Learning, Technology Acquisition and Governance Challenges in Developing Countries

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Abstract: Development is fundamentally about learning to use modern technologies to create jobs and prosperity in poor countries. Poor countries cannot produce their way out of poverty despite their low wages because even if they have some formal skills, they cannot actually use modern machines at competitive levels of efficiency. The most important missing ingredient is *tacit knowledge*, the knowledge that cannot be learnt in manuals but has to be acquired through learning-by-doing. The implication of this simple observation is that startup firms in developing countries will have to finance periods of loss-making while the tacit knowledge is being acquired through practice. The market failure that constrains economic development most seriously is that investors cannot be sure that they will be able to enforce the levels of *effort* that will make this investment viable. The institutional and governance conditions that ensure high levels of effort in learning in at least some sectors are vital and perhaps the most important preconditions for any policy aiming to sustain development.

Old-style industrial policies failed because they could not ensure effort. The abandonment of ambitious industrial policy did not remove the market failure, which still needs to be addressed. Today, firms and countries are trying to finance these learning attempts in a multitude of different ways. The success of countries and sectors in 'the market' depends on the variables that determine whether their financing strategies will work. We argue that the effectiveness of any *'financing instrument'* applied to the learning process depends on the interaction and appropriateness of three other sets of variables: the *governance agencies* implicitly responsible for enforcing the terms of the instrument, the *firm structures* describing the internal hierarchies of firms, their relationships with the state and the markets they operate in and the broadly defined *political settlement* that describes the relevant distribution of power between the different agents involved in the learning and financing process.

Through a set of extensive case studies in Thailand, India, Bangladesh and Tanzania, we show that this approach can explain the emergence of competitive success in their most important high growth sectors. The success of these sectors depended not just on access to the market in a liberal economy but much more fundamentally on deliberate and accidental factors that combined specific financing instruments with appropriate combinations of governance, market and political factors that ensured high levels of effort, and therefore the achievement of global competitiveness. As these factors are interactive, blueprints are not transferable, but the methodology provides a guide for thinking through in policy terms, the types of financing instruments and governance capabilities that are most likely to work in different contexts. The analysis also prioritizes different types of market failures affecting technology acquisition, and allows us to think through the most effective way of sequencing policy. It establishes the importance of limiting technology support to sectors where success is most likely. But it also establishes that without specific policies to develop technological capabilities, the market by itself will not pull sectors, regions and countries with low capabilities towards sustained development.

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Acknowledgements

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Introduction

This paper builds on our analysis of the growth experiences in our sample of countries that was developed and presented in an earlier paper in this series (Khan 2008b: 270). In that paper we provided an overview of the growth strategies pursued by our sample of economies (Thailand, Maharashtra, West Bengal, Bangladesh and Tanzania) since the 1960s and the relationship of these growth strategies to the changing pattern of rents that characterized each economy. The general economic policies and phases of growth in these countries will therefore not be further discussed in this paper. Here we develop that analysis further by looking in greater detail at some specific problems of technology acquisition and learning in our countries. We do this by developing a general analysis of learning and technology acquisition problems that we believe are of relevance across developing countries. We then use this analysis to structure a number of detailed case studies of country and company experiences with technology acquisition, development and learning. These case studies are based on in-depth interviews and in many cases factory visits to production sites. The case studies shed light on the relevance of some of the problems identified in the theoretical analysis. This analysis contributes to the contemporary policy discussion about the relevance and significance of a number of different 'market failures' that may be constraining technology acquisition in developing countries. This discussion is important for determining the appropriate focus for policy aiming to accelerate technology acquisition in developing countries.

Developing countries have found it very difficult to industrialize and to modernize their traditional agricultural sectors, despite low wages and large underemployed labour forces. A variety of factors have limited the ease with which new technologies could be absorbed and learnt on any significant scale. Even when the relevant technology is freely available, developing countries typically lack the capability to adopt, learn or adapt these technologies. In addition, some technologies may be owned by individuals or companies in advanced countries. With the growing protection and control of intellectual property rights an additional challenge for developing countries is to achieve a transfer of foreign-owned technologies to domestic companies. This can be a significant problem for middle income countries trying to achieve integrated production processes in their national economy so that high value-adding activities of design and innovation can be integrated with domestic production processes. The latter is also a learning and adaptation problem but with additional constraints set by the external ownership of intellectual property rights.

In the 1950s and 1960s there were ambitious attempts in many developing countries to develop technological capabilities through ambitious 'industrial policies'. In most cases, including in our sample of countries, this took the form of infant industry protection to develop technological capabilities at the sectoral-level through a variety of instruments including import protection, export subsidies, subsidized credit, subsidies on inputs and other related subsidies. But by the late 1970s these strategies began to be abandoned. Despite the spectacular success of some East Asian countries, in most countries, even when performance was initially good, it was subsequently less so and the proliferation of subsidies eventually made the cost of financing increasingly unsustainable.

The reasons why industrial policy performed so differently across countries and even across sectors *within* a country have to do with differences in the underlying market failures and the appropriateness of the institutional and political responses. Clearly, most developing countries did not have the institutional capabilities to manage the ambitious industrial policy interventions they had attempted. Nevertheless, despite these limitations, in *some* of these countries, early attempts to adopt new technologies in the 1950s and beyond *did* achieve significant pockets of technological capabilities. These capabilities allowed them to benefit most from the 'liberalization' that began in the 1980s. The apparent success of liberalization in some developing countries cannot be understood without looking at the capabilities that were built up in the previous period. In some cases significant new capabilities continued to be developed through new mechanisms in the 1980s. It is important to understand the nature of these different responses to be able to respond adequately in countries with different technological characteristics and suffering from different types of market failures.

In our review of growth experiences in our sample of countries in Khan (2008b) we saw that growth takeoffs were based on very different capabilities and involved different combinations of policy-determined and accidental 'rents'. In our least developed countries, the acceleration of manufacturing growth in the 1980s depended on incentives created by fortuitous rents that allowed capability development and investments in new sectors. The story of the garments industry in Bangladesh is a classic example of this. The growth of investments in Tanzania was also assisted by rents in the mining sector but here with more limited implications for employment generation and the development of broader technological capabilities. In India a vital role was played by firms and sectors that had built capabilities during the industrial policy period. Some of these firms had developed high enough levels of capabilities to drive further capability acquisition on their own or through foreign partnerships after liberalization. But much of the Indian economy remains at very low levels of technological capability manifested in very unequal regional and sectoral growth patterns. In all these countries, the challenge is to learn appropriate lessons from their pockets of success and build new capabilities in new sectors and regions.

In Thailand liberalization was more extensive and more rapid than in India because it took place in the aftermath of the 1997 crisis. Many domestic capabilities were unnecessarily destroyed by an excessively rapid opening up, and foreign technology providers played a significant role in the subsequent growth. To attract foreign companies, intellectual property rights were strongly protected and foreign multinationals were allowed to become majority partners in joint ventures. These policies induced foreign investors, particularly Japanese corporations, to relocate the assembly of products using advanced technologies to Thailand. But behind the rapid growth in manufacturing, worrying questions have emerged. As a middle income country without strong national technological capabilities, Thailand faces a double squeeze from cheaper wage assemblers in China and elsewhere and the difficulties of moving up the value chain in a context where high end technologies are closely controlled by multinational companies. Thailand remains vulnerable to the locational decisions of foreign multinationals in a region where alternative locations are striving to emerge.

Table 1 Labour Productivity as Percentage of OECD Level

	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Whole Economy							
China				2.1	2.2	3.1	3.8
India			1.6	1.8	1.9		2.2
Thailand	4.5	5.2	5.4	5.6	7.4	8.5	8.3
Industry							
China				3.1	3.8	6.4	8.7
India			2.5	2.4	2.8		2.9
Thailand	11.0	12.7	12.8	14.9	15.9	15.9	15.7
Manufacturing							
China				3.3	3.8	4.6	7.0
India			5.7	6.6	8.3		10.2
Thailand	11.4	14.1	14.6	16.7	19.8	20.4	18.7

Source: ADB (2007: Using underlying data for Figs. 3.1.4, 3.1.5 and 3.1.6). All productivities measured in constant 2000 dollars.

The productivity performance of China, India and Thailand relative to the global frontier defined by the OECD countries is shown in Table 1. It shows that these countries converged somewhat towards frontier productivity levels, though at a very slow pace. Bangladesh and Tanzania which were further downstream in manufacturing technologies made slower progress but nevertheless enjoyed rapid growth in output (Khan 2008b). But almost three decades after their growth accelerations began in the 1980s, all our countries remain far away from the global technology and productivity frontier defined by the OECD countries, and their convergence is slower than the pace achieved by earlier East Asian developers (ADB 2007; Felipe and Estrada 2007).

Our basic argument is that convergence depended on a variety of arrangements that allowed countries to address market failures constraining technology acquisition to varying extents. These arrangements differed significantly across countries in their scope and success, and in the 1980s our countries certainly did not follow their own earlier ambitious industrial policies. Nevertheless, we argue that growth was still based on their relative success in addressing market failures affecting technology acquisition. We argue that the most important market failures were those affecting the process of *learning how to use new technologies* in different sectors. Learning involves the absorption of tacit knowledge and therefore can only be achieved by *doing*. This simple observation has significant implications. Success in learning-by-doing involves investors (who can be private or social) financing a period of implicit loss-making. But the financing here is subject to severe potential market failures because the success of learning depends on levels of effort that may be difficult to enforce. A number of institutional and political conditions can therefore determine the likely success of catching up processes. Understanding the nature of these market failures is vital for devising appropriate policy responses. This is particularly important because a range of other market failures have been suggested in the literature as potentially constraining technology acquisition. It is important to categorize and distinguish between them because each has very different policy implications. Using extensive case studies, we argue that the market failures affecting learning and effort are the most important ones for policy to address. This has significant policy implications.

The challenge of sustaining growth after liberalization is twofold. First, for the sectors and firms that did well because they either already had or managed to improve technological capabilities the challenge is to sustain the process of upgrading. Will their existing institutional arrangements suffice? Many growth sectors may actually be vulnerable even though their historic performance has been exceptionally strong. Secondly, large parts of the economy have not yet benefited from previous attempts at capability development and for these sectors and regions the gains from liberalization have been very limited. Here the challenge is even more significant. A better understanding of the success that has been achieved in some sectors and countries needs to be deployed to achieve a broader-based growth. An understanding of the institutional conditions explaining success and failure can help to change the debate about the conditions required for sustaining and deepening the gains from liberalization in developing countries.

1. The Catching up Problem

Developing countries find it difficult to catch up despite their significantly low wages and large pools of underemployed labour, often with many unemployed workers having respectable levels of formal education. This paradox can be explained in terms of a simple catching up model. Competitiveness depends not just on wages but also on the productivity of labour, and its effectiveness in converting expensive (often imported) inputs into outputs. The productivity of labour and input use depend not just on the formal education of workers and managers, but more significantly on their tacit knowledge embodied in routines of production that can only be learnt through actual practice. Without more or less long periods spent in learning-by-doing, a developing country typically has productivity levels that are too low for it to competitively engage in production. This is even true for many relatively low quality and basic production processes. As a result, a new firm or even an entire country can find entry into even low-quality production blocked.

Competitiveness depends on both price and quality. Developing countries are entering a global market where products have established price-quality combinations and for many products there are minimum product qualities below which it is not possible to find a market regardless of price. The simplest way to capture critical features of the problem is to define products as combinations of characteristics. Broad clusters of characteristics define a particular type of product, but any product also has detailed characteristics of reliability, performance, attractiveness, design and a range of other functions that can distinguish particular products within the broad group in terms of ‘quality’ (Lancaster 1966; Sutton 2005, 2007).

Clearly, products like garments, cars or television sets are differentiated by quality. A product of a broad type like a ‘car’ must have enough common characteristics with other cars to be classified as such, but cars are distinguished by detailed characteristics that make them more or less desirable for consumers. Consumers are willing to pay a higher price for characteristics like performance, durability, reliability, attractiveness and so on. Products can therefore be indexed by quality, with higher quality cars (for instance) being (in general) more difficult and more expensive to produce, but also attracting a higher price that is high enough to make it worthwhile for producers to always seek to improve product quality. A commercially sustainable improvement in quality is one that attracts a sufficiently higher price to pay for the

extra investments and costs in producing the higher quality product. We begin by distinguishing between qualities within a particular product group, but the argument can be generalized to discuss choices between high and low value-adding parts of a value chain producing a particular product, or between entirely different products of different levels of sophistication.

Developing countries are generally not in the business of producing goods of higher quality than are already being produced. The latter describes the process of product innovation that at best characterizes a small part of the productive sector even in middle income developing countries. Rather, their problem is to learn how to produce an increasing range chosen from the product qualities that already exist at a price that is equal to or lower than the ones already available. Ideally, if it can produce an existing product of a particular quality using its cheaper labour at a price lower than that currently prevailing it has a chance of capturing markets from already established producers. At the very least, it has to be able to sell that product at the current global price for that quality. As lower quality products are generally easier to produce, poor countries are likely to find it easier to try and enter at lower quality indices for any product. But a minimum quality level usually exists for any product and if it fails to achieve this minimum quality, it will not be able to enter even if it has very low wages. Even if the developing country can produce at the minimum quality, it also has to be able to do this at a cost of production that allows it to match the prevailing price.

Higher quality products have, by definition, a higher selling price, so in general they allow either a higher wage or a higher profit mark-up or both. Wage and profit growth is therefore likely to require movements up the quality ladder or shifting to other products where quality levels are higher. A further reason for aiming at higher quality is that lower quality products are or can become inferior goods and as world incomes increase, global consumers are likely to shift away from some goods of lower quality. Finally, lower quality products are more likely to be targeted as entry points by other even poorer countries attempting to break into global production.

The move up the technology ladder is not always a smooth and incremental process. Low and high quality products even within the same product family are not necessarily very closely linked technologically. A country that specializes in low quality garments or mid-technology motor cars is not necessarily in the same technological trajectory as other countries producing sophisticated designer garments or hybrid ‘green’ cars. Moving up the quality ladder can therefore in some cases mean significant and discontinuous shifts in the technological trajectory from ‘mature’ to ‘evolving’ technologies that in turn has significant implications for future productivity growth and quality improvement potential (Perez and Soete 1988). The production of mature products only allows wage growth as long as improvements in labour and input productivity are taking the developing country towards the frontier already established in more advanced countries. But sustained productivity growth is only likely in product qualities that are closer to the technological frontier where innovations are still taking place in more advanced countries.

It is therefore socially and privately desirable to produce the highest quality products that are feasible. Of course, for countries that do not yet have the technological capabilities to produce even basic lower quality products the challenge is to increase technological capabilities sufficiently to enter production at some acceptable level of

quality. The catching up problem can therefore be defined as a) achieving the minimum quality that allows entry into globally competitive production for a variety of products even if the initial entry quality is low, b) spreading these basic manufacturing and productive capabilities broadly across the working population and c) systematically moving up the quality ladder across product categories. Many developing countries find it difficult to produce anything at a quality high enough to have a market, others produce a very limited range of items but of low quality and find it difficult to move up the product and quality ladder, and the more advanced produce a range of products, some of higher quality, but face challenges in sustaining quality improvements and even more in entering into new products.

As we are primarily interested in products that already exist and have a global price, modelling consumer preferences as a determinant of price does not add any significant insights to our analysis. We assume that a range of products and qualities exist, that in general consumers are willing to pay a higher price for products of higher quality, and that the relevant price-quality combinations are already known. In addition, we assume that in general it is desirable for a country to produce products of a higher quality for the reasons outlined above. To examine the implications of the quality and productivity problem in the simplest way, we use a simple mark-up pricing model that allows us to distinguish between the key variables that determine a country's ability to produce competitive products. The current global price of a particular product of quality Q is set by its cost of production in the global production leader as shown in eq. [1]:

$$P_Q^{global} = \left[\frac{W_Q^{leader}}{\Pi_Q^{leader}} + \sum_i \frac{P_{Qi}}{\alpha_{Qi}^{leader}} \right] \left(1 + m_Q\right) \qquad [1]$$

To simplify the notation we do not denote products, so the discussion at this stage refers to a particular product with varying quality indexed by Q, so Q+1 represents a higher quality of the product compared to Q. P_Q^{global} is the international price of the product of quality Q. W_Q^{leader} is the wage level in the leading country in the industry producing the product of quality Q. Π_Q^{leader} is the productivity of labour, measured by the output per person in this activity. There are also *i* other inputs used in the production of the product, and to simplify, we assume these inputs are globally traded, each with a global price of P_{Qi}. The efficiency with which inputs are used is measured by the productivity of input use (output per unit input). In the leader country, the input productivities of each of the *i* inputs are represented by α_{Qi}^{leader}. The price of the product is determined by the direct input costs per unit (of labour and the other *i* inputs) and the mark-up m_Q. The mark-up can be differentiated by quality not only because higher qualities are likely to face less competition but also because the capital-output ratios required may be different. Some higher qualities *may* require more capital per output (though this is not a necessary feature of higher quality), and may therefore require a higher mark-up to give the same rate of return to capital. In reality, the relevant m_Q for our purposes is the minimum acceptable mark-up. The current mark-up may be higher than the minimum the advanced country firm(s) may accept if they faced greater competition.

The developing country attempting to catch up through the imitation of products and technologies would like to imitate the highest possible quality that it can competitively produce (as higher qualities sustain higher wages and mark-ups, and potentially faster rates of productivity growth in the future). The cost of production (in a common currency) in the developing country is $C_Q^{domestic}$ for quality Q given by:

$$C_Q^{domestic} = \left[\frac{W_Q^{domestic}}{\Pi_Q^{domestic}} + \sum_i \frac{P_{Qi}}{\alpha_{Qi}^{domestic}} \right] \left(1 + m_Q\right) \qquad [2]$$

To simplify the analysis, we assume the mark-ups m_Q required for each product quality are the same in the developing country as in the advanced country. This does not significantly change any of the results. The developing country can only engage in free market production if $C_Q^{domestic} \leq P_Q^{global}$. It may appear that it should easily be able to do this since its wage level is significantly lower, $W_Q^{domestic} < W_Q^{leader}$. In fact generally it cannot break in because the developing country typically suffers from significant productivity disadvantages that more than negate its wage advantage. Output per person is generally lower, $\Pi_Q^{domestic} < \Pi_Q^{leader}$, indeed so low that despite low wages, the developing country cannot enter the production of most products, particularly high quality products.

In theory a low enough wage level could compensate for this, though in reality the required wage may be lower than is feasible even in the developing country. But while a lower output per person could in theory be compensated by lower wages, low wages may not even in theory be able to compensate for a lower efficiency of input use. This is because inputs have a global price that has to be paid. If $\alpha_{Qi}^{domestic} < \alpha_{Qi}^{leader}$, and if we assume that both countries face the same globally traded input prices, P_{Qi}, differences in input efficiency can only be compensated by further falls in the domestic wage rate. In this case, a small efficiency disadvantage across a number of inputs could mean that even with *zero* wages, the cost of production in the developing country may be higher simply because of inefficient input use. In fact, the general problem of development is that the domestic cost of production of almost everything is higher than the globally competitive price so that $C_Q^{domestic} > P_Q^{global}$ for most or even all products and product qualities.

But why is productivity so low? Output per person, Π_Q, depends on both economy-wide and firm-level factors. Firm productivity can depend on public goods and utilities including the general level of education, infrastructure and the reliability of utility supplies. Firm productivity is also determined by firm-level variables like the capital equipment used by labour and the skill and experience of the workforce and management. In the same way, the efficiency of input use, α_{Qi} depends on the same economy-level variables as well as firm-level variables like the type and sophistication of the capital equipment used and the skill and experience of the workforce using this equipment. The firm-level determinants of productivity describe the *technological capability* of the firm, its workers and its management.

Understanding the factors that might determine technological capability is vital for understanding the catching-up problem faced by developing countries.

If productivity were simply a function of the type of machinery used, developing countries could achieve global competitiveness by investing in the purchase of the appropriate machinery. This is why early development theory and practice put much emphasis on accumulation and machinery imports. We now know this is not sufficient and differences in labour and input productivity can persist even with identical machinery (Clark and Wolcott 2002; Sutton 2007). This directed attention on the one hand to economy-wide 'infrastructural' conditions and on the other to the firm-level skills of labour and management. The firm-level capability factors affect both the direct productivity of labour and its indirect productivity in converting inputs into outputs. Indeed, input productivity in isolation has no meaning as inputs do not transform themselves into outputs without human agency.

The effects of general infrastructural constraints on productivity are well known. Developing countries have inadequate physical infrastructure and investments in education. But this is a chicken and egg problem because the resources for significant improvements in infrastructure or in utilities that enable reliable and competitively priced utility supplies can only come from sustained growth. In the meantime, significant shortfalls in infrastructural quality, education and in utility supplies are likely to persist. For instance, developing country industries typically have to rely on more expensive captive power to supplement the unreliable grid, or use more expensive road transport because of underdeveloped rail systems. Directly or indirectly these constraints impact on measured labour and input productivity and therefore raise costs of production in the developing country. The only viable short term response is to provide temporary assistance to catching up sectors in the form of more focused infrastructure provision to industrial clusters and/or compensatory fiscal and other arrangements to offset their higher costs.

While infrastructure constraints are widely recognized, the *technological capabilities* of workers and management are probably much more important in explaining why some countries take off when they do. But these technological capabilities have often received less policy attention. With the same infrastructural constraints, developing countries often find that they can only break into the intensely competitive lowest ends of the quality chain. Paradoxically, because these tend to be high volume low quality goods, the infrastructural demands for shipping and processing them are often no lower and may be higher than higher value goods. Poor physical infrastructure cannot typically explain why developing countries specialize in these inferior types of products. Moreover, we find that typically developing countries break into particular activities *not* because of sudden improvements in either physical infrastructure or general levels of education but because conditions emerged that allowed them to improve critical firm-level technological capabilities. Technological capabilities refer to the capabilities required to use available machines and technologies in efficient ways. The acquisition of these capabilities is a slow process of learning-by-doing, skills development and discovering what works in the local context through a process of experimentation and trial and error. The importance attributed to technological capabilities as a constraint on technology acquisition and growth is based on three interrelated observations.

First, there is the observation that *tacit knowledge* is an important part of the skills and organizational capabilities that are necessary for the success of firms (Nelson and Winter 1982; Dosi 1988; Pelikan 1988; Perez and Soete 1988). Tacit knowledge is knowledge that cannot be codified (Polanyi 1967). All human activity involves the use of a mix of formal or codifiable knowledge (knowledge that can be communicated in words or symbols) and a variable amount of uncodifiable 'knowing-how-to' knowledge that is embodied in unconscious and often complex routines. The process of learning these routines inevitably involves practice rather than simply someone explaining what to do or reading a manual. Think of learning how to drive or to type. After many months of practice, complex sequences of actions can be carried out effortlessly and rapidly as unconscious routines, distinguishing a novice driver from an experienced one. In the same way, cutting fabrics accurately and rapidly in a garment factory or soldering a chip onto a board in an electronics factory are complex routines that can look easy and effortless when an experienced worker is in action.

As a result, buying the machines for a factory together with the operation manuals does not give the investor anything like the distribution of tacit knowledge across all segments of the firm that is required to achieve international competitiveness. Even relatively low-technology production of relatively low quality products like garments requires a huge amount of tacit knowledge embodied in hundreds of workers and managers if production is to proceed smoothly and effectively to produce internationally competitive products. The tacit knowledge involved in producing higher quality products is likely to be exponentially greater.

Anyone who has visited startup companies in developing countries will need no persuasion that the absence of vital tacit knowledge explains a large part of the low productivity in operating technologies that may otherwise be freely available. The machinery and inputs may be as good as in competitor countries. There may even be a sufficient supply of unemployed domestic workers with *formal* skills, and the formal codified knowledge for operating the machines may be freely available. What is missing is the mix of organizational and operational capabilities and skills that can only be developed through actual experience. The tacit knowledge required is not just about how to operate particular machines and processes, but how to operate these at a very high rate, to match the rates of different machines so that throughput is maximized, to set up the organizational structures to coordinate and link together different parts of the operation from purchasing inputs to marketing, including communicating with trading partners, responding to feedback, improving store keeping and so on, till an appropriate throughput of inputs and outputs is achieved. As initial conditions (including formal skills, working habits and social hierarchies) are different across countries, the layout of production and the organizational structure that works best can very well be different between countries, as an observation of factory layouts and practices even across advanced countries shows. The layouts and organizational structures that will work in a particular country can only be discovered through trial and error with arrangements that work slowly becoming unconscious routines.

