# REVIEW ESSAYS

## TECHNOLOGY POLICY AND TECHNOLOGICAL CHANGE: A Latin American Emphasis

*Dilmus D. James*
*University of Texas at El Paso*

*THE POLITICIZED MARKET ECONOMY: ALCOHOL IN BRAZIL'S ENERGY STRATEGY.* By Michael Barzelay. (Berkeley and Los Angeles: University of California Press, 1986. Pp. 289. $32.50.)

*LONG-RUN ECONOMICS: AN EVOLUTIONARY APPROACH TO ECONOMIC GROWTH.* By Norman Clark and Calestous Juma. (London: Pinter, 1987. Pp. 206.)

*INFORMATION AND DEVELOPMENT: TRADE AND INDUSTRIAL POLICY IN ARGENTINA, BRAZIL, AND MEXICO.* By William R. Cline. (Washington, D.C.: Economics International, 1987. Pp. 161. $19.95.)

*ECONOMIC AND SOCIAL PROGRESS IN LATIN AMERICA, 1988 REPORT; SPECIAL SECTION: SCIENCE AND TECHNOLOGY.* By the Inter-American Development Bank. (Washington D.C.: Inter-American Development Bank, 1988. Pp. 604.)

*STATE-OWNED ENTERPRISES IN HIGH TECHNOLOGY INDUSTRIES: STUDIES IN INDIA AND BRAZIL.* By Ravi Ramamurti. (New York: Praeger, 1987. Pp. 306. $42.95.)

*LEARNING BY DOING: SCIENCE AND TECHNOLOGY IN THE DEVELOPING WORLD.* By Aaron Segal, Wallace Koehler, Jr., Wenlee Ting, Richard Suttmeir, Ward Moorhouse, and Brijen Gupta. (Boulder, Colo.: Westview, 1987. Pp. 239. $46.00.)

*AUTOMATION AND GLOBAL PRODUCTION: AUTOMOBILE ENGINE PRO-*



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*DUCTION IN MEXICO, THE UNITED STATES, AND CANADA.* By Harley Shaiken, with Stephen Herzenberg. (La Jolla: Center for U.S.-Mexican Studies, University of California, San Diego, 1987. Pp. 120. $10.00.)

In playing technological catch-up, Third World nations face at least three fundamental decisions. First, to what extent should the acquisition and mastery of technology rest on deliberate state intervention? Is it prudent to depart from the sage advice of conventional economics that counsels relying on unfettered market forces to generate and disseminate new technology? As will be shown, regardless of where wisdom lies, policy interventions in the arena of technology abound in developing countries. Second, with the revolutions in biotechnology and microelectronics now in full swing and a new revolution in materials not far behind, to what extent should developing countries (many having low per capita incomes and abundant labor) attempt to get their foot in the door? Third, there must be well-considered (or lucky) as well as ill-advised (or ill-starred) measures for fostering a more robust technological advance. Here decision makers who are influencing science and technology policy in developing countries must confront myriad permutations of alternative priorities, policy instruments, sectoral emphases, and sequencing and meshing of programs. The group of books under review here shed more than a little light on these issues. They are especially valuable in illustrating the range of options and the variety of experiences pertaining to Third World technology policy.

The essay will proceed by first discussing the works of William Cline and the Inter-American Development Bank (IDB). Cline's *Information and Development: Trade and Industrial Policy in Argentina, Brazil, and Mexico* is a small but useful volume. It begins by reviewing arguments for free trade, more or less in the Ricardian tradition emphasizing comparative advantage, and then moves on to justifications for protection. The latter include achieving dynamic comparative advantage through technological change, realizing economies of scale, and taking advantage of beneficial external economies. The next three chapters describe trade and investment policies pertaining to the computer industry in Brazil, Mexico, and Argentina. The final chapter contains brief sketches of the "export specialization" computer policies of South Korea and Taiwan and the shifts toward "self-sufficiency and reopening" made by India and France.

As many readers of this journal know, each annual report of the Inter-American Development Bank features a special section on some aspect of Latin American development. The 1988 edition contained a welcome four-chapter section put together under the direction of Miguel Urrutia, head of the IDB's Economic and Social Development Department. *Economic and Social Progress in Latin America, 1988 Report* contains a general introduction to science and technology in Latin America followed

by three sections: a survey of information technology, based on a study by Ricardo Soifer; an overview of biotechnology in the region, based on a study by Pablo Bifani; and a look at scientific and technological research indicators in Latin America compared with other regions, based on a study by Patricia de Arregui. The three substantive chapters are thorough, informative, and based on top-notch research.

