Transnational Corporations as Educational Institutions for National Development: The Contrasting Cases of Mexico and South Korea

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Economic development in South Korea, Singapore, Hong Kong, Taiwan, and Ireland has accelerated dramatically since the 1960s, as it has in China more recently. These areas share a common element in their development strategies—the aggressive pursuit, acquisition, and incorporation of knowledge from industrialized nations. In this article, I argue that, when situated in a less developed country (LDC), the higher-tech transnational corporations (TNCs) knowingly and unknowingly function like educational institutions by transferring knowledge and technical expertise to national institutions, including domestic industries, universities, and public schools. This transfer can, and sometimes does, drive the country up learning and development curves. But, the acquisition of foreign industrial knowledge by an LDC is not automatic. Rather, it must be pursued consciously and tenaciously. It must be integrated into a strategy of national development that is supported by the collaborative actions of government, school systems, and domestic industry. Based on the potential of TNC knowledge transfer, some LDCs pursue such knowledge and integrate it into development strategies more effectively than others.

The TNCs' offshore, technology-driven manufacturing plants in LDCs play major roles in the distribution of intellectual capital that is like the DNA of growth and development in the "new economy." The Organization for Economic Cooperation and Development (OECD) points out that "fostering the production and diffusion of scientific and technical knowledge has thus become crucial to ensuring the sustainable growth of national economies in a context of increased competition and globalization and the transition to a more knowledge-based economy."[1] Today, the acquisition of intellectual

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[1] Organization for Economic Cooperation and Development (OECD), *Science, Technology, and Industrial Outlook* (Paris: OECD, 2002), 23.

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capital, if managed properly, becomes what Peter Meso and Robert Smith call "the only strategic asset."[2]

In order to attract TNCs seeking cheap labor and easy access to world markets, many LDCs have established export processing zones (EPZs) or industrial parks with incentives, such as free land, subsidized electricity, tax holidays, convenient transportation (railroads and ports), and minimized paperwork delays. Approximately 3,000 EPZs (up from 500 in 1995) have now been established in 116 countries (up from 73 in 1995), employing 43 million workers (30 million in China alone).[3] The research presented in this article will be relevant to many developing countries, particularly those in Central America and Eastern Europe that are beginning to receive substantial amounts of foreign direct investment (FDI) and outsourced jobs from industrialized nations.

Five Conceptual Assumptions about Development

First, a distinction between growth and development needs to be made. Growth signifies "more of something," while development signifies the "betterment of something." For example, it is quite possible to have growth in the number of schools, books, and teachers or in the number of factories, machines, and jobs but still generate no qualitative improvement in the education system or the economy. However, development signifies qualitatively better schools, books, and teachers or better factories, machines, and jobs that collectively improve the quality of life.[4]

Second, knowledge is the meaning and understanding of specific information attached to and accepted by a particular community of learners, such as engineers or fishermen. Third, knowledge transfer, whether rendered by schools, community organizations, or industries, is at the core of education. Thus, schooling is only one source of education.

Fourth, LDCs possess both a knowledge-driven learning curve and a development curve, with the former (given facilitating conditions) leading the latter. The connection between the two is vital to understand, as the OECD reminds us: "Claims that a technological leap would enable a society to bypass certain stages in the development of knowledge infrastructures should be taken with a pinch of salt."[5]

Fifth, knowledge-driven learning can come in different forms: personal (e.g., going to school or technical training), organizational (e.g., cumulative

[2] Peter Meso and Robert Smith, "A Resource-Based View of Organizational Knowledge Management Systems," *Journal of Knowledge Management* 4, no. 3 (2000): 224–34.

[3] International Labour Office (ILO), *Employment and Social Policy in Respect of Export Processing Zones (EPZs)* (Geneva: ILO, 2003), 2.

[4] Peter Drucker, "The New Society of Organizations," *Harvard Business Review* 70, no. 5 (September–October 1992): 95–104.

[5] Center for Educational Research and Innovation, *Innovation in the Knowledge Economy: Implications for Education and Learning* (Paris: OECD, 2004), 28.

technological upgrading in a company), or national.[6] At the national level, a country learns as its body of core knowledge is enriched and deepened by streams of new knowledge that are absorbed and diffused by its own interacting institutions (e.g., universities, industries, R & D centers, and public schools). National user networks of various types are free and motivated to adapt the evolving core body of knowledge to their own uses and add their own innovations and discoveries, thus advancing the core even more.[7]

Research Questions

Two research questions drive this article. First, regarding LDCs, to what extent and by what means is knowledge (e.g., technical expertise, job skills, management techniques, and production methods) transferred from TNCs to national institutions (e.g., domestic industries, universities, public schools, and government agencies)? Second, how do recipient countries use the acquired knowledge to move up national learning and development curves toward national development goals?[8] Comparing the cases of South Korea and Mexico allows us to address these two questions.

A Reversal of Economic Fortunes: Korea and Mexico

For much of the early twentieth century, the political, economic, and educational history of Korea was wracked with turbulence and tragedy. At the end of World War II, 36 years of Japanese colonial rule ended, but the residue of the inflicted damage was everywhere. The majority of the population of 25 million was illiterate, the impoverished educational system had produced few workers with any degree of technological sophistication, and the only manufacturing experience had been in firms under the control of the Japanese.

By 1954, still trying to extract itself from the rubble of civil war, the government of South Korea (the Republic of Korea) spent only 0.1 percent of national income on education, considerably behind nations such as India (1.9 percent), Iraq (2.4 percent), the Philippines (2.4 percent), Burma (2.5 percent), the United States (4.0 percent), Japan (6.1 percent), and Mexico (1.0 percent). Of the nation's youth, 54 percent of elementary- and 36 percent of secondary-school-age students were actually enrolled.[9]

[6] For a discussion of organizational learning in the maquiladora industry, see Jorge Carillo and Alfredo Hualde, "Third Generation Maquiladoras? The Delphi–General Motors Case," *Journal of Borderlands Studies* 13, no. 1 (Spring 1998): 79–97.

[7] W. Mark Fruin, *Knowledge Works: Managing Intellectual Capital at Toshiba* (Oxford: Oxford University Press, 1997).

[8] Over a 2-year period, I made numerous trips to various parts of Mexico, gathering published reports and conducting extensive interviews with maquiladora managers, government officials, and Mexican scholars. Five Mexican graduate students also conducted numerous interviews for this project. The information on the Republic of Korea was drawn from a rich literature on the subject.

[9] UNESCO, *Statistical Yearbook, 1963* (Paris: United Nations, 1964), 286–89.

Leading up to the 1960s, Mexico (United States of Mexico) had its own collection of profound educational and economic problems. Its 2,000 mile northern border with the United States had always been a problem for Mexico, because the families streaming up from the interior overwhelmed the capacity of the municipalities to provide jobs, as well as education, health care, housing, and other forms of basic services. With a population of 30 million in the mid-1950s, the illiteracy rate approached 40 percent, and 45 percent of primary- and only 6 percent of secondary-school-age students were enrolled in school.[10] The traditional unemployment problem became acute on the border when the U.S. government in 1964 terminated the Braceros program, leaving some 200,000 fieldworkers unemployed who had previously migrated within the United States during picking seasons.