The technological capability of a country describes its effectiveness in using different technologies to produce different products and qualities. The presence of tacit knowledge suggests that technological capability depends on two sorts of knowledge. The productivity of the production system depends of course on the formal education

and training of workers and managers drawing on the general level and quality of education and scientific knowledge that exist in a society. But it also depends on the tacit knowledge that these workers and managers have managed to acquire in the actual process of production (Dosi 1988). As the general level of education and skills are public goods that are likely to improve relatively slowly over time, there are clearly limits on the types of technologies that a developing country can aim to adopt. Nevertheless, the problem is that even when there are enough workers and managers available with the formal skills to operate an available technology, the plant may not be profitable because the appropriate tacit knowledge has not yet been acquired.

Secondly and closely tied to the importance of tacit knowledge is the observation that *learning-by-doing* is critically important for acquiring this tacit knowledge. The recognition of its importance goes back to Adam Smith's example of the pin factory where the division of labour allowed the production process to be broken up into a set of routines that allowed significant productivity growth as a result of learning-by-doing. In Smith's example, the workers involved were developing tacit knowledge that did not exist before by repeating routines till they became unconscious. For modern developing countries, much of the tacit knowledge that workers have to acquire already exists somewhere else. But that does not make the acquisition of this knowledge much easier. Practice and repeated doing are still the main mechanisms through which much of this knowledge can possibly be acquired, regardless of the fact that it has been significantly developed somewhere else. The modern terminology was popularized by Arrow (1962) who summarized a number of studies that showed the importance of learning-by-doing. These included for instance a study of the Horndal iron works in Sweden where productivity was observed to increase by two per cent a year with no new investment or even any changes in the methods of production. However, Arrow's analytical model in his original article is not strictly about learning-by-doing but actually a model of productivity growth driven by the rate of accumulation in a vintage capital accumulation model. The model generates a result that is close to that of *successful* learning-by-doing in that a greater volume of doing (a higher investment rate) results in higher productivity growth as we would expect in this case. But the model does not adequately model the processes that determine the success rate of the learning-by-doing.

Learning-by-doing as the mechanism for acquiring tacit knowledge can explain why developing countries can initially only achieve a level of labour and input productivity significantly lower than in more advanced countries. Together, they also explain why the developing country can get stuck in a cumulative cycle of low technology. Investments in new higher technology production facilities would allow opportunities to engage in learning-by-doing that could eventually raise productivity enough to allow the competitive production of products adding greater value. But these investments will not be undertaken if entrepreneurs believe that at current levels of productivity the investment would not be competitive. In turn, the failure to invest prevents the acquisition of experience that may have raised productivity over time. This learning trap can only be feasibly overcome if production can be initiated through a period of 'loss financing'. The question then becomes: why do private investors fail to treat this temporary loss financing as part of the overall investment cost of the project?

This takes us to our third and final observation. Since the private financing of these loss-making periods is not sufficiently widespread, there must be significant *market failures* constraining the financing of learning. By market failures we refer to contracting failures that result in a failure to capture achievable improvements in net social benefits. If the financing of learning-by-doing would allow the firm and the country to achieve higher levels of wages and profits, the failure of private contracting to achieve this financing is by definition a market failure. In the next section we will discuss a number of different market failures that can explain why the private financing of learning is likely to be limited and insufficient. If these market failures did not exist, private loss-financing of learning would take place systematically across all technically feasible sectors and product qualities, and the developing country would converge to advanced country incomes through market processes. Nothing further would need to be done. Here we focus on the loss-financing required to organize learning in developing countries. In the next section we discuss the implications of the market and government failures that constrain the solution of these problems, and the types of capabilities that may assist in the resolution of some of these problems.

The loss-financing that is required can be described by considering a developing country facing a domestic cost of production for a particular product of quality Q that is higher than the global price: $C_Q^{domestic} > P_Q^{global}$. The loss financing that would allow production (and learning-by-doing) to commence can be measured as a per unit 'subsidy', s_Q, which brings the domestic cost of production $C_Q^{domestic}$ into line with the global price P_Q^{global}. The 'subsidy' is not necessarily a transfer from government and could be private loss financing in the form of investors accepting a lower mark-up or putting in additional cash to cover a period of loss-making. A public subsidy can also be delivered in a variety of ways, some explicit, others more subtle. The possibilities include export subsidies, import protection, subsidized interest rates, subsidized inputs or infrastructure, or a cash subsidy. Contribution to loss-financing could also take the form of prioritized public spending on certain types of education or skills, or they may be implicit in the locational and pricing decisions of public infrastructure providers that reduce the costs of production of some industries in a differential way.

These different types of subsidy are linked to the learning problem if in their absence the low levels of tacit knowledge and therefore low productivity would have prevented some types of production to commence. Thus a variety of loss financing schemes may enable learning-by-doing to commence, and in general we can describe these as providing 'rents for learning' (Khan 2000b). Conceptually, these mechanisms reduce or remove the financial loss that would otherwise have been suffered in firms where the current levels of technological capabilities of workers and managers operating in the current infrastructural context implies production costs higher than the globally competitive level. In principle, the loss-financing enables production to commence and thereby enables some firms to acquire the knowledge that *may* make them competitive in the future.

Of course, for many quality levels and products, there may be no level of subsidy that allows the production of a marketable product. The absence of tacit and formal knowledge may be so serious that initially a wide range of products cannot be produced in a form that can be sold. In these extreme cases the initial level of subsidy

for quality Q will be notionally equal to the entire domestic cost of production till a product of quality Q is available that can actually be sold with a lower subsidy. It is unlikely but not impossible for such extreme cases of loss-financing to eventually lead to the production of a competitive product. We also ignore for now the possibility that at early stages of learning how to produce a product of quality Q, the firm may sell its output as a product of quality Q-1 at a lower price. This reduces the required subsidy at early stages of startup from the full domestic cost of production to a lower amount. However, the essential features of the problem can be shown by focusing on the situation where the domestic firm can actually produce products of quality Q, but at a higher cost than the current global price. The required effective rate of subsidy, s_Q, is then given by the equality:

$$C_Q^{domestic}(1-s_Q) = P_Q^{global} \qquad [3]$$

Inserting eq. [2] defining $C_Q^{domestic}$ into this gives the required s_Q:

$$s_Q = 1 - \frac{P_Q^{global}}{(1+m_Q)}\left[\frac{W_Q^{dom}}{\Pi_Q^{domestic}} + \sum_i \frac{P_{Qi}}{\alpha_{Qi}^{domestic}}\right]^{-1} \qquad [4]$$

If follows from [4] that:

$$\frac{\partial s_Q}{\partial P_Q^{global}}, \frac{\partial s_Q}{\partial \Pi_Q^{domestic}}, \frac{\partial s_Q}{\partial \alpha_{Qi}^{domestic}} < 0$$

Not surprisingly, the required rate of subsidy declines if the global price rises, or if domestic labour productivity or input productivity rise. It follows that the faster domestic labour and input productivity grows, the sooner the subsidy can be removed. The subsidy per unit required for entering production is also likely to differ depending on the quality level the developing country initially aims for. Lower and higher quality versions of the same product are indexed by Q and Q+1. Using [3], the per unit subsidy required in each case is shown in equations [5] and [6].

$$s_Q = 1 - \frac{P_Q^{global}}{C_Q^{domestic}} \qquad [5]$$

And

$$s_{Q+1} = 1 - \frac{P_{Q+1}^{global}}{C_{Q+1}^{domestic}} \qquad [6]$$

Under plausible assumptions it is likely that $s_{Q+1} > s_Q$ implying that the rate of loss financing required for entering higher quality products is in general higher than that required for entering the production of lower quality products. The plausible assumption is that the productivity gap between the advanced country and the

developing country is *greater* in the higher quality product than in the lower quality product. Both the gap in labour productivity and gaps in input productivities are likely to be greater in higher quality products because the latter typically require greater labour skills and more sophisticated management of inputs. A greater labour and input productivity gap between the two countries in quality Q+1 compared to quality Q can be represented as a set of inequalities:

$$\frac{\Pi_{Q+1}^{leader}}{\Pi_{Q+1}^{domestic}} > \frac{\Pi_{Q}^{leader}}{\Pi_{Q}^{domestic}} \; and \quad \frac{\alpha_{Q+1}^{leader}}{\alpha_{Q+1}^{domestic}} > \frac{\alpha_{Q}^{leader}}{\alpha_{Q}^{domestic}} \; for \; some \; or \; all \; i \qquad [7]$$

An inspection of equations [1] and [2] shows that costs of production in both countries are inversely proportional to the productivities (of labour and inputs) in the respective countries. All *i* inputs may not be used in the production of both qualities of the product, but if some or all of the inequalities in [7] hold, it must be the case that

$$\frac{P_{Q+1}^{global}}{C_{Q+1}^{domestic}} < \frac{P_{Q}^{global}}{C_{Q}^{domestic}} \qquad [8]$$

The inequality in [8] says that the cost of production in the developing country is greater (relative to the global price) for the higher quality product compared to the lower quality product. Using inequality [8] and comparing equations [5] and [6] it follows that a greater subsidy per unit will be required to achieve competitiveness in the higher quality product compared to the lower quality product.

$$s_{Q+1} > s_{Q} \qquad [9]$$

These results suggest two propositions.

Proposition 1. *The subsidy (loss-financing) required to enter production is in general higher the higher the quality of the product.*

Proposition 2. *By moving down the quality ladder, it may be possible to find a product quality for which no subsidy is required, but this is not assured.*

A further proposition follows from the observations of technology trajectories in developing countries. Economics textbooks often show innovation and technical progress as the outward shift of the production function that a country faces. In reality, this is very misleading because improvements in technological capabilities are likely to be very localized to the learning and innovation that happens around specific technologies (Atkinson and Stiglitz 1969; Stiglitz 1987). As a result, the learning-by-doing that results in productivity growth is likely to benefit technologies that are directly involved in the learning-by-doing and very closely associated technologies, rather than raising productivity across all technologies in use in the country. Learning-by-doing in the motor car industry is likely to raise productivity there but is unlikely to have any effect on the productivity in the garment industry, let alone in agriculture.

Technologies not only differ significantly across products; they may also differ significantly across different qualities of the same product. For instance, the production of CRT televisions is based on significantly different production processes and competences compared to the production of televisions using newly emerging LED technologies. A country specializing in the former is not necessarily acquiring capabilities to efficiently produce the latter. The contrast between these technologies is very significant but in general a developing country that is absorbing technologies to produce lower quality products may be only marginally if at all improving its capability to potentially produce higher quality products. Thus, rather than the smooth improvement of productivities across the board over time that is suggested by an outward shift of a 'production function', we are likely to see 'bumpy' improvements in productivity clustered around technologies that are actually being adopted and where learning-by-doing is successfully happening.

Differences in the rates of technical progress between sectors and technologies can on their own justify policies to encourage specialization in the sectors with higher rates of technical progress, particularly if there are market failures that prevent dynamic technology sectors from capturing the full benefits of their productivity growth. The spillover of some of these benefits to other sectors means that the social benefit of a more rapid expansion of these sectors is greater than the additional profits they directly generate. Greenwald and Stiglitz (2006) have argued that this is sufficient to justify the subsidization of growth in dynamic modern sectors in developing economies. Their model is a simplified one that makes a binary distinction between the modern/industrial sector which enjoys technological progress and the traditional agriculture/craft sector which does not. In reality the differences in potential technical progress can be very different *between* different subsectors of industry and indeed between different qualities of ostensibly the same product. Moreover, Greenwald and Stiglitz do not focus on learning-by-doing difficulties that can make some desirable manufacturing/modern activities more difficult to adopt than others. These observations have implications for the desirability of financing learning-by-doing in different sectors and product qualities in a way that is similar to the Greenwald and Stiglitz model, except that we suggest a gradation of technological progress possibilities and different levels of difficulty in their adoption. These features have important implications for the types of governance capabilities that are required to sustain growth in developing countries.

Lower quality products are more likely to involve mature technologies as quality is a moving target and lower quality in manufacturing usually means products and technologies that have been around for some time. Older, mature technologies are easier to absorb for a number of reasons. The best practice production processes for these technologies are by definition well known and markets are already saturated, so advanced country firms are typically moving away from these product qualities that are no longer very profitable. Indeed the best source of technologies and machines for lower quality products may be firms in other countries, including developing countries that are moving up the quality ladder. Firms from more advanced countries may even be willing to assist less developed countries to buy these technologies with technical support to set them up. Significant tacit knowledge is still required but this is likely to be embodied in well-known routines to a greater extent compared to newer technologies. The initial scientific and educational base required to absorb mature technologies is also likely to be lower as they represent older technologies.

The problem is that almost by definition, future productivity growth in mature qualities/technologies is likely to be lower. A developing country adopting these technologies may then be stuck with a 'technology trajectory' that only allows productivity growth while moving towards a well-defined frontier, but once there, the mature industry is unlikely to offer further room for product or process innovation. Indeed, that is why advanced countries moved away from these qualities and technologies in the first place. Moreover, capabilities based on learning these technologies may have limited effects on improving capabilities and potential productivity in higher quality areas, for the reasons discussed by Atkinson and Stiglitz (1969).

This is *not* an argument for staying away from mature industries and low quality products. For very early stage developers, with low educational and scientific bases, there is no alternative but to proceed by adopting some of these technologies. Indeed, the problem for many of the poorest countries is that their initial technological capabilities may be so low that they cannot even enter mature industries and low quality products without policy assistance. The important point is simply that once a poor country has broken into one or a few (typically low quality) products, policy-makers should not assume that further progress will be automatic from then on. Rather, policy has to be prepared to repeatedly assist in moving up the technology ladder till economy-wide improvements in productivity and product quality can be led by a wide base of high-capability national firms.

The challenge is even more serious for somewhat richer middle income countries attempting to make the transition from low to medium value assembly and to establish integrated production bases that can sustain product and quality innovation. At some point, the transition has to involve a significant move into the production of products and qualities that are still at the level of development and product innovation (Perez and Soete 1988). This allows the technology adopter to achieve not only the productivity growth possible through learning, but also by sharing in the ongoing productivity and value growth in the evolving product. Thus, significant capabilities are required at the societal and firm level as the developer makes the gradual transition to an innovation society. Clearly, this transition requires higher levels of educational and scientific capabilities as public goods, as well as policies to further develop firm-level capabilities. These observations about differential productivity potentials lead to our third proposition:

Proposition 3. *Potential productivity growth is likely to be localized around products and technologies involved in learning-by-doing, and productivity growth is likely to be higher in higher quality products that are likely to benefit from further innovation.*

We draw on these three propositions to construct Figure 1 which summarizes some of the fundamental issues facing catching up and technology acquisition in developing countries. The issues are presented in the figure in terms of 'capability curves' facing different developing countries across qualities of a particular product. However, the issues are of general applicability for understanding choices between sectors and technologies. The x-axis measures the quality of the product, and the y-axis the degree of competitiveness in producing that quality. Competitiveness in different qualities depends on the technological capabilities of firms in the country, and is

measured by the ratio: $\frac{P_Q^{global}}{C_Q^{domestic}}$. The higher this ratio, the more competitive the developing country, and when the ratio is equal to 1, it can competitively sell in global markets.

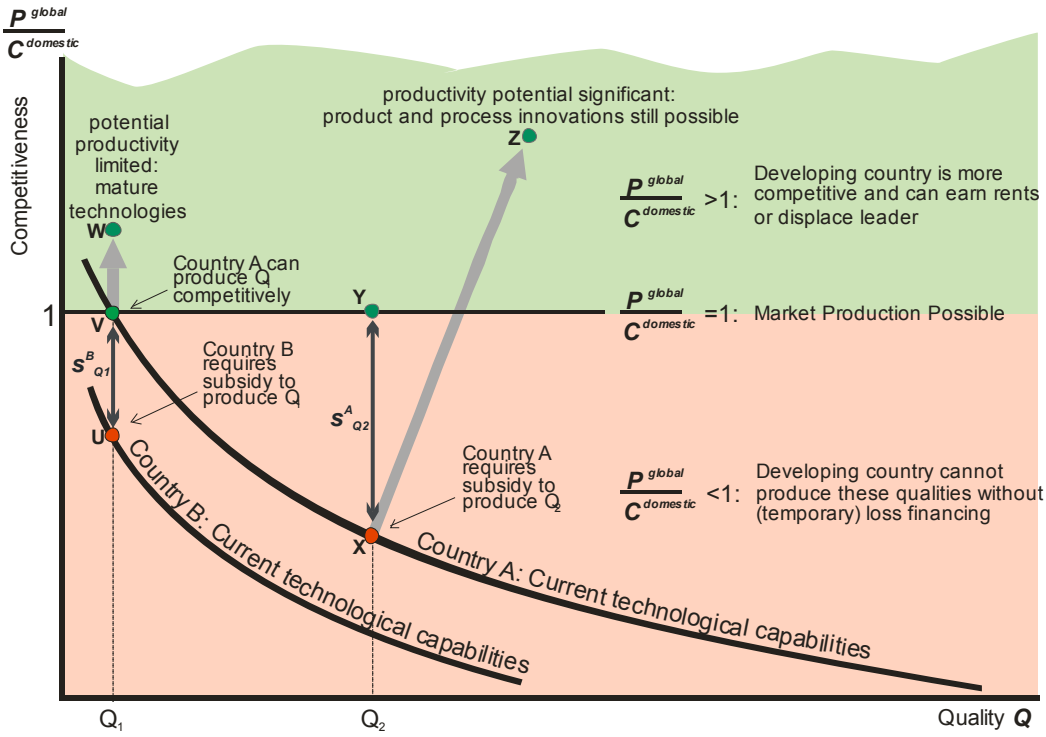

Figure 1 Loss Financing and Learning-by-doing

When the competitiveness ratio is less than 1, the developing country will either not enter production or will require (temporary) loss-financing from some source to allow production to commence. The required rate of 'subsidy', s_Q, equals $1-\frac{P_Q^{global}}{C_Q^{domestic}}$ in eq. [5], and is shown in Figure 1 as the gap between the unit competitiveness line and current competitiveness defined by the current technological capability curve.

From proposition 1 we know that competitiveness is likely to be lower for higher quality products so the curve of current capabilities is likely to be downward sloping. Thus, the greater productivity gap in higher qualities will result in market-led developing countries specializing in low quality products, and this may have nothing to do with the relative price of labour and capital as in standard neoclassical theory. While we have developed this argument for products with the same general characteristics but of different 'qualities' the capability curve can also be used to understand a range of related problems. For instance, we could see the different 'qualities' as components of the same product in a vertically organized value chain. Low qualities would in this case be low value-added parts of the value chain (like packing and assembling), medium qualities would be producing the intermediate products going into the assembly and the higher qualities would be the design, product development and marketing parts of the value chain. In exactly the same way, the global 'price' of the low value added activities would be lower, and they would

very likely be activities which require less tacit and formal knowledge and therefore open to greater competition and lower mark-ups. To enter production at any point of the value chain a developing country would have to achieve a 'competitiveness ratio' of at least 1, so that its cost of production was no higher than the globally competitive level set by the global leader. At an even more general level, we could use the capability curve to think about choices across all products ranked by technological sophistication or 'quality'.

Consistent with proposition 2, it is easy to imagine a developing country like B in Figure 1 where current capabilities are so low that it cannot even produce the lowest quality of this product, and indeed may not find any globally traded products that it can competitively produce. Country B needs loss-financing of s^B_{Q1} from the outset to even begin production of quality Q_1 at point U. Higher capability countries (like A) may be able to competitively produce some lower quality products like Q_1 at point V, without any loss-financing. But movements up the technology and quality ladder may again require loss-financing. If country A wants to begin production of quality Q_2 at X, it will require temporary loss-financing of s^A_{Q2}.

If the competitiveness measure became more than 1, the developing country could either earn a rent (a mark-up higher than m_Q) by selling at the global price or it could bid down the global price in these qualities to below a price acceptable to the leader, thereby displacing the leader from these segments of the market and capturing much larger sales volumes. If the latter is the more profitable option, the developing country becomes one of the leaders for that quality and the global price is eventually defined by the cost of production and market power of the new leader. The aim of catching up is to maximize the rate at which new (and preferably higher quality) segments of the market acquire competitiveness ratios of unity or above. In principle, as productivity levels approach advanced country ones at any quality level, developing countries can potentially achieve competitiveness ratios greater than unity because of their wage advantage.

Finally, proposition 3 tells us that even if a competitive quality level exists, there is a further policy issue to be considered. If technological trajectories are localized around particular qualities and technologies, catching up can require sequential programmes of assistance in developing countries till they acquire significant firm-level capabilities for product development and innovation across the economy. In Figure 1 the potential productivity growth at quality Q_1 is relatively low because the technology is already mature and no further product and process innovations are likely at this quality level. The challenge for country B is to go from point U to point V. While country A can produce unaided at V, progress up the productivity ladder at this quality may be limited to W. In addition, there may be no or very limited progression to higher qualities that comes from concentration at very low qualities.

Thus, even for country A, there may be a policy justification to assist learning-by-doing around quality Q_2 by organizing temporary loss-financing of s^A_{Q2}. If it did that, the initial challenge for A would be to go from point X to point Y to achieve competitiveness. But the product and process innovations still going on at this quality could take it to point Z over time. In addition, producing and learning at a higher quality level may also develop firm-level capabilities to move further up the quality ladder. This is because learning to produce evolving products forces firms to develop

capabilities to be adaptive to, and possibly, even to innovate around the evolving product. These capabilities can make further moves up the quality ladder or into other high quality products easier. Thus by focusing on learning around the higher quality product there is a potential not only for higher productivity growth but also of further improvements in quality. This is shown by a longer productivity growth arrow at Q_2 and in a more north-easterly direction, combining both competitiveness improvements and quality improvements.

But if temporary loss-financing can always induce more rapid moves up the productivity and quality ladder, how high should a country aim in terms of its entry quality for a product? Proposition 1 tells us that given existing capabilities, the higher the quality level that the country tries to achieve, the greater the financing cost measured by s_Q. Moreover, the greater the gap with leading countries at that quality, the longer is the catching up likely to take to reach break-even levels of competitiveness. As a result, trying to aim too high may involve excessively long periods of subsidy. Moreover, the competitiveness gap is only partially due to the absence of tacit knowledge. Some of the gap is also due levels of formal education and skills. If the initial gap is too big no amount of firm-level experience and learning-by-doing is likely to remove it entirely. As both the social time preference and the cost of finance in poor countries are likely to be high, there is a limit to how high up the quality ladder it is feasible to go. Nevertheless, the very limited evidence of private investments in learning-by-doing in developing countries suggests that market failures must be significant.

Much greater private investment in learning-by-doing may have been profitable under plausible assumptions if market failures did not prevent the requisite private contracts. The private calculation would be of the following type. The private investor compares an investment in loss-financing of s_Q for the prospect of achieving a competitiveness of $\frac{P_Q^{global}}{C_Q^{domestic}} > 1$ after n years. In principle a competitiveness ratio greater than one can be achieved through productivity growth towards the advanced country simply because the developing country wage level is significantly lower. As soon as these levels of productivity are achieved (by assumption after n years), the developing country can achieve a rent in the form of a higher mark-up of $m_Q' > m_Q$ if it sells at the price set by the global leader. The firm also has an expectation that the rent $m_Q' - m_Q$ will last for x years. Then the magnitudes of s_Q, n, $m_Q' - m_Q$, x, and the discount rate or cost of finance of the entrepreneur will determine whether the investment in learning-by-doing is privately profitable. Both s_Q and n are likely to be lower if the product quality aimed for is close to the capabilities that already exist in the firm. Given the vast pools of cheap underemployed labour in developing countries, including workers with formal education at different levels, and with an array of technologies freely available at low to medium quality levels, we would expect a wide range of sectors and product qualities where investments in learning-by-doing by private entrepreneurs should be profitable. But in fact we see very little private investment in learning-by-doing in developing countries.

This suggests that the market failures that prevent private investors from contracting to achieve these investments may be important. In many developing countries it may appear that finance is not available for financing learning in the way we have

described, but this may be because entrepreneurs do not believe that they can *actually* achieve the profits that are *potentially* available. Since the gains from successful catching up are potentially great, if these market failures could have been addressed, private financing alone may have allowed a significant increase in investments in learning. Thus, instead of attempting greater precision in determining the appropriate level of investment, it may be more appropriate to focus on the governance capabilities that may allow the country to address these market failures. In either case, a greater range of learning-by-doing could then be effectively financed.

2.Why Do We Need Technology Acquisition and Learning Policies?