The Cline and IDB studies compare and contrast national computer policies in Argentina, Brazil, and Mexico. From the 1950s until 1983, Argentina lacked a specific sectoral policy, and its electronics industry developed with the benefit of some protection from foreign competition. An embryonic effort to develop domestic capacity in information technology during the 1970s was aborted by a change to more open-market policies combined with undervalued foreign exchange. The current computer policy has been forged since the mid-1980s and has relied on tariff protection and an open stance toward foreign firms. But the zigzagging of the Argentine program has sent confusing signals to national and foreign investors alike. In addition, an attempt to support the domestic manufacture of too many types of products and an internal market smaller than those in Brazil and Mexico have undermined Argentine success in moving toward international levels of competitiveness.

Brazil entered the 1970s with a solid base of human capital for developing an internal computer industry. The country established a market reserve for minicomputers, regulations that automatically applied to microcomputers when they appeared. In general, these measures were designed to discourage foreign participation, although they allowed as much as 30 percent foreign ownership of equity. The export of computer products was not given high priority in the planning, but Brazil's domestic production of computers and peripheral equipment has flourished.

Mexico's consumer electronics sector progressed under a regime of import-substituting industrialization (ISI) during the 1950s and 1960s. Control of import licenses for computer-related products date from 1975, after which a few locally owned producers started operations. In 1981 Mexico issued a computer decree that spelled out a program aimed specifically at promoting a national computer industry based on protection and incentives. Joint ventures with minority holdings by foreign partners were encouraged,[1] and an important thrust of the provisions was to encourage export-led development.

The IDB study on modern biotechnology makes it clear that Latin America has not neglected this newly emerging technology. Active pro-

1. International Business Machines entered into lengthy negotiations with Mexico and was eventually permitted to produce computers at a wholly owned facility in Guadalajara. Other foreign firms subsequently cut similar deals. For detailed analyses, see Weiss (1990) and Whiting (1991).

grams can be found in many areas: nitrogen fixation, tissue culture, biopesticide production, embryo techniques for improved livestock, single-cell protein production and enzyme production, and genetic engineering in developing new serums, vaccines, diagnostic reagents, and pharmaceutical items. All these efforts have produced some winners in all three countries. In 1980 Argentina imported forty million (U.S.) dollars worth of potato seed. But by 1985, the success of five Argentine firms in micropropagating potato microstakes had shrunk import costs to less than one thousand dollars. Meanwhile, Brazil has developed viral insecticides to be used against two insects that harm soybeans, sugarcane, and other crops. These new biotechnology insecticides are cheaper than traditional pest controls that rely on chemical products. Mexico has become a large producer of amino acids, including L-lysene, which is being exported on a competitive basis.

Two major points emerge from the Cline and IDB volumes. First, it is evident that the more technologically advanced countries in Latin America are determined not to be left standing still in the wake of the microelectronics and biotechnological revolutions. Second, Latin American experiences with nurturing local computer production indicate that with appropriate policies (and perhaps a little good fortune), top-tier countries in the region can attain dynamic comparative advantage in high-technology industries. Yet these experiences also demonstrate that successfully nurturing an infant industry is tricky business. Argentina cannot be considered a success story, and Brazil has built up domestic computer capacity at a rather high cost, according to Cline. Mexico, in contrast, appears to have made considerable progress in increasing computer production, exports, and technical learning at modest cost.[2]

A couple of noteworthy aspects of Latin American computer policy are not treated adequately by Cline or the IDB report and deserve more attention. The efforts to foster a domestic computer industry depart from the old ISI model in a number of important ways. Perhaps the break with ISI is clearest in the Mexican case. First, computer policy (especially in Mexico) eschewed the broad umbrella approach covering a wide range of industrial products. Indeed, during the dismantling of Mexican requirements for import licenses, those for computer-related items were among the last 3 percent left in effect and were removed only recently. In addition, facing a steady decline in Mexican tariffs since 1983, recent changes raised the tariff on most computer products from 10 to 20 percent.