Figures 1 and 2 profile a dramatic reversal of fortunes that took place over a 40-year period for South Korea and Mexico. In 1960 the gross domestic product (GDP) in South Korea was US$33.1 billion, and the GDP per capita was US$1,300. In Mexico that same year the economic conditions were somewhat better with a GDP of US$60.5 billion and a GDP per capita of US$1,600.[11] By the turn of the century, the economic numbers reveal that Korea was

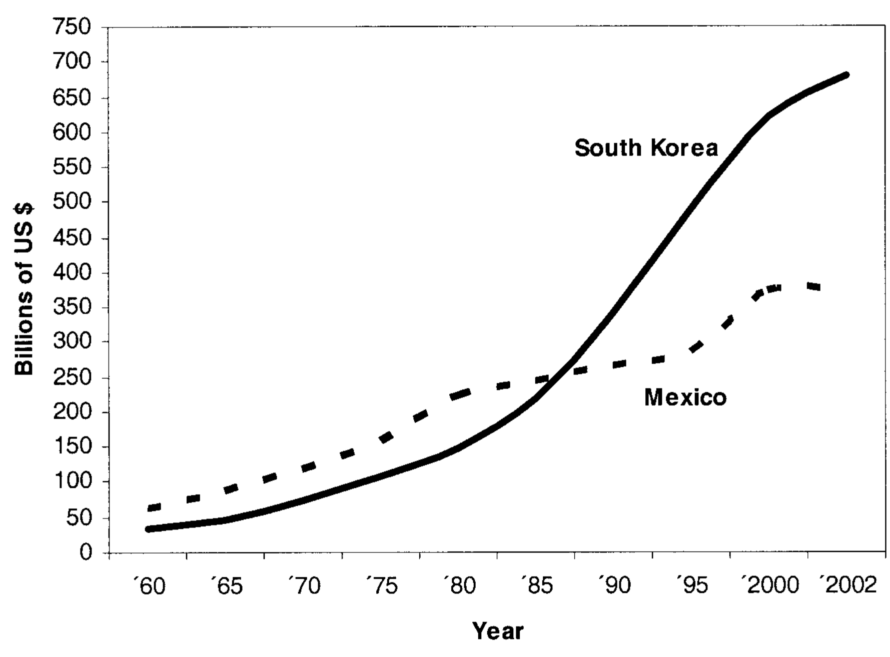

FIG. 1.—The GDP in constant 1995 U.S. dollars. Source: World Bank, *World Development Indicators* (Washington, DC: World Bank, 2004), CD-ROM.

[10] UNESCO, *Statistical Yearbook, 1963*, 14, 101.

[11] Gross domestic product is the total output of goods and services produced by a nation in a given year; GDP per capita is the GDP divided by a nation's total population.

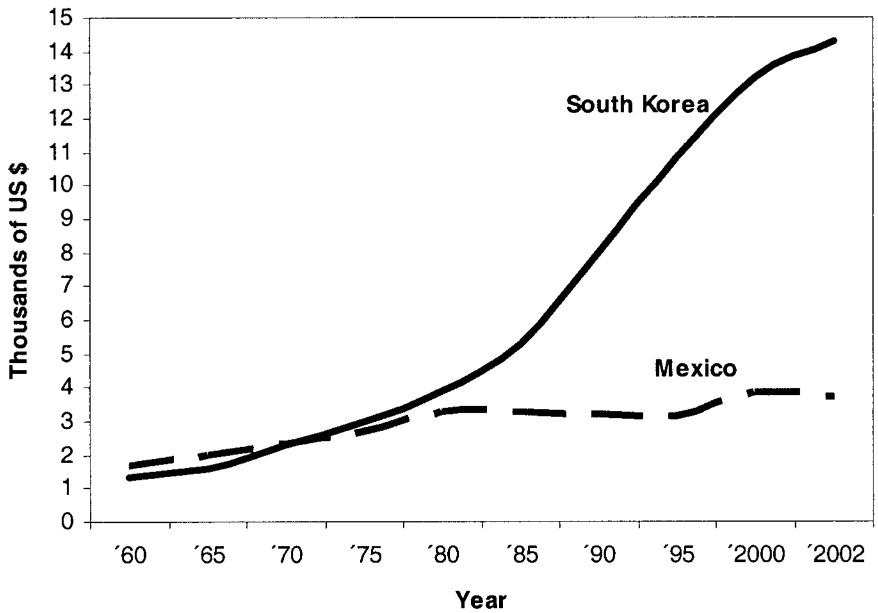

FIG. 2.—The GDP per capita in constant 1995 U.S. dollars. Source: World Bank, *World Development Indicators* (Washington, DC: World Bank, 2004), CD-ROM.

exploding up the economic development curve with a GDP of US$680 billion and a GDP per capita of US$14,280. Meanwhile, Mexico's economic development curve was progressing slowly with a GDP of US$375 billion and a GDP per capita of US$3,717.[12]

Notably, one reason why Mexico's GDP per capita tails off so dramatically is due to population growth. From 1970 to 2004, Korea's population grew from 32 million to 48 million, or a total increase of 16 million. Mexico's population, by contrast, grew from 50.6 million to 104 million, or a total increase of 53.4 million.[13] Consequently, as the population expanded notably in Mexico (but not so in Korea), Mexico's wealth on a per capita basis made only limited advances. However, the strength of a nation's economic engine is measured typically by GDP, and it is by this measure that the reversal of fortune between Korea and Mexico can most clearly be seen.

Why have the fortunes of these two countries varied so dramatically when they began the decade of the 1960s afflicted by similar conditions of underdevelopment? The next section will initiate the argument that the key to development in this globalized world is the transfer of knowledge from industrialized nations to LDCs.

[12] World Bank, *World Development Indicators* (Washington, DC: World Bank, 2004), CD-ROM. The GDP data are in constant 1995 U.S. dollars. An interesting facet of this GDP comparison is that Mexico produces 175.5 million tons of oil, while Korea produces only .6 million tons (2001).

[13] OECD, *OECD in Figures: Statistics on the Member Countries* (Paris: OECD, 2005), 6–7.

Economic Infrastructure: Impacts of Knowledge Acquisition and Diffusion

Like individuals and corporations, nations have learning curves. These curves depend upon the acquisition of knowledge that supports and energizes the processes of national development. A recent World Bank report makes this point, stating that export-oriented development based on technologies introduced by foreign TNCs has proven to be feasible as well as rewarding: “The successful countries have consistently taken an active approach to integration in the world economy by upgrading the learning capacity of firms, selectively financing R & D, encouraging the licensing of foreign technologies, and extending intellectual property rights and ICT [information and communication technology] infrastructure—in short, progressively deepening and tuning up their NIS [national innovation system] rather than passively waiting for MNCs [multinational corporations] or imports to transfer technology. Thus engagement in the long process of undertaking the necessary institutional reforms needs to start early in the development process.”[14] Even though there can be many sources of new knowledge (e.g., imitation, R & D, licensing, purchasing, hiring experts, and reverse engineering), typically their entry into an LDC is shaped principally by three dominant institutions, which can be called the “development triangle.”

As seen in figure 3, governmental bodies, formal educational institutions, and TNC industries are the dominant players in the triangle, with each having various degrees of freedom. But how can the presence of the TNC industries

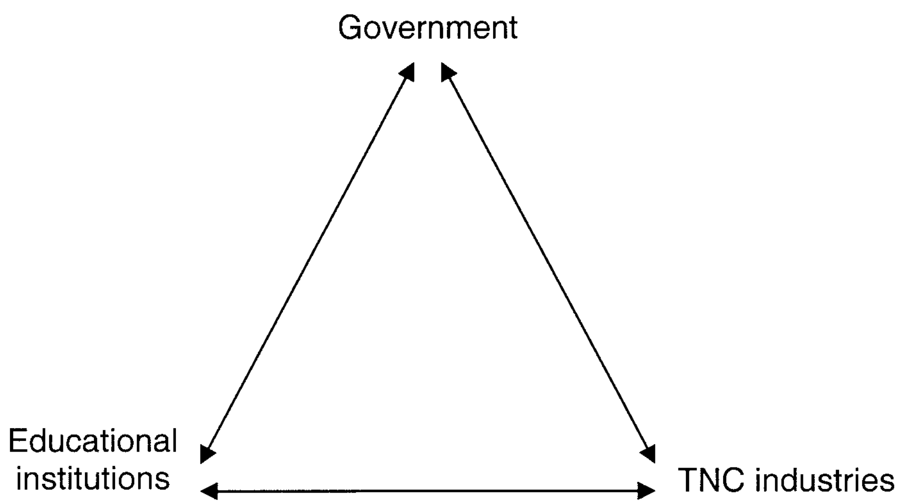

Fig. 3.—Development triangle

[14] David de Ferranti, Guillermo Perry, Indermit Gill, J. Luis Guasch, William Maloney, Carolina Sánchez-Páramo, and Norbert Schady, *Closing the Gap in Education and Technology* (Washington, DC: World Bank, 2003), 200.

