

OED Précis



Operations Evaluation Department

June 1994

Lending for Industrial Technology: Lessons from Six Countries

The Bank's lending for industrial technological development (ITD) should form part of a broader strategy for industrialization or else its impact may be diluted, according to an OED study of industrial technology development projects. An integrated approach, addressing incentives, technological capabilities, and institutions is essential if countries are to build up the capabilities they need for long-term industrial development. Though the Bank has been an effective proponent of trade and industrial policy reform, often its assistance has not helped borrowers to develop such an integrated approach.*

The study analyzes the impact of the Bank's ITD lending in Hungary, India, Indonesia, Korea, Mexico, and Spain, and the factors that contributed to success or failure. It assesses the Bank's view of the determinants of industrial technology development, and the policies the Bank has recommended, and draws lessons for the future.

Incentives, capabilities, institutions

Industrial technology development depends on the interplay of incentives, capabilities, and institutions (see Box). The *incentive framework* gives the "demand" for technological effort. Apart from the need to produce things, incentives for technological effort arise from the macroeconomic environment

and growth prospects, from technological progress, factor markets, the intellectual property regime, and domestic and foreign competition.

Capabilities and institutions determine the "supply side" of ITD. Final capability building takes place inside manufacturing firms, but firms depend on external sources for inputs that they cannot create easily: skills, financing for physical and capability investment, and access to information and technology. Each input has its own market. Each may suffer from market failures, and there may be a need for governments to ensure that the supply of skills, finance, and information necessary for ITD is adequate.

Many countries lack the capabilities to use a new manufacturing facility efficiently. Nor are these capabilities easily imported as part of the sale of equipment, patents, or blueprints. There are "tacit" elements in the transfer of all but the simplest technologies that call for the creation of indigenous skills, learning, and the collection of new information—only parts of which occur as a passive process of learning by doing. Mastery of operational technology (know-how) does not automatically lead to the development of deeper technological capability (know-why). Developing capability requires a conscious and sustained effort on the part of the

manufacturer, and is costly and uncertain. A strategic decision generally has to be made to invest in the more risky and prolonged process of gaining the knowledge and skills required.

Projects reviewed

The projects reviewed were all designed to strengthen industrial competitiveness and productivity. They showed a keen awareness of the importance of the incentive framework. In all the six countries, ongoing industrial/trade liberalization was expected to promote the demand for ITD. There seemed to be broad agreement in all projects on the need for government to take a proactive role in strengthening the supply side of ITD.

In Indonesia, the main constraint on technological progress was seen to be the shortage of technical skills. The other five countries were considered to have ample technical skills within enterprises and insti-

**"Bank Lending for Industrial Technology Development". Report No. 12138. June 30, 1993. OED reports are available to Bank Executive Directors and staff from the Internal Documents Unit and from Regional Information Services Centers.*

Definitions

Much of the technological effort in developing countries is directed at the acquisition of the technical, managerial, and organizational skills that enterprises need to set up a plant, use it efficiently, improve and expand it over time, and develop new products and processes. Industrial technology development (ITD) refers to the growth of these technological capabilities. ITD is an integral part of efficient industrialization at all levels of development.

In most developing countries ITD means the ability to become more efficient and competitive in the use of imported technologies. In the least developed countries ITD comprises the mastery of simple

and well-diffused technologies, while in newly industrialized countries it involves mastering complex, scale- and skill-intensive technologies.

ITD involves the "deepening" of technological capability, undertaking more complex and demanding tasks (adaptation, improvement, design, engineering, development, and innovation) within the technologies that the country uses. Technological deepening can lead to more widespread diffusion of technology, greater use of local inputs, more product differentiation, higher added value and the ability to respond more effectively to changes in market conditions.

tutions, though most projects provided for some training for financial, appraisal, and management skills.

All the projects except that in Indonesia emphasized finance for technological activity. The three in Korea focused on venture capital and other instruments for absorption of imported technology and commercialization of local technologies. Projects in India, Mexico, and Spain combined technology finance with efforts to remedy failures in information markets. That in Spain financed the import, development, and diffusion of technologies as part of a specific strategy of changing the country's technology culture. That in Hungary mainly provided loans for the import of up-to-date equipment and technologies. The India project provided venture capital to support local innovations as well as imports of technology.

Efforts to strengthen information and technical services networks generally had two goals: improving the capabilities of S&T institutions, and establishing closer links between them and industry. In India, the project fed into the govern-

ment's broader market-oriented reforms of technology infrastructure. The project in Mexico linked investment in selected research institutes to their partial privatization. In Hungary, the project included strengthening metrology centers and quality control institutes, and establishing facilities for academic research.