Second, the motive of gaining access to and mastery over new technologies is now an explicitly stated goal. Although Latin American structuralists talked a good game about technology transfer, they tended

2. See Villarreal (1990) and James and Villarreal (1992).

to be very thin on specific suggestions for building national technological capacity. Those pushing ISI tended to trust that technological advance would occur automatically as a by-product of direct foreign investment and industrialization.

Third, although exceptions occasionally arose (and major ones at that), the usual modus operandi of ISI was to provide blanket support for a large segment of the industrial sector and let the chips fall where they might. In the case of the Mexican computer industry, rewards are tied to a series of performance standards involving expenditures on research and development, investment in new capacity, and the ability to generate foreign exchange.

This infant-industry approach contrasts markedly with the ISI approach. It is also striking because it incorporates some of the valid lessons that can be gleaned from the Korean developmental experience: careful selectivity of product lines deserving support, an emphasis on acquiring and absorbing new technology, and the use of performance criteria as motivational devices.[3]

A further observation can be made in response to claims that Latin America has insufficiently integrated science and technology into the process of socioeconomic development. This condition is often referred to as an inadequate "socialization" or a lack of appreciation of the benefits flowing from technological change.[4] Here lies another reason why the drive to develop national computer capabilities is significant. Surely expanded exposure to computers in manufacturing, commercial, financial, professional, public, and educational sectors (not to mention use in individual households) will heighten the general public's familiarity with and appreciation of the potential of new technology.

If one concedes that more technologically advanced developing countries can acquire and master some elements of high-technology, is there a meaningful role for large state enterprises? If so, what circumstances and actions lead to healthy results for some parastatal firms but to failure for others? These two questions are the main ones addressed by Ravi Ramamurti in *State-Owned Enterprises in High-Technology Industries.* He presents longitudinal studies of four state enterprises: Bharat Heavy Electricals Limited (BHEL), a firm founded in India in 1956 specializing in power plant equipment; Heavy Engineering Corporation (HEC), founded in India in 1959 engaging in heavy mechanical engineering; Empresa Brasileira de Aeronáutica (EMBRAER), a producer of light aircraft founded in 1969; and Computadoras e Sistemas Brasilieros (COBRA), a manufacturer of micro- and mini-computers founded in 1974. BHEL of India and

3. On selectivity, see Pack and Westphal (1986); on technology, see Park and Enos (1985).
4. I have attempted here a brief summary of the arguments made in James (1990).

EMBRAER of Brazil are given high marks, while India's HEC ranks at the bottom of the class and Brazil's COBRA somewhere in between.

Taking the less successful cases first, HEC was plagued with excess capacity from the beginning, a condition compounded by an excessively optimistic projection of the rate of expansion of Indian steel production. HEC also suffered from ever-changing institutions having oversight over the firm as well as from high turnover in management. Unstable management contributed to difficulties in hiring and holding top-notch personnel. Losses piled up, but the state was reluctant to admit defeat, partly because of inertia and partly due to concern over the large number of jobs that would be lost if the enterprise were allowed to fold.

COBRA's situation was also fluctuating constantly. Strategy dictated from the outside shifted continually in response to serious tension between the goals of acquiring technological mastery and showing a profit. The Brazilian state never gave as much market support for computers as it did for products like light aircraft. Yet COBRA was in the black during the 1983 fiscal year and had invested heavily in research and development, and the Brazilian computer market was growing rapidly. Thus at the time when Ramamurti ended his investigation, COBRA's situation was far from hopeless.

Of the two successful high-technology ventures by parastatal enterprises, BHEL was blessed by a growing market for power equipment, and its pace was accurately forecast by Indian government projections. The growing market, coupled with trade protection, allowed the company to move along its learning curve as well as to achieve substantial economies of scale. Once BHEL had reached a size comparable with international companies, it began to export successfully. This state enterprise proved astute in acquiring technology from abroad. In the 1950s and 1960s, it turned to Eastern European sources when Western firms were unwilling to sell their latest technology. After BHEL's bargaining position improved, it was able to obtain technology from capitalist countries during the 1970s and 1980s. Considerable synergism developed: the growing market and rising profits enhanced BHEL's public image, which gave top management more political clout and greater internal control over operations. As a result, BHEL became a more pleasant place to work, one that could attract and hold skilled employees. Also, management developed an entrepreneurial attitude and became more politically adroit.