The temporary loss-financing required to acquire vital skills and capabilities necessary for global competitiveness is no different from any other investment required to increase future profitability. If these investments are not forthcoming, there are likely to be specific contracting problems preventing the investments, which we define as 'market failures'. In this section we look at a number of possible market failures identified in the literature. These include the institutional difficulty of ensuring high levels of effort when learning is being subsidized, several different types of appropriability problems limiting the future profits of investors in the presence of externalities and the costs of coordinating complementary investments across sectors. In principle, several different market failures may be operating simultaneously, constraining investment in learning and technology acquisition, but some may be more important than others. Moreover, the governance requirements of addressing different market failures may be markedly different. If an important market failure cannot be addressed with existing governance capabilities, attempts to address parts of the problem are likely to result in unsatisfactory results. One reason why policies supporting learning and technology acquisition in the past often yielded poor results is that important sources of market failures were not properly understood. As a result, governance capabilities that were necessary to address them were not adequately developed.

Our use of the term 'market failure' simply refers to a variety of reasons why voluntary private contracting can fail to exploit opportunities for increasing collective welfare. In using this terminology we do not presume that private contracting *could* have captured all these opportunities in a real market. For many market failures there is no *feasible* way in which private contracting could capture these potential gains, so some areas of necessary intervention remain even in societies where markets are very efficient. Nor do we use the general equilibrium benchmark as indicative of what markets could in theory achieve. If market failure is defined as a deviation from a welfare-maximizing general equilibrium, the usefulness of the concept can be justifiably questioned (Nelson 2008). Thinking of real economies as deviations from a general equilibrium can hinder rather than help the identification of policy because general equilibrium is not an achievable target and markets are systematically in disequilibrium (Scitovsky 1954; Kaldor 1972; Arndt 1988; Stiglitz 1996). Instead our definition of market failures simply refers to pragmatically identified potential improvement in net social benefits that are not being achieved because of various failures of contracting.

If private investors are failing to invest in ways that could make them better off, either they do not have good information about profitable opportunities or (more likely)

existing institutions do not provide them with adequate assurances that these potential future profits can actually be realized. For instance, investments in learning will only be forthcoming if workers and managers whose learning is being subsidized are sufficiently compelled to put in the high levels of effort to justify the investment. If existing institutional, political and other conditions are such that investors cannot be assured that the investment will actually be profitable, the investments will not be forthcoming. The existence of market failures can provide a justification for intervention (for instance in the form of full or partial public financing of learning) but parallel governance capabilities are required to ensure that the interventions will add net value. Without these governance arrangements the intervention could result in an even worse outcome which can described as a government failure. For instance, public resources could be expended *and* the technology could fail to be adopted. Government failures are defined as government actions or inactions that reduce (or fail to raise) net social benefits (Krueger 1974; Toye 1987; Krueger 1990).

Market Failure Constraining Learning and Technology Acquisition	Policy Implications	Required (Growth-Enhancing) Governance Capabilities
Appropriability problems facing **investments in skills**: Trained personnel can easily leave the firm	Co-financing of employment of new workers/workers in new sectors may be required	Requires agency with incentives aligned to ensure subsidies/co-financing not significantly mis-allocated
Appropriability problems facing **innovators**: Innovation companies avoid investing or training in developing countries	Protect IPRs but TRIPS may be too restrictive for developing countries: Weak incentives for MNCs to transfer core technologies	Requires strategies to create backward and forward linkages with domestic suppliers.
Appropriability problems facing **discovery**: Startups discovering new areas of national competence lose rents rapidly	Subsidize startup companies: But model based on specific technological and market competitiveness assumptions	Develop public-private partnerships to invest in discovery. Develop capability to stop subsidies beyond startup period
Failures of **coordination** can lower profits in complementary sectors and constrain investments in learning	Coordination of investments up to and including 'Big Push' strategies	Very significant governance capabilities required to coordinate and discipline investments across firms and sectors
Institutional problems in ensuring **effort** during learning: Both public and private investors in learning lose money	Co-financing of learning is often necessary but will fail unless high levels of effort can also be assured	Critical significance of country-specific institutions that can ensure high levels of effort during periods of loss-financing

Figure 2 Market Failures Constraining Learning: Implications for Governance Capabilities

The likely source of the government failure will depend on what was causing the market failure in the first place. For instance, if the market failure was primarily caused by the difficulty of compelling effort on the part of workers and managers, the reduction of government failure would have to ensure that the *effort* is forthcoming if learning is financed by public funding. In contrast, if the market failure was caused by a failure of the private sector to coordinate investments across complementary sectors, public policy would require governance capabilities for effective coordination of investments. Identifying the most important sources of market failures is therefore a critical part of developing appropriate growth-enhancing capabilities to ensure that public policy is effective and the possibility of government failure is minimized.

Figure 2 outlines a number of critical market failures affecting learning and technology acquisition in developing countries. Most have been discussed extensively in the literature but differences in the governance capabilities required to address each of them have not received sufficient attention. In particular, we argue that an important source of inadequate investment in learning-by-doing comes from institutional failures to *enforce effort* and these can result in both public and private investments in learning eventually failing to deliver results. We argue that for many developing countries, the most important starting point is to focus on a more or less limited range of institutional fixes (depending on initial institutional and governance capabilities) that can address this problem.

Without a strategy for dealing with problems of enforcing effort, attempts to address other market failures are very likely to fail. One of the weaknesses of learning and technology policies in the past was that the full range of problems causing potential market failures were often not identified, so the most critical governance capabilities for limiting government failures could not be identified. Our case studies of greater or lesser success with catching up in different countries suggests that success depended very critically on the presence of institutional arrangements that ensured that private or public investments in learning elicited the high levels of effort necessary to make them viable. We discuss these market failures in terms of their relationship to the simple model of the technology acquisition presented in Section 2, and identify the different governance issues that each aspect of market failure raises.

Appropriability Problems: Investing in Skills Development

Appropriability problems in general arise whenever improvements in productivity require investments but investors cannot privately capture enough of the total returns on these investments. The result is low or no investment in the relevant productivity-enhancing activity. A common way of describing different appropriability problems is that the investment in improving productivity has positive externalities (spillovers) so that the investment provides a private benefit to the investor that is less than the collective benefit to society. The mechanism through which the spillover happens, and therefore the extent to which the private return is reduced varies across different appropriability problems.

A simple appropriability problem with investment in skills has long been recognized. A private entrepreneur investing in the training of workers and managers generates positive externalities because trained personnel can leave for other employers who are willing to pay a slightly higher wage or offer better conditions. Employers who have not incurred the investment in training may find it cheaper to poach workers who have achieved formal training or 'tacit knowledge' in a firm that invested in formal training or in subsidizing learning-by-doing. If trained workers leave, the original investor is clearly left worse off, and this can result in underinvestment or no investment in training by the original firm.

If we consider country A in Figure 1, the move from quality Q_1 to Q_2 requires investment in learning-by-doing which we can measure as a per unit investment of s^A_{Q2}. If we think of this as an investment in training, how seriously does this particular non-appropriability problem affect the private financing of learning? The answer will depend on the assumptions we make about the rate of labour loss and the magnitudes

of the variables determining the profitability of private investment discussed earlier. Private investment in learning-by-doing is potentially viable if there is an expectation that productivity can be increased to a point where the firm would expect to earn a rent, namely a mark-up m_Q' that was higher than the normal mark-up m_Q. But before this non-appropriability problem can even emerge, we have to make a significant assumption, namely that the firm has the internal hierarchy and disciplining mechanisms in place such that its investment of s^A_{Q2} will *actually* achieve the productivity improvement that gives it global competitiveness and more. In other words, we have to first assume that the firm has solved the problem of ensuring high levels of effort from its workforce. We will see later that this is a major problem that can constrain learning, and if so, the appropriability problem discussed here will not even emerge.

Suppose this fundamental problem has been overcome and learning actually takes place as a result of the loss-financing. An extreme case of non-appropriability would emerge if the firm spends n years in training its workers to the level that it earns rents of $m_Q' - m_Q$, but finds at the end that its entire workforce leaves as soon as the rent-earning level of competitiveness is achieved. If such an outcome is expected the firm will obviously not invest at all in the first place. However this is an extreme scenario. A more likely scenario is one where the firm expects to suffer a partial leakage of skilled workers once they achieve high productivity levels. As the loss of some workers will reduce the overall productivity Π_Q the result is likely to be a reduction of the firm's expected rents to a level lower than indicated by $m_Q' - m_Q$, with the total disappearance of these rents being an extreme case. As long as positive rents survive in the presence of labour turnover, some private investment in learning-by-doing can be sustained.

The labour market can also adapt to these expectations with inexperienced workers initially being paid less than the market wage in the expectation that working in the firm will increase their future earning potential. We find evidence of these types of adaptations for instance in the Bangladesh garment industry, where workers are initially employed as trainees or 'helpers' with a lower than market wage as long as their productivity levels are low. These arrangements suggest that in labour surplus economies some costs of financing can be passed on to workers, particularly when the initial productivity gap (and therefore the loss-financing required) is relatively small. This means that the appropriability problem may be less serious in the case of simple technologies and lower qualities. However, loss-sharing with workers may not work when the productivity gap is significant, as is likely to be the case where more sophisticated technologies and qualities are involved. Nor will loss-sharing with workers be easy when labour markets are tighter, as is likely to be the case in more advanced developing countries. Therefore in general, government responses to this potential market failure may be necessary to enhance investment in learning or even to enable it in some cases.

The governance capabilities required to address this type of market failure are not necessarily simple, but are not very challenging either. As the social return to investment in learning-by-doing is high, the government could simply provide a subsidy to startup companies in products of a minimum specified quality who employ workers not previously employed by a firm producing a product of that quality. As we have deliberately abstracted from the problem of enforcing effort, the only

governance requirement to make the intervention viable is to ensure that the subsidy is not captured by firms producing lower qualities or employing already skilled workers. The latter may be difficult to monitor and administer, but in a country that is at the early stages of entering a high quality product, it would not be very wasteful to subsidize all employment in these product qualities for a while. If the subsidy is a general subsidy (available to all firms or workers of a particular type), it should be possible to construct programmes of publicly funded training that are WTO-compliant. The fiscal constraint would, however, require that low product quality employers were excluded as clearly not all employment in the economy could possibly be assisted. The focus could be on designing an agency with the competence to allocate subsidies to firms of the right quality. It would have to be insulated from rent seeking and other social pressures to some extent to limit losses due to misallocation. But clearly the governance requirements here are not too demanding.

Appropriability Problems: Innovation and Intellectual Property Rights

Another type of appropriability problem widely recognized in the literature derives from the difficulty of appropriating the returns to innovation. As innovation is the driver of productivity growth in advanced countries, there is an extensive literature on the benefits of ensuring the temporary appropriability of Schumpeterian (or technology) rents by innovators (Dosi 1988; Khan 2000b). In the case of innovation, productivity growth comes not from training workers but from creating new products and processes. Hence it is not directly related to the catching up problem described in Section 2. But it is indirectly related because developing countries are under pressure to protect the innovation rents of advanced country firms. If their technology rents are protected, multinational companies may be more likely to invest in the production of these products in developing countries. But it can also constrain opportunities for learning by indigenous firms.

Once an innovation take place, the knowledge embodied in the new product becomes a potential public good and in the absence of specific protection, this knowledge can be imitated by anyone who has the capability to copy. Faster imitation can result in benefits for consumers in the form of cheaper products as well as higher profits for imitating producers. Easy imitation can also allow faster innovation across the board as new innovators can apply innovations from multiple sources to create new products without worrying too much about complex sets of intellectual property rights. But rapid imitation also means that the rents or extra profits that the original innovator could have earned by being a monopoly supplier of the new product could be very short-lived and too short-lived to be a sufficient incentive for innovators (Khan 2000b). Therefore, in principle, too rapid a rate of imitation can slow down the rate of future innovation. This provides a justification for the temporary protection of intellectual property rights (IPRs).

Getting the trade-off right between the benefits of allowing rapid diffusion of new innovations and the costs of doing this too rapidly is the subject of innovation policy in advanced countries. The aim is to determine the types of innovations that should be protected, defining genuine innovations and determine the period of protection for different types of innovation to induce the highest rates of innovation at the lowest cost to the diverse users of knowledge. These questions are by no means easy to answer and there is a strong case that the way in which IPRs have been defined in international agreements like the TRIPS agreement of 1994 are detrimental to the

interests of developing countries and may even be detrimental to innovation in advanced countries (Stiglitz 2007: 103-32).

The desirable rate of protection for innovation may also be different depending on whether we look at the interests of advanced or developing countries. The interests of developing countries are clearly different as they benefit from faster diffusion of knowledge (Khan 2000b). Moreover, faster diffusion in developing countries does not necessarily hurt most innovators in advanced countries because their lucrative markets are not in the developing world. But some powerful industry groups in advanced countries may benefit from stricter and longer periods of protection and they may have had an unbalanced influence in global negotiations like TRIPS. Paradoxically, a complex and extensive set of protections for technology rents can also be harmful for the rate of innovation in advanced countries because it can slow the flow of knowledge to new innovators, and can make innovators very careful in not developing new products that *may* infringe any of a vast array of patent rights. The costs of infringement are potentially prohibitive and may lead to the abandonment of a product that took significant investments to develop. The reason why IPRs have been defined in these restrictive ways probably does not reflect a balanced consideration of all the costs and benefits. Rather, the final agreement probably reflects the intense lobbying by a relatively small but well organized group of industries in advanced countries, in particular pharmaceutical and media interests (film and music), and the correspondingly weak organization of other global stakeholders, particularly in the developing world (Stiglitz 2007).

Developing countries by definition have relatively few sectors that are engaged in genuine innovative activity where IPR protection is a relevant determinant of productivity growth. However, such sectors do exist in pockets. Software and cinema are examples in India of sectors where IPRs may be important for protecting incentives for domestic innovation and creativity. But even for the Indian pharmaceutical sector, India's inclusion in global agreements on IPRs were damaging because the sector was growing more rapidly through imitation and copying of established molecules and the manufacture of generics than by inventing entirely new products. Following the TRIPS agreement, India introduced a series of amendments to its Patent Act in 1999, 2002 and 2005 that significantly strengthened the enforcement of patent rights of foreign companies. Indian pharmaceutical companies were forced to slow down on their growth strategies based on process innovations on known molecules and the development of generics. Indian pharmaceutical companies have had to move into the relatively much more expensive and risky area of innovating new molecules, where fewer of them are likely to remain major players over time. In general, relative to the possibilities of catching up through imitation, sectors involved in genuine innovation are likely to make a small contribution even in India, and in many developing countries these sectors simply do not exist.

On the other hand, the protection of the IPRs of multinational companies can have a partially mitigating effect for developing countries by making the former more likely to invest in outsourcing parts of their production process to developing countries that strongly protect IPRs. This can include investing in training the local workforce in appropriate ways. Investment by multinational companies has become an important source of industrialization in a number of developing countries, particularly in South East Asia. In Thailand, Japanese investment in manufacturing has been the driver of a

significant growth in manufacturing employment. A precondition for Japanese investment has been Thailand's willingness to protect Japanese IPRs and to doubly ensure this protection by allowing majority Japanese ownership in partnerships that bring in new technologies. One way of looking at these new relationships is that the protection of the Schumpeterian rents of multinational companies guarantees them high profits which in turn encourages them to finance investment in learning-by-doing that may be required for setting up parts of the assembly and manufacturing process in the developing country. The strong protection of IPRs is therefore often recommended for middle income developing countries as a way of attracting high technology FDI (Hoekman, et al. 2004)

However, unless complemented by other policies, this could be a partial and problematic solution to the problem of catching up. The developing country has little control over the long-term locational decisions of the multinational company or the pace at which it transfers technological capability to a particular country. Thus the protection of multinational IPRs can be a double-edged sword for developing countries, as we will see later in the case of Thailand. For a time it can work in favour of the developing country by allowing a rapid relocation of manufacturing and assembly to countries like Thailand where multinationals feel secure. The relocation is likely to be particularly rapid if high capability workers are already available, whose wage-productivity profile puts them close to the global competitiveness frontier for technologies that the multinational wants to produce. This is likely to be in the assembly of products, and sometimes these can be relatively high technology products. But the assembly of high technology products in a country does not amount to rapid technology transfer unless the multinational can be persuaded to train national personnel to participate at the higher value-added levels of the value chain.

The real question for the developing country is whether the attractiveness of making profits in assembly can bring in high technology products, and *then* the multinational can be persuaded to train and transfer new capabilities to domestic workers that allow them to produce value at quality levels that did not exist before. If so, this can be a new variant of financing learning-by-doing in developing countries. Here the paradoxical model of strong protection of IPRs *could* lead to investments by multinationals in learning-by-doing in medium capability developing countries. In terms of our Figure 1, a multinational with a high quality product could invest in a medium capability country A not just to assemble products that are immediately profitable but also the s^{A}_{Q2} required to manufacture medium to high quality parts of the value chain it controls, *which cannot already be produced*. The multinational firm's expected rents, $m_{Q}' - m_{Q}$, is higher the stronger the protection of its critical IPRs in the country and globally, which determine the technology rents it can earn by selling the final product. The expected rent can be achieved faster the higher the initial level of education and training of the workforce and the better the quality of its infrastructure. The expected rent can be higher if the country also has some level of protection in its domestic markets and if these markets are large.

There is no automatic reason why the protection of IPRs should set off this beneficial set of investments. A multinational could just choose to use a particular country for assembly of high technology products without transferring capabilities at the higher ends of the value chain. And even if it did transfer some high end capabilities, it may not do this fast enough. As wages rise in the country and as other developing

countries begin to offer cheaper cost assembly alternatives, the challenge for middle income developing countries is to acquire the capabilities to enter into higher points on the value chain rapidly enough. A high level of protection of IPRs may be neither necessary nor sufficient to ensure the most rapid movement of the country up this value chain. Perverse effects of the type Stiglitz suggests can emerge if the strong protection of IPRs encourages multinationals to try and protect their technology rents as long as possible by slowing down capability transfers to the assembler countries.

If this happens, the potential productivity growth arrow in Figure 1 from the initial point at quality Q_2 describing the assembly activities of the multinational is now shorter because knowledge about critical parts of the overall technology which is required to produce the final product are owned and not transferred to the developing country. Alternatively, the capability curve to the *right* of Q_2 is likely to rise very slowly. Under these circumstances, and given that the multinational has no long-term stake in any particular country, the emergence of lower cost assembly options elsewhere poses grave challenges for middle income developing countries relying on this strategy for sustained technological capability building. If relocation of some multinational assembly operations took place, would the country have enough domestic technological capabilities to move up the value chain on its own? Or would the missing technological capabilities in product design at the high-end parts of production prove decisive?

Clearly the answer would vary across products and the best strategy in electronics may be different from that in motor cars. There are also likely to be significant differences across countries in their ability to extract technology transfer from multinationals such that domestic companies could eventually take over. As this is a relatively new model, the long-run prospects of developing countries on this route are not yet clear. In the case of China, technological catch up was initially significantly driven by the locational decisions of multinationals. In the 1990s, Taiwanese firms began to relocate simple assembly operations to China on a significant scale, implicitly investing in learning processes. In the electronics industry, assembly was followed rapidly by components and more recently design work. Plastic mouldings and machine tools servicing the electronics industry also developed eventually resulting in an integrated Chinese electronics industry (ADB 2007: 280). But China is possibly an exceptional country in having a combination of structural subsidies that aided learning (an undervalued exchange rate, a low real interest rate), a large domestic market growing rapidly in effective purchasing power (giving the government bargaining power over multinationals), high quality and relatively cheap infrastructure for industry, and concerted strategies of technology acquisition that were successful in other sectors. China's success in broad-based manufacturing growth across many sectors made it possible for it to offer integrated sourcing possibilities for multinationals that were very attractive and which could therefore induce them to make long-term investments in capabilities. (ADB 2007: Figure 3.1.5). In the absence of such conditions much more concerted policies may be required to accelerate technological capability development in countries like Thailand.

The success of countries like China with multinational technology transfer may also be closely linked to their success in building up technological capabilities outside the multinational sector. If multinationals had to invest in all the learning across integrated production systems, investing in technological upgrading in that country

would not be an attractive proposition. If on the hand, the country has a range of different sectors that are already at global competitiveness or approaching it on the basis of its own loss-financing strategies, it may be very viable for the multinational to invest in technological capability upgrading in its particular area to take advantage of the possibility of input sourcing or local market opportunities. Thus, IPR protection seen in isolation is unlikely to solve broader technological capability building issues, particularly in smaller developing countries without integrated capability building strategies.

It follows that a viable strategy of capability development based on multinationals would have to go beyond the strong protection of IPRs (and indeed there is some question as to how far IPR protection is necessary to induce rapid rates of technology transfer). It is certainly not enough to have the capability to simply protect multinational IPRs to the satisfaction of global companies. Countries like Thailand have developed effective capabilities to protect global IPRs, but this may not be sufficient to enable them to make the transition to advanced country status. Additional capabilities are required to design policies to induce multinationals to move progressively more parts of the integrated production processes to the developing country, including eventually design and R&D. These in turn are predicated on broader governance capabilities to induce technological capability development in other sectors and to ensure that incentives and compulsions exist to ensure high levels of effort in sectors where learning is being assisted. Without these governance capabilities, dependence on multinational investments may in the long-run constrain developing countries to lower technological trajectories, as well as making them vulnerable to multinational locational decisions.

Appropriability Problems: Financing Discovery

An appropriability problem that has attracted considerable attention involves the *discovery* of activities that are profitable in particular developing countries (Hausmann and Rodrik 2003). This is not strictly a model of learning-by-doing but it suggests similar results, so we need to consider its implications for governance. The argument here is that developing countries have underlying comparative advantages in the production of certain products but not others but these are not known till an entrepreneur actually sets up production and tries out different things. This part of the model is actually unconvincing as a general proposition. Why should some countries be better at producing bed sheets and other countries better at producing hats? Hausmann and Rodrik suggest that this is the case, and in fact they argue, for instance, that Pakistan is better at producing bed sheets and Bangladesh in hat production as revealed in the mix of their exports.

There are at least two possible ways of explaining the types of observations of specialization that Hausmann and Rodrik report, with different implications for policy and the governance capabilities required to address the problem. The first possibility is the one that the authors offer: there are innate differences between countries that are real, but not known. These differences can only be discovered through the organization of production. The process that they describe is therefore not learning-by-doing at all but rather ‘discovering-by-doing’. But what kinds of innate characteristics could give societies an advantage in making some basic products rather than others? Are they likely to be genetic or cultural? While innate capabilities could clearly be important in determining whether an individual becomes a sportsperson or

a musician, I find it far less convincing that entire countries have innate capabilities that make them more or less capable in mundane production activities like making hats or bed-sheets. But for the model to make sense, this has to be true.

In terms of our notation elaborated in Section 2, the Hausmann and Rodrik explanation suggests that there are exogenously given competitiveness levels $\frac{P_Q^{global}}{C_Q^{domestic}}$ that vary across products and qualities but these are not known *ex ante* to the country or to its entrepreneurs. The key assumption is that there is an *exogenous* distribution of productivities Π_Q and α_{Qi} across products and qualities based on innate capabilities. The model claims that an entrepreneur has a probabilistic hunch as to whether a particular product of a particular quality can be produced at a globally competitive price or not, but the actual productivities are not known. It follows that the true Π_Q and α_{Qi} for each product and quality can only be 'discovered' when production is actually set up and productivity is observed. The entrepreneurial function is to discover the distribution of Π_Q and α_{Qi} through a process of experimentation that is described as 'discovery'. As soon as a sector and quality is discovered where the hitherto hidden Π_Q and α_{Qi} do in fact allow global competitiveness, globally competitive production can immediately commence. The appropriability problem is that these pioneering firms cannot appropriate sufficient profits that would justify their investments in the discovery process, for reasons we discuss later. The policy recommendation is therefore to enhance the scale of experimentation and discovery through an appropriate financing strategy, and this requires the requisite governance capabilities.

In contrast, our alternative explanation, based on the analysis developed in Section 2, is that competitiveness in developing countries is likely to be below unity for almost every product and quality that is not already being produced. Tacit knowledge and formal training needs to be acquired for almost any activity to become competitive, and potentially a vast range of activities can become profitable if the appropriate effort in learning-by-doing is put in. Indeed, in some countries the initial discovery may be that nothing can be produced competitively. According to our alternative interpretation, the initial distribution of labour and input productivities across products and qualities, Π_Q and α_{Qi}, and therefore the initial differences in competitiveness across sectors or qualities may not be indicative of anything intrinsic. It is most unlikely that countries are innately more suited to produce a particular set of low quality products compared to others. In this context, specialization may emerge as an accidental consequence of some entrepreneurs successfully investing in learning *and* succeeding in achieving high levels of effort, thereby achieving global competitiveness in specific activities.

