Technological Leapfrogging by the Chinese Banks in the People's Republic of China

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Abstract

Technological leapfrogging means adopting advanced technology immediately by a technologically backward country. Successful technological leapfrogging would mean that the technologically backward countries are exposed to unprecedented opportunities offer by the new and advanced technology. The possibility of achieving significant benefits through leapfrogging to advanced information technology seems exceptionally attractive. The intent of this paper is to determine the technological leapfrogging capability of an industry from a developing country that has a technologically backward background. The case study involved in this paper is the Chinese banking industry in the People's Republic of China.

Keywords

BA0213 Banking Industry, BD06 Computing in Developing Countries, HB05 Banking IS, UF Information Technology Adoption

INTRODUCTION

The advances in information technology have been very rapid and significant over the past decades. One of the notable technological breakthroughs in information technology is the convergence of computer technology and telecommunication technology, which enables information to be processed and transmitted at unprecedented speed and time. Significant benefits could be harnessed from this technological innovation in information technology – such as customer service improvement, costs reduction, productivity improvement, competitive and strategic relationship between the user and its customers (King 2000, Terry 2000, Fong 1999, Porter and Millar 1985, Cash and Konsynski 1985). In fact, information technology not only has the capability in creating competitive and strategic relationship at the industry and national levels (Roccapriore 2000, Ungson and Trudel 1998, Branscomb 1994), but also in extending this relationship to the global level (as evidenced by the internet capability). This implies that the technology is capable of speeding up globalisation and intensifying competition among nations. This compelling potential of information technology has actually triggered off the pursuit of information superhighway[1] in the developed nations and in industrialising countries (Jeong and King 1997, Wong 1997, Kahin 1997, Petrazzini and Harindranath 1997, Vedel 1997, West et al. 1997). Developing countries, especially the technologically backward countries that have been trying to integrate into the world market for economic development, are aware of the powerful impact of information superhighway. It is risky to ignore the rapid advancement of information technology and its potential because the non-adopters will run the risk of missing out on new horizon opportunities unleashed by the technology.

Comparatively, the developed nations are more established and experienced in the adoption and application of information technology because they were the early adopters of information technology. Their experience in the adoption and application of information technology generally involved an evolutionary process, in which these countries tend to replace their superseded technology with the new and advanced technology as the latter emerged in the market place. The developing countries were, on the other hand, late adopters of information technology and are more technologically backward than its developed counterparts. With the relative ease of access to advanced technology in today's world[2], this raised the question on the extent of developing countries (which are still using traditional or backward technology) adopting advanced technology immediately (termed as "technological leapfrogging") rather than proceeding by mastering intermediate technologies in turn (refer to Appendix 1). Successful technological leapfrogging has significant impact on the technologically backward countries as they are exposed to unprecedented opportunities offer by the new and advanced technology. The intent of this paper is to determine the technological leapfrogging capability of an industry from a developing country that has a technologically backward background, which is the Chinese banking industry in the People's Republic of China. This paper will first discuss the concept and relevance of technological leapfrogging. In this discussion, it considers the value of technological leapfrogging from the characteristics of advanced technology and intermediate technology for the purpose of identifying the optimal technology for adoption based on these characteristics. Subsequently, the Chinese banking industry's technological leapfrogging capability is determined through tracing its technological path and through analysis based on using a grid (which was constructed based on insights gained from literature on both the generic technology and specific information technology).

TECHNOLOGICAL LEAPFROGGING BY TECHNOLOGICALLY BACKWARD COUNTRY

The technological leapfrogging concept was first established by Soete (1985), from his observation of the microelectronic industry which allowed rapid industrialisation within the adopting countries. The concept has received recognition of its bearing on information technology applications in the developing countries since the early 1990s (Antonelli 1991, Mody and Dahlman 1992, Lamberton 1994). However, there is limited evidence to determine the actual occurrence of technological leapfrogging in the developing countries involving this new technology (Sharif 1989 and Ausubel 1991). This paper serves as an initial effort to contribute to this relatively new field of study on technological leapfrogging in information technology.