Brazil's involvement in aviation dates a long way back to the years soon after the Wright brothers. The state became involved as early as 1941. The aeronautics ministry thus began to break packages of technology into their individual components, and a portfolio of skills and local capacity for research and development was accumulated over a period of time. EMBRAER, a mixed public-private enterprise, was blessed with an excellent "public entrepreneur" in the person of Ozires Silva, who headed opera-

tions from its inception. Because the company was governed by law pertaining to a private firm, much bureaucratic red tape was avoided. This factor and the longevity in tenure of EMBRAER leadership were conducive to managerial autonomy and an entrepreneurial attitude. In addition, the firm was able to provide customers with alternate financing through a state bank. Moreover, the enterprise absorbed technology effectively and generated designs internally, which allowed the company to keep creating or penetrating successive market niches. For the most part, EMBRAER shied away from manufacturing high-value, high-technology components and concentrated on designing and manufacturing fuselages and final assembly. This approach has required a large proportion of imported components, but the strategy has also enabled the firm to conserve its financial resources for research on developing new products, reducing risks, penetrating foreign markets, and meeting foreign specifications.

Readers of *State-Owned Enterprises in High-Technology Industries* are left with the conclusion that parastatal enterprises, under the appropriate circumstances, can indeed participate successfully in making products that require sophisticated technology. As with infant-industry protection (illustrated by the computer industry), there are no guarantees, as HEC's horror story amply testifies. Yet the incidence of parastatal triumphs also implies that the current wave of privatization in many developing countries will throw out a lot of wheat with the chaff. What seems warranted is a case-by-case examination of state enterprises—rather than a blanket ideological proclamation—combined with more emphasis on creating environmental and intra-enterprise conditions that are conducive to efficient and progressive parastatal operation. Ramamurti's investigation is rich in clues as to what these conditions might be.

Some have expressed trepidation about the possibility that new microelectronic technologies might erode the competitive advantage of exports of manufactured goods by developing countries (Olle 1986; Hoffman and Rush 1988). The argument is especially plausible for production that relies on repetitive and discrete hand movements by inexpensive skilled labor. Harley Shaiken and Stephen Herzenberg shed some light on this issue in *Automation and Global Production: Automobile Engine Production in Mexico, the United States, and Canada*. This study compares the technologies and their use in three automobile engine plants in the three countries indicated in the title. The authors consider the study a work in progress and the first phase of a broader investigation of high technology in the current global economy,[5] and they reach some interesting conclusions. After only two years of operation, the Mexican plant was experiencing 80 percent of the mechanical efficiency of the U.S. plant and 75 percent of

5. Readers who find the book under review rewarding might also be interested in a recent work by Shaiken (1990).

U.S. efficiency in labor productivity. Mexican product quality fell somewhere between the U.S. and Canadian counterparts.

With wages of the Mexican operation costing less than 10 percent of those at the U.S. plant, one may wonder why, given the relative performance of the Mexican engine-producing facility, a stampede is not taking place to set up operations in Mexico. The study supplies some potent hints. Management of the Mexican plants generally views local suppliers of spare parts and other inputs as being unable to match the quality of imported items. Obtaining an import permit can be a time-consuming process (it took one manager six months to get a dial indicator and more than a year for wire strippers). Finally, ordering through Mexican intermediaries can add 200 to 300 percent to the cost of the imports.

Yet those who fear a technology-driven reversal in the direction of trade can draw little support from *Automation and Global Production*. In a short time, the Mexican plant has been able to absorb state-of-the-art technology and achieve respectable productivity levels. Ample evidence suggests that many "in-bond" plants in northern Mexico, known locally as *maquiladoras*, are also adopting microelectronic innovations (Palomares and Mertens 1987; Brown and Domínguez 1989). Although one finds suggestions in the literature as to why low-wage, labor-abundant regions are upgrading their technology so markedly in export enclaves, economists are still waiting for a systematic and convincing explanation. Certainly the trend does not seem to accord with conventional rationales given for the "new international division of labor."