The importance of effort rather than simply of discovery is clearly demonstrated by the successful East Asian industrial policy cases where these countries often took many years of effort to achieve international competitiveness in high-technology industrial sectors. It was rarely the case that innate capabilities were rapidly discovered. This suggests that the focus of attention should be on how they achieved high levels of effort, rather than in the opportunities they created for discovery. Even

relatively simple technologies like the Bangladeshi garment industry emerged in the context of specific learning incentives created (accidentally) by the Multi-Fibre Arrangement (MFA). The fact that MFA rents were time-bound created strong incentives and compulsions to achieve competitiveness rapidly (together with a number of other institutional conditions that we will discuss later). This is why the opportunity of learning-by-doing created by MFA rents actually resulted in a globally competitive sector while many other earlier subsidies in Bangladesh aimed at accelerating learning in different sectors did not result in the discovery of any globally competitive products.

Patterns of *ex post* specialization can then emerge based on the results of attempted learning across different activities. Some entrepreneurs may achieve success in specific areas because the type of subsidy (and their own skills) induced high enough levels of effort to achieve global competitiveness rapidly. Countries could therefore end up specializing in hats rather than bed-sheets because attempts at learning happened to be focused in, or more successful in, hats rather than in bed-sheets (assuming they tried doing both). The issue then is not discovering what you are good at but understanding why there was differential success in learning and then improving the organization of learning-by-doing across more sectors. In our alternative explanation, an important reason why learning-by-doing is not always successful is that effective learning requires effort. Ensuring that this effort is put in depends on the incentives and compulsions provided by states and within the firm when there is policy assistance or external financing for the learning. *Ex post* differences in specialization across countries can emerge, according to this explanation, because of differences in the effort put into learning across different products and qualities.

Once a product of a particular quality becomes globally competitive, a rapid expansion of production around that product is expected for a number of reasons. First, global buyers coming to the country to place orders will induce an expansion of production capacity by the original entrepreneur. Secondly, if the order magnitude is significant, other entrepreneurs will imitate production processes as well as the organizational characteristics of the successful firms. Tacit knowledge is easier to imitate if it is 'local' and operations can be observed. The presence of buyers with orders can make it easier for new entrants to get financing from banks to finance their startup costs, and the possibility of selling creates strong incentives to put in high levels of effort in learning, which is still necessary even for the imitating firms. Thirdly, the emergence of a pool of workers and managers with the appropriate tacit knowledge can assist the growth of further firms through the migration of workers and managers with the appropriate tacit knowledge. Finally, successful learning by the first firm or group of firms is likely to create a sense of psychological confidence amongst others that this is a technology that they can master. These are well-known factors that induce clustering and specialization through external economies of scale. But none of these explanations assume any innate capabilities distinguishing countries that entrepreneurs have discovered. The policy recommendation that follows is to identify the problems constraining effort so that learning-by-doing is more systematically successful and to promote learning in sectors, products and qualities where growth prospects are greater.

Returning to the Hausmann and Rodrik model, they also have to describe an appropriability problem that could explain why there will be underinvestment in discovery. Their argument is that as soon as the first investor identifies a product (of specific quality) in which the country has innate competitiveness, other entrepreneurs will rapidly begin to produce this product and bid down the high profits (rents) of the first firm very rapidly. Here too, the specific mechanism that the authors suggest is unlikely to be generally applicable to all developing countries. In terms of the notation in Section 2, the assumption is that the discovery of a competitive product and product quality initially implies a competitiveness ratio greater than one, so the entrepreneur making the discovery earns a higher than normal mark-up, $m_Q' > m_Q$. This rent provides the incentive for the investments in discovery, because these investments will often fail by definition, whenever the product or quality chosen turns out to be one in which exogenously determined competitiveness is lacking. Given the unavoidable probability of failure in this model, only the existence of rents for the successful entrepreneur making a discovery can induce investments in discovery. The analogy that the authors explicitly make is with technology rents that are necessary for supporting innovation in advanced countries.

But if $\frac{P_Q^{global}}{C_Q^{domestic}}>1$ for a successful discovery, why should imitation and the entry of new firms drive down the rents of the first firm? The answer the authors provide is that the entry of new firms drives up the wage level till the country's competitiveness in this product and quality drops to unity and no rents are earned any more. This is a contingent argument that need not necessarily hold, but the model requires something like this to establish why there will be underinvestment in discovery. In fact in most developing countries, the rapid growth of production in a specific product like hats or bed-sheets is most unlikely to have any discernible effect on the wage level. Indeed, in Bangladesh the growth of the entire garments sector from virtually zero to around three million workers in three decades has had a very limited effect on the wage level. It would require a broad-based industrialization across many sectors and for a sustained period to push up wages significantly given the vast pools of underemployed labour in most developing countries. As a result, the possibility that wages will rise significantly when competitiveness is discovered in a particular product in a particular sector of manufacturing is not in general plausible but may be true in a small minority of cases. It may be true, for instance, if very specialized labour is required for an activity. But if this specialized labour already exists, the entrepreneurial discovery function is not relevant. If it does not exist and the problem is that labour has to be trained within the firm and may then leave, we have a different type of appropriability problem, not a problem of discovery. Thus, the mechanism explaining non-appropriability in this model is not necessarily of general applicability and we need a better explanation of why investments in startups in new products and qualities may be constrained.

Despite the unrealism of the model in several respects, the discovery model does suggest that it is justified to provide subsidies to entrepreneurs setting up production in new products. The authors also take from the East Asian experience that the carrot of subsidies has to be combined with the stick of subsidy withdrawal, but it is not clear from the logic of the discovery model why subsidy withdrawal is important. Clearly there is no point in continuing to give subsidies to an entrepreneur beyond the

initial startup phase when there is a possibility of failure. The internal logic of the discovery model suggests that what is required is a time-bound subsidy to any entrepreneur engaged in discovery (investment in a new sector) so that the entrepreneur does not suffer a private loss if competitiveness is not discovered. In this case, subsidization beyond the set-up period is neither required nor justified, since either the activity will be rapidly proved to have the requisite underlying productivity or it will prove to be in the wrong area. The governance requirements for managing time bound subsidies for startups are modest.

There are significant differences in the focus of policy depending on whether we think learning is constrained by the absence of sufficient opportunities for discovery or whether it is constrained by inadequate incentives and compulsions for ensuring high levels of effort in learning. The disciplining of subsidy recipients in East Asia was a critical part of their success in achieving high levels of effort across a range of learning activities, but achieving this is actually of qualitatively greater difficulty than increasing opportunities for discovery in general. An important problem with subsidies to finance learning-by-doing (as opposed to discovery) is that to be successful, high levels of *effort* have to be induced. If the appropriability problem was primarily one of discovery, the importance of disciplining and the institutional structures inducing discipline would be of relatively minor importance. If, on the other hand, the problem with technology acquisition is fundamentally to do with ensuring high levels of effort, the disciplining problem and the appropriate institutional structures are of paramount importance. The discovery model does not capture the vital links between disciplining, effort and success in learning-by-doing, but these links have important implications for developing the governance capabilities necessary for 'discovering' new areas of technological competence.

Failures of Coordination and the Case for the Big Push

The problems of private contracting in conditions where coordinated investments are required have long been recognized as an important source of market failure by development economists (Rosenstein-Rodan 1943; Nurkse 1953; Scitovsky 1954; Murphy, et al. 1989). The 'lumpiness' of investments can create a number of related problems that prevent private contracting effectively coordinating investments to achieve enhanced social benefits. Lumpiness refers to fixed costs, which also result in scale economies. In the presence of lumpiness, investments in one sector or firm can have more than a marginal effect on other sectors: it can change the profitability of other sectors and firms by raising the demand for their products and/or cheapening the price of their inputs. The efficiency attributes of market prices as signals of social costs and benefits break down in this context.

The social 'profitability' of an investment in the first firm or sector undertaking an investment can be much larger than the private profit because the investment can trigger additional potential profits in other sectors. In an extreme case, an investment in the first firm or sector could even have negative private profit (if underdevelopment meant that domestic markets for its output did not exist or the lack of input suppliers made inputs excessively expensive) and yet the investment can be socially desirable because it adds to the potential profits of other sectors. If development across a number of sectors could be simultaneously triggered many such investments would be jointly profitable because markets and inputs would jointly develop. A variant of the lumpiness argument is that initially infrastructure may be absent and indeed

investment limited to one sector may not justify investment in the requisite infrastructure. However, if investments in several sectors that require this infrastructure could be simultaneously organized, the investment in infrastructure would in turn become profitable. The sectoral interdependence of investments is not explicitly considered in our simple catching up model in Section 2 but some of the implications can be easily incorporated.

In our model, the target price that determines competitiveness is set by the advanced country leader. Domestic investment coordination can only help in our model if it results not only in higher domestic demand but also a higher domestic price than the international price. But this is only possible if the domestic market is protected. But even protection cannot raise the domestic price for many (higher quality) products because in smaller countries there may be insufficient domestic demand for these products. Nevertheless, if investment coordination in a protected market raised the domestic price of a product, it could provide learning industries with a degree of implicit loss-financing. Of course, import protection and investment coordination are not the only tools for financing learning. A subsidy on exports would have sufficed as well, and does not require creating effective domestic demand for the industry's product. Thus, as a mechanism for providing an implicit subsidy, investment coordination is not strictly necessary.

However, the investment coordination argument becomes much more persuasive if it is presented as an effective mechanism for *lowering* the prices of inputs. In our model there is a simplifying assumption that all inputs are traded at exogenously given world prices. But this is unrealistic. Many inputs such as utilities and domestic services are non-tradable, and their prices are likely to depend on the scale of domestic demand. Thus utility supplies may be poor and expensive if only one sector develops, but may dramatically improve if many sectors can share in paying for a utility that has significant scale economies. In many relatively high technology sectors, the ability to plan product development also requires close collaboration between product and input manufacturers. As countries rise up the income and quality ladder, the ability to achieve balanced development of different technology sectors can be critical to enable the coordination of input production, quality and price.

A significant advantage that China has over India for instance, is in the efficiency of its intermediate industries and utilities. We saw in Table 1 that compared to China, India's manufacturing sector (which is much smaller and focused on higher technology manufacturing) had a higher labour productivity around 2005, though the gap was rapidly shrinking. But when we look at overall industrial labour productivity, China was significantly higher than India, and the gap was increasing. These differences are likely to be related to the integrated industrial takeoff in China and the effect this has had on the competitiveness of a wide range of intermediate goods and utility suppliers. The high and growing productivity in these intermediate and utility sectors in turn gave China greater global competitiveness in manufacturing, contributing to its growing manufacturing productivity through accelerated investment and learning. Moreover, if China's manufacturing diversification keeps increasing, it will also develop a strong advantage in having many different domestic input suppliers with whom producers can collaborate to improve product design and achieve quality upgrading.

If private investment coordination is likely to fail because of the high costs of contracting and information, these market failures could support the case for a state-coordinated Big Push. This could involve the coordination of investment across sectors potentially enjoying complementarities and external economies. But the governance requirements for a state trying to achieve Big Push industrialization are significant. It has to be able to identify the sectors to be included in the Big Push, and it has to do this without being excessively influenced by rent-seeking to include sectors that cannot be justified on economic grounds. To effectively coordinate investments, the state's indicative planning has to be credible and aligned with private sector interests. Or else incentives through the tax system or direct regulations have to be effective in influencing resource allocations. There is no point publishing detailed indicative plans that everyone ignores. If real resources are being allocated, it is also important to have the capacity to identify possible mistakes early on so that policy can be changed or abandoned quickly. Most importantly, for the Big Push sectors to become profitable it is not sufficient that there should be coordination. Each sector has to achieve competitive levels of underlying productivity.

Other conditions must be in place to ensure that scale economies translate into actual *productivity increases*. In other words, the coordinated sectors must themselves be successful in their learning effort. Only then will the coordinated demand be sustainable and declining input prices can feed into the growing competitiveness of a broad range of other learning sectors. Thus, the policy will only work if it can ensure high levels of effort and effective learning in the new sectors where investments are being channelled. The success of the policy therefore ultimately depends not just on coordination, but also on the productivity and learning success of each component of this structure. Without that, the Big Push will not translate into falling input prices or sustain demand across sectors. So in addition to the governance capabilities outlined earlier, the Big Push also requires effective conditions for ensuring high levels of effort in the industries benefiting from coordination.

Big Push governance capabilities are therefore very demanding. This assessment is consistent with the observation that very few developing countries have achieved successful balanced development through public policy in this way. The East Asian countries that did so had exceptionally strong governance capabilities of coordination, disciplining and error correction. Some of these capabilities were also involved in limiting other market failures. Coordination capabilities for a Big Push can therefore be seen as a higher level governance capability that could be aimed for if other necessary capabilities have already been achieved. Many developing countries would be fortunate to achieve some of these lower-level capabilities that may allow a relatively more limited industrialization and technology acquisition.

Thus, the suggestion by Sachs et al. (2004) that Africa requires a Big Push implicitly ignores that African countries are far away from the governance capabilities that would be required for coordinating investments on a big scale. While they are right in pointing out that market-enhancing governance does not seem to explain African performance, the missing growth-enhancing governance capabilities are not adequately identified. Once these are broken down and identified it would be clear that in many developing countries, before the capabilities for managing large scale coordinated investments can be contemplated, capabilities for solving more specific market failures constraining viable investments need to be in place. But as countries

like Thailand and India move up the value chain the benefits of solving the market failures constraining investment coordination in these countries steadily increase.

Institutional Problems of Ensuring Effort in Learning

Effective learning clearly requires time, but it also requires significant effort if it is to be successful. Time and effort are inversely related: the lower the effort, the longer the learning takes. Since learning has to be financed, this has obvious implications for the investors financing learning, whether public or private. Thus, in Figure 1 firms in country B may not be able to begin production at point U without loss-financing, but the question from the perspective of the feasibility of the financing is *how long* the firm will take to go from U to V, or even whether V will ever be reached. The policy responses to all the other market failures discussed earlier assume that the problem of ensuring high levels of effort in the learning process has been solved. In other words, the assumption is that if we resolve the different types of financing issues, the requisite global competitiveness can in fact be achieved.

In fact, this is one of the most difficult problems to solve. For many developing countries, the failure of investments in learning can be traced back to the absence of governance capabilities for ensuring effort. Without appropriate incentives and compulsions, a production team can keep on repeating procedures without any improvement in their productivity. The 'learning' process can then continue indefinitely, as all countries with infant industries that refused to grow up discovered. If the private or public principals who may have invested in financing the loss-financing period suspect this in advance, they will not even invest in the first place.

The object of learning is to achieve the breakeven point of competitiveness where loss-financing is no longer required. If we define this length of time as the breakeven time, B_t, we can see that this plausibly depends on a number of obvious variables. First, it must depend on the initial gap between the country and the global leader which we can measure by the initial competitiveness ratio. The gap between the actual competitiveness ratio and the competitiveness that is required to match the leader is measured by the loss-financing or subsidy s_Q required to enter production at that level of quality. The greater the initial gap, the longer it will take to catch up and break even. The second variable determining the breakeven time is most important for our analysis, and that is the level of *effort* the different participants in the production process put in. Whatever the initial gap, a higher effort is likely to result in a faster convergence towards the global standard. Effort can be measured by the intensity of application of workers and managers to continually improve productivity. This can be observed along various dimensions including the rate at which managers and workers experiment and adapt production processes to achieve improvements in productivity. As effort imposes costs on individuals and can also create differentiation between the more and less able, particularly at the level of management and supervision, higher levels of effort are more difficult to achieve, everything else being the same.

Finally, the breakeven period can also depend on country and firm specific factors. Country specific factors refer to general levels of education, exposure to technology, prior history of production, infrastructural quality and so on. If a country is significantly behind the technological capability required to produce a product of a particular quality, it may fail to approach required levels of competitiveness within any feasible time period. Firm level factors refer to idiosyncratic differences in the

quality of entrepreneurship, the quality of technicians and managers inherited by a firm and so on. These variables are summarized in eq. [10]:

$$B_t = f\left(s_Q, e, C, F\right) \qquad [10]$$

The breakeven period B_t is likely to be longer the higher the initial gap in competitiveness measured by s_Q, the lower the level of effort, e, and also on C and F, which describe country-specific and firm-specific factors respectively.

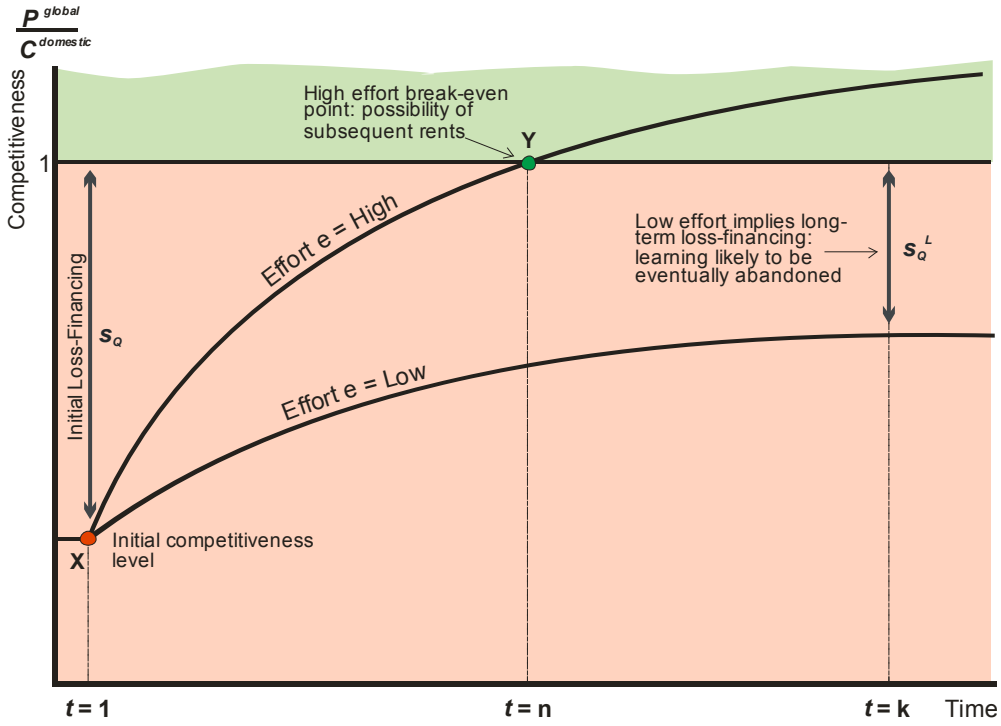

Figure 3 Effort Levels and the Viability of the Learning Process

Figure 3 focuses on the key role of differences in the level of effort keeping all other determinants constant, and focusing on catching up in the production of a specific product quality, Q. The figure tracks the achievement of competitiveness over time. Comparing with Figure 1, the critical question we are now asking is the following: if country A began at point X, how long will it take to reach Y, or will it reach Y at all? The idea is that with any given level of loss-financing, the pace of achieving improvements in labour and input productivity, and therefore in achieving international competitiveness, depends on the level of effort put into learning. To simplify, we distinguish between two levels of effort, defined as high and low.

At time t=1 country A's competitiveness is too low for it to enter production at quality Q without loss-financing from some source. The initial loss finance is shown as s_Q in Figure 3, which allows the country to begin production and initiate the learning-by-doing process. If effort levels are high, the breakeven period B_t = n periods. At that point, loss financing can be abandoned and indeed the country may even be in a position to earn rents in subsequent periods. In contrast, if effort levels are low, international competitiveness may not be achieved even if there are some initial improvements in productivity. In the low effort scenario shown in Figure 3 $B_t = \infty$,

which means convergence does not happen. After k periods a steady-state subsidy of s_Q^L emerges which is indefinitely required for production to continue. Note that productivity growth is also happening in the leader country, so a constant s_Q^L may emerge even with some domestic productivity growth. This is equivalent to the case of infant industries that failed to grow up. Eventually, loss-financed learning in these circumstances is very likely to be abandoned because the social cost grows over time.

Clearly, financiers of learning would like the highest level of effort to be forthcoming so that not only is there convergence but also convergence in the shortest possible time. In contrast, workers and managers engaged in learning may have mixed motives. They may understand that jobs and perhaps income growth may eventually depend on productivity growth. But since learning is costly in terms of effort and may result in adverse outcomes for individuals who fail, workers and managers have an individual interest to free ride on the effort of others, which can lead them to distort true information about their own levels of effort. They may often also articulate a collective interest to pursue a less traumatic learning path without recognizing its long-run non-viability. These individual or collective strategies can extend the period of loss-financing much beyond what is acceptable to public or private financiers. In extreme cases, such as the low effort trajectory shown in Figure 3, the result may be that financiers are stuck in a situation of permanent loss-making and the project has to be eventually abandoned with significant losses. Alternatively, financiers may suspect that this will be the case and the investment will not be forthcoming in the first place.

Since in the long run it is plausible to argue that high levels of effort would have potentially benefited all participants and society, there is a market failure here that can be described as a failure of credible 'contracting' between investors and producers in the firm engaged in learning. But of course the contracting at issue here is a metaphorical one because effort levels are typically not contracted for in writing. The problem is therefore not one of an inadequate rule of law and the insufficient enforcement of formal contracts in courts, but broader political economy issues of achieving sufficiently high levels of compulsion for different sets of agents who are required to put in high levels of effort. The underlying institutional failure here is very similar to principal-agent problems that can in general result in breakdowns in team effort and in credit markets result in inadequate investment (Alchian and Demsetz 1972; Stiglitz and Weiss 1981; Shleifer and Vishny 1997). However, the specific problems here refer to a much wider range of issues than the asymmetric information literature on monitoring or credit market failures normally address. The broader variables that are likely to affect the level of effort in our analysis are listed in eq. [11]:

$$e = f(FI,\ GA,\ FS,\ PS) \qquad [11]$$

Effort *e* is defined as the intensity with which learning is carried out. The higher the level of effort, the faster the movement up the competitiveness ladder, as Figure 3 shows. *FI* is the specific *financing instrument* through which the learning is being financed. Different financing instruments have design features that aim to compel high levels of effort through different mechanisms. We can think of financial instruments as 'rules' that define who contributes what and what the expectations are. *GA* are the *governance agencies* of different capability that monitor and enforce the

financing instrument. The enforcement of the rules implicit in each instrument can vary widely depending on the formal and informal enforcement capabilities of the agencies responsible for enforcement. *FS* is the *firm structure* within which learning is being organized, referring to relevant characteristics of the firm(s) including size, age and internal organization, and the type of market in which it operates. *PS* is the *political settlement* which describes the bargaining power of the different types of agents involved in financing and participating in the learning process. The function *f* allows interactions between these variables so that the effect of any variable *can* depend on the 'value' of the other variables in a non-linear way. We first discuss the variables to see some of the interdependencies between them and then discuss the consequences of these non-linear relationships for learning and technology policy in the next section.

Financing Instruments

Learning can be financed through a wide range of arrangements that can be described as financing instruments. Each instrument implicitly defines rules of contribution and reward and therefore the incentives and responsibilities of the different participants in the learning process. Effort is likely to be maximized if the individuals putting in the effort gain significantly from their effort. But effort will only be financed if the financiers also get a return. In team production where large numbers of people have to cooperate, sustaining high levels of effort is complex. Supervision and coordination at different levels become important because individuals can attempt to conceal their true levels of effort. Sustaining effort may now require supervision and incentives for those supervising the effort for instance by making them 'residual claimants' (Alchian and Demsetz 1972). But even this may not be sufficient unless the residual claimants also have the effective authority to impose discipline on team members. The residual claimant model describes in a partial way the basic 'capitalist' firm and its underlying property rights. It is partial because it underplays the significance of the political power that gives owners the effective power to carry out their disciplining functions.

In an earlier paper in this series we argued that property rights have a number of functions including the creation of compulsions for productivity growth (Khan 2009). In early developers, compulsions for high levels of effort and labour discipline were based on a configuration of property rights described as 'capitalist'. Capitalist rights define a class of asset owners (residual claimants) and a class of propertyless workers who are compelled to accept workplace discipline. This configuration of property rights was sufficient to ensure productivity growth in the early capitalist developers who could grow by imposing discipline and achieving incremental innovations in products and processes. As technology leaders, the early capitalist developers had to innovate, but they did not have to achieve significant jumps in their productivity through learning to become globally competitive.