be integrated into the economy as an engine of development? At one end of the policy spectrum, strong governments control the process by maximizing initiatives to shape the industrialization process, a position Korea took particularly in the early years. At the other end is a quasi-laissez-faire approach of letting the market decide, a strategy followed by Mexico. Linsu Kim points out that particularly in the early years the South Korean government played a strong and vigorous role by mobilizing its financial resources and allocating them for prioritized industrial projects that were supported by linkages with a well-balanced expansion of the educational system.[15]

Mexico's approach to integrating TNC industries into its national economy was virtually the opposite of Korea's strategy. In the mid-1960s, small groups of businessmen, with minimal government help and frequent opposition, began building privately financed industrial parks along the U.S. border as a first step to attracting TNC industries. These industries became known as maquiladoras.[16] Maquiladora, frequently shortened to "maquila," refers to plants (either foreign owned or Mexican) that assemble products for final export out of Mexico. These plants take advantage of preferential tariff laws allowing for the temporarily tax-free import of raw materials and machinery into Mexico.[17] When the assembled products are returned to the United States, the American government assesses an import tax on only the value added to the work done in Mexico.

By December of 1965, 12 maquiladoras employing 3,000 workers were established along the border. As can be seen in table 1, the growth of the maquiladora industry was extraordinary, realizing over 3,000 plants and em-

TABLE 1
Evolution of the Maquiladora Industry for Export (1975–2004)

Year	No. Maquiladoras	No. Maquiladora Personnel	Female (%)	Value Added (% of Gross Production Value)
1975	454	67,214	78.3	31.6
1980	620	119,546	77.3	30.7
1985	729	211,968	69.0	24.9
1990	1,920	446,436	60.9	25.1
1995	2,267	648,263	59.1	19.2
2000	3,590	1,285,007	55.2	20.8
2001	3,713	1,309,253	50.5	26.8
2002	3,367	1,097,117	49.8	26.2
2003	2,972	1,065,847	49.3	25.0
2004	2,805	1,060,880	48.8	23.3

Source.—Aguascalientes: Instituto Nacional de Estadistica, Geografia e Informatica, 2004.

[15] Linsu Kim, "Korea's National Innovation System in Transition," in *Technology, Learning, and Innovation: Experiences of Newly Industrializing Economies*, ed. Linsu Kim and Richard Nelson (Cambridge: Cambridge University Press, 2000), 337–43.

[16] Informative interviews with businessmen who were pioneers in developing these first industrial parks are found in *Mexiconow* 2, no. 8 (2004).

[17] Presidencia de la República, "Decreto que reforma al diverso para el fomento y operación de la industria maquiladora de exportación" (Mexico D.F., May 12, 2003).

ploying more than 1 million workers by 2002. In 2003, Mexico's US$18.4 billion in foreign-exchange revenue generated by the maquiladora industry far exceeded that of oil at US$15 billion, remittances from workers out of the country at US$13.3 billion, and tourism at US$4 billion.[18]

Technological Advancements and the Learning Curve: The Korean Case

During the mid-1960s, as wages rose in Japan and the United States, Korea began offering low-cost labor and financing to support TNC needs for low-cost, standardized, high-volume goods. Joint-venture product licenses were frequently established with large Japanese companies, with Korean firms as the junior partners. As Michael Hobday points out, and as is illustrated in figure 4, Korea's move up the industrialization development curve had begun with the foreign TNCs acting as educational institutions providing the knowledge and know-how to produce huge volumes of goods, initially under foreign brand names in original equipment manufacturing (OEM).

Hobday emphasizes that learning to become an OEM manufacturer for American and Japanese TNCs was a harsh training school for Korean firms as they struggled to learn the skills and techniques of producing high quality for the lowest prices. Production engineers in the rapidly expanding fields of consumer electronics and computers often worked long hours, 7 days a

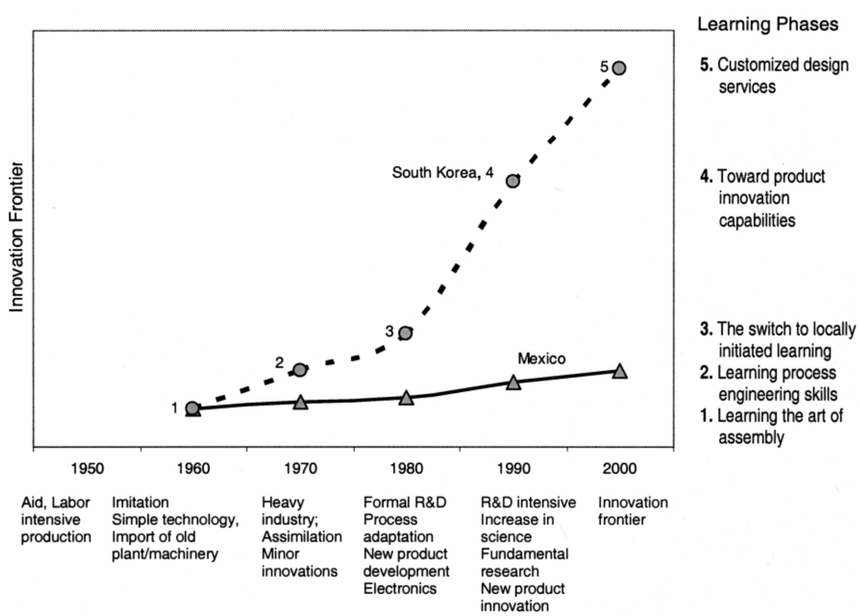

Fig. 4.—Stages of technological development in South Korea and Mexico

[18] Federal Reserve Bank of Dallas, "Workers' Remittances to Mexico," *El Paso Business Frontier* 1 (2004): 1–4.

week, and even slept by their machines to get their jobs done. Taking the long view, an immediate return of profits was secondary to learning how to produce for international markets. In short, "within the OEM channel, South Korean firms learned by strenuous in-house efforts, by trial-and-error investments and by on-the-job training. Eventually they mastered much of the production and design know-how for electronics, narrowing the gap with the leaders."[19]

By the 1990s, Korea was crossing the innovation frontier through its own product designs or through purchasing overseas high-tech companies that owned leading technologies. Hence, in less than 4 decades, along with the other Asian Tigers, Korea had become a newly industrialized nation and world-class competitor in the international marketplace (particularly in electronics).

Dramatic moves up national learning and development curves do not come simply because governments issue policies. The engines of industry must be mobilized to carry out those policies. In the 1960s, the South Korean government formulated a national strategy to establish, support, and guide the institutional framework of the industrialization process, particularly in the electronics industry. Using the Japanese *zaibatsu* (business groups) as a model, the Korean government fostered the emergence of a small group of privately owned, near-monopolistic firms called *chaebols*.

Of the 30 most powerful *chaebols* controlling Korea's industrial complex, the big five are Samsung, Hyundai, Lucky-Goldstar, Daewoo, and Sangyong. Kim observes that these special firms became powerful engines driving Korea's economic development and also played instrumental roles in moving the nation up the learning curve by being positioned to attract, from home and abroad, the best trained and experienced workers. In addition, "they also developed organizational and technical resources to identify, negotiate, and finance foreign technology transfer, taking advantage of their capacity to acquire both explicit and tacit knowledge at a high level from the international community."[20]

Significantly, in recent years the Korean government has demonstrated the capacity to change its industrial policy by shifting institutional support from the mighty *chaebols* to small and medium enterprises (SMEs). An OECD economic survey reports that "SMEs makes up the core of the Korean economy, accounting for 99.7 per cent of enterprises, 84 per cent of the workforce, 48 per cent of output and 43 per cent of exports. Moreover, smaller companies have an important role to play in the development of a knowledge-based economy."[21]

[19] Michael Hobday, *Innovation in East Asia: The Challenge to Japan* (Brookfield, VT: Edward Elgar, 1995), 67.

