

## **KNOWLEDGE AND TECHNOLOGY MARKETS**

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### **ABSTRACT**

On the recognition that the consolidation and stabilization of an advanced industrializing economy for further growth necessitates the development of a cluster of knowledge-based firms, this paper explores the dynamics of the knowledge-technology linkage. Essentially, overcoming the difficulties of the knowledge-technology-market interaction process and enhancing it are important challenges for strategists and policy makers. Thus, the objective is to establish a basis suitable for understanding the strategic implications of this linkage in the real economy.

### **INTRODUCTION**

#### **Knowledge and Technology**

Technology can be defined as those components of knowledge derived from the sciences, the arts and practical experiences to develop the tools and techniques that are used in the design, production and application of products, processes, systems and services--the real economy. Indeed, a former chairman of Texas Instruments asserted that science is a systematic pursuit of knowledge, while technology is the application of that knowledge to the production of specific goods and services. Technology is the design and manufacturing know-how to produce goods. Products are the results of technology but are not themselves technology. While science is the basis of technology, it is not technology. Gaynor (1996) goes on to define technology as a way of doing something, or of performing a value-chain activity. When a product is used to do something, it is that use which defines it as technology for the user.

From this context, it is useful to consider the notions of technology generation and technology application. Technology generators are the agents or organizations whose activities develop the knowledge that enables ideas, concepts, inventions and techniques of science and engineering to be rendered suitable for commercialized usage. Technology applicators are agents or organizations which use this knowledge to bring out new products. They are also involved in developing, modifying or improving current products into new forms. Notably, a given product may incorporate many technologies and firms are generally both generators and applicators of technology to varying degrees.

Under regimes of inter-firm competitive pressures and increasing sophistication in customer requirements, new and improved products are critical elements for the profitability and growth of firms. To transform new ideas and concepts into final products rapidly and cost effectively, new technologies need to be generated and applied optimally. This being the case, strategic

and economic motivations dictate the extent to which these technologies are to be developed in-company or acquired externally. Figure 1 schematically depicts the acquiring of external technologies to complement in-company capabilities in the process of product development.

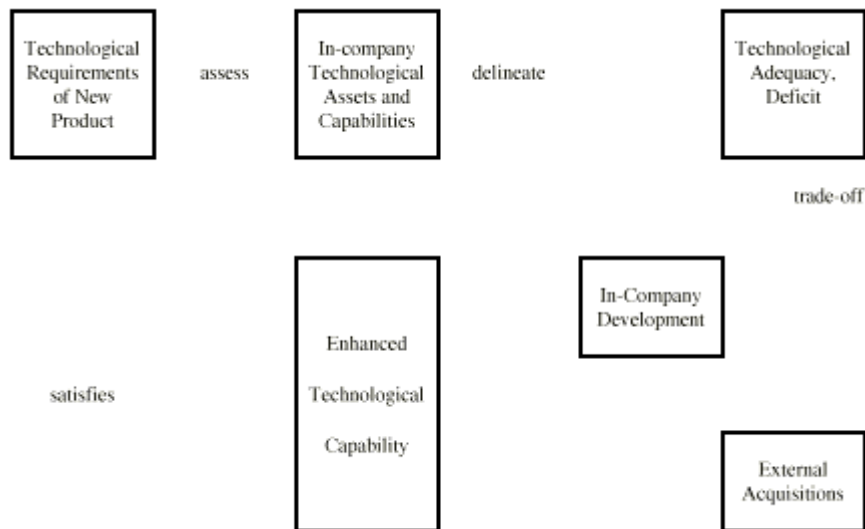


Figure 1. Technological Accounting in Product-Development

Also, and for similar motives, new technologies are required to improve productivity and effectiveness of manufacturing processes and operations. Consequently, the knowledge-technology linkage is concerned with the advancement of a firm through new understanding of the nature and value of products, processes, organizations and markets. It relates to enhancing the competence of a firm as it strives for competitive advantage by anticipating opportunities and responding ahead of industrial rivals.

## TECHNOLOGY AND THE NEED FOR A MARKET

Appropriately, technology is the ultimate know-how of scientific and engineering knowledge used to perform specified functions to achieve desired objectives. A technology can be conceptualized as a single technology if it encompasses a body of knowledge or know-how with special functional characteristics that distinguishes it from others. A technology may be used to delineate a set of product-markets related by a strong frame of association with a readily definable technology. For example, a machine-tool, such as a CNC machine is used to perform a production operation and is regarded as manufacturing technology.