The learning requirements of contemporary (late) development are different. They do not have to innovate to the same extent, but are faced with a massive gap between their initial technological capabilities and the minimum required to produce anything in global competition. An important consequence of the catching up problem is that 'capitalist' property rights are no longer sufficient for ensuring effort. Contemporary late developers need to organize learning-by-doing to learn to use technologies far in advance of their existing capabilities. This now requires loss financing for entry into new sectors and technologies, and often requires financing from outside investors

including the state. More complex financing instruments and complementary governance structures need to emerge at a much earlier stage of development. It also follows that more complex systems of incentives and compulsions to ensure effort are also required at a much earlier stage.

In theory, learning could still be financed by owner-entrepreneurs investing in their own firm. For instance, an owner-entrepreneur can accept a longer period of losses to set up in a higher quality sector. This is no different from any other investment, where the entrepreneur accepts temporarily low profits to achieve higher profits later. The only difference is that here the investment is in the acquisition of tacit knowledge. As the owner is the residual claimant, there are strong incentives to monitor effort to reduce the period of loss-making. This case is closest to the simple capitalist firm with its strong incentives and compulsions for sustaining effort. Whether high levels of effort can be sustained in this case is likely to depend on exogenous political factors that determine the extent to which owners can enforce discipline on their workforce, and social and political factors determining collective discipline, cooperation and trust (Leibenstein 1982).

But owner-financed learning is likely to be relatively rare given the long periods of learning required and the uncertainty of ensuring effort in new products. There is also likely to be a significant gap between the resource base of the typical entrepreneur in a developing country and the investments required to acquire machinery and finance periods of loss-making of uncertain length. The risks and the financing may both be beyond the capacities of most individuals attempting to become entrepreneurs in a developing country. Therefore successful development is likely to be associated with more complex 'financing instruments' where the entrepreneur does not directly own the finance but raises it in different ways.

If the entrepreneur borrows from a bank with debt backed by collateral, the incentives could be quite similar to the first case. If the bank has the power to sell collateral in case of non-performance, the entrepreneur bears all the risk of learning. For large investments or new technologies, where there is a chance of failure despite the best effort of the entrepreneur, they may refuse to accept the risk. But banks in most developing countries are unlikely to have effective powers to realize collateral and the weak compulsions on the entrepreneur can result in *low* effort and potential losses for banks. If banks know this, they in turn may be unlikely to lend for new technologies or to new entrepreneurs. If the financing comes from equity investors or other investors outside the firm, standard principal-agent problems emerge. Will the manager put in sufficient effort; will workers accept the discipline that managers try to impose on them under these circumstances?

More complex issues arise when financing comes from the state. This can take various instrumental forms, ranging from tax breaks, low interest credit, subsidized inputs, utilities or infrastructure, export subsidies, or the protection of domestic markets. In theory, it should be possible to devise financing instruments that allow periods of learning to be financed with strong compulsions for rapid productivity growth. For instance, the instrument could be designed to progressively increase exposure to competitive international prices by announcing *ex ante* the rate at which the level of export subsidy or the level of protection of domestic markets will be reduced.

Governance Agencies

A financing instrument may make sense on paper, but it requires enforcement, and the enforcement capabilities of the agencies responsible are therefore important. For instance, the announcement that export subsidies will be reduced over time is only credible if the agency responsible can actually do it without pressure from firms changing its policy in the future. The governance agency that is relevant depends on the financing instrument. For instance, if loss-financing is based on credit from industrial banks, the relevant agencies are the banks and other agencies they rely on for enforcement. Do they collectively have the capabilities to monitor loans effectively; do they have the power to withdraw loans if firms are failing? If the loss-financing is organized through subsidies, the relevant agencies are those responsible for administering the subsidies. Do they have capabilities for monitoring performance, deciding on credible actions, ultimately to the point of withdrawing subsidies from firms that have failed to demonstrate high levels of effort?

If financing is internal to the firm, the enforcement of productivity growth is also a struggle largely internal to the firm. Loss-financing could take the form of owners accepting a lower mark-up before the project becomes profitable. The enforcement of effort in this case is indistinguishable from 'normal' conflicts over labour discipline in a capitalist firm. The governance agencies relevant here would be formal and informal agencies regulating and enforcing labour contracts, or contracts between owners and firm managers. This is why in the 'good governance' literature, contract enforcement and the rule of law are considered to be necessary and sufficient capabilities for achieving growth (Acemoglu, et al. 2004; Khan 2007b).

The credibility of an agency depends on how effectively the state will support its enforcement of rules. This in turn depends on the agency's relationship with powerful constituencies and higher political authorities in the country. Industrial development banks are likely to have higher levels of credibility for enforcing their instruments if they are implementing an industrialization drive supported by a strong president, rather than if political authority is fragmented and banks have been captured by competing political factions. Even in the case of private contracting, we know that contract enforcement and the rule of law are bound to be poor in developing countries (Carothers 2003; Khan 2007a). In fact, the effectiveness of private contractual arrangements always depends on the political context. The 'private' bargaining between employers and employees is never entirely private, and more so in a context where the overall rule of law and contract enforcement is structurally weak. In general, all sides to a conflict will attempt to mobilize broader social forces to support them. As a result, outcomes of labour-capital or investor-manager conflicts are likely to depend on the political forces the different parties can mobilize to influence the effectiveness of enforcement of the relevant agencies.

Firm Structure

The degree to which effort can be enforced is also likely to depend on the internal organization of firms, and on the structure of the market. We have already seen that effort is more likely to be forthcoming in firms where owners are investors and they control the firm. This case comes closest to the classical model of a capitalist firm driving productivity growth. (Alchian and Demsetz 1972; Wood 2002). The ideal type capitalist firm has a number of characteristics that ensure that it can mobilize high

levels of effort. First, it has strong internal hierarchies and a workforce disciplined by a competitive labour market (possibly with a reserve army of unemployed labour creating a credible threat of replacement in case of low effort). Secondly, the theoretical capitalist firm has significant retained profits giving it the financial strength to invest in itself and the incentive to protect its own capital. Thirdly, the theoretical capitalist firm already has the capability to use its technology. Finally, the capitalist firm is not individually politically connected or powerful, though the class of capitalist firms may have significant political voice. This means that the textbook firm does not have the capacity to override contracts with external investors or the state using political connections and power. The real capitalist firm may significantly differ in some or all of these respects, particularly in developing countries, with significant implications for the effort expected after investments in learning.

Internal hierarchies are likely to be strong only in relatively few firms in developing countries. These are likely to be older more established firms where employees have large sunk investments in firm-specific career structures. These employees stand to lose their investments and their career prospects if the firm collapses, and they are likely to put in high levels of effort when called upon by the owners. Newer, startup firms are likely to face significant problems with their internal organization of effort, slowing down their learning process. Secondly, internal finance is also likely to be significant only in well-established and larger firms. The greater the internal financing, the greater the incentives of owners to ensure effort. On the other hand, most firms in developing countries are likely to require significant outside finance, diluting the incentives of owners to put in high levels of effort in the absence of significant and effective governance of effort by appropriate agencies.

Thirdly, by definition, most firms in developing countries do not have high levels of technological and entrepreneurial capabilities. Most new firms have to spend a considerable amount of time to learn how to learn before they actually start learning (Stiglitz 1987). Finally, real world firms are likely to have strong political connections and indeed many firms may be set up by entrepreneurs closely connected to politics, particularly in developing countries. Here, older, larger and well-established firms may have the disadvantage that they are more likely to be well-connected to different political organizations and it may be difficult to discipline them in a context where external loss-financing is coming from instruments controlled by the state.

These considerations mean that external providers of financing for learning in firms have to look at a complex range of issues in determining which types of firms are more likely to achieve competitiveness. Large firms may have greater technological capabilities, better internal discipline and are perhaps able to commit more of their own finances. But they may also have oligopolistic political power that makes it difficult to impose credible threats on them to enforce effort. Given the interdependence of political and technological factors determining effort and efficiency, it is not surprising that the characteristics of the efficient firm varies significantly across countries (Whitley 1992).

For instance, both Pakistan and South Korea in the 1960s financed large conglomerates to acquire new technologies and move into exports. However, effective compulsions for high levels of effort for firms of this type could not be achieved in Pakistan but were achieved in South Korea. To a significant extent this was because

large conglomerates in Pakistan acquired the political capacity to protect their rents from threats of withdrawal in a way that South Korean *chaebol* could not. In nearby Taiwan, a large firm strategy may also have failed because the immigrant political leadership of the 1950s and 1960s may not have had the political authority to stand up to powerful locally owned conglomerates so early on in the development process. Fortunately for Taiwan, government strategies of technology acquisition focused on much smaller firms in high technology sectors, either by accident or design. As a result, Taiwan's ability to maintain discipline was not impaired. The interesting counterfactual is whether countries like Pakistan may have fared better if they had designed support schemes for smaller firms who may have found it much more difficult to capture policy in the way in which the 'twenty-two families' of Pakistan did (Wade 1988; Amsden 1989; Wade 1990; Whitley 1992; Khan 1999; Khan and Blankenburg 2009).

Of course, in many product and quality lines, scale economies mean that a competitive market structure is implausible. In these cases, the design of learning strategies has to be aware of the difficulties and take measures to strengthen governance agencies to prevent big players holding external financing to ransom. In some developing countries the answer may be to delegate the governance of the financing to independent and high quality external agencies like industrial banks. If the management of the industrial bank is perceived to be committed to competitiveness, and not accessible to political factions, the credibility of withdrawal may be high enough to enable learning to be financed in sectors with scale economies. The success of industrial policy in South Korea is now widely understood to have been based on political conditions that enabled the enforcement of implicit performance conditions (Kohli 1994; Chibber 1999; Khan 1999, 2000a; Chibber 2003). For instance, some types of subsidies can induce effort if firms are unable to organize protection, but fail if firms can politically protect their subsidies. We turn now to the importance of these political conditions in the general case.

The Political Settlement

The political settlement describes the distribution of organizational and bargaining power between different social groups in a society (Khan 1995). The relative power of different groups clearly determines the capability of the governance agency to enforce particular financing instruments. The configuration of power may also determine the design of the financing instrument in the first place. A mechanism of financing that requires high levels of effort from agents who can mobilize powerful social forces for their own protection is unlikely to work. Threats to withdraw support from them may not be credible or enforceable. This is why institutional arrangements for financing that initially appear to be less effective may actually work better in some contexts because they provide financing to firms that can actually be enforced.

Differences in underlying political settlements can explain why apparently similar governance agencies, firm structures and financing instruments have resulted in very different outcomes across countries. We have already referred to South Korea and Pakistan in the 1960s which used fairly similar strategies of providing long-term bank credit to large conglomerates involved in capability development in export-oriented sectors. But the outcomes were significantly different because their political settlements were different and financing instruments could be enforced in one case but not in the other (Khan 1999).

Equally, looking at the political settlement can help to explain why effective financing instruments and the governance agencies responsible for their enforcement have *differed* so significantly across successful catching-up countries. South Korea, Taiwan, China or Malaysia, display significant differences in their catching up strategies across all these variables. Success simply required that the ensemble of variables determining effort in eq. [11] were consistent in terms of the political settlement so that the mechanisms for imposing compulsions required for high effort were credible and enforceable (Khan 2000a, 2008a; Khan and Blankenburg 2009). In section 4 we will discuss the policy implications of the interdependence between these variables determining effort. But first we look at what the preceding discussion tells us about policy priorities for learning and technology acquisition.

Policy Priorities for Addressing Market Failures Affecting Learning

Developing countries face such a vast variety of problems that it is easy for policy effort to be dissipated in a large number of initiatives. It is important to identify priorities and concentrate reform capabilities on the most important problems first. The preceding discussion suggests that not all market failures constraining learning and technology acquisition are equally important. The market failures that prevent the assurance of high levels of effort emerge in a logically prior position because if these problems are not addressed, any investments in learning and technology acquisition will not be successful even if they can be organized. The market failures linked to appropriability problems are contingent possibilities that *could* affect investment in learning in some cases but may not be relevant in every case. The market failures preventing the coordination of investments across sectors can constrain a Big Push, but poor countries can make significant progress without attempting ambitious coordinated strategies. The sequence of priorities suggested by this discussion is summarized in Figure 4. This draws on our discussion in this section which suggests a logical sequence in which different market failures need to be addressed as well as indicating the difficulty of addressing the governance issues in each case.

There are two reasons why we should prioritize the importance of failures constraining effort. First, we have argued that the problem of tacit knowledge, learning and low productivity is a *general* problem that the technology literature identifies as systematically affecting the entire range of technologies and production processes in developing countries. It is unlikely that there will be a significant number of firms or sectors in developing countries which do *not* suffer from the problem of ensuring effort during difficult learning processes, but *do* suffer from some of the other appropriability problems constraining investments in firm-level skills or knowledge about production processes. If this is right, then in general, an attempt to solve other market failures without the capability to ensure high levels of effort is likely to result in wasted financing targeting other market failures.

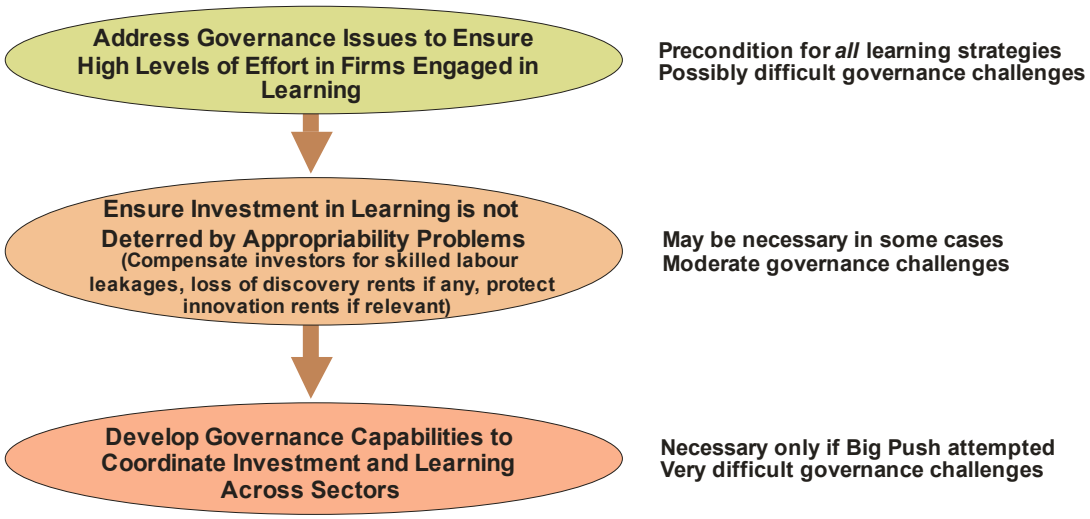

Figure 4 Sequential Policy Priorities for Learning and Technology Acquisition

Secondly, as Figure 4 also notes, the governance requirements of ensuring compulsions for high levels of effort are unfortunately also rather difficult to achieve. If effort cannot be assured across the board, not all sectors or firms may be appropriate for policy-supported learning programmes. Given the political settlement and the types of technologies and firms that are in contention for learning in that country, it may be that only a small number of sectors or firms are likely candidates for support. Support could justifiably be limited to the subset of firms or sectors where effort is likely to be sustained with the governance capabilities available. Clearly, it only makes sense to go to the next set of questions about appropriability for this limited subset of firms and sectors, supporting the logical sequence suggested in Figure 4.

Otherwise, attempts to address general problems of appropriability using subsidies or other policy interventions are likely to be largely wasted because they will be applied to many firms where the crucial precondition of ensuring high levels of effort is missing. Indeed, this has been one of the characteristics of a vast variety of subsidy and cost-sharing programmes in the past. However, if appropriability problems affect firms where high levels of effort *are* expected, these additional problems *do* need to be addressed. Fortunately, as we have seen, the governance capabilities required for addressing these additional problems are in general likely to be less onerous compared to the governance conditions required for ensuring effort.

Finally, we have also argued that the governance challenges for coordinating investments across sectors are likely to be very challenging, and perhaps the most challenging of all. Significant governance capabilities of identifying sectoral interdependence, coordinating and financing investments and monitoring performance across the economy are required for this type of effort. Fortunately, while organizing an effective Big Push is desirable (and was a characteristic of the most successful industrial policy states), it is not necessary for achieving significant progress in most poor countries. Consequently, policy can turn to coordination problems only if significant progress has already been made in the first two areas. Once again, there is no merit in spending policy time in addressing a coordination problem if we are not assured that the investment in coordinated sectors will not be wasted due to poor

levels of effort. In the policy priority sequence shown in Figure 4, these market failures come at the bottom of the list because it is only worthwhile addressing problems of coordination if the first two sets of market failures can already be addressed on a significant scale across multiple sectors.

Policy responses clearly need to be scaled in terms of feasible governance capabilities. If governance capabilities for ensuring effort are limited, it is appropriate to focus on limited learning strategies to improve the chances of success. An important source of failure with learning and technology policies in the past was that they worked fully only in those few countries that accidentally had the political and institutional conditions for the governance of ambitious learning strategies. In other countries, ambitious strategies failed to a greater or lesser extent because the seriousness of the governance problem was misunderstood.

By abandoning the ambitious strategies of the past, some of these countries achieved much higher growth, paradoxically because they could also mobilize pockets of competitiveness that had developed as a result of decades of technology policy support. This deepened the impression that technology policies were not necessary in the first place, and had just created significant social waste. In fact, while technology policies performed relatively poorly in some countries because of a poor understanding of governance requirements, even in these cases they often created the pockets of capabilities that drove growth after liberalization. The challenge is to develop new, more targeted and effective technology acquisition strategies to spread growth to new sectors and regions in the future.

3. Interdependencies Affecting Policies for Learning

We have argued that effective learning strategies require as a precondition an ensemble of conditions to ensure high levels of effort. This is not always easy to achieve, and the failure to address or even understand these problems have been responsible for the abandonment of many learning and technology acquisition strategies across developing countries. An important reason why effective policies have been difficult to devise is because the variables in eq. [11] determining levels of effort are *interdependent* and so their effects are likely to be non-linear. This means that the best instrument for financing, for instance, may depend on the type of political settlement and firm structure that a country has inherited. As a result, there is no single set of financing and governance arrangements that characterize all successful catching up countries. It follows that it is not possible to simply imitate the policy or governance structures of more successful developers.

The likely interdependence between the variables affecting effort in eq. [11] is shown in Figure 5. From a policy perspective, it is important to distinguish between variables that are very difficult to change and which can therefore only be the targets of policy in the long term, and variables that are relatively easier to change. The variables that are most difficult to change have 'exogenous' characteristics as policy is likely to have to accept them as 'given' in the medium term. In Figure 5, the political settlement, *PS*, appears at the top as it is likely to be the 'variable' that is most difficult to change. However, even the political settlement can of course change, and it can change as a result of 'political' policy, for instance through the organization of new political coalitions or movements. Indeed, if the political settlement is very

unfavourable for organizing any serious process of learning, the only meaningful policy would be to begin the process of changing the political settlement. Of course, this is only a task that strong political organizations with legitimate leaderships can ever hope to achieve.

Next in terms of difficulty of changing is the firm structure variable, *FS*. This can be affected by policy (by selecting particular groups of firms for support and then developing their capabilities) but it may also be difficult to change this rapidly. Finally, the variables that are usually the most direct targets for policy appear at the bottom, the financing instruments, *FI*, and the associated governance agencies, *GA*, though governance agencies are not necessarily easy to set up or change rapidly. Our discussion suggests that the most appropriate financing instruments and associated governance agencies cannot be identified without at least identifying the constraints set by the other variables. In some cases the other variables may be such that policy has to address either or both of them as a medium or long-term goal. What is ruled out is the hope that these variables are 'separable', namely that 'good financing instruments' or 'effective governance agencies' can be identified independently of a political economy analysis of the interactions between these variables.

The most important interdependencies between these variables are shown by the arrows between the variables in Figure 5, drawing on the discussion in section 3. The political settlement describing the distribution of power (in this case between different groups of entrepreneurs and the state) defines the bargaining power of different types of firms vis-à-vis the state or private financiers. The political settlement also determines the likely enforceability of particular financing instruments and the credibility of the associated governance agencies. Combinations of financing instruments and governance agencies may be more or less enforceable and credible depending on the distribution of power. Finally, financing instruments have to be appropriate for the financing needs of different types of firms and the learning problems they face. The problem of sustaining effort is therefore an iterative search across these variables to find the combination that is both feasible for a country and is likely to achieve moderate to high levels of effort, even if in a restricted subset of firms and sectors. We will see later that some of these interdependencies can explain why particular types of learning processes worked in particular contexts.

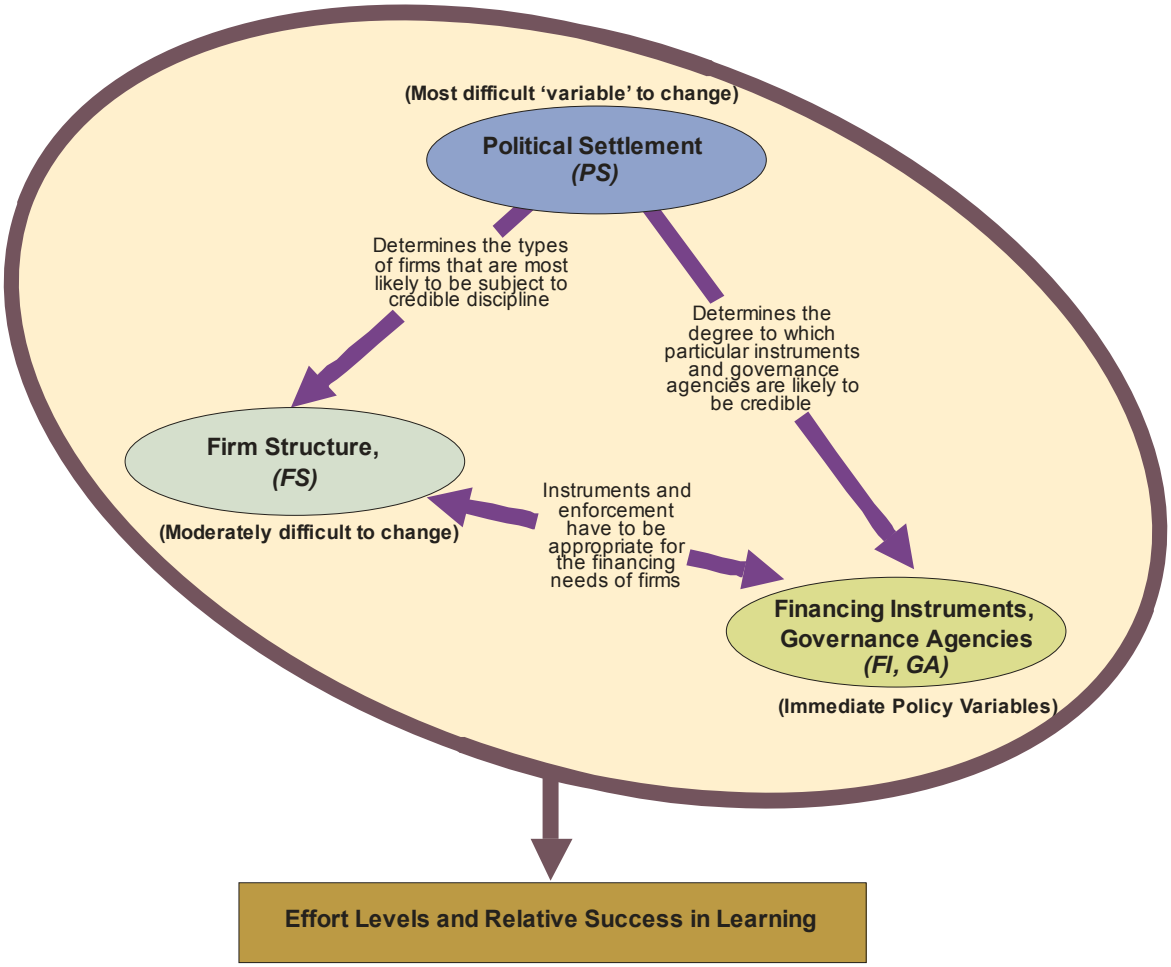

Figure 5 The Interdependence of Variables Determining Effort

Given these interdependence, there are likely to be non-linearities in the relationship between these variables and effort. A financing arrangement that would result in an acceleration of learning in a particular political settlement and with a particular structure of firms could have the opposite effect in a different political settlement or applied to a different structure of firms. For instance, historical evidence shows that financing learning-by-doing through conditional export subsidies to large firms may work very well if the political relationship between firms and governments allows an accurate observation of performance and if subsidy withdrawal is credible. But export subsidies to large firms may be a poor way of delivering financing if implementing agencies are weak and if large firms have powerful political friends who can protect them from state attempts at subsidy withdrawal.