Turning to a different issue, if the intermediate or appropriate technology movement is alive and well, it is not evident in this group of recent publications. Although appropriate technology gets a rare nod here and there, not one of the books gives technological pluralism serious treatment. This is a shame. Although it is true that problems exist with appropriate technologies, as in trying to achieve commercial production and distribution, there have been triumphs as well. Furthermore, there is reason to believe that very high technology can be constructively integrated with low-income, small-scale activities and thereby raise income and productivity in traditional sectors.[6] If these books are roughly representative of works on technology that apply to the developing world, most attention is currently being preempted by the more modern sectors in the more technologically advanced developing countries. Argentina, Brazil, and Mexico have usurped the attention in these studies (and in this essay) to the exclusion of countries like Peru, Uruguay, El Salvador, and Bolivia.

It may be true that even the three leading countries in Latin America pale in their science and technology endeavors when compared with

6. For an evaluation of what has come to be called "technology blending," see Bhalla and James (1991).

the developed and industrialized world, but the sad fact is that the other countries of the region (with the exception of Chile and Venezuela) are not even in the hunt. The study by Patricia de Arregui in the IDB report states that of all the scientific papers published in journals with an international circulation between 1973 and 1984, Argentina, Brazil, and Mexico accounted for 69 percent, Chile and Venezuela for 20 percent, and the rest of Latin America for only 11 percent. A very similar pattern emerges from examining patents granted.

Should not more energy be devoted to determining reasonable and responsible actions that low-income countries (or regions) can take to upgrade their technological capabilities? By definition these countries have extremely scarce resources, and thus the question becomes, what criteria for scientific or technological projects will serve as an adequate filter for selecting promising undertakings? Fortunately, some suggestions along these lines can be found in *Learning by Doing: Science and Technology in the Developing World*, the volume by Aaron Segal and the other contributors. Segal provided an introductory chapter, a chapter each on Latin America, the Middle East, and Africa, and coauthored a chapter on the Caribbean with Wallace Koehler, Jr. The three remaining contributions were written by Wenlee Ting on East Asia, Richard Suttmeir on China, and Ward Moorhouse and Brijen Gupta on India. Although the material tends to be highly descriptive and even journalistic at times, some valuable insights emerge.

Segal champions on-site research and development projects because they are more likely to be related to local problems and will probably require fewer externally supplied material inputs and less technical assistance. Attractive possibilities might include renewable energy systems, tropical agriculture, agribusiness, environmental protection, climate systems, natural resources, geology, marine biology, hydrology, applied biotechnology, tropical medicine, and paramedical health delivery services. Segal also suggests that developing countries eliminate or merge the many research and development institutions that are patently too small and underfunded to yield useful results. Many of the contributions present data that verify how far the least developed countries lag behind in resources devoted to science and technology.

The findings or issues touched on thus far can be usefully summarized at this point. First, Argentina, Brazil, and Mexico are making determined bids to participate in the microelectronic and biotechnological revolutions. Second, Mexico's experience with promoting domestic production and export of computer products indicates that an infant-industry approach for achieving international competitiveness can be a viable option. Third, computer policy in Latin America in some ways constitutes a marked departure from past attitudes and approaches. Fourth, under the appropriate circumstances, state enterprises can be workable vehicles for introducing high-technology products into Third World economies. Fifth,

both the infant-industry and state-enterprise routes entail risks and are neither easy nor automatic policy vehicles for achieving desired technological goals. Sixth, a kind of gravitational pull seems to be attracting a disproportionate amount of attention to technological change in the relatively affluent developing countries.

Three other points about these seven books struck me as fascinating: the predominance of an interdisciplinary approach; the high esteem accorded the goal of fostering internal technological capacity; and the low priority assigned to orthodox economic cost-benefit analyses in making advance assessments of large-scale, expensive technology projects. The first point will require lengthy treatment, but the remaining two will not take long.

Of the seven volumes reviewed, only those by Cline and the IDB are written in the tradition of orthodox economics. Even here, both shun doctrinaire approaches and are cognizant of significant impacts from public-sector actions and the importance of historical settings. The other five books are unabashedly multidisciplinary. That by Michael Barzelay and that coauthored by Norman Clark and Calestous Juma are particularly noteworthy in that each lays a foundation for a formal interdisciplinary approach to making sense out of how new technologies evolve and how the institutional environment fits into the picture.