Because the technologically backward country has been inactive in the adoption of each newly emerged intermediate level of technology, it has the option of adopting either intermediate technology or latest 'state-of-the-art' technology (technological leapfrogging) in its late decision to invest in technology for production. According to the World Bank and the Asian Productivity Organisation (Hanna et al. 1995 and APO 1990), information technology provides developing countries with the opportunity to accelerate economic development. The advent of this technology to each higher stage level is commonly associated with greater technological capability potential. Adopting the latest 'state-of-the-art' technology would mean that this once technologically backward country is exposed to the unprecedented opportunities offer by the new technology. These unprecedented technological opportunities were not readily accessible to the advanced countries without incurring (intermediate technology) displacement costs in these countries, due to their previous intermediate technology structure. Thus, the late adopter in technology may be able to avoid incurring the

time delays and the costs that were incurred by the advanced countries in their active adoption of each newly emerged intermediate level of technology. The possibility of achieving significant economic growth through leapfrogging to advanced information technology thus seems exceptionally attractive to developing countries.

RELEVANCE OF TECHNOLOGICAL LEAPFROGGING

There are particular features of the information technology developments taking place in the past decade that seem to increase the relevance of this concept to the developing countries. When the following features of the advanced information technology are contrasted against the intermediate information technology, technological leapfrogging seems to qualify as an inevitable move in information technology adoption.

Firstly, the rapid decline in the prices of microelectronics has made information technology applications affordable to the developing countries. Secondly, the favourable implications of advanced information technology to an economy do not present intermediate technology as the appropriate choice for adoption. Why should a developing country commit themselves to intermediate technology while the more advanced countries are pursuing a sophisticated national information infrastructure (national information superhighway), even with the foresight of a global dimension (global information superhighway)? Thirdly, recent trends in information technology places less demand on knowledge and experience accumulation, emphasising ease of use – that is, the human-computer interface factor in technology development. This area of focus in technology development is highly evident in funding criteria for technology R&D, training, design development and market demand (Australian Science and Technology Council 1990). An effective human-computer interface was found to share a strong positive correlation coefficient with learning ability, performance speed and user satisfaction (Shneiderman 1992)

OPPOSITION TO TECHNOLOGICAL LEAPFROGGING

The relevance of the technological leapfrogging concept still remains unresolved for developing countries. There are opponents who doubt the ability of the developing countries to take advantage of information technology leapfrogging (as found by Hanna et al. 1995). Those who oppose the idea of technological leapfrogging in information technology could make use of two perspectives drawn from technological leapfrogging in generic technology. One is that leapfrogging runs in contradiction to the accumulative nature of the learning process (Pavitt 1984, Hobday 1994); the other is that new technology has a strong tendency to undermine the social structure, and to dismantle the existing stock of human and physical resources (ILO 1985a & b, Wang 1991). In other words, an ‘unprepared’ (lack of prior knowledge and experience) economy or society would not be able to cope with the new technological paradigm nor to exploit the potential it offers (Jian 1995).

However, it is noted that advanced technology does not necessary brings only hardship to the adopting entities. The social context of a developing country may turn out to favour technological leapfrogging. For example, the status symbol associated with owning a mobile phone has not only led to a quick diffusion of the mobile phone technology in the People’s Republic of China, but the social consciousness of being seen with the latest mobile phone model has driven technology leapfrogging in this area in the country. On similar ground, the pattern of mobile phone adoption fits the Chinese business and organisation environment well. This is because most managers of local Chinese companies do not often have the privilege to work in clean and nice offices. The mobile phone technology provides a mobile office environment for them to conduct businesses in more appropriate settings with their

clients. Thus, advanced technology may not present the same challenges to organisations from different social environments, its unprecedented potential may befit the social condition of the technology adopting entities.

THE GRID

The value of technological leapfrogging in information technology for China must be evaluated in light of its domestic banking capability to do so, and also of the characteristics of advanced information technology versus other intermediate information technology available for adoption. To facilitate analysis of the technological leapfrogging situation in China, information technology adoption in the banking context is viewed from the perspective of the technology embodied in equipment (y-axis) and of the exploitation of its potential benefits for the work process (x-axis) as per Figure 1.

Work Process refers to the way inputs or objects (people, ideas, materials, methods, and machines) being integrated within and between organizations to achieve the objective or complete a task/job (Spain 1996). The different degrees of integrating inputs or objects can be represented on a continuum, ranging from traditional process at one end to best practice at another end. In the context of the Chinese banking industry, traditional process refers to the centrally planned work system where functions are distinctly segregated and defined. Best practice, on the other hand, has been generally used to mean high performance in a particular practice or process. The author adopts the definition of Australian Manufacturing Council (1994) which refers to the way which business activities in all key processes are undertaken and integrated, leading to world-class, superior performance in quality and customer service, flexibility, timeliness, innovation, cost and competitiveness.

