

SETTING NATIONAL TECHNOLOGY TRAJECTORIES:
THE TECHNOLOGY ASSESSMENT ROLE OF
DEVELOPMENT FINANCIAL INSTITUTIONS
IN DEVELOPING COUNTRIES

BY

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Biographical Note

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Abstract

Development financial institutions (DFIs) in developing countries regularly face challenges in the micro-level assessment of technology to support their decisions of financing proposed technology development investments by firms and technology institutions. These financing decisions are also guided by national technological priorities such as achieving technological self-reliance and addressing energy-environmental concerns. DFIs are therefore well placed to consciously channel technology finance into national priority sector technological research. I argue that by consistently doing so, DFIs play a key role in the setting of macro-level technology trajectories in key technology areas that are of national importance to the developing country. I also argue that as developmental finance increasingly takes prominence over private finance for supporting investments in risky but essential priority sector technological research, this role played by DFIs can be superior to other modes adopted by national governments for encouraging priority sector technology development. I therefore suggest that national governments in developing countries actively support DFIs in playing this role, and in developing higher levels of expertise in technology assessment to enable them to set and guide appropriate national technology trajectories. International development institutions can also support DFIs in developing countries by providing them targeted technology funds through national governments.

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Introduction

Development financial institutions (DFIs) in developing countries are actively involved in developing programs and providing facilities that support technology development by firms as well as scientific and technological research and development (R&D) institutions within the country. By financing technology development projects for industrial application, DFIs fill an important resource gap. External finance can encourage R&D work and commercial investment in some high growth - high risk areas, where both firms and technology institutions find it difficult to either single handedly, or jointly, take the entire investment risk. If technology institutions rely largely on research contracts from the industry, they may increasingly work in areas of concern to some large and resources rich firms in the country that can afford such research, neglecting other areas that have small scale sector domination. The entry of technology financing through DFIs considerably reduces the risk and investment for firms with low internal resources, till they are willing to take up the high risk - high return R&D project, either singly, or jointly with technology institutions (Prabhu, 1996).

Though firms can rely on internal financing and internal technology development and assessment, their endowment through an external specialized source such as a DFI, considerably reduces the risk borne by the firm, even though it incurs a higher transaction cost in dealing with the external organization. DFI financing can complement venture capital financing by supporting priority sector projects that may not be easily acceptable under normal venture capital financing norms. DFIs therefore play an important role in helping firms and technology institutions build their technological resources, combine their expertise and increase utilization of available resources, especially in priority sectors. DFIs thus facilitate the emergence of new commercialisable products or processes, through entrepreneurial and intrapreneurial ventures in these sectors (Prabhu, 1996).

This paper essentially describes the process through which a series of micro-level assessments of technology by a DFI in a developing country over time, in taking its technology financing decisions using internal policies broadly guided by national technological priorities, eventually leads to the development of macro-level technology trajectories in sectors of national importance. Figure 1 depicts this process and the linkages between the various components of the process described below.

Figure 1 about here

DFI Technology Investment Choices

Apart from commercial viability, the technology financing decisions of DFIs in developing countries are broadly guided by national technological priorities such as achieving technological self-reliance and addressing equity-energy-environmental concerns. At the initial identification and appraisal stage, the DFI procedures are usually very comprehensive - apart from financial viability, the appraisal covers the impact of the project on indigenous technological, social and economic development over a fairly long-term horizon. Results of common analytical methods like social cost-benefit analysis and environmental impact assessment are likely to play an important role in the selection of the project - rather than serve only as minimum requirements. DFIs across the world also have a strong propensity to share and adopt effective appraisal and follow-up techniques and procedures. Thus innovations in DFIs are likely to be rapidly diffused. DFIs by their very orientation are therefore well placed to consciously channel technology finance into national priority sector technological research (Jequier and Hu, 1989).