[20] Kim, "Korea's National Innovation System in Transition," 338.

[21] OECD, *Economic Surveys 2002–2003: Korea, 2003* (Paris: OECD, 2003), 162.

Some key policies, however, were considerably less flexible. For example, unlike Mexico's open-door policy to FDI and firms wholly owned by TNCs, Korea was selective in receiving FDI because of bad experiences during the Japanese-occupation period. Joint ventures were the norm. These had the added advantage of giving Korean partners direct access to the incoming technology. In addition, during the years when Korean firms gave most of their attention to imitating products from more industrialized nations, "the government tried . . . to minimize intellectual property right protection to help domestic firms use foreign intellectual property. Laws and regulations were formulated in such a way as to meet minimal international standards. Furthermore, enforcement of the law was less than strict."[22]

Eventually, the more Korea learned from the TNCs, the less it needed their presence. Hobday writes that "during the 1980s, the share of foreign ownership in electronics fell considerably. Despite growth, employees in foreign-owned plants fell by one-third between 1976 and 1985. Japanese TNCs including Matsushita, Sanyo and NEC withdrew from joint ventures as tax advantages were cancelled and firms were encouraged to leave by the government."[23] Consequently, in little more than 4 decades, Korea had moved from conditions of severe poverty and dependence on industrial knowledge from foreign TNCs to the status of a newly industrialized nation pushing the innovation envelope with one of the strongest economies among all the developing countries.

What is noteworthy is not merely that South Korea fostered *chaebols* as engines to drive the nation's economy. Rather, the important point is that the Korean government, in collaboration with key groups from the private sector, initiated and followed a defined strategy that moved Korea systematically up the development curve (fig. 4). The strategy was flexible enough to change with the changing times yet strong enough to survive intense periods of social and political turbulence, including massive street riots, involuntary changes in government, economic recessions, political corruption, and a constant threat of war.

Interestingly, none of the three Asian Tigers (Taiwan, Singapore, or Hong Kong) followed Korea's industrial model relying on *chaebols.* Rather, they produced their own development strategies based on local advantages and circumstances. Learning from other Asian countries, China's new development strategy has produced over the last 10 years the fastest growing economy in the world (at an average compound annual rate of over 8 percent).[24] However, there are at least two elements central to the strategies pursued by each of the Asian Tigers. First, their governments played an active role in

[22] Won-Young Lee, "The Role of Science and Technology Policy in Korea's Industrial Development," in Kim and Nelson, *Technology, Learning, and Innovation*, 284.

[23] Hobday, *Innovation in East Asia*, 66.

[24] Sergio Ornelas,"China's Amazing Leap Forward," *Mexiconow* 2, no. 11 (2004): 12.

shaping and executing a national development strategy, and, second, they facilitated the diffusion and utilization of an ever-expanding body of knowledge acquired from foreign TNCs.

Technological Advancements and the Learning Curve: The Mexican Case

The Mexican government's approach, as previously noted, was fundamentally unguided laissez-faire. The Border Industrialization Program did not stem from development planning but, rather, was created in 1965 solely to reduce the high unemployment created on its northern border by the cancellation of the Braceros Program. This single-minded focus, Gabriela Dutrénit and A. O. Vera-Cruz point out, was the "original sin" present at the birth of the industry. This focus on reducing unemployment "limited the vision that the business and government leadership might have had regarding the industry's potential for technological and national development."[25]

It would be unfair to conclude that Mexico had no policy apparatus that could (and probably should) guide the introduction of new technology-based knowledge into its national institutions. The constitution requires that the Mexican government produce a national development plan every 6 years at the start of each new presidential cycle. This plan should signal the course of economic, social, and environmental policies and provide for their integration. An OECD economic survey states that "the most recent plan (2001–2006) makes explicit the goal of reaching a sustainable development path. This plan has three main objectives: improving social and human development; achieving economic growth; and improving the rule of law. Three interministerial committees have been established to deal with each of the goals." The OECD continues, "On the basis of past experience, though, there must be some doubt about the extent to which these plans will be implemented."[26] The fact that each new president of Mexico, not to mention the various ministers and state governors, is motivated to create new public policies rather than fulfill the policies and promises of the previous administration contributes to the lack of continuity.

During these first 2 decades, various laws and decrees were passed that demonstrate that Mexico recognized the importance of technology transfer. However, these laws and decrees tended not to include the maquiladoras, or they simply remained legal principles or goals with no specific policies or enforcement mechanisms to back them up. Hence, knowledge-based technology transfer was little more than what José Sampedro and Argenis Arias call "good intentions."[27]

[25] Gabriela Dutrénit and A. O. Vera-Cruz, "Rompiendo paradigmas: Acumulación de capacidades tecnológicas en la maquila de exportación," *Innovación y Competitividad* 6 (2002): 11.

[26] OECD, *Economic Surveys 2002–2003: Mexico, 2004* (Paris: OECD, 2004), 110.

[27] For an insightful discussion of Mexican intentions toward technology transfer, see José H. Sampedro and Argenis N. Arias, "Captura tecnológica y mecanismos de negociación maquila—Gobierno en la industria maquiladora de exportación Mexicana" (final report, Mexico D.F., June 2003).

After years of exercising limited control over the maquiladora industry, the Mexican government shifted in the 1990s to a more assertive strategy of squeezing the maquiladoras for a greater share of their wealth but not their knowledge. These tax and tariff policies were subjected to repeated revisions (thus time delays and huge additional administrative costs for the maquilas), creating what James Gerber calls a process "drenched in uncertainty and indecision."[28] Such uncertainty, which was successfully reduced by the Asian Tigers governments to acceptable levels, directly harmed the knowledge-transfer process in Mexico.

While the policies of the Mexican government have not steered the nation's industrial institutions much farther up the learning curve than product assembly and producing minor innovations (see fig. 4), a second major restraining force has been the ways in which TNCs organize and control the maquiladoras. The TNCs such as General Motors, Sony, Samsung, Sanyo, Honeywell, and Toyota have constructed plants and outsourced jobs to Mexico almost exclusively for its low-cost labor and close proximity to the United States, the largest market in the world. In a process known as "production sharing," the critical decisions (about financing, product planning and design, new technology development through R & D, and parts production or purchasing) are made by the corporate home office located in the United States, Europe, or Japan. The maquiladora then operates only as a production platform where the product is assembled, packaged, and finally shipped out of the country.[29]

In addition, where only the bottom line counts, the TNCs will search the world for product parts that meet international quality standards at low cost in high volume with on-time delivery. Unlike Korea, Mexico produces less than 2 percent of the materials that go into the maquiladora supply chain, while 78 percent arrives from the United States. The TNCs typically explain this by saying that Mexican firms do not meet cost, volume, and quality specifications. Whatever the reasons, the fact that local suppliers are almost shut out of the supply chain limits the incentives and pressures for them to produce more, better, and faster products through knowledge acquisition and greater technical training.

Even though the new technical knowledge is typically developed outside of Mexico, for many in the industry and the government an illusion exists that the maquilas contribute significant amounts of technology transfer. The National Statistical Institute (INEGI) states that the industry plays three particularly important roles in Mexico: (1) facilitating a growing participation

[28] James Gerber, "Uncertainty and Growth in Mexico's Maquiladora Sector," *Borderlines* 9, no. 3 (March 2001): 2.

[29] Under the 1994 North American Free Trade Agreement (NAFTA) between the United States, Canada, and Mexico, the maquiladora industry could progressively sell a percentage of its product to the Mexican market.

in international markets, (2) providing for technological development, and (3) supplying worker training (particularly at the managerial and technical levels).[30] While the third role is not disputed, the first two contribute to the illusion.

For example, in celebrating 10 years of NAFTA, on March 5, 2004, President George W. Bush observed that "over the past decade, trade between the United States and Mexico has nearly tripled to about $230 billion. Today, Mexico is America's second largest trading partner, and we are Mexico's largest."[31] (The trade calculation is the sum of exports and imports between the two countries.) Such pronouncements are technically correct but can be misleading regarding both technology transfer as well as the rapidly growing participation in international markets.