Technology. Intermediate technology refers to earlier technology that became obsolete because advanced technology offering better and more powerful technological capabilities became available from the market. In this paper, new technology refers to advanced technology. Traditional technology refers to the heavy reliance on manual method rather than automation through the adoption of technology.

The grid shows that there are several ways of complementing technology and work process, which are explained in the following paragraphs:

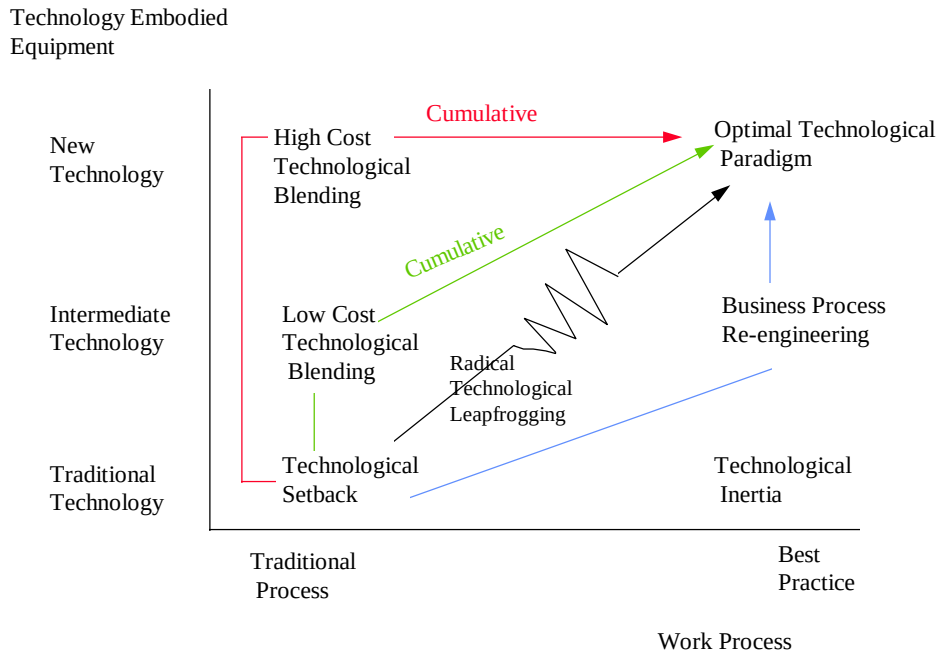

Figure 1: Technological Leapfrogging Grid

i) High Cost Technological Blending. This term is adapted from the definition of 'technological blending' used by the ILO (1985a), which encouraged developing countries to integrate newly emerged production technologies with traditional modes of work process. The purpose is to achieve higher productivity with minimal social disruption. This technology strategy requires the undertaking of substantial investment costs in acquiring new technology equipment and in transforming resources, as well as the bearing of costs related to equipment underutilisation. This might result in a costly and highly underutilised investment instead of higher productivity, if the advanced technology is taken on without a clear long-term strategy to build the capability of personnel and institutions to harness the technological potential. This was evident in the People's Republic of China during the 1970s, when advanced production technology was imported for the sake of modernisation, but without appropriate support structures.

ii) Low Cost Technological Blending. This is a situation where the developing country adopts appropriate or intermediate technology[3] to suit the specific internal conditions or domestic environment. This involves lower investment costs and imposes less demand on the transformation of local resources. Unless the rationale of such investment is to allow for a cumulative learning process to occur at an appropriate pace, and there is a plan to embark on a higher level of technology in the near future, the country will be destined to lag behind the technological frontier. In addition, this rationale also has to be endorsed with a strong commitment to bear the substantial replacement costs which will be involved when discarding the intermediate technology for the next newly emerged technology. Otherwise, the technologically backward country may remain in its original backward position, or find itself stuck in a specialised subordinate role to the perpetually dominating advanced nations.

iii) Technological Setback refers to the situation where internal organisational factors and conditions (such as organization structure, task/systems, people, culture and strategy) are not favourable to science and technology development in the country. For example, the Cultural

Revolution era in the history of the People's Republic of China has adversely hindered technological progress in the economy.