However, even as a technology may or may not be discrete it is often not clearly reflected in a given product, and technologies are essentially inter-linked, integrated or indistinguishable in application and operation. This is attributable to the utilization of technologies as the imaginative configuration of knowledge to find solutions to problems. Technologically then, products are more integrated than ever as the output of one firm forms the parts or components of the products of another which in turn form those of larger systems. Firms must be adept at applying and adapting new technologies to useful and salable products. The attainment of the end result can be made more effective with the availability of a market process.

In the wake of intensifying industrial competition, the demand for knowledge-technology bearing-information spells the need for a technology market and network to propagate, transact, catalogue or index technology opportunities on offer. Such a market is essential for the successful and improved efficiency of the use of knowledge-technology resources. A technology market can be a means of bringing about a wider application of a technology. It has to be founded on open inquiry, information availability and firm culture that guides both technology generators and applicators to heed the essence and potential of the market mechanism. This function of the market is certainly multifaceted and will become more pronounced as the merging of different branches of knowledge flows into increasingly complex technology bundles.

A patents database is an aspect of such a market. The success of technology generation and application can be patented and protected as innovations or inventions. Many firms facilitate and advance their R and D programmes through the use of such databases. Their own achievements can be measured by the number of patents they market and contribute to this database. Technology generators and applicators should be aware of the existence and importance of patent databases in the search for new knowledge. With the existence of a market, firms can search or enquire of available technologies and avoid the duplication of proven efforts. As resources for R and D are scarce, they need not reinvent the wheel by wasting them. Advancements in information technology enhances market development and facilitate on-line searches through patent information. A following sequence of brokerage activities can help identify potential partners to a business investment or research project.

Technology markets are also needed to initiate new products or new applications for existing technologies. They provide a network of agents to catalogue license opportunities or to index licenses on offer or wanted. With technology licenses marketed and traded effectively, they help to provide engineering solutions to problems; to assess the technical feasibility and viability of new products on the drawing board. Sometimes, as a body of knowledge becomes available for the solution of a technological problem, an alert entrepreneur can see that as the foundation of a whole new set of industrial and business opportunities.

Consequently, a critical thinking of the relevant objectives and concepts of the knowledge-technology linkage and of the role of markets is in order, commensurate with the inherent creativity of a new information and knowledge oriented society.

## **AN ORIENTATION FOR A TECHNOLOGY MARKET**

To Mansfield (1971) technology is society's pool of knowledge regarding the industrial arts. Technology is society's assets. Trade in technology becomes more pressing with the current emphasis toward the globalization of manufacturing. Technology markets should be a network which offers more than the sum of the knowledge flowing through the linkages at a given time. It must be regarded as one dimension rather than as a separate subsystem of the economy. Trade in whatever form is recognized as a powerful engine for the enhancement of the quality of life through the generation of wealth for any economies; advanced, advancing or otherwise.

Knowledge-technology flows can be seen in the light of their role in keeping economies on the track of wealth generation. The immediate results and early exploitation of a new technology may lay the foundation for the advancement of this technology, but to promote an efficient allocation and utilization of society's resources the rapid and widespread diffusion of that

technology become important. This is a central function of technology markets. Figure 2 conceptualizes the interactive roles of the various agents in a technology market.

<u>Technology Generators</u>	Directions of Public Policy on Issues of:  Macro-economics  Education  Law  Industry  Micro-economics
Basic, Applied Development      R      and      Technology D;	
<u>Technology Markets</u>	
Broad-based, Customized, generalized technologies      application-specific	
<u>Technology Applicators</u>	
Technology adaptation      Direct Application of Technology	

**Figure 2: A Model of Technology Markets**

With an increase in technology trade and transactions, a firm's decision-making systems must be able to keep pace with the change demanded of it. They must be versed in be knowledge-technology market and be able to exploit the benefits of technology. With R and D and innovations as the basis of technology generation and application, a transaction for the sale-purchase of technology can be assessed at four levels of the activity; technology-production, product-market, strategic-competitive and financial considerations. Figure 3 shows the main issues to be evaluated from the two perspectives.