Regarding technology transfer, in 1993 Mexico exported $43 billion in goods to the United States, which increased to $146 billion by 2003. Because of the rapid expansion in exports to the United States, and because much of that expansion came from increasingly higher-tech maquiladoras (e.g., computers, cellular phones, automobiles, and television sets), a natural assumption is that Mexico has been the beneficiary of an increasing amount of technology (knowledge) transfer in order to produce these increasingly sophisticated goods. However, as noted in table 1, the value added in Mexico (e.g., labor, electricity, and local transportation) has remained stable in the 25 percent range and has not increased with the ever-increasing technological output.

With this increasing technological output, what is often touted as technology transfer is really technology relocation. Such is the case, because even though a rapid expansion of higher-tech maquiladoras took place in Mexico under NAFTA, these TNCs jealously protect their technology in order to retain their competitive advantage in international markets. Also, under NAFTA, Mexico committed itself to protecting intellectual property rights. Consequently, sophisticated technology may be located in Mexico for production purposes, but unless it escapes the confines of the TNC to become integrated into academic centers or the production processes of national industries, it is little more than colonized knowledge—not transferred knowledge. Colonized knowledge leaves Mexico if the TNC leaves Mexico.

Just as President Bush stated, a rapid penetration in international markets is also true, but with an important qualification. As noted previously, the maquiladora industry is almost unique because the goods (parts, machinery, supplies, and raw materials) imported duty free from the United States are the same goods that are assembled and exported back to the United States, with value added. Even under these conditions, international accounting

[30] Instituto Nacional de Estadística, Geografia e Informática (INEGI), *El ABC de la estadística de la industria maquiladora de exportación* (Aguascalientes: Dirección General de Defusion, 2001), 3.

[31] "USA in Mexico," *Mexiconow* 3, no. 14 (2005): 34.

standards require that goods crossing borders should be included in a country's import and export statistics. However, in real terms no such changes in ownership take place.[32]

Consequently, in 2003, trade between the maquiladoras and the United States was recorded at $136.7 billion ($59 billion in imports plus $77.7 billion in exports). However, as one of Mexico's leading maquiladora economists, Sergio Ornelas, observes, "Some analysts argue that Mexico's new real exports in this sector is a mere $18.7 billion, or the value added in Maquiladora operations. For the most part, the $59 billion worth of imports coming into Mexico, actually under a temporary import customs status, was exported right back out after assembly and reprocessing in Mexico. By this measure, Mexico's foreign trade may be overstated in 2003 by $118 billion ($59 billion times 2) by the Maquiladora imports of parts and components, which have a 'pass-through' nature."[33]

Thus, Mexico participates minimally in at least three important areas that limit using the TNC industries as mechanisms of knowledge transfer. First, the country has no systematic plan or program to acquire advanced industrial-related knowledge from the TNCs located on its soil. Second, Mexican suppliers are shut out of contributing to 98 percent of the materials in the maquiladora supply chain, thus local suppliers have little incentive and few opportunities to acquire the advanced knowledge necessary to compete in the industry. Third, the TNCs' plants in Mexico typically do little more than assemble products and thus are minimally involved in the knowledge-generating activities of planning, research, design, and marketing.

Educational Transitions in Korea and Mexico

The development triangle (see fig. 3), which focuses attention on the interactions of government, industrial, and educational institutions, is a tool for guiding a country's efforts to move up the national learning and development curves. Regarding institutional integration in Korea, a UNESCO report states that the government produced a sequence of policies and programs designed and timed to advance systematically the nation's development plans.

In the 1950s, for example, a massive literacy campaign was initiated to produce a literate workforce that was needed for low-skilled, labor-intensive industries. In the 1960s, the educational focus turned toward emphasizing

[32] In a personal communication to a senior World Trade Organization economist asking for clarification of why the data report that Mexico is the owner of the goods while they are in Mexico for assembly but not sale, the response was that the "Concepts and Definitions (IMTS) for Merchandise Trade Statistics recommend that all goods sent abroad for processing (either between related parties or not) should be included in a country's imports and exports statistics, valued on a gross basis before and after processing. These statistics are used as input for compiling the Balance of Payments for a country" (personal correspondence, June 10, 2004).

[33] Sergio Ornelas, "NAFTA's Shadowy 10th Anniversary," *Mexiconow* 2, no. 9 (2004): 14.

vocational education at the secondary-school level in response to the growing need for an increasing number of skilled workers for light industry. By the 1970s, heavy industry began coming on line, and educational institutions devoted attention to producing technicians competent to deal with the complexities of modern manufacturing processes. Junior colleges expanded rapidly during this period in order to fill the need for making production plants function on an operational level. The 1980s saw the nation strengthen its educational and research capacities in science and technology in order to compete successfully at the high-technological end of the fierce competition of the international marketplace.

Korea also established a "fast track" by creating special secondary schools in priority areas for students with unique academic or physical talents. By 1996 there were 15 science secondary schools, 14 in foreign languages, 16 in the arts, and 13 dedicated to young athletes.[34] The sequence of industrial advances closely tied to educational reforms is noted in figure 4.

While Korea has regularly adapted its educational system to the advancing technological needs of industrialization, Mexico has been slow to change. By the 1990s, Mexico's educational system was openly and publicly recognized as underfunded and inefficient, resolutely centralized, and impervious to the intervention of parents and other outsiders, with poorly trained teachers and an antiquated curriculum that had not been changed in 20 years. One observer called it "a silent catastrophe."[35]

In 1993, a new general law of education was passed in an effort to modernize the system of public education. A principal goal was to decentralize the management of primary and secondary education to state levels, while centralizing policy formation at the national level.[36] Also, lower-secondary education was made compulsory.[37] Efforts to introduce technical-professional and work training at the secondary-school level were undertaken, but the large majority of enrolled students continued to pursue the academic curriculum designed for those going to university (which unfortunately is not the destiny of many). The various technical-vocational programs that were created by various administrations lacked coordination, resulting in significant duplication. Also, keeping training equipment up to date is a constant problem.

Within the context of Mexico's development triangle (fig. 3), the degree

[34] UNESCO, "Republic of Korea," in *World Data on Education*, 4th ed. (Paris: United Nations, 2001), 1, 2, 10.

[35] Gilberto Guevara Niebla, ed., *La catástrofe silenciosa* (Mexico D.F.: Fondo de Cultura Económica, 1992).

[36] Carlos Ornelas, "The Politics of Educational Decentralization in Mexico," *Journal of Educational Administration* 38, no. 5 (2000): 426–41.

[37] The structure of education in Mexico and South Korea is the same: six grades in elementary school, three grades lower secondary, and three grades upper secondary (together referred to as secondary school).

of institutional interaction and support has been significantly less than that found in Korea. Mexican institutions have operated with considerable independence and at a lower priority from the government than national development needs would suggest.

Noting the economic and educational gaps between Mexico and the other OECD countries, an OECD survey emphasizes the importance of producing a comprehensive strategy integrating the needs of the business sector and labor market with the outputs of education. Called for now are policies that will ease regulations inhibiting investment in key infrastructure areas that would promote the use of new technologies. Consequently, by reducing bureaucratic burdens that constrain development in the private sector, pressures will be placed on the educational sector to produce a higher level of training in quality and quantity.[38]

Investing in Education for Knowledge-Based Development

Nations make choices as to how to invest their scarce resources, and those choices represent expressions of national priorities. As table 2 illustrates, following the long years of Japanese occupation ending in 1945 and the destructive civil war in the early 1950s, Korea made a decision to establish a literate society with a strong basic-education system, in order to support its industrialization strategy. Korea's commitment to improving the nation's educational base can be seen clearly in the dramatic increase in expenditures as a percent of GNP from 0.1 to 4 percent between 1954 and 1960. Mexico's investment in public education was slower to begin, but since the 1980s it has been investing a higher percent of its GNP on public education than Korea has (4.7 vs. 3.7 percent in 1980).