iv) Technological Inertia. This is an extreme situation where obsolete technology remains in use or a fully manual process remains in existence, and where improvement in the work process is non-technological based. The 'autarky' situation during the Great Leap Forward period (1958 to 1960) in China relates to such situation, where the opportunity for foreign technology access is highly limited and the 'self-reliant' technological capability of the country is weak. To overcome the technology supply shortfall, the then leader Mao Zedong attempted to enhance the productivity of the other factors of production or of work activities. It was during this period that the substitutability of labour for capital and labour's capability in technology exploitation were encouraged in massive propaganda campaigns.

v) Business Process Re-engineering involves a combination of intermediate technology and redesigned human tasks and business processes. This tends to occur in advanced countries which they are committed to a structure of intermediate technology and do not see the economic advantage in replacing it with the latest technology. This approach involves studying the impact of the committed technology and sought to identify ways to further exploit this technology as a tool for enhancing productivity and benefits. Since 1990, developed countries, like Australia and the USA, are increasingly undertaking this approach to ensure existing information technology potential is effectively harnessed (Banaghan 1996).

vi) Optimal Technological Paradigm refers to the situation where the entity is well positioned in all aspects to fully exploit the potential of the latest state-of-the-art technology. The movement from 'technological setback' position to 'optimal technological paradigm' represents the paradigm of a successful attempt at technological leapfrogging. Computer networks utilising groupware can support an integrated workflow. In this paradigm, best practice work process is enabled or enhanced by advanced information technology that is moving towards unified engineering software suite, vendor consolidation and alliances and open systems and standards. Because of the unified engineering environment and the open standards, these allow interoperability of models and software systems that were sourced from different suppliers or manufacturers without the need to pursue special user interface. As a result, the advanced technology can be used for innovation and organisational improvement to promote customer focus and to provide continuous improvement in cost, quality and delivery within and between different organisation in the supply chain.

RELEVANT FEATURES OF THE CHINESE EXPERIENCE

In assessing the domestic capability of the Chinese banking system in technological leapfrogging, the relevant features of the Chinese experience in technology adoption are outlined in the below paragraphs as per Fong's (1998) study.

A major feature of the adoption and diffusion processes in China is that the learning paradigm of most users in the banking system is largely based on advanced technologies (at least late 1980s generation technologies). That is, by and large the Chinese banks have jumped straight to advanced information technology products. There were a few cases where the lower level bank branches (which are located in the rural areas) adopted intermediate technologies during the Eighth Five-Year-Plan (1991 to 1995). These intermediate technologies were the then advanced technology adopted by the higher level bank branches (which are located in the city areas) in the early 1980s, and were subsequently handed down to the lower level bank branches in the rural areas for learning purposes. These technologies were largely standalone

computers. However, it was arranged by the banking headquarters that these lower level bank branches will adopt new technology during the Ninth Five-Year-Plan period (1996 to 2000), whereby sophisticated communication systems would be linked to the applications of the new technologies. The technological usage paradigm differed, to a limited extent, in these two situations. The higher-level bank branches were involved in the use of newly emerged technology at their initial point of technology adoption and, thus, traced a cumulative learning trajectory within an advanced technology paradigm. On the other hand, those lower level bank branches, where their initial adoption experience involved intermediate technology, adopted intermediate technology in the form of standalone computers that were a number of years behind the newly emerged technology in the marketplace at that time. In this sense, when these lower level bank branches came to adopt newly emerged technology in the Ninth Five-Year-Plan period, the whole adoption process became a process of blended technology usage. This, however, has had less disruption to their learning experience than might have been the case, because the initial application with the intermediate technology was largely confined to standalone computers for basic learning purposes.

There are two possible extreme outcomes from radical technological leapfrogging. Technological leapfrogging has the potential of bestowing unprecedented technological possibilities on the banking system and on the other hand, it also has the possibility of adverse impacts, by shocking the traditional system through a sudden technological transplantation. Despite technological leapfrogging in the technical sense, the advanced technologies adopted in the Chinese banking system were underutilised and underexploited (Fong 1998). This was due to factors such as the limited capability of the human resources, systems and infrastructure to immediately and fully exploit the advanced technological potential. Among these factors, a significant technical attribute that hindered the full exploitation of the technological leapfrogging concept was the prolonged usage life span of the adopted technology. Although the average equipment life was reduced from 10 years (before 1980s) to between 6 to 8 years, it still lagged behind the international standard rate of depreciation that has been between 3 to 5 years (Mao 1994).