In doing so, DFIs in developing countries essentially face seven types of priority sector technology investment choices (a) Investments in the incremental self-driven upgradation of existing priority sector technology in the country. (b) Investments in the diffusion and adaptation of readily available priority sector modern technology. (c) Investments in the purchase and adaptation of specialized priority sector modern technology from abroad. (d) Investments in the development of entirely new priority sector technology where investments are low both in the developing country and abroad. (e) Investments in the developing of entirely new priority sector technology in areas of normal investment levels. (f) Investments in small and medium sized firms that operate in non-priority industrial sectors, but nevertheless

are required by the country's industrial policy to be given priority in financing (g) Direct investments in basic or applied research in priority sector technology (Jequier and Hu, 1989)

In making these investment choices, major national concerns of equity, energy and environmental may at times even supercede concerns of commercial viability. Operationally this may mean that a minimum threshold level of financial returns may be considered adequate by the DFI, if the proposed project shows higher levels of benefits on national priorities (Prabhu, 1996). This is usually because developmental funding provided to DFIs by national governments or by international funding agencies is often expressly targeted to address such concerns. Making a clear prioritization among the various types of investment choices is obviously difficult. Even if the DFI actually makes a percentage allocation of its available funds to each types of investment opportunity, it still faces a difficult assessment and choice problem as these investment opportunities usually present themselves in random order.

Micro-level Assessment of Technology by DFIs

In playing an active technology development role, DFIs in developing countries regularly face challenges in the micro-level assessment of technology to support their decisions of financing or otherwise supporting proposed technology development investments by firms and technology institutions. Technology assessment includes techniques for anticipation of social, economic, and environmental consequences of technological development, including technological forecasting, impact identification and policy analysis. DFIs need a certain level of expertise in order to provide a variety of advisory supports to their client firms to help them make realistic prior assessments of technological investments. This expertise is often developed by the DFI through the learning derived from assessing and guiding several projects as well as from post-mortem analysis of failed projects (Prabhu, 1996).

However the role of the DFI does not stop at assisting in or making a technological assessment of proposed projects. They are also actively involved in the generation of viable technological investment proposals that are then made available to prospective firms and technology institutions for implementation with DFI support. By providing such readymade proposals, DFIs attempt to stimulate investments in areas that they consider worth investing in. These areas may be national technological priority areas or areas where they see rapid

growth with high and quick returns that can be ploughed back to priority sector investments of longer gestation (Bhatt, 1993)

DFIs are also actively involved in the compilation and processing of technological and market related information in the set of industries that they have invested in or wish to concentrate on. This information is usually kept by the DFI for its own use in the form of industry files - though some DFIs do release them in the form of industry reports for prospective clients or the larger investing public. The DFI also maintains a contact list of key resource persons or firms in the technological areas of their interest or major funding. They may also commission studies by consultants and academics on technological areas of interest and then propose projects that are in a fairly advanced stage of development to prospective clients (Bhatt, 1993)

DFI Technology Investments Set National Technology Trajectories

In developing countries, the central concern of technological development has not been on developing entirely new products and processes - rather it has been on the development of technological capabilities and their translation into better technological choice assessments as well as their application in making incremental improvements in existing technology (Jequier and Hu, 1989). Given the difficult situation in most developing countries, this activity often has to take advantage of local resources. The DFI needs to effectively combine both local and imported technology such that over time local technology and expertise is enhanced. When national policy or the DFI's internal policy dictates that effective local technology should be preferred over imported technology, the implications of choices made under this constraint has developmental implications that go well beyond the proposed project. Where such policy preferences are known, proposals are likely to be tailor-made to take their advantage

By consistently considering national technological priorities in making significant technological investments, DFIs play a key role in the setting of macro-level technology trajectories in key technology areas that are of national importance to the developing country. The DFI's technological choices can also open new technological trajectories that are emerging and close existing ones that are reaching obsolescence. Technological investments by DFIs also have significant multiplier effects on technological development within the country and as a consequence on social and economic development. These effects on technological development can take place at various stages of the technological project life cycle - from

initial identification, assessment, appraisal, selection, implementation and evaluation. However, the DFI may choose to concentrate its resources and interest on one or a few of these stages - and only the larger DFIs are likely to play a role in all these stages (Jequier and Hu, 1989)

Influences and Pressures on the DFI

DFIs are broadly guided in their selection of projects by national economic and developmental policies. But internal funding targets and policies also considerably influence them. Large and powerful DFIs can also set their own priorities and targets that do not necessarily follow national government set priorities - specially if government priorities change often due to changes of ruling governments (Jequier and Hu, 1989). DFIs therefore act as a beneficial inertial force in setting national technological priorities. This role is especially important in setting and sustaining momentum in nationally important technological areas where sustained investment over longer time frames is essential for effective and sustained technological development.