However, these numbers mask some important realities, the first being the total country expenditure on education as a percent of GDP. When educational expenditures from private sources are added to public sources, Korea's 8.2 percent of GDP makes it the highest among the OECD's 30 industrialized nations (e.g., United States, 7.3 percent; France, 6.0 percent; Australia, 6.0 percent; Mexico, 5.9 percent; Japan, 4.6 percent; and the OECD-country mean of 5.6 percent in 2002). Also notable is the fact that the 3.4

TABLE 2
Total Public Expenditures on Education as a Percent of GNP

	1954	1960	1970	1980	1990	2000	2002
South Korea	.1	4.0	3.4	3.7	3.5	4.3	4.8
Mexico	1.0	1.6	2.3	4.7	3.7	4.7	5.1

Sources.—Years 1954 and 1960 data are from UNESCO, *UNESCO Statistical Yearbook* (Paris: United Nations, 1963), 286, 289. Years 1970–2000 data are in USAID, "Global Education Database," http://qesdb.cdie.org/ged/index.html. Year 2002 data are in OECD, *OECD in Figures: Statistics on the Member Countries* (Paris: OECD, 2005), 66–67.

38 OECD, *Economic Surveys 2002–2003: Mexico,* 107.

percent of GDP (2002) expenditures on education from private sources (many times that of the .7 percent OECD-country average) signals the enormous sacrifice Korean families are willing to make to assure the education of their children.[39]

This high level of GDP invested in education has created a virtuous circle. The education investment has played a key role in Korea's rapid economic growth rate (fig. 1), which in turn generates an ever-increasing sum for reinvesting in education, which promotes additional economic growth, and so forth.

A government's priorities can be seen in the total public expenditure that goes into supporting the educational institution. In 2002, the OECD-country mean for government expenditures in education (13 percent) was surpassed by both Korea (17 percent) and Mexico (24 percent; table 3). In a wider international comparison, Mexican governmental spending was, by this indicator, among the highest in the world. Just 19 percent of Chile's public expenditures went to education, while in the United States, 15 percent; in Brazil, 12 percent; in Spain, 11 percent; and in Germany, 10 percent.[40] However, as significant as Mexico's efforts are to support the development of its educational system through the public purse, the extraordinary 24 percent figure masks another reality. Mexico's tax receipts (in 2002) of only 18.1 percent of GDP are about half that of the OECD mean of 36.3 percent and considerably below Korea's 24.4 percent.[41] Even by Latin American standards, Mexico's tax receipts are low, and thus far less funding is available to support the educational system and other public services. Other reasons for

TABLE 3
KOREA AND MEXICO: CONTRASTING KEY INDICATORS

	Korea	Mexico
Population, 2004 (millions)	48.0	102.7
Children aged 0–15, 2004 (millions)	19.6	32.1
GDP, 2002 ($ billions)	680	375
GDP expenditures on public and private education, 2002 (%)	8.2	5.9
Secondary education per pupil expenditures, 2002 ($ thousands, PPP)	5,882	1,767
Government expenditures on education, 2002 (%)	17.0	24.0
Tax receipts as percent of GDP, 2002 (%)	24.1	18.1
Aged 25–34 with high school education, 2003 (%)	97	25
Aged 25–34 with tertiary education, 2003 (%)	47	19
University grads in science and engineering, 2001 (%)	39	25
GDP spent in R & D (%)	2.64 (2003)	.39 (2001)
R & D expenditures by business, 1990s (%)	74	30

SOURCES.—OECD, *OECD in Figures*, 6–7, 36–39, 67–68; OECD, *Science and Technology Statistical Compendium*, 23; World Bank, *World Bank Development Indicators* (Washington, DC: World Bank, 2004), CD-ROM; OECD, *Education at a Glance*, 205.

NOTE.—PPP = purchasing power parity; GDP in constant 1995 dollars.

39 OECD, *OECD in Figures*, 66–67.

40 OECD, *Education at a Glance* (Paris: OECD, 2005), 205, http://www.OECD.org/edu/eag2005.

41 OECD, *OECD in Figures*, 38.

the low tax receipts are that an estimated 40 percent of the near full-time, economically active population does not pay their taxes, and billions of dollars generated by illegal activities in the underground economy are untaxed.[42] Simply stated, Mexico invests a lot on education from the small public purse that it collects in taxes.

The seriousness of Mexico's problem is evident if we consider that the reduced governmental budget must be spread to cover the educational needs of 32.1 percent of Mexico's population of 102.7 million who are now or will shortly be of school age (aged 0–15). For those not yet in school, advanced preparations need to be made, such as constructing schools, training teachers, and purchasing equipment. Korea, however, has only to cover the educational needs of 19.6 million, or 20.3 percent of its population of 48 million who are now or soon will be of school age (aged 0–15).[43] Mexico obviously must spread its educational resources across a much larger and continuously expanding school-age population than must Korea, thus producing a serious countervailing force to development.

Korea's strategy of investing to create an educated populace in support of industrialization objectives has produced spectacular results. From the end of World War II until the beginning of the industrialization process in the late 1950s, approximately 50 percent of the population had attained at least an upper-secondary-school education. By 2003, 97 percent of Korea's youth that began their education in the 1970s (aged 25–34) had attained an upper-secondary-school education (table 3). Korea's secondary-school graduation rate for this age group is thus the highest of all the OECD countries, not to mention other comparison countries (e.g., Switzerland at 76 percent, the United States at 87 percent, Spain at 60 percent, Peru at 54 percent, Brazil at 35 percent, and Argentina at 52 percent).[44]

Mexico, however, has made limited progress in developing a secondary-level-educated populace to support an industrialization process. By 2003, only 25 percent of the student population (aged 25–34) that began their education in the 1970s had graduated from secondary school. In fact, only limited progress has been made since the 1950s when 12 percent of the population (aged 55–64) had a secondary-school education.[45] Mexico has also not progressed much in providing technical-vocational training; 89.1 percent of the upper-secondary-school students are in the general (university preparatory) track, while only 10.9 percent are in vocational training programs. Meanwhile, in South Korea almost 30.7 percent of the upper-secondary students are in these vocational training programs.[46]

[42] Sergio Ornelas, "NAFTA Trade: NAFTA 10th Year Anniversary," *Mexiconow* 2, no. 9 (2004): 18.
[43] OECD, *OECD in Figures*, 7.
[44] OECD, *Education at a Glance*, 36.
[45] Ibid.
[46] Ibid., 248.

In short, the educated labor pool at the secondary-school level in Mexico is less well prepared to support an industrialization process leading into the knowledge economy. Too much of the available labor pool has either dropped out of school or has an academic secondary-school education preparing them for university training in the professions—a goal that only a few will attain. Consequently, schooling for the majority of secondary-school-age students has left them unprepared for the employment demands of a knowledge-based economy, which limits Mexico's ability to move up the development curve (see fig. 4).