The particular attention that several projects paid to the need of small and medium-sized enterprises was welcome, since these enterprises face greater financial constraints than large enterprises.

Project outcomes

- In *Korea* the three projects helped to promote research and development (R&D) activities in small and medium-scale enterprises which needed risk capital to sustain such activities.
- In *India*, the project helped private industrial enterprises to acquire technology from abroad, innovators to have access to venture capital funds, and several research and development institutes to direct their activities to the needs of industry.

- In *Spain* the project promoted the development of new processes and products and helped bring them to the point of commercialization, though a greater push came from Spain's 1986 entry into the European Community and exposure to the Community's R&D activities.

- The *Mexico* project failed to achieve its major goals of promoting R&D activities in the private sector and the privatization of research institutes. But a study supported by the project helped to bring about the formulation of a new technology policy.

- The *Indonesia* project achieved its goal of training science and technology professionals and developing some collaborative relationships between Indonesian and foreign universities and institutes. But because of its focus on the government R&D institutes, with few links to the rest of industry, it is unlikely to enhance the technological capabilities of Indonesia's industry very much.

- *Hungary's* National Office of Measures used Bank loan proceeds to import valuable instruments, but many of the project's other beneficiaries face serious problems because their markets have changed radically.

Assessment of the Bank's approach

In general the projects' analysis of ITD needs was soundly based. Long-term investments in capability development and R&D are highly sensitive to the incentives arising from the macroeconomic and competitive environment. The Bank's decisions to undertake ITD projects, and the design of specific projects, depended strongly on its interpretation of the incentive regime in each country.

Incentive framework: In the Bank's view, as reflected in various documents on industrialization,

the desirable incentive framework for capability development:

- Provides a liberal trade regime, so that domestic producers face international competition.
- Provides full access to foreign technology and equipment.
- Promotes domestic competition fully, removing all artificial constraints on entry and exit.
- Emphasizes the role of the private sector.

Theoretically and practically, these criteria have much to recommend them. ITD is strongly driven by international competition. Technology imports are a necessary input into local capability development, and attempts at technological self-reliance have generally been disastrous for healthy ITD. Selectivity does not have a good record; picking technological winners is especially difficult. Domestic competition is conducive to ITD and to efficiency and growth. Finally, the private sector is generally more efficient and responsive to market signals than is the public sector.

Trade policy: As to the relationship between trade policy and ITD, there remains a valid case for protecting infant industries while they develop their capabilities. To ensure that infant industries invest in ITD, interventions may become necessary. But experience shows that the interventions are best located within a strongly export-oriented regime that offsets the disincentive effects of infant industry protection, while providing the competition and information benefits of participating in world trade. In the more advanced stages of industrialization, the deepening of industrial technology capacity may also call for interventions in trade and technology regimes, to promote local research capacity.

Yet the immediate policy problems confronting the Bank and the

developing world today have less to do with promoting infant industries than with the restructuring of industries set up under distorted incentive frameworks. Where competition has been restricted, as in highly protected trade regimes, liberalization may be needed before firms can develop competitive technological capabilities. But because capability development involves time, risk, and investment, firms may need a cushion, to promote technological learning.

For industries that have been protected but are potentially competitive, there may be a case for phased programs of restructuring and relearning. New and complex activities may still need to be supported by trade policies.

Supply-side issues may need more analysis in future projects. Capital market failures and insufficiencies in infrastructure obviously impede ITD, but the benefits of remedying them may be narrower than these six projects envisaged. Such remedies may improve operational capabilities but not promote more sophisticated technological activity. Where the incentive regime is highly distorted, as in Hungary when the project began, even well designed measures on the supply side do not lead to a dynamic ITD process. *If a country does not have a history of undertaking research and development, supply-side measures may not suffice to stimulate deeper ITD.*

Attention to country peculiarities: Some projects did not sufficiently tailor the design to the country's history and industrial traditions. There was perhaps a belief that the underlying process of ITD was uniform across countries, and that all would adopt this process once the incentive structure was liberalized and the capital and information market failures were overcome.

In Korea and India, project design was generally well suited to country conditions. The Indonesia project suffered from serious design flaws, given its goal of improving

skills that would broadly benefit technological capabilities. In the Mexican and Spanish projects, the removal of financial constraints on ITD was correctly designed for stimulating existing technological activity, but not for enabling a significant jump in ITD.

The design of each project needs to be tailored to the borrowing country's industrialization strategy, stage of development, and other country specific factors.