When the usage life span of those information technology products is taken into consideration on an aggregate basis, it was evident that a pattern of widespread technology incompatibility and of different stages of technology adoption was common within the different banks. The technology adopted initially may have been newly emerged technology at that time, but because of prolonged and variable usage life spans, a mixture of often inconsistent new and intermediate technologies were being employed at any time. This meant that, despite the general occurrence of technology leapfrogging in the adoption process, the lack of coherent standards in usage life span for information technology prevented the full technical exploitation of the potential of new technology across different banking systems.

The gap between the potential benefits from technology leapfrogging and that achieved from actual technology usage was further aggravated by the absence of deliberate coordinating efforts to achieve technology unification and standardisation, at both the organisation and national levels. In addition, the Chinese method of innovation adoption normally involves a trial period confined to a specific geographical venue, before implementation is carried out on a wider scale. This, together with the inherent intricacies in the transitional system, led to the new technology permeating the system on a gradual basis. Hence, the potential adverse impact of technology leapfrogging did not materialise to drastically affect all levels of the organisation within a short period of time.

TECHNOLOGICAL LEAPFROGGING IN CHINA

In the technological leapfrogging approach, the immediate transformation of work process to complement or exploit the new technology would introduce 'shocks' into the banking system at both the micro and macro level. In the context of the Chinese banking system, radical technological leapfrogging, in terms of advanced technology equipment and complementary best practice work process, could upset the functioning of a market economy that is still in transition and that is still rudimentary in coping with the impact of technology. The transitional Chinese economy would have considerable difficulties in coping with socio-economic repercussions, such as unemployment and the demand for skills, which would be likely to result from the radical approach.

In the case of the Chinese banks, their technology adoption process thus far can best be described as the high cost technology blending approach, with some elements of the low cost technology blending approach. The high cost technology blending approach involves an advanced technology paradigm for usage and learning to take place on a gradual basis. Given the open system features of the advanced technology, the applications from such technology will remain relevant for a considerable period of time and will thus provide undisrupted continuity in the learning process. In addition, the ease of usage features also represent positive benefits to the learning process. Although the high cost technology blending approach has its attractions, it does involve an initial high set-up cost and low returns on investment for a considerable period. The high cost technology blending approach requires a high degree of tolerance towards technological capability underutilisation, while the work process is being reformed or restructured on an evolutionary or transitional basis. Despite the falling cost of information technology (Braga 1996 and Wallis Report 1996), the Chinese banks have been unable to fully enjoy this advantage because of the weak condition of their organisational factors and resources. It is envisaged that when these factors and resources have achieved a reasonable level of capability in exploiting advanced technology that the Chinese banks may then be able to enjoy the falling cost of collecting, storing and analysing information. Perhaps, at that point of time, the resistance to the cost of new technology adoption within the Chinese banks may be eroded by the improvement in this capability.

The eventual achievement from the high cost technology blending approach should be the optimal technological paradigm, where new technology is complemented by best practice in the work process. As at the end of 1995 (even into the late 1990s), the type of technology adopted and nature of the complementary work process transition in most of the banks show signs of resembling the high cost blending approach, although considerable effort is needed to reform the work process to exploit the applied advanced technology fully.

As noted above, in some cases the lower level branches in the rural areas started off using intermediate technology before progressing to advanced technology. The approach in these cases involved the initial adoption of the low cost technology blending approach and eventually, a move to a high cost technology blending approach. The realisation of the optimal technological paradigm has to be achieved not only through the adoption of new technology, but it requires work process to be reformed to complement the new technology.

In both the technology blending approaches (high cost and low cost) for the Chinese banking system, the progression towards the optimal technological paradigm requires capability issues to be resolved. The capability issues involved were identified in Fong (1998): clearer business structures and strategies, increased funds availability, technology efficiency, adoption of a total management approach, thoroughgoing business process re-engineering, increased skill availability, and development of a transparent operating environment and reliable infrastructure. Government support is considered crucial for realising the movement

of the banks towards the optimal technological paradigm. The Chinese government's role constitutes an essential element in assisting to remedy the deficiencies in the system.

CONCLUSION

From the above discussion, it is clear that leapfrogging of information technology to advanced products and systems is inevitable in the twenty-first century for the Chinese banking system, but has to be adapted to the respective local conditions of the industry and the country. The high cost and low cost technology blending approaches appear to be the appropriate strategy for advanced technology adoption for the banks. However, reforms on the identified capability issues have to be consistently undertaken, to remove the negative factors in the work process that impede the full exploitation of the potential of advanced technology.