In addition to graduation rates, the academic performance of secondary-school graduates also needs to be considered as a contributor to the national learning curve. In the comparative Program for Comparative Assessment (PISA) study of 15-year-olds' academic achievement in the 30 OECD countries (2003), Korean students were third behind Japan and Finland on both the mathematical literacy and scientific literacy scales. Mexico was thirtieth on both scales.[47]

Higher Education and Investments in Science and Technology

If an educated labor pool depends on a secondary-school education, then university education is the leading edge of industrial innovation and technological advancement. An OECD report states that "flows of university graduates are an indicator of a country's potential for diffusing advanced knowledge and supplying the labour market with highly skilled workers."[48] By 2003, over 47 percent of the Korean population (aged 25–34) had attained a tertiary level of study (table 3). Among OECD countries, Korea was third highest (behind Canada's 53 percent and Japan's 52 percent), while 19 percent of Mexico's 25–34-year-olds had attained a tertiary education.[49]

Within the flow of higher-education graduates, students who pursue the humanities, social sciences, arts, health, and other humanistic fields certainly make important contributions to a nation's learning curve. However, the percentage of students who specialize in science and technology subjects signal a nation's drive to move up the national learning curve in support of industrialization. Korea's massive commitment to industrialization is illustrated by the fact that it grants a far greater percentage of its new university degrees (39 percent) in the fields of science and engineering than do other OECD nations (table 3). Germany is the second highest with 35 percent, followed by other notables: France with 29 percent, the United Kingdom with 28 percent, the United States with 18 percent, Norway with 16 percent,

[47] OECD, *OECD in Figures*, 68–69.
[48] OECD, *Science, Technology, and Industry Scoreboard* (Paris: OECD, 2003), 50.
[49] OECD, *Education at a Glance*, 37.

and the OECD mean of 22 percent.[50] Sanjaya Lall writes that the Korean government played an active role in boosting enrollments in specific technological fields that reflect industrial priorities: "Efforts were made to gear training to emerging technological needs, often by getting industry involved in the management of training and education institutions."[51]

With respect to Mexico, 25 percent of its university graduates are in science and engineering, which is above the mean of the 30 industrialized OECD countries.[52] When compared to Latin American nations, Mexico's percentage of university graduates in science and technology has been second only to that of Chile for the past 25 years. Mexico's efforts to improve its capacities in science and technology can be seen in the increasing level of student support. In 1990, the number of publicly funded advanced-degree scholarships in science and technology fields was 9,400, by 1997 it reached a high of 30,300, but by 2002 with the economic downturn the awards declined to 21,600. As the economy improves, so does the number of scholarships.[53]

Despite some improvements on both sides, barriers to collaboration between the TNCs and many staff members in Mexican institutions still exist. In numerous interviews, university personnel opined that at the end of the day the American maquiladoras are in Mexico only to exploit the nation and its workers. On the other side of the collaboration barrier, TNC managers often expressed the view that Mexican universities are too theoretical, inflexible, and obsolete for the bottom-line, rapidly changing needs of higher-tech maquiladoras.

Maria Isabel Rivera Vargas analyzed the degree of collaboration between institutions of higher education and 13 foreign higher-tech electronics companies in the state of Jalisco, which has one of the highest concentrations of universities and higher-tech maquiladoras in Mexico. She found there were few efforts to draw the manufacturing companies into collaborative working relationships that could upgrade the technical offerings of regional institutions of higher education. "In Guadalajara, although five of the thirteen corporations included in the study have research facilities, where approximately 249 Mexican engineers are involved in research and development activities, there is no contact between these scientists and their academic counterparts."[54]

[50] OECD, *Science and Technology Statistical Compendium* (Paris: OECD, 2004), 23.

[51] Sanjaya Lall, "Technological Change and Industrialization in the Asian Newly Industrializing Economies: Achievements and Challenges," in Kim and Nelson, *Technology, Learning, and Innovation*, 58.

[52] Note that 31.5 percent of the science and engineering degrees go to women; see OECD, *Science, Technology, and Industry Scoreboard*, 51.

[53] CONACYT, *Tercer informe de gobierno apartado de ciencia y tecnología* (Mexico D.F.: Consejo Nacional de Ciencia y Tecnología, 2003), 128.

[54] Maria Isabel Rivera Vargas, *Technology Transfer via University-Industry Relationship* (New York: Routledge Falmer, 2002), 112–13.

In the 1980s, a decision was made by the secretariat of public education (SEP) in Mexico to educate a new type of worker that would better serve the technological needs of industry (national and maquiladora) and the employment needs of secondary-school graduates. After studying varying approaches taken to address similar problems in Europe, Japan, and the United States, the SEP settled on a 2-year technical community college model called "technological universities" (UTs). With a motto of "to know and to do," these institutions emphasize full-time, practical training plus supervised on-the-job internship experiences for 3,000 hours over the 2 years. The first four UT institutions began operations in 1991, and by 2003 53 were functioning with approximately 60,000 students attending. Significantly, foreign maquiladoras frequently contract with specific UT institutions to provide special technical training to groups of students who are targeted by them for employment after graduation. The TNCs, such as in Toyota's recent arrangement with UT Tijuana, provide scholarships for the students, supervise on-the-job internships for their practical training, and send their own experts to teach classes where the technology is unknown to the regular UT instructors. At this point, a significant transfer of new knowledge takes place.

The locations of these 2-year UTs are decided based on surveys of the specific technical-labor-force needs of the different regions in Mexico. However, a few are found in southern Mexico, where the populations have historically been poor and marginalized from the rest of society. Twenty-four career curricula (e.g., agrotechnology, industrial electronics, and materials chemistry) are available with sufficient flexibility to be tailored to the regional needs of existing industries or are attractive to TNCs looking for a place to locate new production plants. Of considerable importance is the fact that 80 percent of the graduates obtain employment within 6 months, and 70 percent are working in jobs (often maquiladoras) related to their training. In short, the special technological needs of the maquiladoras have resulted in a knowledge acquisition and transfer process for an entirely new type of educational institution in Mexico. The 2-year higher-education technological institutions are particularly well suited to fill the historic gap in the traditional educational system, with the various UT campuses strategically placed with specialized and flexible curriculums to support Mexico's development process.[55]

As noted, Mexico has been increasing its efforts to support knowledge transfer through upgrading science and technology investments. However, there are at least 16 major national training programs (begun at different times by different governments) with much duplication in content and target audiences. This lack of coordination results in considerable waste of energy and resources. In an analysis of such training programs, the National Council for Science and Technology (CONACYT) points to the core of the problem:

[55] Coordinación General de Universidades Tecnológicas, *Universidades tecnológicas: Mandos medios para la industria* (Mexico D.F.: Editorial Limusa, 2000).

"Presently, the National System of Science and Technology is a collection of institutions from diverse sectors (academic, private, social, Congressional, federal and state), but they do not operate as a system. Practically in all cases they lack an adequate institutionalization of working relationships and information flows between them."[56] This lack of institutional and program coordination and lack of a systematic science and technology strategy is a hindrance to Mexico moving effectively up the national learning curve.

Movement up the national learning curve in support of industrial development is dependent on significant investments in the acquisition of knowledge that leads progressively to innovative activity. The OECD defines investment in knowledge as the sum of R & D expenditure, expenditure for higher education (public and private), and investment in software. These three investment targets are particularly critical because they can enhance institutional (and interinstitutional) productivity.

In 2003, the mean investment in new knowledge in OECD countries amounted to 4.8 percent of GDP. Mexico's investment of 1.9 percent was the second lowest (ahead of Greece's 1.8 percent) and considerably below Korea's 5.6 percent, which was fourth highest (behind Sweden's 7.2 percent, the United States' 6.8 percent, and Germany's 4.8 percent).[57] Mexico's level of investment can be interpreted as an indication that knowledge acquisition is not a priority.

The TNC Impact on Research and Development

A primary tool in knowledge acquisition is R & D. In the case of Korea, but not in Mexico, the presence of TNCs served as a powerful stimulus for R & D activities in national firms. Examining the early stage of the Korean economic upsurge, Won-Young Lee observes that in the mid-1960s the nation was investing minimally in science and technology because Korean institutions were primarily imitating the product lines of foreign companies. Small-scale R & D activities were undertaken by public research institutes, but they were interested primarily in testing and inspecting. Industries and universities were virtually uninvolved. "Nevertheless, policy makers, including President Park, had strong faith in investing in [science and technology]. The government did not demand immediate return from government-funded research institutes, which consumed most of the government's R & D funds."[58]

Following the completion of the first 5-year plan in 1966, Korean government began to play a pivotal role in funding, building science and technology infrastructures, establishing training programs, and promoting col-

[56] Dirección Adjunta de Información, Sistemas y Normatividad, *Programa especial de ciencia y tecnología, 2001–2006* (Mexico D.F.: CONACYT, 2003), 21.

[57] OECD, *Science and Technology Statistical Compendium*, 8.