Lessons

- *Clear definition and articulation:* To be most beneficial a technology project needs to be conceived and implemented as part of a clearly defined and articulated technology strategy. An important reason for the success of the Korean projects was the government's clear strategy for technological development.

- *Incentive framework:* In addition to a sound macroeconomic setting, liberal trade, industrial, and technology policies play a decisive role in promoting ITD. ITD projects should not be implemented until the economic environment is favorable.

- *Access to foreign technologies* is critical to ITD, and the Indian case illustrates the damage that may result from widespread and severe restrictions on technology imports. The *mode* of technology imports may affect the extent and nature of local capability development: heavy reliance on foreign direct investment can be an extremely effective way to obtain operational know-how for new technologies, but it may not be the best way to promote technological deepening. Korea preferred "arm's-length" technology imports rather than foreign direct investment; a battery of government policies encouraged local firms to invest in their own R&D in complex areas, while forcing them to face export competition. In Spain and Mexico,

foreign technology substituted for, rather than complemented, efforts to deepen ITD. The Bank should improve its understanding of what drives the creation of an R&D culture.

- *Financing:* To finance ITD by firms, the Bank should look for financial intermediaries that have technical expertise, are knowledgeable about the industries to be assisted, and are willing to take risks. Specialized financial institutions are better suited to this than are normal financial intermediaries. The intermediaries should have strong private sector participation and support and be independent, so that their managers can avoid bureaucratic interference in decision making. Korean and Indian experiences illustrate the advantages of privately managed institutions that are responsive to market needs and have intimate relationships with industry. Conversely, in Mexico the first tier commercial banks made very little contribution to the technology loans.

Successful technology and *venture capital financing* depends greatly on the experience and quality of the institutions' staff. Skills to manage venture capital and risk-sharing operations are rare and take time to develop, so these operations must be selected carefully.

Government-assisted risk-sharing activities require enough *financial resources* to permit prudent risk taking. There must be reasonable certainty about the sources of finance and the government's commitment to provide assistance in the early stages, and a well-designed devolution program.

- *Private R&D effort:* Government policy should encourage private

R&D through fiscal and other incentives while the role of public institutions should decline to allow support for private technological activities. Very few countries have managed this transition. In Korea, the successful encouragement of private sector R&D took several financial and fiscal measures, implemented within the context of clear strategies for trade, industry, and science and technology. In Mexico, technological activity was very limited and almost entirely in public institutions. In general, while it is important to have the private sector represented in the policy making bodies of public R&D institutes, it is unlikely that private R&D institutions can be put in place through the collective participation of private sector firms without strong government support and financial assistance.

- *Links between public R&D institutions and manufacturing:* In all six countries, public R&D institutions had difficulty linking up with manufacturing firms. These links may be especially hard to establish in economies in transition. Since large firms normally have their own resources for R&D, the Bank should give priority to financing ITD activities that will benefit small and medium-sized enterprises. Efforts to strengthen research links should give primacy to R&D institutes with a "service to industry" culture. Often firms face serious difficulties in subcontracting research to institutes. These difficulties may best be overcome by subsidizing the creation of links, at least at the start, while securing some financial commitment from private enterprises.

- *ITD projects for less industrialized countries:* Efficient industrialization at any level requires technological effort. Though most of the Bank's

ITD projects have been in newly industrializing economies, more should be undertaken in less industrialized countries. Some countries in this group may need help with improvements in skills and in technology infrastructure (for standards, metrology, quality assurance, and so on), to promote their competitiveness and efficiency, rather than elaborate R&D facilities.

Bank management, in its response to the OED study, generally endorsed the conclusions of the study but argued for different emphases on the recommendations. Research, development, and engineering (RD&E) expenditure in many developing countries was very small compared with that in advanced countries. Given the rate at which new technology was being produced in advanced countries, greater emphasis should be placed on policies and institutional support to increase access to foreign technology and less on developing local RD&E capabilities in publicly owned research institutions. More emphasis should also be put on developing other kinds of institutions to support technological development—such as institutions for standards, testing, technological information, and technological extension. The need for technical human resource development was not considered to be adequately covered in the OED study.

The Joint Audit Committee of the Bank's Board of Executive Directors reviewed the study and the management response. The Committee strongly endorsed the recommendations in the report which were relevant for all Bank borrowers—newly industrializing countries as well as lower-income countries. Members noted the need to enhance the Bank's staff capacity to address the issues raised in the report. The Committee also urged greater interaction between the Bank and the International Finance Corporation in industrial technology development.

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