DFIs also rely on several types of agencies that work with it as partners in making technological assessments. On broader funding policy issues and procedures as well as on specific technical matters related to specific projects, they work with organizations like international DFIs, other national DFIs, national planning agencies, public firms, scientific and technological institutions, research foundations, non-governmental voluntary organizations, consulting firms, other financial institutions and private agencies. Some of these organizations can also work as funding partners and exercise a greater role in the assessment process. This means that the DFI need not have all the required resources in-house. It also means that its control on the entire process is also to an extent constrained by its partners (Jequier and Hu, 1989)

Types of Support Provided by DFIs

Under their technology development initiatives, DFIs in developing countries have gone far beyond just financing projects by introducing programs which provide firms and technology institutions multiple and complementary types of support and address multiple concerns. This is exemplified by the Industrial Development Bank of India, that in its annual report of 1971-72 itself, saw its role beyond that of just financing projects to include "identification of project ideas, preparation of preliminary feasibility studies, search for managerial and entrepreneurial

talents, preparation of detailed project reports, managerial, technical and financial assistance for project implementation, critical evaluation of projects from the national point of view and finally project supervision" (Jequier and Hu, 1989).

Some of the types of support provided by DFIs in developing countries are (a) *educational* support in terms of training of entrepreneurs and technical personnel within the country and abroad, (b) *technical* support in terms of technical consultancy and development of project profiles, (c) *informational* support in terms of creating awareness of business opportunities, (d) *infrastructural* support in terms of providing expensive common testing facilities to groups of firms on a rental basis, (e) *planning* support in terms of assisting in the development of feasible and efficient project plans, (f) *managerial* support in terms of assisting in the administration of projects and turnarounds, (g) *financial advice* with regard to taxation and portfolio investment planning, (h) *purchasing* support in terms of helping in technology sourcing and purchase, (i) *marketing* support in terms of help in identifying markets within the country and abroad, (j) *interactional* support in terms of initiating and convening firm and technology institution interaction exercises (Prabhu, 1996).

Roles Played by the DFI in Project Implementation

In providing multiple types of support to the projects the finance, DFIs play multiple roles in project implementation. Apart from playing the role of the financier, some of the roles played by the DFI are that of: (a) *informer* - providing information as and when required, (b) *connector* - between various interested organizations and/or people, (c) *initiator* - of the project itself, (d) *convener* - of meetings between interested project participants before and during the project, (e) *manager* - of the project if required and of peripheral activities, (f) *arbitrator* - of disputes between participants and (g) *risk taker* - in providing risk finance to the project DFIs can play an active role in the solving the technical, managerial and organizational problems that arise during project implementation. They can involve themselves in the acquisition of equipment and services for the projects and by exercising choice in these, they can indirectly promote the development of indigenous ancillary industries (Prabhu, 1996)

Depending on the level of technological capability of the client firm in the relevant industry, the DFI may have to play different roles. If the firm is at a low level of technological capability, the DFI may need to support the firm in building its technology absorption

capability, especially in an industry in which competing firms already have higher levels of technological capability. At a relatively higher level of existing technological capability within the firm, the DFI can concentrate on the internal development of technology. If the firm's existing technological capability is already high enough, the DFI can concentrate on promoting the firm's ventures in that technological area directly through venture financing or indirectly through networking with other financing institutions. The logical extension of this role can result in the DFI also taking the role of a commercial bank, either directly or through a subsidiary. This helps the DFI in directly monitoring and influencing the firm during the implementation of the technological project and thereafter in attaining commercial viability (Jequier and Hu, 1989).

DFIs can take an active role in the promotion and adoption of non-conventional technology - moving the industry away from conventional environmentally unfriendly and resource consuming technologies - by providing appropriate incentives. It can also play a role in supporting the development of indigenous technological innovations. Of course comprehensive evaluations of, and experimentation with, such technologies is essential and once made can be applied to subsequent projects in that field. This requires the DFI to closely monitor technological developments at both the national and international level, finance experiment development of indigenous technology, and learn from both these areas to continually revise and improve their decisions on financing technology projects in that area. Overtime, the DFI can accumulate knowledge and translate it into better advise for prospective clients that are new to an industry as well as better internal resource allocation and financing decisions (Jequier and Hu, 1989).