Barzelay's *The Politicized Market Economy: Alcohol in Brazil's Energy Strategy* analyzes Brazil's program for producing alcohol from sugarcane. According to this account, actions taken during the first phase (1975–1979) constituted a reasonable way for Brazil to insure itself against high energy costs and low sugar prices. Most of the distillery capacity could produce either sugar or alcohol, thus market swings could dictate distillery activity. But during the second phase (1980–1983), serious rigidities developed. Production began to shift toward "autonomous" distilleries, those that could not produce sugar as an end product. In addition, automobile production and purchases were geared to alcohol-consuming vehicles. Thus the whole alcohol undertaking has acquired certain technological and economic imperatives that have made it difficult to reverse the program no matter what happens to the prices of petroleum and sugar. Brazil thus lost opportunities for occasional social benefits from exporting sugar and, more seriously, became locked into an enormously expensive enterprise that was being propelled forward by technological irreversibility and powerful vested interests.

The body of *The Politicized Market Economy* is devoted to investigating how a program designed to bail out sugar interests was transformed into policies that encouraged substantial investment in autonomous distilleries and alcohol-powered vehicles. Barzelay employs a political-economy model that views both sector-specific state decisions and private-sector investment decisions as endogenous variables. His explanations

are insightful and plausible. Unfortunately, however, one volume cannot cover everything, and two important externalities do not receive much attention. First, one can make a reasonable case that the alcohol program causes considerable environmental degradation. Second, and on a more positive note, a good deal of technical learning must exist that will spill over into the general economy. The old biotechnological processes were upgraded as were the technologies of milling and distilling. Complementary technological innovations arose in sugar cultivation, transportation, and motor-vehicle production. Experiments employing other vegetation as raw materials are ongoing. It should also be noted that Barzelay's cost-benefit analysis that found the early phase moderately beneficial was based, as he points out, on data from the central-south region of Brazil, where plantations, mills, and distilleries are technically more efficient.

Clark and Juma's *Long-Run Economics: An Evolutionary Approach to Economic Growth* mounts the most ambitious attempt to formulate an eclectic framework for viewing technological change. One gets a clue from their prefatory statement: "we wanted to explore why it is that the world described in most economic models is not the world in which we live, at least not without the most extreme suspension of belief." Clark and Juma's preface describes the real world as "an 'open system,' non-linear, indeterminate world and [it] is certainly not one that can be described meaningfully in equilibrium terms." Drawing on a Veblenesque tradition that treats economics as an evolutionary phenomenon, the authors focus on long-run strategic questions and decisions with a strong technological dimension. They emphasize the evolutionary interaction between institutional and organizational structures as well as the pace and direction of technological change. The institutional environment, which most orthodox economists either take as a given or assume away, is perceived by Clark and Juma as endogenous to the process of technological change. They correctly insist that no single conventional discipline can do full justice to understanding and exploiting this evolutionary perspective.

After covering some epistemological issues, Clark and Juma present some of the typical orthodox economic models for handling technology, describe evolutionary concepts that can be found in the works of earlier conventional economics, and then use the following two chapters to delineate their own brand of evolutionary economics. Here it becomes clear that although they have much in common with Thorstein Veblen and contemporary American institutional economists,[7] Clark and Juma take the biological analogy more seriously. The book ends with two case studies: a comparison of U.S. and Brazilian research and development efforts

7. Most American institutionalists use the terms *institutional economics* and *evolutionary economics* interchangeably. Note that the most influential organization of institutional economists in the United States is the Association for Evolutionary Economics.

at using agricultural products to make alcohol (they use the term *ethanol*); and a comparison of the evolution of photovoltaic technology in the United States, the European Economic Community, and Japan. In both case studies, the authors adduce evidence that institutional arrangements affect the evolution of technological systems significantly. Clark and Juma make a bold attempt to break away from neoclassical mishandling of technological change, revealing their close affinity with U.S. institutionalists and the European-based neo-Schumpeterians who favor an approach that owes more to Charles Darwin than to Isaac Newton.[8]

The reviewed volumes illustrate how, over the past ten or fifteen years, the preoccupation with technology transfer as an end in itself has waned. Not one of the volumes emphasizes technology transfer. In different ways, they all focus on the importance of accumulating internal technological capability. Also, for better or for worse, I could find no evidence in the monographs or the collaborative works that any decisions that led to instigating big-ticket projects (such as the formulation and implementation of industry-specific computer policies, alcohol production from sugarcane, or state investments in large, high-technology state enterprises) rested on conventional economic studies that attempt to estimate social benefits and costs. Orthodox economic considerations were encountered far less often as motivations than were balance of payments problems, national defense considerations, the desire to combat technological dependence, and pressure from internal groups with vested interests.