From the case of the Chinese banking industry in the People's Republic of China, it appears likely that technological leapfrogging is an inevitable move in information technology adoption for most industries and most developing countries in this twenty-one century era, based on the increasingly powerful characteristics of emerging technologies. But this must be implemented in accordance with the local conditions of the technology adopting entity and having regard to the capabilities, traditions, culture and objectives of both businesses and consumers. Nevertheless, the above discussion on technology leapfrogging invites further crystallisation by future research work, since this topic is relatively new in the information technology research field. On the whole, technology leapfrogging in information technology constitutes a field of study that deserves future research attention. This is especially pertinent to the technologically backward developing countries.

ENDNOTE

1. 'Information superhighway' is envisaged to be an efficient electronic network that links up most existing users and is supported by sophisticated information technology and operating environments, enabling information to be processed and transmitted in the fastest possible way (high-speed) and in the most flexible form (voice, video, data) possible.

2. This is in contrast to the Cold War period during which some of the developing countries were specifically prevented from procuring leading-edge technology, such as computer hardware, computer software, telecommunications switching equipment and related technology for the possibility of a military buildup.

3. The intermediate technology approach was popularised in the 1970s by British economist E. F. Schumacher (1973), who advocates the view that technological leapfrogging will inflict misery on the population in the developing countries.

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APPENDIX 1

The concepts of evolutionary process of information technology adoption and technological leapfrogging are illustrated in Figures 2 and 3. Figure 2 provides a simplified illustration of the evolutionary process of information technology adoption in the developed countries. This illustration was constructed on the assumption that the stages of technology development could be presented by a neat series of steps and that higher technological superiority is attached to each higher stage of technology development. The diagram shows that costs are incurred by the technologically advanced developed countries in their active adoption of each newly emerged intermediate level of technology and in the displacement of their superseded

intermediate technology structures that were incompatible to the newly emerged technology. Figure 3 portrays the concept of technological leapfrogging, in which a technological backward country skips intermediate technologies and goes straight to the latest state-of-art technology.

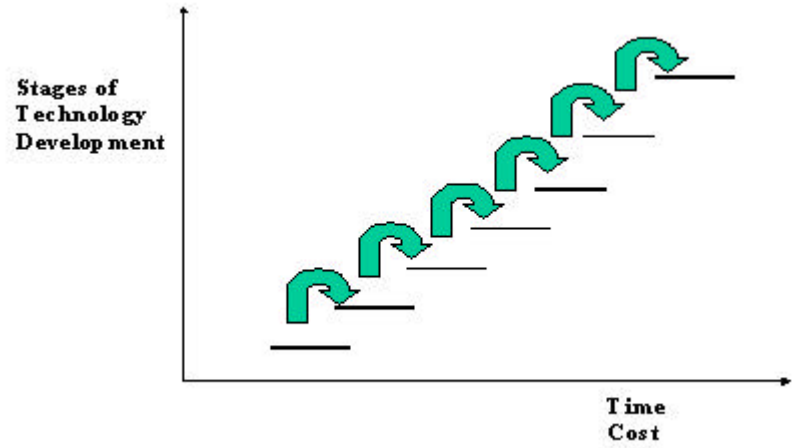

Figure 2: Adoption of information technology in developed countries

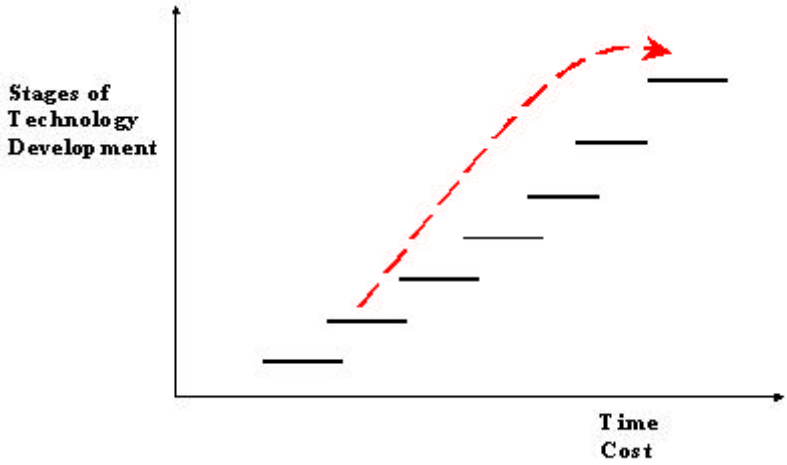

Figure 3: Technological leapfrogging by developing countries

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