[58] Lee, "The Role of Science and Technology Policy in Korea's Industrial Development," 273–74.

laboration among foreign TNCs, universities, and research centers. Several government-funded research institutes were created to absorb and assimilate foreign technology, the first of which was the Korea Institute of Science and Technology established in 1966. In 1967, the Ministry of Science and Technology was established with the function of integrating science and technology planning for nationally coordinated R & D activities

However, as the Korean economy began to accelerate, the private sector (principally the large *chaebols*) moved beyond simply imitating products to developing new generations of its own products. As the private sector moved up the learning and development curves, so too did the demand for private-sector R & D. By the 1990s, when the Korean private sector was doing world-class manufacturing in quality and quantity, the business sector was financing approximately 74 percent of the nation's R & D, with the government and other institutions financing less than 24 percent (see table 3). By 2003, South Korea was investing almost 2.64 percent of its GDP in R & D alone, considerably above the OECD mean of 2.24 percent and even the United States' 2.60 percent.[59]

In Mexico, consistent with its quasi-laissez-faire posture toward the TNC industry, the government never played a strong and active role in establishing an institutional infrastructure to support or even pursue targeted TNC technologies. Mexico's R & D as a percent of GDP reached a slim .39 percent in 2001, which is the lowest of the OECD countries.[60] By 2000, one important consequence of these expenditure levels is that, proportional to their numbers of employees, for every researcher produced in Mexico, South Korea was producing 10.[61]

Notwithstanding these past deficiencies, in recent years Mexico has done a great deal to strengthen its research capacities and activities. One of the most important roles of CONACYT is to identify Mexico's most accomplished and recognized researchers and appoint them as members of its National System of Investigators (somewhat similar to the National Academy of Science in the United States). By 2003 there were almost 10,000 members, a selection of whom received approximately 22 percent of the CONACYT budget in support of scholarly activities. The CONACYT directly supported almost 27,000 R & D projects in 2003 covering a wide range of fields (36 percent in health care, 11 percent in agriculture, and 7 percent in energy). Of the 15 principal projects supported in 2003, only one involved technological learning in maquiladoras, which was funded for about $US11,000.[62] Efforts to advance the national learning curve with this level of investment would seem to be a daunting task.

[59] OECD, *OECD in Figures*, 70–71.
[60] Ibid., 70–73.
[61] Ibid., 70–71.
[62] CONACYT, *Tercer informe de gobierno apartado de ciencia y tecnología*, 169–71.

Despite the importance of R & D capacities for the advancement of Mexico's private industry, during the 1990s as much as 60 percent was funded by government and only 30 percent by business enterprises. This was nearly the reverse of Korea's funding pattern.[63] Reflecting on national business firms, a CONACYT report addresses the issue: "Because few Mexican businesses have opted to use science and technology as important business tools, the nation possesses a weak production platform. In 2000, of approximately 2.8 million firms, 99 percent are at only the beginning stage of competitiveness; [only] 3,377 have achieved the ISO 9000 level (meeting international quality standards); [only] 2,500 are exporting, and less than 300 do some type of research and development. This explains, by and large, the low competitive position that Mexico occupies compared, for example, to Korea and Brazil."[64]

Although there are a growing number of small, creative production initiatives now underway in Mexico,[65] there are at least four reasons why the private sector (domestic industry and maquiladoras) in Mexico plays such a marginal role in R & D activities. All are well illustrated by the contrasting South Korean experience. First, the maquiladoras are seen more as instruments for generating jobs than institutions where new technical, production, and managerial knowledge is acquired for use in homegrown industries. Second, as noted in the earlier section on the illusion of technology transfer, the arrival of higher-tech maquiladoras over the years often tends to be viewed as technology transfer rather than simply technology relocation. Consequently, pressure for spending significant sums on R & D is impeded by the misconception that Mexico is receiving new technologies every time a new high-tech manufacturing plant comes to town. Third, Mexican industries that produce for the international marketplace are under minimal pressure to conduct R & D because they remain rooted in product assembly rather than advancing to higher stages of product imitation, design, and innovation. And, fourth, when the maquiladoras require new technologies, the R & D activities are carried out at the TNC home headquarters rather than in Mexico.

Lessons Learned and Conclusion

In the new age of globalization, if policy makers and scholars are to understand and promote accelerated rates of national development in LDCs, they must understand more precisely why some nations are significantly more successful than others. By contrasting means and outcomes in the development of South Korea and Mexico since the 1960s, when both nations were

[63] OECD, *OECD in Figures*, 70–71.

[64] CONACYT, *Science and Technology Indicators at a Glance* (Mexico D.F.: National Council of Science and Technology, 2003), 22.

[65] Regarding some of the innovative science-and-technology-driven enterprises underway in Mexico, see http://innovationmexico.com/.

impacted by similar conditions of underdevelopment, this article offers some insight into this debate by identifying a few lessons learned.

First, education is not synonymous with schooling. Unlike the conventional view that education means schooling, South Korea equated education with knowledge transfer from higher-tech foreign industrial sources in conjunction with schooling. Consequently, targeted industrial-knowledge transfer from TNCs was integrated with targeted schooling reforms as part of that nation's successful development strategy.

Second, assigning a high priority to government spending on schooling does not necessarily move the nation up the development curve. Since the 1980s, Mexico's public expenditures on schooling as a percent of total public expenditures have been higher than South Korea's and almost the highest in the world. However, by combining private spending by families, along with public spending and government-targeted schooling reforms, South Korea has produced one of the highest quality, technology-oriented school systems in the world.[66] Third, outsourcing transfers knowledge along with jobs. While outsourcing from TNCs tends to be routinely excoriated as exploitive at home and abroad (and justifiably so at times), it can provide development opportunities through knowledge transfer. South Korea used foreign TNCs to learn progressively complex and innovative manufacturing processes, as well as to learn the "business of business." In contrast, Mexico has valued foreign TNCs primarily as a source of jobs.

Fourth, knowledge acquisition must be tied to a development strategy. The tenacious pursuit of advanced knowledge (both TNC and schooling) should be tied to long-term development goals rather than the specific policies of a particular leader or political party. South Korea's industrialization process retained continuity despite years of raging political battles in the halls of government and in the streets. Mexico never developed a policy directed at the acquisition of knowledge from TNCs located on its soil. What policies did emerge in later years tended to focus on extracting revenue rather than knowledge from these firms.

Fifth, LDCs need a broker to arrange for collaborative knowledge development and sharing activities between university and TNC personnel. In Korea, the government often arranged for and provided incentives, such as funding, to promote collaborative R & D projects between foreign industries and domestic universities. A quasi-laissez-faire approach by an LDC government to give structure to its incipient industrialization process can result in minimal levels of knowledge transfer between TNC industries and school systems (K–12 and universities). In Mexico, long-standing suspicion about the motives of foreign companies on its soil has significantly reduced the spirit of collaboration between university personnel and foreign industry.

[66] Such family investment reflects what one reviewer termed the "culturally and historically constructed zeal of educational demand from the people."

Sixth, trained personnel must precede rather than follow upgraded industrialization processes. A critical mass of students in targeted technical/vocational fields is necessary to advance accelerated development that is rooted in specific types of industries, such as electronics or agribusiness. South Korea's government anticipates the workforce needs (in number and content) of those domestic industries it targets for rapid development, and it makes serious efforts to prepare the necessary personnel. In short, Mexico has done quite well in upgrading the content and quality of its technical training programs, particularly through its relatively new 2-year UT system. However, as pointed out by a Mexican business publication, "Mexican programs have not fostered or encouraged R & D activities, technical 'incubators,' 'scientific and technological pioneering centers,' or the creation of venture capital to facilitate the creation of technological enterprises."[67] In South Korea, by contrast, the decades-long aggressive pursuit of foreign industrial knowledge has lead to an abundance of all those listed activities that were not energetically pursued in Mexico.

In summary, to explain their reversal of fortunes since the 1960s, we might conclude that while South Korea's educational and economic programs pursued both growth (more of something) and development (the betterment of something), Mexico's concentrated solely on growth.

[67] Ramiro Villeda and Miguel Díaz Marín, "Mexico's and China's Programs to Attract Foreign Investment," *Mexiconow* 2, no. 9 (2004): 55.