This means that the effects of institutions and governance arrangements on the pace of learning in particular countries can only be identified by looking at possible interactions between (at least) the variables identified in Figure 5. Historical case studies support this argument by demonstrating that the efficacy of particular instruments and governance arrangements for learning and catching up have varied across countries according to their underlying political settlements (Khan 1999, 2000a; Khan and Blankenburg 2009). While almost every developing country attempted some form of state-led catching up, their relative success depended very

critically on compatible combinations of variables that ensured high levels of effort to achieve competitiveness.

What Went Wrong with Early Learning Strategies

The complexity of the relationships between policy-targeted variables like financing instruments and governance agencies and hard-to-change variables like the political settlement meant that plausible strategies of learning often failed. In many developing countries, strategies of learning and catching up between the 1950s to the late 1970s failed because while many new sectors and firms emerged, the progression to global competitiveness was too slow. Financing costs multiplied and found expression in growing budget deficits or in growing non-performing assets of state-owned industrial development banks. Eventually, many of these strategies were abandoned, partly because of internal reasons, partly because of the global academic and policy consensus in favour of cutting back subsidies in developing countries in the 1980s.

An intriguing question is whether the countries which eventually abandoned learning strategies (which include all the countries in our sample) could have done significantly better had they followed a different approach for identifying and addressing the market failures that affected their learning. India and Pakistan (of which Bangladesh was a part at that time) attempted ambitious 'East Asian' industrial policies but without the political settlements that would allow effective compulsions for high levels of effort. Large, relatively well-connected firms benefited from different types of 'learning rents' but managed to buy themselves sufficient protection from different factions to prevent threats of subsidy withdrawal to be credible. The result was significant industrialization but slow growth towards global competitiveness levels (Khan 2000a).

Figure 5 suggests that there could have been two types of responses to this problem (apart from abandoning the strategy). The first and more ambitious response would have been to use policy to change aspects of the political settlement that were preventing the imposition of credible compulsions on the types of firms receiving external financing for learning. Clearly, the political settlement is difficult to change rapidly, though it is always changing endogenously. The relevant aspects of the political settlement that constrained growth could have been addressed if political entrepreneurs realized that seeking to accelerate growth would further their own interests. The distribution of power between firms receiving assistance and the state could have been altered through the creation of new political organizations based on mobilizing new constituencies. These could have created bases of power for the state that could support or bolster state attempts to sanction firms or re-allocate social resources away from firms that had not performed as required. But in fact, the importance of creating political support for enforcing discipline was hardly recognized at all by political and bureaucratic leaderships in developing countries.

This is despite the fact that the political and bureaucratic leadership in charge of industrial policy did understand in general terms that there had been a significant failure of disciplining. For instance, the Dutt Committee in India (Government of India 1969) clearly recognized that licensing was primarily helping a small group of very large firms who were also difficult to discipline. But the politics of responding to this effectively and constructively was not simple. To the extent that it was attempted, responses were blunt and counterproductive. All of South Asia was going through a

phase of authoritarian populism in the late 1960s to the mid-1970s, and political responses to the limitations of contemporary strategies of catching up were also influenced by these prevailing ideologies.

Thus, in India, one response to the type of analysis presented by the Dutt Committee was Indira Gandhi's Monopolies and Restrictive Trade Practices Act (MRTP) of 1969 which set asset limits on the asset holdings of large business houses which had accumulated significant concentrations of wealth under the licensing regime. The new act was largely punitive, and had little effect on actual levels of concentration. Significantly, it did not seek to change the bargaining power between state and firms or strengthen key governance agencies responsible for monitoring and enforcing learning. It did not try to set new conditions for competitiveness or attempt to change asset ownership if productivity conditions were not met. Given the political climate of support for government actions against perceived corporate concentration at the time, this was possibly a missed opportunity.

Similarly, widespread public disapproval of the concentration of wealth in the hands of Pakistan's 'twenty-two families' led to nationalizations in Pakistan and the newly created Bangladesh in the early to mid 1970s under both Bhutto and Mujib. The nationalized industries were even closer to political power and therefore even less likely to put in high levels of effort in learning, representing significant missed opportunities in the prelude to the abandonment of learning strategies and the transition to liberalization.

A second and less ambitious response might have been even more effective, given the difficulty of changing relevant aspects of political settlements in the short term. This would be to address a combination of lower level policy variables in Figure 5, such as the types of firms addressed by learning strategies, the financing instruments used, and the capabilities of the governance agencies enforcing these financing arrangements. From our earlier discussion, one response may have been to focus the industrial policy effort in sectors and technologies where the potential number of firms benefiting was larger and their sizes smaller. These firms may have been less able to politically subvert attempts to impose competitiveness conditions on them. Simpler financing instruments that provided time bound protection in some sectors, or startup assistance for high technology small firms may have created credible compulsions for productivity growth while providing enough external financing to enable entry into products and technologies that may otherwise not take off. One implication of our analysis is that the scope of an effective learning strategy in these countries may have been much smaller and limited to a different set of firms and technologies. Nevertheless, a more effective policy may in fact have had a much broader impact than a broad-based policy that was in large part ineffective in achieving sustained competitiveness in the sectors supported.

Positive Legacies: The Possibility of 'Alpha' and 'Beta' Strategies

Despite the overall problems with the early industrial policies and their eventual abandonment in our sample countries, the experience of learning was actually very useful for them in supporting pockets of growth in the subsequent period. While the conditions for enforcing high levels of effort were not fully present when they attempted ambitious learning strategies in the 1960s and 1970s, the attempt to absorb new technologies and move up the value chain was not entirely wasted. An extremely

important characteristic of success with market-driven and competence-led growth in the 1980s and 1990s in these countries is that the enterprises that drove growth in the latter period had acquired many critical technological and entrepreneurial capabilities as a direct consequence of their learning-by-doing in the previous period. Our case studies show that earlier periods of technology acquisition created the technological capabilities that were essential for the subsequent market success of some countries and sectors. Documenting these cases is important for understanding the importance of designing technology and learning policies better in the future.

Subsequent success in the free market was very often based on technological capabilities developed during the 'ambitious' period of industrial policy. Given the overall poor performance of these industrial policies this appears to be something of a paradox. In fact this observation can be explained in terms of our basic propositions of tacit knowledge and learning-by-doing. Technological learning and capability development is 'localized' around specific technologies and qualities where learning was focused. The policies of building technological capabilities may not have resulted in a general improvement in technological capabilities across the country, but they raised capabilities in the technologies where success was achieved. Consequently, even if a particular technology did not achieve global competitiveness during the policy period, in many cases the previous policies significantly increased technological capabilities in the vicinity of the technologies that were attempted.

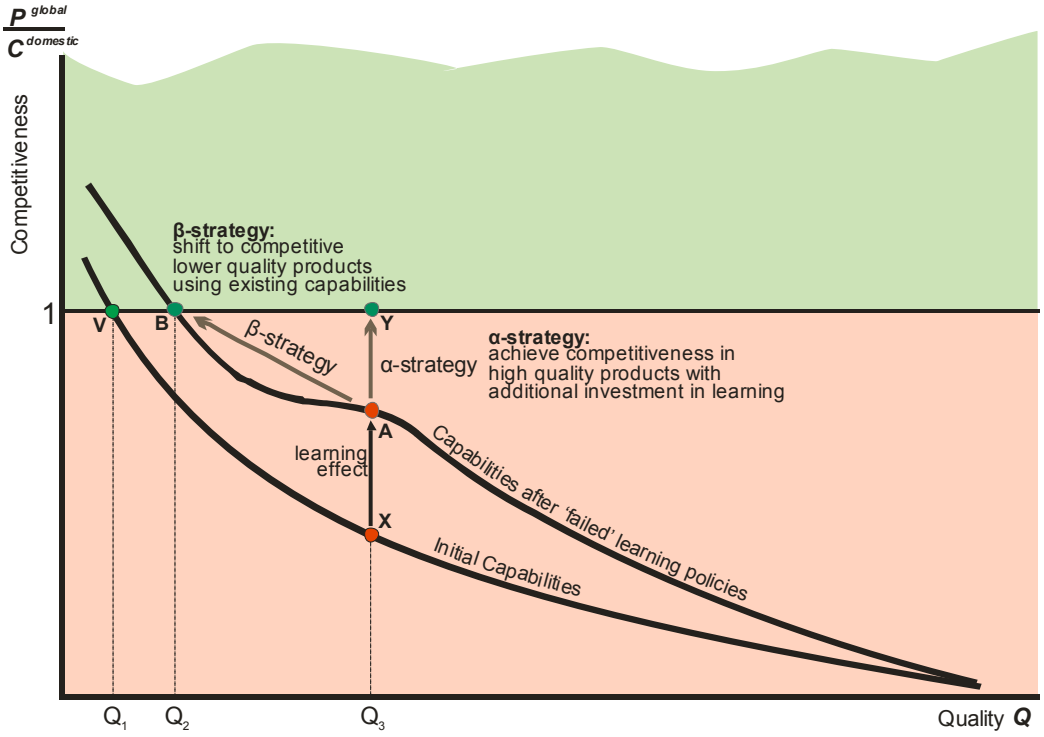

Figure 6 Liberalization Responses: 'Alpha' and 'Beta' Strategies in India and Thailand

Figure 6 shows a developing country with initially limited technological capabilities, shown by its initially limited capability of producing any but the lowest quality of a particular product. Without learning policies, it could only produce the lowest quality Q_1, at point V. Technology policies allow it to begin production of a significantly higher quality product Q_3. Its initial competitiveness in the production of Q_3 is only at

level X, which is considerably below the global competitiveness level of Y. However, loss-financing allows it to commence learning-by-doing and technological capability building. But in this case there is a failure to ensure high levels of effort and this prevents global competitiveness being rapidly attained. The underlying competitiveness only improves to point A, at which point the technology policies are abandoned, which means that the loss-financing dries up. The likely response of the firms at this stage is the interesting question. The simplest possibility is that the firms become bankrupt and disappear. But this is not the only possibility. The point is that despite the apparent 'failure' of the policy on the whole, technological capabilities in the vicinity of the products that were produced have nevertheless improved well beyond what they may have in the absence of the attempted strategy. The precise way in which underlying competences changed is likely to differ across technologies, and Figure 6 shows one plausible possibility.

Firms which have only reached a true level of competitiveness at level A in the production of quality Q_3 are still not at a globally competitive level. If the external financing sustaining them did not come to an abrupt end, so they had time to adjust, they could respond in two different ways to achieve global competitiveness. First, if A was close to the global competitiveness frontier, one strategy would be to finance the rest of the required learning using in-house or private external financing. In the past, key stakeholders within the firm may have had limited compulsions to increase productivity to achieve global competitiveness. But with the abandonment of public financing strategies, more credible compulsions are likely to emerge and bankruptcy becomes a real possibility. At the same time, opportunities can simultaneously open up for private financing of the acquisition of technological know-how through foreign partnerships and machinery imports, and even to privately finance periods of time-bound learning with more credible compulsions. In particular, if the gap with global competitiveness is relatively small, some high capability firms may finance the rest of the journey to competitiveness using internal or private financing.

We refer to this as an α-strategy in Figure 6 and it is shown by the possibility of an upward move of the firm from A to Y, where it finally achieves global competitiveness in the production of quality Q_3. This strategy is likely to be rare except in the case of technologies and qualities that were relatively simple to start with, or in the case of a few firms with relatively high technological capabilities that were already close to the global frontier. However, we do find some examples of this type of strategy, particularly in India, where a number of large, high competence firms came close to the global competitiveness frontier under the previous industrial policy regime.

A second type of strategy may be the more common response for firms whose technological capabilities increased under industrial policy but not quite to the level of global competitiveness. If A is still far from the global competitiveness level, or if the firms lack sufficient internal capabilities to risk the rest of the journey using their own collateral or financing, the strategy of moving to Y may be ruled out. The judgement here would be that the required period of learning was still too long or too unpredictable for the financing to be privately viable. However, even in this case, improvements in technological capability in the vicinity of supported technologies may have been sufficient to enable these firms to seek global competitiveness in products of lower quality where their existing capabilities would be sufficient to

achieve global competitiveness. In some cases these products may be related to the products they were initially producing, but in other cases they may be unrelated products or services, but of lower value-added than the ones initially attempted.

We describe this as a β-strategy. In Figure 6 this is shown by the move from point A to point B where the firm is already competitive using its existing technological capabilities. The quality of product it now produces at Q_2 may be lower than the quality Q_3 that it was initially trying to produce. But Q_2 may still be significantly more sophisticated and more value-adding than the products in the vicinity of Q_1 that it may have been producing in the absence of any history of industrial policy. The response of the Thai electronics industry to become assemblers for Japanese electronics companies after markets opened to global competition is one of many examples of how developing country industries that developed under protection responded using what we have called a β-strategy.

A more roundabout example of a β-strategy was the re-deployment of the technically skilled personnel whose training was subsidized by the Indian government as part of its industrial policy. This was an important mechanism through which public financing was targeted to industrial catching-up sectors. With the abandonment of industrial policy, most industrial firms had not achieved global competitiveness and the demand for these capabilities would have collapsed. But the redeployment of significant numbers of graduates from technical universities and colleges into the newly emerging IT-based service sectors provided a useful globally competitive employment for large numbers of people. The *bulk* of India's global services employment has so far been in the lower value-adding business outsourcing and back office work, but it has nevertheless been a significant source of growth in the period after liberalization (Panagariya 2005). The important point in all these examples is that the capabilities would very probably not have existed at all in the absence of a prior history of financing capability development.

It is important to understand and document these processes. If success in market competition in poor countries depended on the development of capabilities even in a few pockets, this has obvious implications for strategies of sustaining their growth, spreading it to more sectors and to include more people in the benefits of participating in globalization. In the next sections we look at a number of case studies in our sample countries to demonstrate different ways in which global competitiveness emerged in a few sectors. These cases are illustrative of the more general arguments made so far.

4. Thailand: MNC-Led Capabilities and an 'Inverse-U Squeeze'

At one level, Thailand's recovery from the financial crisis of 1997 has been remarkable. Manufacturing growth has been rapid in the subsequent period, driven by electronics and automobiles. Thailand has become the regional hub for sophisticated electronics products like hard drives and has attracted a significant number of Japanese car manufactures like Mitsubishi and Toyota who are increasing capacity and consolidating Thailand as their premier regional base. On the other hand, Thai ownership in the advanced segments of these markets has almost entirely been driven out. Many but not all of the tier 1 auto parts suppliers are now multinationals as well. The very policies that attracted multinationals to Thailand after 1997, free trade

agreements and the credible protection of intellectual property rights, also made it very difficult for domestic producers in its leading manufacturing areas to continue with their strategies of building technological capabilities. The overall performance and policy evolution in Thailand during this period is discussed in an earlier paper in this series (Khan 2008b). As the most advanced middle income country in our sample, Thailand demonstrates types of problems that developing countries are likely to face as they approach Thai levels of income and capability, though obviously there are country specific aspects of capabilities and competences. Several features of Thai technology strategies emerged systematically in our discussions.

First, discussions with industry insiders suggest that the development of basic manufacturing capabilities in the 1960s and 1970s during the period of protection was very important for subsequently making Thailand attractive for foreign investors. However, the pace of liberalization was excessively rapid and there were relatively few examples of Thai companies that successfully followed what we described as α-strategies in Figure 6. Few national Thai companies were close enough to the global competitiveness frontier to continue progressing to the frontier using their internal financial and technological resources given the speed with which the economy opened up particularly after 1997. As a result, since the 1980s and more dramatically after 1997, many Thai-owned companies either closed down or followed β-strategies, moving down the quality or value-chain ladder. This allowed many to survive and even thrive, but some of the leaders in these segments of the market report significant problems in moving further up the quality and value chain. The implication, of course, is that Thailand's rapid growth and overall move up the value and product quality ladder has been almost entirely driven by foreign-owned companies, particularly Japanese but with significant US participation in electronics. If national capabilities do not develop out of this process, this may represent a problem were multinationals to relocate in the future.

A second and related problem is that the protection of intellectual property rights and the majority foreign ownership of high technology operations have encouraged rapid multinational investments but may also have made technology diffusion slower and more tightly controlled than in the early East Asian developers like South Korea and Taiwan. Many Thai companies reported limited technological benefits from joint ventures and willingly sold out to their foreign partners even when they started off as majority or equal shareholders. As a result, the indigenous capabilities of Thai companies to drive a move up the technology and quality ladder on their own has been slow to develop.

Finally, as a middle income country, Thailand also faces competition from below. As lower wage countries enter the global competition for markets, Thailand is being squeezed out of lower quality and lower value-added segments of the market by countries like China and Viet Nam where wages are significantly lower. Thailand thus faces a dual pressure. From below, it faces competition from low wage countries progressively eating into its mass manufacturing markets. And above, it faces serious hurdles to moving rapidly up the quality and value ladder, set by its constrained indigenous technological capability. Middle income countries like Thailand thus face a capabilities curve in many sectors that looks like an inverse-U that can begin to be squeezed at both ends. The challenge for middle income countries like Thailand is to accelerate the pace of national capability development. At the moment, the pace of

movement up the technology ladder is largely determined by the strategic decisions of foreign companies. There is a gradual diffusion of technological knowledge taking place, but primarily through the employment of Thais in foreign companies. We conclude with policy implications that emerge from this analysis.

Some of the challenges facing technology acquisition in contemporary Thailand are summarized in Figure 7. In middle income developing countries, the technological capability curve is not downward sloping everywhere. It is likely to have an inverse U-shape because for qualities below Q_1, the global price will be set not by an advanced country, but by even lower wage new entrants into the sector. Therefore, the middle income country will have higher costs of production compared to the global price both for very low as well as for moderately high qualities and technologies. The squeeze that it faces is that that as Q_1 creeps higher over time as newer countries enter and poorer countries improve their technologies, Q_2 may not be rising rapidly enough.

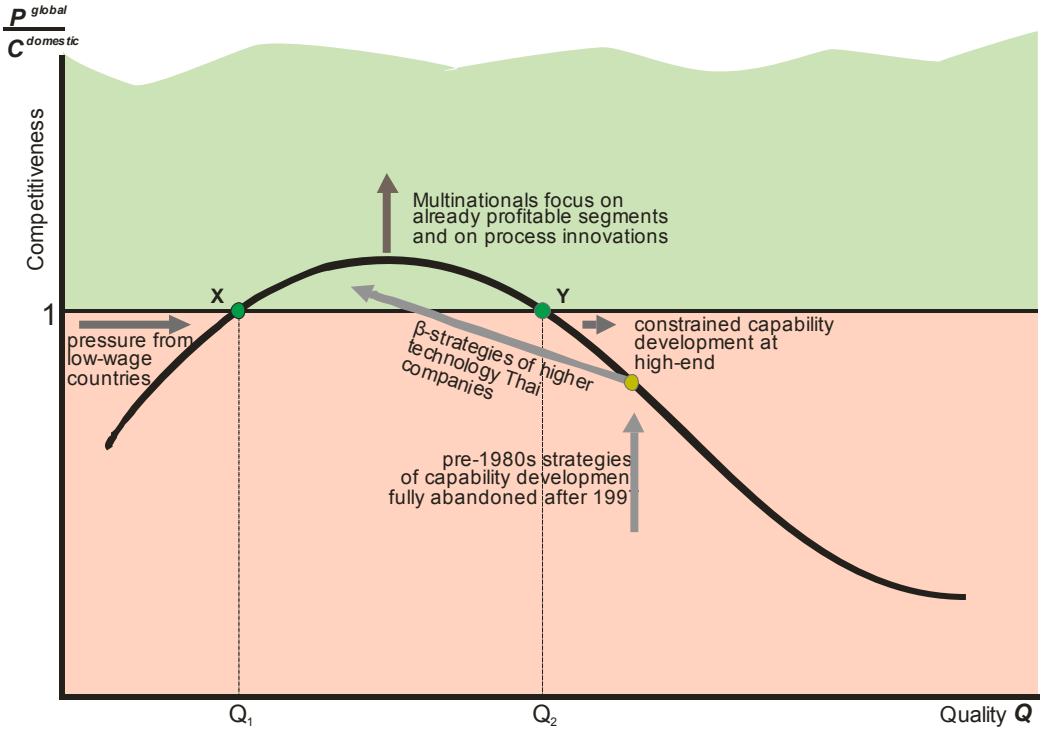

Figure 7 Middle-Income Thailand's Inverse-U Squeeze

A specific challenge for countries like Thailand is that domestic strategies for raising capability are increasingly dependent on the strategic calculations of foreign investors rather than being determined by the long-term technology development requirements of the country. The bulk of the learning that is happening is financed by commercial decisions of multinationals. Multinationals can clearly ensure high levels of effort, *e*, in eq. [11] when financing learning within their firms. Their *financing instrument* is primarily internal retained profits, the *governance agencies* protecting their formal rights including their technology rights are sufficiently strong, the *firm structure* in question is a high capability and well managed multinational, and Thailand's contemporary *political settlement* presents limited challenges to the security of multinationals and the bargaining power of different groups is appropriate for the enforcement of internal effort.

The problem is that multinationals, even when they are making significant technology rents, have little incentive to invest in capability development at high levels of the value chain. Multinationals want to operate in the profitable middle segments of technology, between Q_1 and Q_2. Their production operations are typically at medium technology parts of the value chain (even when the product is high-technology), and process innovations are often focused at making manufacturing assembly more efficient. In terms of [10], by focusing high effort capability developments close to capabilities that already exist, multinationals ensure that their investments in learning, s_Q, are small, and the returns are very quick: B_t, the breakeven period, is very short. The challenge at the higher end is to induce technological capability building at levels Q_2 and higher. Otherwise, the hump can get progressively squeezed by new entrants. A competitive segment will always remain, but the challenge is to spread employment and prosperity across a broad range of the population.

The Electronics Industry

Electronics currently constitutes the biggest single group of exported products. In 2008 electrical appliances and electronics accounted for 26 per cent of total exports, and employed over 500,000 people. While much of the growth in employment has happened in the last twenty years, the chairman of the Electrical, Electronics and Allied Industries Club of the Federation of Thai Industries, Katiya Greigarn, is in no doubt that the basis of this growth was laid by the capabilities created in the 1970s by import protection. It was then that Japanese and American companies began to invest in the production of components like integrated circuits mainly to meet domestic demand for telecommunications equipment and to sell in the emerging domestic consumer market. The most important contribution of the import substitution period was the creation of a broad-based workforce in the electronics industry, and the strengthening of technical training in electronics in technical colleges. In particular, the protected investments created the initial base of workers and managers with a critical mass of tacit knowledge about electronics production processes. In turn, this provided Thailand with a strong comparative advantage which influenced the subsequent locational decisions of multinationals.

Initially production was entirely for the domestic market, but exports began to grow from the 1980s onwards. A further boost came after 1985 with the revaluation of the Japanese currency which led to another round of Japanese investments, but this time in an economy that was rapidly opening up. One problem with the protected internal Thai market was that it was not big enough to provide sufficient rents to make it attractive for foreign investors to invest in higher technologies. So Thailand could only have been an export base for foreign investors. But since it could not offer domestic market rents the Thai government needed to provide other incentives to have any bargaining power with multinationals about the types of technologies they should transfer. These incentives (effectively sharing the financing cost of further learning) were largely missing. As a result, foreign investors invested in qualities and technologies that were already profitable rather than investing in further capability development. In those early days the Japanese set up a large number of joint ventures, around thirty according to Greigarn, but of those only one remains a joint venture today. The rest were later bought up by the Japanese and became either wholly owned Japanese companies or ventures with a significant Japanese majority. Therefore it appears that even when higher technologies came in, the capabilities to coordinate,

manage and develop these technologies remained in the hands of the foreign investors.

Very few of the initial joint ventures resulted in genuine technological capabilities being developed by Thai companies. However, some examples do exist. An example of such a successful joint venture was Kulthorn Kirby, established in 1980 for making compressors for refrigerators and air conditioners. The foreign partner was an Australian company with American backers. In this case, the full technological capability to produce the product was transferred and not just knowledge about specific manufacturing processes. One difference was that in this case the domestic market was important for this particular product, and this may have given the Thai partners greater bargaining power in achieving technology transfer over time.