DFI Expertise and Learning

To be able to play a range of roles and to provide a variety of support while implementing technology financing activities, DFIs require a range of skills different from those of managing other types of lending institutions. For projects where the technology is new, unproven and at times undiscovered, its personnel require high levels of technical competence and ability to assess potential success. They need to be in touch with the field on both technology and commercial aspects. While many such skills cannot be maintained in-house and have to be hired, the DFI over time learns from the projects it finances and guides, to become a repository of such skills as well as a connector of such skilled people from multiple

organizations. DFIs have also addressed the issue of expertise by establishing their own consulting subsidiaries. These consulting subsidiaries operate on a larger scale as, apart from consulting for the parent DFI, they are also players in the larger consulting market. This larger scale of operations enables them to maintain a larger range of technological expertise than viable for the DFI activities alone. With its subsidiary consulting firm, the DFI also is able to direct its assessments more towards non-financial considerations (Jequier and Hu, 1989)

Role of the DFI Project Appraiser and Coordinator

The DFI project appraiser, who is usually in the best position to select the most promising and appropriate project, plays the most important role in the effective assessment and selection of projects. An experienced and sensitive appraiser is likely to effectively bring multiple and conflicting criteria into consideration in selecting appropriate projects among the proposed ones. He/she is also likely to take a proactive role in initiating interest and investments from prospective project implementers. Also by evaluating a number of technological options, the DFI project appraiser can build expertise in that area, that can be used in other projects in that area. This continual buildup of expertise is an asset in advising prospective clients and in bringing realism in the DFI's negotiation with prospective clients (Prabhu, 1996).

The DFI therefore needs to develop and maintain a small pool of qualified and experienced project appraisers who have a generalist orientation and can rapidly understand the essential details of the technologies that they need to assess. Experienced project appraisers-coordinators are valuable assets for the DFI. It is imperative for the DFI that its compensation, human resource and human resource development policies are able to attract and retain the best available talent. This is difficult given attractive alternate career options available for persons qualified in engineering and management. One notable exception is the Industrial Credit and Investment Corporation of India that has consistently attracted the best talent from India's business and engineering schools. One of the notable non-monetary perks that the DFI can offer its project appraisers-coordinators is board membership as DFI representative, on the firms that they have themselves appraised and financed. For fresh entrants, board memberships at a relatively young age, can act as a powerful motivator. Also as board members, the DFI project coordinators are able to help decision making in the firm by bringing in technological, managerial and industrial expertise from multiple projects (Jequier and Hu, 1989)

Benefits to the Firm

DFIs benefit the technology development initiatives that they support by enhancing the transformation of current resources into useful and viable future resources. They give firms indirect access to other funds - as investment by the DFI acts as reference about the project's quality and gives credibility to its promoters. Start up investment by a DFI also avoids opportunity loss for the firm due to lack of resources or appropriate knowledge. The DFI also helps through its monitoring and control activities. As interest in new technology venture investments by venture capital firms declines due to increasing technological risks, DFIs may have to increasingly fill this gap to enable the emergence of priority technology ventures. Some venture capital firms finance projects only from the prototype stage onwards. In such cases DFIs may have to take the role of investing at earlier stages in promising new technologies that are important for national development (Prabhu, 1996).

Benefits to the Nation

Developing country governments have promoted technology development through a variety of policy instruments - the most common being subsidies and tax credits. Though such "passive" forms of promotion (without active hands on involvement) can work in technological areas that have high interest levels within the nation's industrial community, the same may not be the case with some priority sector technological areas where the interest is low. Developmental finance is likely to increasingly take prominence over private finance for supporting investments in risky but essential priority sector technological research (Prabhu, 1996). In this scenario, the active hands-on role played by DFIs in this area can be superior to other "passive" modes adopted by national governments for encouraging priority sector technology development

Government Recognition of DFI Role

It is important that the national government recognize the role that a DFI can play in setting important technological trajectories. This recognition can manifest itself in the national government inviting the participation of DFIs in major technology promotion schemes as well as in involving them in technology policy formation and advisory bodies. Such recognition can reinforce the DFIs thinking and internal policy formation towards the selection and support of nationally important technological projects. It can also encourage the DFI in developing the

support infrastructure that facilitates the initiation of promising projects that address nationally important technological issues (Jequier and Hu, 1989)