Technology	Product-Market	Strategic-Competitive	Financial
<b>Technology Generator</b>			
Uncertainty of new technology; safety performance, reliability	Opportunities for new products, processes	Resource utilization and acquisition	Cost outlay in development, sources of financing
Engineering-economic benefits	Needs to be met by new technology	Effectiveness and efficiency in resource utilization	Contribution towards required return on investment
Possible spin-offs, Business, technical obsolescence risks	Effect on market or industry standards, practices; other industries	Skills and knowledge sufficiency	Exposure to financial risks; risk-return profile of firm, time for development
Resources, time required to develop the technology	Expected speed of diffusion of technology	Frontiers of knowledge opened up	Effect on investment base of firm
Technological opportunities foregone	Conditions for technology benefits to be realized	Overall development cost	
<b>Technology Applicator</b>			
Effect of new technology on firm's technological assets	Size of market served with incorporation of new technology	Fit of technology firm's strategy	Cost outlay of acquisition, sources of financing
Extent of adaptation required	Opportunities for market growth	Contribution to operating strength of firm; synergy, productivity in use of resources	Consistency with firm's financial policy
Contribution to firm's future development efforts	Likely changes in product-market needs in future	Time, cost from acquisition to launch of product	Changes to financial position of firm
Expected performance of new technology in product, process	Pricing, promotion; perception and acceptance of product by market	Competitor's likely response to new technology	Contribution towards increase in sales
Extent of generator support needed	Effect on current products, markets	Alternative strategic opportunities	Risks involved in acquisition of technology

**Figure 3: Some Issues for Consideration in the Sale-Purchase of Technology** Technology is traded or transacted for a price for which firms have to account with anticipation of greater returns in the future. Firms operate with profitability objectives and have to strive towards them. Any investment in technology, generation or application, would have to be evaluated rigorously. But, their actions depend on the overall environment in which they operate.

**MOVING FORWARD**

To the extent that the emergence of a technology market is advocated, many firms are at risk of being excluded from the mainstream of such markets and of being unable to tap on the benefits offered. This exclusion or inability to access such a market may be a limitation on its effectiveness or efficiency. Nevertheless, at the level of the firm are be the motivations for the

identification of ideas to provide the lead for technology advancement. They provide each other with the rivalry and the challenge to undertake technological investments projects. For projects that are too heavy in investment outlays, they can cooperate through joint-ventures. From the perspective of the firm too, the rate of diffusion and adaptation of technology may be influenced by inter-firm rivalry. However, that firms have corporate objectives for technology development as part of their strategy implicates that while they may be the best agents for technology generation and application they may not be so for technology diffusion from the national perspective.

Thus, although public policies could be directed at encouraging innovations and R and D with incentives and assistance schemes, they are in effect encouraging an increasing diffusion of technology. Such activities are perceived as bringing benefits to a nation over and above those appropriating to the firm performing the innovation.

National policies set directions of growth and do influence the novelty of technologies developed as well as their rates of diffusion and adaptation by firms. Without the foresight of public policies, even firms in advanced developing economies are unsure as to the type of technologies they need. Since goods are demanded and marketed increasingly in the customized modes, more technology and information intensive products are needed. Lowering the risks involved in knowledge-technology transaction are helpful. As such, policy initiatives could be focused towards this aim. These include:

- Capabilities of technology generators and applicators.
- Quality of information about the nature of technologies available.
- Proper matching of the firms and of the technologies required and offered.
- Quality of information about the functioning of the technology markets.
- Encouraging cooperation between firms; streamlining the legal framework.
- High standards of technical and engineering practices.

## **CONCLUDING REMARKS**

The shaping and formalization of knowledge-technology markets as an integral part of wealth creation rest on the identification and characterization of knowledge-technology and information as assets in total. One can envision a nation which is knowledge driven and technology oriented. It has a strong culture of market perspective, identifying, communicating and transacting the elements of knowledge and technology purposefully and intensively. On a global scale, this should also be a possibility.

With the world moving fast towards globalization and information networks, nations will vigorously explore new approaches to technology and wealth creation. Some countries are tempted to enforce technology controls in the fear of losing national competitiveness, but information and communication development which lead to a more efficient information flow, can render controls impractical and counter productive.

A provocative view that can be forwarded from this analysis is that one can hope for the time when technology may flow freely. The implications are many. Until then, there must be raised the concern that yet many countries are outside the periphery to the benefits of any new technological world order. A fundamental rethink is necessary. Technology as a component of real wealth should be seen as facets of a global economic heritage rather than as images of an object of proprietary possession and insecurity. Undoubtedly, there will be a need to assess

the realities driving a move to relate the generation of knowledge-technology with the concomitant concepts of wealth creation and shared economic prosperity.

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