As the economy opened up after the 1997 crisis, and particularly after the FTA with Japan in 2007, there was a dramatic shakeup of the industry. Domestic producers who were not already competitive and exporting, or who did not have deep pockets simply went out of business. Greigarn argues that the accelerated liberalization of this period was very damaging for national technological capabilities even while it allowed production to increase through multinational entry. Domestic capabilities that had been built up over two decades were simply knocked out by cheaper imports. This included successful national companies like Leonix who made UPS systems for computers. On the other hand, exports by big multinationals became easier because the complications of differential tariffs on inputs and exporting finished goods disappeared. Today over 90 per cent of the output of the industry is exported. Big players like Western Digital, CK, Nikon and others have made significant investments in the electronics industry. But the Thai Federation is acutely aware that its own members play a relatively minor role in the value chain. They are also concerned by growing competition from low wage regional countries and are unsure of the long-term locational decisions of the multinationals.

Reflecting these concerns, the Federation has developed initiatives to promote domestic capabilities. In 2009 a proposal was submitted to the Ministry of Science and Technology (MOST) to strengthen the domestic capacities of the sector. The proposal pointed out that most national producers were at the low end of the value chain, were mostly assemblers and lacked capabilities of product development. It pointed out that multinationals may relocate and that Thailand faced competition from low wage assemblers. The proposal identified the need for capability development and applied for a budget of 4000 million baht (around US $120 million) over three years. There were indications that the government may approve half of that sum. The focus of the plan was to improve training mechanisms, improve infrastructure, and to improve product development but details of the policy mechanisms were not available. Nevertheless, the fact that the industry was mobilizing in this way was at least an indication of its concerns despite the apparently rapid growth of the sector.

A number of government initiatives already existed that attempted to raise the technological capability of the sector. One was the National Electronics and Computer Technology Centre of Thailand (Nectec), set up in 1986 under MOST. This is supposed to have promoted technologies through research and by developing collaborations between universities and firms. It has a budget of around 500 million baht per year. But most of the funding goes to universities and the links with

developing industry capabilities are not as strong as they should be. Clearly, while the need has long been perceived, effective instruments for financing capability development in actual companies have not yet emerged.

The technology acquisition experiences of the industry demonstrate the importance of designing the financing of learning by taking into account the interactive determination of effort shown in Figure 5. Protection of domestic markets is an implicit 'financing instrument' but its efficacy depends critically on the governance agencies determining credible withdrawal of protection over time, and a market and firm structure that ensures competition within the domestic market. In the 1970s when basic electronics technologies were coming in, and the domestic firm structure was competitive, import protection provided sufficient incentives for capability development and the emergence of a workforce with basic tacit knowledge of the industry. But the Thai domestic market was too small at a relatively early stage of capability development and an opening up happened from the 1980s to attract investments for the export market. But with hindsight, there were a number of weaknesses in Thai technology policy at this stage.

No specific policies were in place to create incentives for foreign investors to transfer technological capabilities to Thai scientists, technical staff and entrepreneurs to allow Thai participation at the higher ends from value creation. So while foreign investments came in from the 1980s, much of it was to use Thailand's existing knowledge base to achieve production for global markets. The experience of indigenous Thai entrepreneurs and independent higher level technical personnel is that they were increasingly left out. The integration that took place was between the Thai operations of multinationals and their own global supply chains. Clearly, as multinationals invested in their operations, some learning and capability development in those firms took place. But there were no incentives to invest in learning at a pace beyond that determined by the commercial calculations of multinationals. As we know there are significant market failures in this area, it is not surprising that this strategy led to a series of potentially inferior outcomes for Thai technology development.

An Independent Thai Electronics Firm: from 'Knowhow' to 'Know-who'

An example of this type of inferior outcome is provided by the trajectory of the Family Group of companies. This is one of Thailand's oldest indigenous electronics companies, initially engaged in innovative product development. In the 1990s it faced a significant double 'squeeze'. From below it faced growing competition from cheaper wage countries at the bottom end. In particular, China was increasingly able to outbid Thailand in the mass assembly of basic electronics. But at the top end, the presence of multinationals who were integrating Thai assembly capabilities to their own global supply chains of high technology components left the middle technology Thai producers out in the cold. They could have been integrated into producing some of these higher technology components domestically. But someone would have to invest in assisting them to acquire the technological knowhow and capabilities to move them towards the global frontier. But this 'loss-financing' was not available for the significant indigenous higher middle ends of the Thai electronics industry. For the multinationals, which could source these inputs at globally competitive prices from other locations, investing in capability building and productive capacities at the middle level did not make commercial sense. But for the country, this was a

significant ‘market failure’ because its indigenous technological capabilities at the higher end were wasted or lost.

In the case of the Family Group, the response was to move out of production and product development and increasingly focus on providing services. Its experience may not be typical of the entire Thai-owned electronics sector, but it demonstrates the kinds of pressures these firms have come under. According to its executive manager, its strategy was to move from ‘knowhow’, the actual process of production, to ‘know-who’, the new and growing specialization of the group. This involved knowing the cheapest assemblers, mostly in China, the advanced product and technology developers, often in countries like South Korea, the technological requirements of major purchasers of equipment in Thailand (often in the government), and connecting all the parties up with sophisticated services, advice and after sales care. This sounds familiarly like the transition to services in many advanced countries, except that Thailand is still a middle income country. The services Family provides are not particularly high value-adding services. If there are systematic pressures underpinning the transition of an innovative domestic electronics company to become a service delivery company this must be a cause for concern.

The Family enterprise dates from 1973 when it emerged as a producer of electric cables. Based entirely on the resources of a small number of not very wealthy investors, the company progressed from cables to electronics during the period of protection. By the mid-1990s the company was involved in its own innovation. It came up with a portable VCD player ahead of its time but failed to find markets because of its lack of access to the capital necessary for global marketing. A number of ambitious plans for dramatic expansion into wafer fabrication just before the crash of 1997 were permanently shelved afterwards. As China came on stream, it became increasingly unviable to compete with them in mass assembled products. Thus began the gradual shift towards the new strategy. Although Family is involved in a range of high technology products ranging from sophisticated modems to solar powered electricity generation, very little of the production process is local. China can already make solar panels apparently at one-third the Thai cost. So the goal of Family is now to connect technology developers, assemblers and markets. Its executive manager claims it can only add value by finding solutions, not by producing. This is an example of what we have called a β-strategy in Figure 6. Except this is even more serious because Family abandoned most of its manufacturing technological knowhow to focus on its ‘know-who’ to provide services.

Multinational Growth Drivers: Western Digital

Western Digital’s move to Thailand in 2000 to join CK and Fujitsu made Thailand one of the world’s biggest hard drive producers. WD alone employs 30,000 workers and 1500 engineers and scientists and Thailand has become its largest manufacturing base. It produces an astonishing 40 million drives every quarter, which together with the output of other hard drive producers in Thailand adds up to a Thai export of around 130-140 million hard drives every quarter. A senior manager at WD confessed that they frequently wondered where all these drives went. The penetration of hard drives into games consoles, GPS devices in cars, video cameras and even refrigerators provide some explanation. The mammoth factory complex at Ayuthaya is a monument to Thailand’s significant presence in the global electronics market.

WD's arrival in Thailand was a fortunate accident. Its Malaysian plant had reached capacity constraints and the firm was looking for regional diversification. In Thailand, Fujitsu was already producing 2.5 inch and 3.5 inch hard drives, but was losing money on 3.5 inch drives and wanted to exit from this segment. Just when Fujitsu wanted to sell one of its plants, WD wanted to come in. It found a ready-made plant and workers and its expertise in this segment allowed it to rapidly make the business profitable. Its advantage over Fujitsu was its greater flexibility in product design in its California headquarters, and its ability to respond rapidly to changing demands. Fujitsu in its turn had come to Thailand because a significant workforce trained in electronics had emerged in Thailand as a result of the IC industry that had developed under protection in the 1970s and 1980s. This had made the incremental learning cost acceptable for the company given the significant potential savings in labour costs compared to say Singapore.

Currently students coming out of Thai technical colleges and universities were sufficiently trained for the company to be able to convert a new employee to the expected productivity in about four months. There were internal courses and curricula for each position. The firm knew the universities that produced the best technicians for each type of job. Interestingly, the firm did not aim to recruit the best academic performers who were often difficult to discipline. The firm wanted assembly line discipline, and typically students in the 75^{th} to 90^{th} percentiles were best suited to its needs. Clearly, the short learning times reflected the fact that an educational system had developed providing the formal knowledge required for assembly line work and a large workforce already existed in these firms at all levels with the necessary tacit knowledge such that new entrants rapidly learnt their functions by imitation. Moreover, virtually all the critical product innovation and much of the most important process innovations were developed outside Thailand, with Thai employees focusing on improving efficiency in assembly.

Although roughly fifty per cent of components were also sourced from Thailand, most of this was produced by globally integrated and foreign owned supplier companies with operations in Thailand. The integration of product design and innovation in components had to happen in a very centralized way through discussions mainly in California between the manufacturer and its key global suppliers. At the local level, keeping every aspect of process technology secret was not necessarily in the interest of the company. Process innovation was essential for productivity growth and there was incredible competitive pressure in the industry. Hard drive capacity was doubling every six months and prices for the same capacity halving. Hard drives were integrated technology systems and so for instance, a problem in electronic signal processing could have a solution in the chemistry of the magnetic film or the mechanics of the drive. Developing local process technology capabilities was therefore part of the firm's strategy. It also encouraged collaboration with universities for process innovation but the total local expenditure on this type of innovation was miniscule. The annual local process innovation budget is a few million baht, perhaps ten million baht (around US$ 300,000).

Thus there is no question that multinationals like Western Digital are vital for Thailand's exports and employment. However, in terms of investing in technological capability development, it was essentially focusing on the points on the quality ladder/value chain where Thai competitiveness was already at or above the global

competitiveness ratio. As a commercial enterprise, its interest was essentially to squeeze more value out of the points on the value chain where its Thai operations were focused. If this resulted in Thailand gradually moving up the value chain that would be a useful by-product, but would obviously not be part of the objectives motivating the company.

Thai technology experts are very aware that the capability development investments of multinationals, important though they were, were not sufficient for building technological capability at the vitally important higher ends of the value chain. There is a difference between efficient mass assembly processes and the capabilities to lead and organize these processes. An example of a local response to this challenge is a network called the Thai Embedded Systems Association which aims to promote the design capabilities in the electronics industry. Its president, himself a university professor in computer engineering, believes that Thailand's nascent design skills were destroyed by the misconceived design and pace of liberalization in the 1990s. (We discussed these liberalization policies in an earlier paper (Khan 2008b) in this series). Re-establishing these capabilities is going to take time. The association now sees the presence of multinationals as an opportunity that has to be leveraged at this stage to help develop Thai design capabilities.

As a first stage, the association sees it vital to encourage multinationals to locate significant design work in Thailand. It uses its university network to assist multinationals to identify appropriate personnel and persuade them that Thai scientists and engineers were ready for these tasks. In 2009 there were several small-scale examples of design work that was coming to Thailand. For instance, Western Digital was setting up a small unit in Thailand to design firmware for a controller chip for its hard drives. This was at its inception phase with about ten scientists. Toyota was setting up a team to design part of the electronics firmware controlling its hybrid engines. Several dozen Thai scientists and engineers had been employed on that project. For the association, this type of design exposure was vital for Thai scientists and engineers and its intention was to assist as much as possible by providing information and support to companies. If multinationals could be persuaded to begin to use Thailand as a design base, the technological capabilities at the upper segments of design would improve. But the association is primarily interested in a possible second and third phase. The second would entail assisting design-competent Thai scientists and engineers to set up their own design companies. That would open up the possibility of a third phase of attempting to become globally competitive in some high value sectors.

The association's overall analysis of the technology challenges facing Thailand is that it must rapidly develop capabilities at the higher ends of the value chain. This is not just to add more value, but primarily to be able to respond to the entry of lower wage countries into assembly and the likelihood that multinationals will then relocate as a result. Clearly, it is likely that more than just information about opportunities will be required to accelerate investment in design. Multinationals have only invested in learning where domestic competitiveness was close enough to the frontier to make relatively small investments in learning profitable. Multinationals were interested in Thailand as an assembly location in the first place because large pools of workers had already been trained and exposed to electronics assembly in the IC industries that had developed under protection.

A large pool of design engineers with global levels of competence does not already exist in Thailand, and many nascent design innovators were wiped out, as the association recognizes. It follows that persuading multinationals to invest in an accelerated way in developing design capabilities will need either significant public investments in universities, or it targeted cost-sharing and financing instruments to persuade multinationals to invest in learning in these areas. An organic and incremental development of design capabilities is of course possible, along the lines that we already see happening on a small scale. But this is likely to be a slow process.

Thai Automotive Part Suppliers: Somboon and Summit Group

The automotive sector is the biggest manufacturing sector by value, but because roughly half of its output is sold in the domestic market, it is the second biggest export sector after electronics. By 2006 Thailand was producing around 1.3 million cars per year. We discussed in an earlier paper in this series how Thai partners in joint ventures in the motor car industry were wiped out after the 1997 crisis (Khan 2008b). The dominant OEMs (original equipment manufacturers) in the car industry are currently five multinationals, four of them Japanese and one American. And of the 200 first tier suppliers, only 20 are Thai (Niyomsilpa 2008: 61). Like the electronics industry, the question is whether Thai companies can develop technological capabilities to re-enter the sector. Otherwise the sector will be vulnerable to the locational decisions of multinationals in a competitive neighbourhood in the same way as the Thai electronics industry. In the case of two Thai owned auto suppliers that we investigated, technology strategies focused on consolidating their middle-technology comparative advantage. There is some evidence of β-strategies in the first firm, which is looking for markets in the lower technology agricultural machinery market.

Somboon Advance Technology is one of the oldest tier-one suppliers, and one of the top five Thai-owned car parts suppliers. It specializes in axle shafts, castings, exhausts and windscreens. The company's history goes back thirty years to the import protection period when it started producing unbranded spare parts for imported cars. The company's founder came from a background in retail and auto service, but knew machine makers and gradually started making local spare parts. With Japanese OEMs investing in the domestic production in the 1980s, the Japanese came with the offer of providing technical assistance to produce parts for the OEM market. The investment was entirely Somboon's but its already established technological capabilities made this a viable learning investment given the likelihood of local markets and the technical assistance. Today Somboon is one of the biggest axle shaft makers in ASEAN, producing roughly a million axle shafts in 2008. The company also has a significant presence in other chassis parts like springs and castings.

Attempts to accelerate technology acquisition through joint ventures after 1995 came to a halt following the 1997 crisis. The company set up seven joint ventures with the Japanese, with roughly equal equity participation in each of them. After 1997, two were sold back outright to the Japanese and in five Somboon currently has limited minority shares. The Japanese preferred to have majority shares in companies if they were to bring in the most advanced technologies to produce components in Thailand. The company's technology purchases are currently based on licensing or buying technologies from Japan. For the payment of a royalty on sales, Japanese sellers assist

with factory set up and provide a formal technology transfer. The tacit knowledge component is internally financed by the firm. As most technologies adopted in this way are very close to the already existing technical capabilities of the firm, these incremental investments are usually feasible. There is however a problem with the leakage of trained workers. The company loses about ten per cent of its workforce every year, usually to foreign-owned suppliers because they are in higher valued segments and can pay higher wages.

The company is strong in manufacturing competitiveness in its core competence areas but is weak in designing new technologies. A strategy the company is experimenting with is employing Japanese designers who have taken early retirement in their home country. The aim is to achieve the capability to produce different model numbers more rapidly and efficiently. Financing learning is difficult given market conditions in bond markets and for public offers. The company went public in 2005 but share markets have not been strong since then. It is unlikely the company will borrow significantly from banks to build design capabilities, given the uncertainties. Another strategy that is being considered is to move downmarket into a sector with significant potential growth: producing parts for agricultural vehicles like tractors. This could be an example of a β-strategy if technological upgrading in its core areas and movement into higher quality segments prove to be difficult. There is a possibility that Thailand emerges as a major agricultural vehicle producer in ASEAN, and companies like Somboon could play a part in that expansion based on already existing competences to produce cheaper variants of axles, castings and springs.

Another major Thai owned parts supplier is the Summit Group, consisting of Summit Auto, Summit Auto Body and Summit Auto Seats. The group manufactures seats, a variety of trim, plastic parts, carpets and insulation, body parts, exhaust systems, chassis parts, parking brakes, with a total workforce of almost 11,500 in 2009. Like other old Thai auto parts makers, this group was founded by a generalist entrepreneur, Sunsurn Jurangkool, in the import substitution phase and moved into higher qualities with Japanese technical assistance as Japanese OEMs started production in Thailand. The company has not floated and is still privately held despite having a very significant asset base. As seats are an important part of the business we focused on technology upgrading in Summit Auto Seats. The technology and standards for car seats are increasingly sophisticated and demanding, and while the company has some high-end seat manufacturing, its focus is on the less demanding seats for pickup trucks. Mitsubishi has made Thailand a regional hub for pickup trucks and provides significant business for Summit Auto Seats.

Car seats for saloon cars are high technology products, with exacting safety standards and sophisticated motors and adjustment mechanisms built in at the higher end. Saloon car seats in Thailand are dominated by three Japanese and two western seat manufacturers. The problem for Thai groups attempting to break in is that for scale economies they need a multi-country presence because the bulk-value ratio of seats usually precludes long-distance shipping. Upgrading technological quality therefore requires significant investments in plants, but also in global management. Summit Auto Seats has begun a process of regional diversification with investments in two plants in China, one in India and one under development in Viet Nam. The Chinese plants are doing well because they are supplying Chinese car manufacturers who require the upper-medium qualities that Summit can deliver at a good price. The

Indian plant is not doing well because it was supplying Honda, who recently shifted orders for their new model to a Japanese seat supplier as Indian production is becoming big enough for Japanese part suppliers to set up there. So Summit faces the same problems in India as it does in Thailand and it has not yet been able to sell to Indian car manufacturers. Future expansion is likely to be in China and Viet Nam.

In the meantime, the core operation of Summit Seats remains the pickup segment in Thailand. Labour training here is not difficult, though turnover is high. As in Somboon, there was a recognition that labour came to be trained in Thai supplier companies and then moved on to foreign-owned suppliers who were in higher value segments, could pay higher wages, but who required a base level of tacit knowledge and training that could come from exposure to Thai-owned seat makers. The potential positive externality in labour training did not appear to deter the Thai parts companies too much. It could be that they had simply absorbed these costs because they were not too significant. It could also be that they had passed some of these costs on to workers, thereby making them internalize some of the costs of training. Workers may be willing to accept lower wages in these segments because the training allowed them to improve their potential for entry into more skilled segments.

Intermediate Technology Companies: Siam Cement and Saha Group

Technology upgrading experiences with foreign partnerships resulted in very similar experiences even in middle technology sectors. One of the most globally recognized Thai corporates is the Siam Cement Group (SCG), a company set up in 1913 by Royal Decree to produce cement and building materials for national development. Today it is a holding company with over a hundred companies in the group, collectively employing 25,000 employees and with a growing number of joint ventures to improve its technological base. Its core competence remains in intermediate products: cement, paper, chemicals, building materials and distribution. Its reputation for financial probity allows it to raise almost all its funding needs through public bond issues that are typically hugely oversubscribed. Its intermediate technology base means that investment in new plant and technology is incremental as is the corresponding learning.

For most of its history SCG was content to incrementally develop its in-house production technologies. More recently it has begun to acquire companies and engage in joint ventures to accelerate technology acquisition and quality improvements. In 2008, SCG was involved in almost twenty joint ventures with its own participation ranging from 40 per cent (as in Siam Kubota discussed below) to a nominal four per cent holding in Siam Toyota Manufacturing. Technology transfer only makes sense for SCG if it builds domestic capability for further quality development. This happens satisfactorily in relatively few cases, but complete failures are also rare for SCG. They too recognized that Japanese partners were more likely to transfer technology if they had majority shares; hence SCG participation is usually as a minority partner. But even then, technology transfer is not always assured. A success story was the alliance with Kubota that began in 1978 to make diesel engines, tractors and other farm machinery. It introduced small diesel engine manufacture to Thailand for agricultural uses and has now expanded into a variety of machinery including combine harvesters and rice transplanters. In contrast, the alliance with Toyota that began as early as 1962 did not bring huge benefits in terms of technology transfer to Thailand beyond what Toyota would have done anyway, and SCG has gradually trimmed its participation.

It appears that in companies with deep financial pockets like SCG the constraint on capability building is not so much the problem of financing learning in intermediate to high technologies, but the strategic calculations of the foreign partner. SCG is in any case unlikely to go into technology partnerships that are significantly distant from its existing capabilities. The incremental learning may well require a period of financing but this is likely to be within the capabilities of a company like SCG. There are some obvious strategic concerns that may deter a foreign partner from fully transferring technological capability. Where markets are local and the technology relatively simple, as with agricultural machinery, technology transfer does not imply a significant loss of rents for the foreign partner. However, where the technology is dynamic and evolving, as in motor cars or high quality steel, technology rents may be dissipated if capabilities are transferred. In these cases, we would expect the technology transfer to be more limited. Some of the SCG experiences with joint ventures are consistent with this expectation.

Similar mixed experiences with the pace of genuine technology transfer in foreign joint ventures emerged in the smaller Saha Pathana Inter-Holding Company. While smaller than SCG, this is a significant Thai holding company that runs three industrial parks and invests in many of the companies located in its parks. The Saha Group was established in 1972, and its main industrial park located in Chonburi's Sriracha district 90 km from Bangkok has 85 factories employing more that 20,000 people. The technologies in use range from garments and noodle factories that are typically wholly or mainly Thai owned to sophisticated thin film televisions where the foreign partner is dominant. The shift to sophisticated technologies happened primarily after the law on foreign ownership changed after the financial crisis of 1997. The Alien Business Law 1999 allowed foreign majority ownership in manufacturing (Phongpaichit and Baker 2008: 270). It was only then that foreign partners proved to be more willing to begin production of more technologically advanced products in the Saha Group's park. For instance, Samsung had focused on relatively low technology CRT televisions when it was a minority partner, but shifted rapidly to plasmas and LCDs when it acquired the majority stake. Japanese joint venture partners were particularly unwilling to bring in superior technologies till they had a majority stake.

Even when the production of parts of a higher technology product is transferred to a developing country, a common observation of domestic partners was that critical parts of the production that determined overall technology rents were reserved for the home country. A curious example of this was provided to us in the form of a hand wash product. The Thai joint venture could produce the soap and the bottle but the machinery to make the soap dispensing cap of the bottle was controlled. The bottle top when pressed dispensed foam produced by mixing the liquid soap with air. The casting required to produce the cap was beyond the capability of the Thai production plant and was the mechanism through which the foreign partner protected the technology rents even for this relatively mundane technology.

To conclude, Thailand's protection of technology rents may have played a significant role in attracting foreign investments to produce parts of high technology products in Thailand. Clearly this satisfied the obvious concern of foreign investors to protect their technology rents. But their concern with their technology rents also explains why they typically transferred the production and assembly of relatively simpler parts of

their advanced products to the developing country. It obviously makes sense for the technology owner to keep significant parts of the technology in the home company and country. This explains why when multinationals invest even as senior partners in joint ventures in countries like Thailand, not all parts of the production process are automatically or even eventually transferred to that country.

Multinationals engaged in technology transfer face complex calculations of costs and benefits. On the costs side, there are genuine costs of capability development because this requires investment in learning. But there are less justifiable concerns that they may *potentially* lose some technology rents in the future. To engage effectively with multinationals, national governments have to be able to distinguish between genuine market failures involved in financing learning, where there is a strong case for developing national strategies of sharing these costs and the less justifiable attempts by multinationals to maximize their profits by controlling technology rents. Our analysis suggests that Thailand has paid a price for allowing its technology policy to be entirely driven by the market calculations of multinationals. The expectation that if multinationals could make significant technology rents they would reward the country by re-investing in learning and capability building *at the highest quality levels* has been too optimistic. In the absence of a technology policy, learning investments of multinationals are likely to be focused on sectors and qualities that are already close to global competitiveness levels.

In principle, policies could be designed which ensured that multinationals making significant technology rents were also faced with incentives (government cost-sharing) as well as compulsions (policy conditions attached to these incentives) to invest in capability development in higher qualities. Clearly in a world where multinationals have many locational options, they cannot be pushed too much. But the Thai case is instructive because it shows that there is a pressing case for policy to engage with multinationals to combine incentives with conditions to see if a significant improvement can be made in capability development at higher levels. Here the significant investments that multinationals have already made in countries like Thailand may work to the advantage of these countries. But there are lessons here even for countries with a lower exposure to multinationals. The need for a national technology policy is increasingly recognized by different sectors in Thailand. The policy challenge is to design policies that are appropriate for the key market failures that need to be addressed, together with governance capabilities for ensuring the enforcement of incentives.

