchers may also want to investigate how to develop academic programs based on skills development rather than content learning. Further, researchers may want to investigate what and why some skills are best taught at both schools and corporations.

The GP has both a kind of centrifugal force and a kind of centripetal force. The same forces that are driven a *complete* GP are driven the centripetal one. Others have realize that job competition for world's jobs is becoming competition between educational systems. This change is because MNCs are becoming important sources of employment, technology and skills.