A final thought: two decades ago it would have been difficult to ferret out a comparable batch of books dealing with technology and Third World development. Now, however, this essay is the second such review in this journal during the span of only a few years (see Schwartzman 1989). I view this trend as an encouraging sign, because in whatever models of Latin American development that emerge to replace the tainted structuralist and monetarist paradigms, technology had better be a major building block.

8. A good introduction to neo-Schumpeterian thought can be found in many of the contributions to Dosi et al. (1988).

## REFERENCES


BHALLA, AJIT S., AND DILMUS D. JAMES
1991 "Integrating New Technologies with Traditional Economic Activities in Developing Countries: An Evaluative Look at 'Technology Blending.'" *Journal of Developing Areas* 25, no. 4 (July):477–96.

BROWN, FLOR, AND LILIA DOMINGUEZ
1989 "Nuevas tecnologías en la industria maquiladora de exportación." *Comercio Exterior* 39, no. 3 (Mar.):215–23.

DOSI, GIOVANNI, CHRISTOPHER FREEMAN, RICHARD NELSON, GERALD SILVERBERG, AND LUC SOETE, EDS.
1988 *Technical Change and Economic Theory.* London: Pinter.

HOFFMAN, KURT, AND HOWARD RUSH
1988 *Micro-Electronics and Clothing: The Impact of Technical Change on a Global Industry.* New York: Praeger.

JAMES, DILMUS D.
1990 "Science, Technology, and Development." In *Progress toward Development in Latin America: From Prebisch to Technological Autonomy,* edited by James L. Dietz and Dilmus D. James, 159–76. Boulder, Colo.: Lynne Rienner.

JAMES, DILMUS D., AND M. ANGELES VILLARREAL
1992 "Calculating Costs and Benefits in the Periphery: Mexico's Promotion of Domestic Production of Computers and Peripherals." Paper presented to the Association for Evolutionary Economics, 3–5 Jan., New Orleans, Louisiana.

OLLE, WERNER
1986 "New Technologies and the International Division of Labor: Retransfer of Foreign Production from Developing Countries?" *Vierteljahresberichte,* no. 103:3–10.

PACK, HOWARD, AND LARRY E. WESTPHAL
1986 "Industrial Strategy and Technological Change: Theory versus Reality." *Journal of Development Economics* 22, no. 1 (June):87–128.

PALOMARES, LAURA, AND LEONARD MERTENS
1987 "Programmable Automation and New Work Contents: Experiences of the Electronics, Metal Engineering, and Secondary Petrochemical Industry in Mexico." Paper presented at the Seminar Automatisation Programmable et Conditions D'Usage du Travail, 2–4 Apr., Paris.

PARK, H. W., AND JOHN L. ENOS
1985 *The Adoption and Diffusion of Imported Technology: The Case of Korea.* New York: Routledge, Chapman and Hall.

SCHWARTZMAN, SIMON
1989 "The Power of Technology." *LARR* 24, no. 1:209–21.

SHAIKEN, HARLEY
1990 *Mexico in the Global Economy: High Technology and Work Organization in Export Industries.* La Jolla: Center for U.S.-Mexican Studies, University of California, San Diego.

VILLARREAL, MARIA DE LOS ANGELES
1990 *Mexico's Trade and Investment Policy in the Computer Industry.* M.A. thesis, University of Texas at El Paso.

WEISS, STEPHEN E.
1990 "The Long Path to the IBM-Mexico Agreement: An Analysis of the Microcomputer Investment Negotiations, 1983–1986." *Journal of International Business Studies* 21, no. 4:565–91.

WHITING, VAN R., JR.
1991 "Mexico's New Liberalism in Foreign Investment and Technology: Policy Choices and Global Structure." *Columbia Journal of World Business* 26, no. 2:139–51.