Conclusions

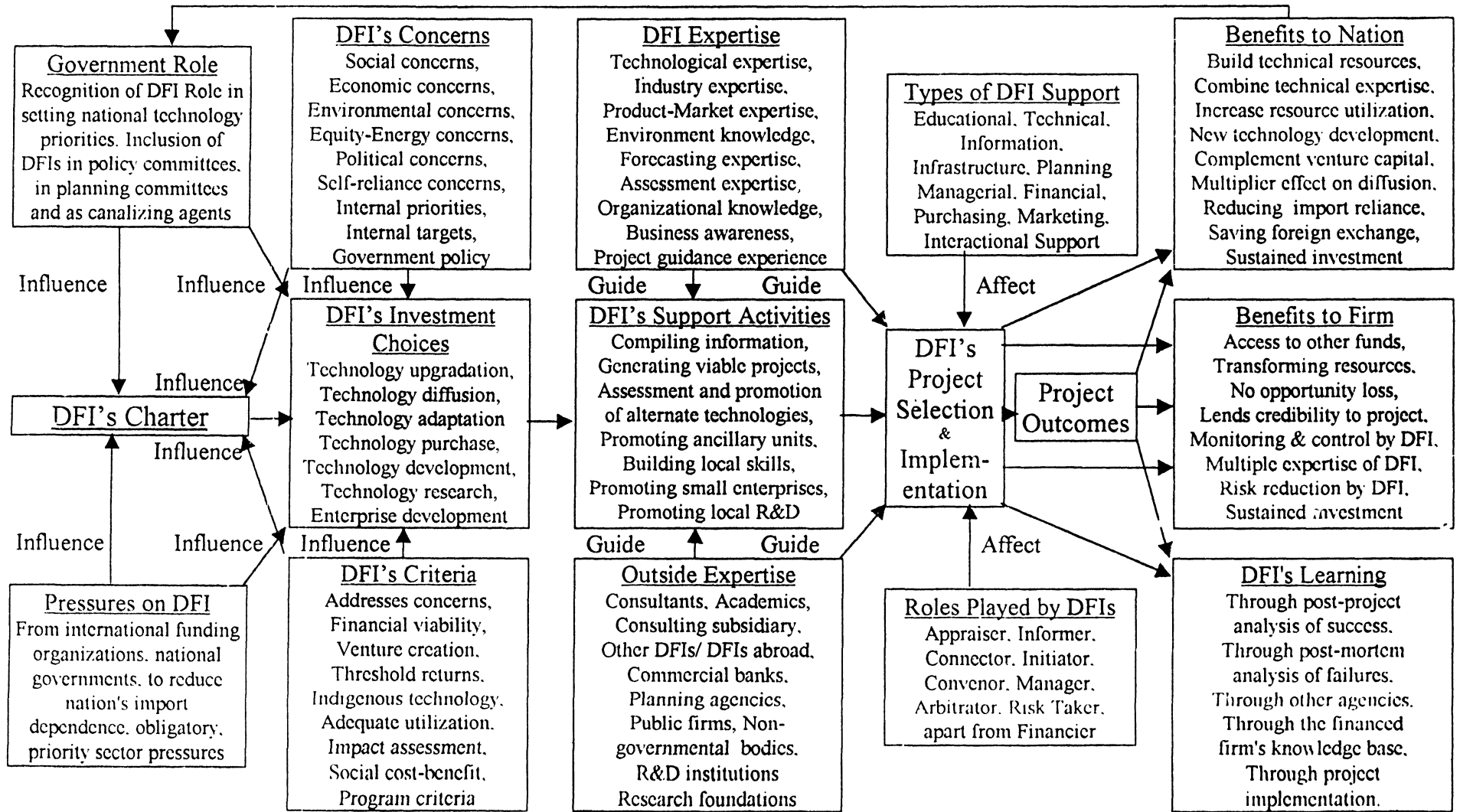
At present and in future, developing countries will be under increasing pressure to develop their own technology, and will have to rely less on imported technology. The developed nations are likely to be more wary of giving advanced technology to developing nations that could offer competition to them in future. As latest technology imports from the developed world become more difficult, developed country firms that lack internal technology development resources are exploring indigenous technology development facilities for new and cheaper technology (Prabhu, 1996). DFIs will play an important role in encouraging such trends towards indigenous technology development

It is therefore suggested that national governments in developing countries actively support their DFIs in playing their role in initiating and setting national technology trajectories in priority areas. They should help their DFIs in developing higher levels of expertise in understanding macro-level national technology priorities to enable them to set and guide appropriate national technology trajectories. They should also support their DFIs in training for developing their ability to make better micro-level technology assessments of initial individual projects that eventually set up nationally important technology trajectories. International development institutions can also support DFIs in developing countries by providing targeted technology funds to them through their national governments

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Figure 1: *Micro-Level Assessment of Technology by DFIs Leads to Setting of Macro Level Technology Trajectories*



← Micro-Level Assessment of Technology by DFI → Sets Macro Technology Trajectories →