5. India: High Capability Firms but Constrained Industrial Growth

India presents a paradox in that it has some of the highest capability firms in the developing world, particularly in manufacturing, and yet it has an unusually small industrial sector and low overall manufacturing growth. Some of its leading manufacturing firms have followed what we described as α-strategies in the period after liberalization, taking them into global competitiveness in a small number of areas. Yet large swathes of the economy remain at very low levels of technological capability and the share of manufacturing in the economy is much lower than we might expect. Figure 6 is directly relevant for understanding the Indian case. The long period of industrial policy in India prior to the 1980s (and aspects of protection and promotion of domestic capabilities that continued beyond 1980) created strong

capabilities *but in a narrow range of technologies*. The opening up that gradually happened during the 1980s and beyond led to both α and β-strategy responses. In the high technology sectors, both sets of responses led to the establishment of high capability firms. A better understanding of the processes through which global competitiveness was achieved in India's successful sectors can inform policy about how to enhance competitiveness in other sectors and regions. If success in some sectors was based on the development of critical capabilities, further successes to ensure higher growth and greater regional diversification require policies for the rapid development of new capabilities.

In an Asian Development Bank estimation of what the share of manufacturing in GDP was *expected* in Asian economies in 2000, given their populations, trade openness and per capita incomes, India comes out as a significant outlier in Asia with manufacturing well below its expected share. Most Asian countries have a manufacturing share that is equal to or higher than that predicted by the average international pattern. India's manufacturing was 15.9 per cent of GDP in 2000, around 4 percentage points below its predicted share of 19.6 per cent. China with a manufacturing share of 34.5 per cent was well above its predicted 27.3 per cent. But much of Asia was also equal to or above their predicted share. Thailand's 33.6 per cent was around 10 points higher than its predicted 23.9 per cent. Bangladesh with 15.2 per cent was slightly higher than its predicted 13.5 per cent (ADB 2007: 294).

Manufacturing is important because it describes a level of capability that many people in poor countries can hope to attain (as workers) to participate in a global economy. Even the lowest capability requirements for globally marketed services like back-office work require a level of human capital that is not attainable in the medium term for the vast majority of the population in a developing country. Capability development in agriculture is a possibility in pockets, but the fragmentation of landholdings and a growing scarcity of water also makes agriculture-driven growth strategies less plausible in countries of the Indian subcontinent (though pockets of high capability agriculture are possible).

The usual explanation for India's sluggish performance in manufacturing and in industry generally is that inflexible labour markets, in particular, laws protecting employment, increased the cost of exit and in anticipation of future problems, firms did not invest in labour-intensive manufacturing (Besley and Burgess 2004; Panagariya 2004). In a further development of the argument, Rajan (2006) argues that because highly skilled workers were not as strongly protected as less skilled workers, Indian industry had a bias towards the employment of the former. This explains India's strengths in sectors like pharmaceuticals and automobiles, and its weakness in textiles and garments. The policy implication is that to grow the manufacturing sector, unskilled workers have to be employed, and this therefore requires a relaxation of labour laws. There may be some truth to some of these arguments but it is questionable whether they can explain significant features of India's performance.

For one thing, it is questionable whether the types of entrepreneurs who may have operated labour-intensive industries like garments and textiles in India have ever been excessively constrained by the effective enforcement of any laws, labour or otherwise (Bhattacharjea 2006). The relevant thought experiment is the following: we have to imagine that there are many tens of millions of potential workers in India who could

have been employed immediately in labour-intensive manufacturing industries but are not being employed because potential employers are worried that if they ever have to lay them off, there may be costs involved. Put in this form, the labour market flexibility argument appears less plausible. The real problem may be that given their present levels of productivity and absent tacit knowledge of factory production of any kind, tens of millions of Indian workers cannot be employed in manufacturing even at very low wages and even if they could be fired at a moment's notice. Indeed, at the very lowest levels of quality, India may already be suffering from an early form of a middle income squeeze because it is unlikely to be able to compete with countries like Bangladesh for instance in many segments of the garments industry.

The relevant comparison is with China where startup manufacturers in broad swathes of intermediate technologies received significant implicit subsidies through an undervalued exchange rate, low real interest rates and a host of other hidden subsidies on infrastructure pricing, land pricing and so on. These subsidies provided the implicit loss-financing that enabled millions of rural Chinese workers to enter the world of manufacturing and engage in learning-by-doing that was disciplined by a number of factors including exporting in competitive world markets. The specific features of Indian's specialization can be explained by the targeting of its learning policies in the past. The firms that had the capabilities to engage in α and β-strategies after learning policies began to be abandoned in the 1980s were all in relatively high technology sectors. This, rather than the relative levels of protection from arbitrary dismissals of workers of different skills provides the more plausible explanation of the areas where Indian manufacturing and other high technology services are currently doing well. The policy implications are significant. Greater flexibility of labour markets is unlikely to help India very much (though this is not necessarily an argument for retaining all types of regulations, some of which are indeed marginally damaging). The policy priority must be to devise new strategies of learning aimed at intermediate technologies, together with the governance capabilities to implement them effectively.

To support our case, we look at the types of processes through which international competitiveness was achieved in firms in two sectors in which India is doing particularly well: pharmaceuticals and automobiles. As success in some sectors required building on capabilities that crossed state boundaries in India, this analysis does not stick to the state-wise distinction between Maharashtra and West Bengal, but we will refer to the regional specificities where relevant. In an earlier paper (Khan 2008b) we examined in detail the differences in the application of licensing policy in the two states, and therefore their differential success in building up technological capabilities in the period prior to the abandonment of learning and technology policies. India's 'political settlement' in the period of its industrial policy resulted in a skewed application of learning both regionally and across sectors, and it also resulted in at best a partially successful implementation of loss-financing where it was applied. One result of this political settlement was that the development of technological capabilities was more broad-based in the west and south. Maharashtra therefore emerged much stronger in terms of technological capabilities compared to West Bengal. The features of India's political settlement that resulted in these outcomes will be discussed in the next paper in this series. Here, using a number of case studies, we connect the dots between the achievement of initial capabilities in some sectors and firms during the industrial policy period, and their subsequent α- and β-strategies for achieving international competitiveness.

'Alpha Strategies' in the Automobile Sector

One of India's emerging success stories in manufacturing is automobiles. From a protected and apparently inefficient sector in the 1950s and 1960s making around 50,000 cars annually of indifferent quality, the sector produced 1.8 million cars in 2009, with exports of more than 330,000 cars, making India the fourth largest global exporter. The vehicle sector as a whole (including commercial vehicles and two-wheelers) employed more than 300,000 people. The broader sector including auto components, as well as related service sector activities of sales and servicing could employ as many as ten million people. While gradual liberalization has provided strong incentives for private capability development and foreign partnerships have brought in new technologies and designs, the success of the Indian automobile sector has been based on vital capabilities that were developed as a result of intended and some unintended effects of policy. Misunderstanding the interplay between liberalization incentives and capability development can result in inappropriate policy conclusions for this sector and others. When India started liberalizing its automobile sector, the latter already had significant initial capabilities as a result of years of protection. In addition, in the early years of liberalization, India continued to have very protected internal markets that created strong incentives for foreign technology providers to enter, and India could continue to use domestic content regulations on foreign investors who were attracted by its domestic market rents. The enforcement of domestic content requirements was also credible given the lack of political protection for foreign investors if they failed to achieve these requirements. This fortunate combination of implicit financing of learning in a sector that was already reasonably close to the global competitiveness frontier and credible incentives and compulsions need to be looked at holistically to understand the subsequent success of the sector.

One of the iconic symbols of India's industrial policy was the sturdy but stolid Ambassador. The rapid displacement of this warhorse after liberalization and the appearance of more attractive and comfortable cars did a lot to support the view that protection protected inefficiency. The 'Amby' was based on the vintage Morris Oxford and steadfastly refused to change its appearance over the decades. Its maker, Hindustan Motors was set up by B.M. Birla in the 1940s. A close supporter of the Congress Party, Birla was one of the nationalist industrialists behind the Bombay Plan that advocated state-supported capitalism. Perhaps because of his close links with the Congress, almost no other licenses were given out for passenger car production. The other early entrant in the 1940s was Premier Auto Ltd., which produced an equally invariant version of a Fiat called the Premier Padmini. Further supporting the case against protection is the observation that neither Hindustan Motors nor West Bengal (where the Ambassador was mainly produced) emerged as significant players in the new motor car industry. West Bengal's failure in 2007 to provide land for Tata's Nano project, discussed in an earlier paper in this series (Khan 2009), put the state even further behind in the competition for a share of India's automobile production.

India's new car industry is based around Indian corporates and joint ventures like Tata, Mahindra and Mahindra and Maruti Suzuki, with production mostly based in states in the west and south. Maruti, Hyundai and Tata alone account for 85 per cent of the automobile market, with around fifteen smaller producers accounting for the rest (Balakrishnan, et al. 2007). The three leading states are Maharashtra with sixteen units, Tamil Nadu with fifteen and Haryana with nine. Maharashtra's Chakan belt

near Pune is emerging as India's Detroit, with a cluster of plants including Tata Motors, Mahindra, Bajaj, Mercedes-Benz and General Motors already there and more apparently on the way. Maharashtra accounts for around forty per cent of India's output of automobiles by value and a similar share of the total workforce. It produces around a third of India's tractors, 70 per cent of medium and heavy trucks and 80 per cent of 'multi utility vehicles' or jeeps.

Despite the identity of the corporate players and regions that dominate the motor car industry today, it would be misleading to conclude that previous policies had little to do with the emergence of the modern Indian car industry. The protection of the Ambassador was only a small part of the package of learning policies that underpinned the growth of capabilities on which the modern industry is based. Tata began producing trucks and commercial vehicles in 1954 with the collaboration of Daimler Benz of Germany. Mahindra and Mahindra produced jeeps and tractors from the 1940s. Both benefited significantly from protection and developed engineering and management capabilities that were to prove significant for the car industry later. A wide range of other engineering and automotive firms acquired capabilities for production as a result of indigenization policies, including Bajaj which specialized in two-wheelers. The 'progressive manufacturing obligation' announced in 1953 aimed to push indigenization and was successful in its own terms. By the 1970s, India had achieved the capability to produce 80 per cent of the vehicles it was producing indigenously, including the capability to design and build engines.

Of course, many of the regulations of this period did not make sense. The reservation of a large part of the auto component industry for small scale producers since 1965 slowed down the development of the component industry whose eventual achievement of efficiency was vital for the takeoff that happened later. The component industry suffered from low quality and productivity for a long time. But a political accident gave an unexpected boost to the development of the component industry. Indira Gandhi's maverick son Sanjay, whose attraction to authoritarianism was often all too evident, took it into his head to produce an Indian version of the Fuehrer's 'people's car'. Sanjay was attempting to attract the original people's car-makers, Volkswagen, to the project. As it happened, he died in a plane crash in 1980 before any car was produced. The company was nationalized and became a public company to prevent Sanjay's pet project being liquidated. The government then began looking for a foreign partner for the project.

Most of the global industry players at that time were not particularly attracted to the Indian market. But Osamu Suzuki, chairman and CEO of Suzuki, a relatively small player in the global market, began extensive discussions with the Indian government. He understood the political dynamics that made it likely that the government would give the project the support it needed to succeed. Suzuki made a good call because Maruti Udyog, as it was then called, received generous government assistance. This included getting land in Gurgaon near Delhi at government acquisition prices, favourable tariffs for the import of new manufacturing equipment, and fast-tracked import clearances in an economy that was still heavily protected. The Indian machine tool industry lobbied strongly against this and lost. Suzuki brought a radical change to the component industry. It did not give in to government pressures for indigenization of parts that it wanted to import from Japan, but worked with suppliers to improve what it needed to make in India.

Maruti's success was rapid. In 1983 the first cars rolled out and soon captured fifty per cent of the domestic market by rapidly displacing Ambys and Padminis. Maruti retains its dominant market position even today. The Indian engineering base was strong enough for the rapid development of a strong component industry, and this had significant implications for the growth of the automobile industry as a whole. Maruti-Suzuki itself followed the path of Japanese takeovers of successful joint ventures that we saw in Thailand. Suzuki initially had a mere 26 per cent stake in the project, but by 1987 it increased this to 40 per cent and by 1992 to 50 per cent. In the late 1990s a bitter conflict emerged between Suzuki and the Indian government over the appointment of a managing director. The underlying conflict was about the pace of indigenization and in particular the production of gear boxes in India as opposed to Japan. Suzuki won in the end and became the majority shareholder. By 2007 the Indian government sold its holdings (though Indian financial institutions retain a minority holding). Thus, the most successful car maker in India so far is not Indian, though Suzuki achieved high levels of indigenization and ironically now makes more cars in India than in Japan. But the spur Suzuki provided to Indian components producers soon allowed Indian brands to emerge.

The components industry was also greatly assisted by a series of very illiberal domestic content policies that accompanied India's liberalization. In the 1990s when India was opening up, it was not constrained by WTO rules. One condition for inviting foreign investment in the automobile sector was a 70 per cent domestic content requirement in three years. The companies that came to invest were not just car-makers like Suzuki, but also global component suppliers who set up joint ventures with Indian component manufacturers. They too had to meet the domestic content requirements. Suzuki worked with them and with entirely domestic firms to collectively meet the 70 per cent domestic content targets as well as maintaining sufficient quality to sell in the domestic market. By the early 1990s Suzuki had captured 70 per cent of domestic passenger car sales. More joint ventures arrived. In the decade of the 1990s car production went up by a factor of 3.5. Of the eight leading firms driving this growth, six were joint ventures and accounted for 85 per cent of the output (Sutton undated). Yet the indigenization conditions meant that this was much more than assembly. By 2004, the local content of Indian-made cars ranged from 20 to 100 per cent, with the more popular makes in the domestic market bunched around the higher figure (Balakrishnan, et al. 2004: Table 2.5).

Auto Components Producers

The clearest evidence of α-strategies in the Indian auto sector comes from the auto components producers. By the end of the 1990s, the improvements in quality control in the auto components sector resulted in ten Indian auto companies winning the coveted Deming prize awarded by Japan to companies achieving high levels of quality. Nine of these companies were auto component producers. These awards are consistent with other observations of improvements in quality in Indian component producers. For instance, Sutton finds that in terms of defect rates of component producers, Indian quality levels by the early 2000s were close to global levels and comparable to Chinese levels. In some areas Indian quality was higher than in China (Sutton undated).

However, when the financial performance of the Deming companies are compared to other Indian component suppliers in the same sector, the surprising result is that the quality improving firms did not perform any better in terms of profitability (Balakrishnan, et al. 2007). This is a surprising observation because the general international evidence is that improvements in total quality management (TQM) leads to improvements in financial performance and profitability (Hendricks and Singhal 1997). The most likely explanation is that the winning firms were not significantly exceptional. There is likely to have been a general improvement in productivity and quality across much of the Indian auto component sector as Sutton's benchmarking work also suggests. The lack of improvement in profitability suggests that productivity and quality improvements were achieved without price increases, or even with price reductions, resulting in an improvement in the competitiveness ratio. Clearly, what was happening here is exactly a move towards the global competitiveness frontier by component producers that we described as an α-strategy in Figure 6.

The possibility that Indian component producers were moving towards global competitiveness is also confirmed by the growing export success of many component producers. Many of the most successful component suppliers were joint ventures. Of the top ten component exporters in the early 2000s, six were joint ventures, and of the four domestic producers, three belonged to the same domestic group, TVS (Sutton undated). The performance of the Indian component producers is even more significant because comparisons with China show that they suffer on average a cost disadvantage of around 20 per cent due to higher costs of power, taxes, duties, labour benefits and so on (Balakrishnan, et al. 2007). Since there is no evidence that underlying productivity of labour and input use is higher by that margin in India, the implication is that global competitiveness was achieved by Indian component producers squeezing their margins, at least compared to China. Nevertheless, the quality improvements by the component producers allowed more and more foreign OEMs to enter the Indian market, and allowed Indian brands to consolidate.

Mahindra and Mahindra: Frugal Engineering

Mahindra and Mahindra was founded in 1945 by J.C. Mahindra, K.C. Mahindra and Ghulam Mohammed and was initially called Mahindra and Mohammed. Ghulam Mohammed moved to Pakistan after partition and became Pakistan's first finance minister and one of the architects of its early industrial policy. Sales in 2009 were around US$3 billion and the firm is part of the bigger Mahindra and Mahindra Group. Since the 1940s, Mahindra and Mahindra's focus was on agricultural vehicles like tractors and pick ups. Through that it built up significant technological capabilities, particularly in engine manufacturing. In the 1990s it was involved in a joint venture with Ford that introduced Mahindra and Mahindra to car production. The emergence of Mahindra and Mahindra as an Indian branded car maker making passenger cars was significantly assisted by the emergence of a strong Indian components sector. Its production strategy was based on significant outsourcing. Other than engines, transmission and body skin, everything was outsourced. Even the engine head and block were bought in semi-finished.

In 1998, the company took a strategic decision to walk away from its joint venture with Ford to design and produce a low-cost Indian MUV called the Scorpio (an MUV or multi-utility vehicle is somewhere between a car and a SUV). It had a limited

budget of US$ 120 million to design and develop the production facilities. It succeeded because it used its already significant component producer base in innovative ways. It brought in its suppliers, defined the technological outcomes and cost targets, and then let the key suppliers develop the technology. The suppliers were mainly joint venture companies or foreign companies with Indian operations. In the end, production was outsourced to 110 suppliers, but though many were joint ventures, 98 per cent of the Scorpio was indigenous. As a senior executive associated with the project said, 'lots of costs get added to get the last two per cent of quality right. But if one sets out to make everything perfect the costs go up exponentially'. Mahindra aimed at reasonable quality keeping in mind the profile of the Indian customer. So while it made sure it exceeded the parameters for the engine, it compromised on the noise levels. At the same time the company made sure that it had backup service plans for every area of weakness so that as soon as a customer complained the service team was ready with action. The effect was that the Scorpio entered the market at 11,000 dollars, around 60 per cent of the price expected by industry analysts (Sutton undated: 48-9).

After an initially lukewarm reception, the Scorpio captured 50 per cent of the domestic utility vehicle market. The strategy followed by Mahindra and Mahindra in this case was a risky one, but a good example of what Carlos Ghosn, CEO of Nissan has described as 'frugal engineering'. In the cheaper and smaller end of the vehicle market, this may be the standard pattern for the future. The company now has ambitious plans to enter the US market with a diesel engine. The US has the toughest emission standards, and Mahindra and Mahindra has developed an engine that meets this in collaboration with Bosch. The only other companies with a similar technology are Volkswagen-Audi and Mercedes Benz.

These cases of accelerated learning in the auto and auto-component sector based on privately financed movements up to global competitive levels are examples of α-strategies. The policy challenge for developing countries like India is to understand the very specific and fortunate combination of initial capability developments and appropriate combinations of incentives and compulsions after 'liberalization' that allowed the α-strategies to emerge.

Factors Supporting 'Alpha Strategies' in the Auto Sector

The Indian auto sector displays strong evidence of α-strategies and high-effort accelerated learning by an ensemble of domestic private and joint venture firms in the period after 1980. First, the ensemble of loss financing instruments, governance mechanisms, firm structures and the political settlement that emerged during this period created credible compulsions for high effort (eq. [11]). Secondly, the gap from the global frontier (shown by AY in Figure 6) was low enough for this level of effort to rapidly enable convergence to global competitiveness within the time frame that the loss-financing for doing this was available. In terms of eq. [10], the initial competitiveness gap, $s_{Q,}$ in 1980 was low enough to make the breakeven period, $B_{t,}$ appear to be viable for private investors in learning and technology acquisition. The key aspects of these determinants are as follows.

First, the most important characteristic of the Indian engineering and vehicle production base in 1980 was that there were many firms with a technological capability within striking distance of international competitiveness. They could hope

to attain global competitiveness with relatively small additional investments in equipment and the associated learning-by-doing. This was clearly a product of decades of slow capability development under protection. It meant that the implicit s_Q in eq. [10] was low. This matters because if the achievement of global competitiveness in the quality and the product that is being attempted is not perceived to be feasible, private investments in effort will not be forthcoming.

Secondly, the gap that did exist in 1980 could not have been covered in a day. A 'big bang' liberalization in 1980 would probably have meant the end of the indigenous Indian automobile industry. The manner of opening up implicitly created *financing instruments*, *FI* in eq. [11], because the implicit state contribution to loss-financing through domestic market protection continued for a while. For small global players like Suzuki, the continued protection of the domestic market provided enough rents for them to be interested in making investments including in learning. These rents were probably a more important incentive for the producers who first came in, like Suzuki, than the possibility that India may become a global platform for production in the future. The rents made it worthwhile for Suzuki to invest in learning-by-doing and also to work with domestic component suppliers to help them raise productivity and quality while meeting domestic content requirements. The pace of opening up was very important. Liberalization can only work in inducing high levels of private effort if the pace of liberalization is consistent with the gap that has to be covered by private effort and investments in learning. Not only was the gap with global competitiveness in key areas of the auto sector in India small, the pace of 'liberalization' was very gradual. In contrast, in Thailand the gap between many domestic firms and global competitiveness was still significant, particularly in electronics, and its big bang liberalization gave firms no time to catch up. The result was the bankruptcy of many domestic firms or their lateral shift into servicing or niche activities.

Thirdly, the relevant *governance agencies*, *GA*, created credible incentives for investing in learning in order to keep getting these rents. The most important was the credible enforcement of domestic content rules that forced foreign investors to work at technology transfer and therefore learning, as opposed to simply assembling knock-down kits, which would have been easier. Clearly, enforcing domestic content rules without the rents would have been impossible (the multinationals would have walked away), but creating the rents without a capability to enforce content rules would also have been a waste for the country. Again, the interdependence of these variables was important and points to the possibility of creating incentives and compulsions for multinationals that result in accelerated technology transfer.

Fourth, changes in the *political settlement*, *PS*, within India also created assurances that liberalization would continue. Equally important was the perception that things were changing. Liberalization was a global process, and many of India's own big corporate players were pushing for it. There was therefore a very high likelihood that the rents in the domestic market would reduce over time. This too had important effects in creating credible compulsions for putting in high levels of effort.

Finally, the *firm structure*, *FS*, was also fortuitous. The old established players like Birla had been sidelined by Suzuki, who gained access to government support for very accidental reasons. Suzuki in turn worked with smaller component firms and newly established joint ventures that did not have the political connections to ensure

their rents would continue. The credibility of enforcement by governance agencies was assisted by the new firm structure, as it was by the macro political changes supporting greater opening up but at an appropriate pace.

By putting the evolution of the auto industry in the context of our interactive variables determining effort (Figure 5) we can see that the outcome was plausibly related to a fortunate configuration that is more complex than may appear at first sight. Clearly, this favourable combination of incentives and compulsions would not be easy to replicate in policy terms. But equally, to believe that the auto takeoff happened just because of 'liberalization' is also wrong. Our analysis can explain why the results in the auto sector were not replicated all across India's manufacturing. It also explains why liberalization can be expected to have very different effects in different countries, and indeed in different sectors of the same country. Finally, it suggests that the success of some sectors may have more to do with their initial endowments of capabilities and incentives for further capability development, than the relative flexibility of their labour markets, which played a very limited role according to industry insiders in explaining the success of this sector. The implication for policy is obviously to focus on the difficult task of creating incentives and compulsions for capability development in other sectors, and indeed for assisting further capability development in the Indian auto sector over time.

Pharmaceuticals: Rapid Catching Up by Breaking into Technology Rents

Pharmaceuticals are the other big success story in India's manufacturing sector. Again, this is by no means a simple liberalization story but rather a story of capability development, in this case through a *financing instrument* that allowed successful Indian pharmaceutical companies to 'break into' the technology rents of multinationals. The 'breaking in' here refers to the Indian state's temporary de-recognition of the intellectual property rights of major pharmaceutical multinationals between 1970 and 2005. The key phase of capability development in the Indian pharmaceutical sector happened in the 1980s effectively because a change in the Indian patent law in 1970 allowed Indian companies to break into the monopolistic technology rents of multinational pharmaceutical companies. The opportunities for rent-capture possible by successful reverse engineering created strong incentives and compulsions for a dramatic spurt of learning. The capabilities developed during that period define the modern Indian pharmaceutical sector.

In 2008, the Indian pharmaceutical sector had 20,000 licensed companies employing around 500,000 people. Bulk drugs account for close to 25 per cent of the sector and formulations the rest. Between 1996 and 2006 sales of pharmaceuticals grew at around 9 per cent per annum in nominal terms, higher than the global average, but lower than in China and Malaysia. Exports have grown even more rapidly in the last two decades, with 22 per cent export growth in 2006. In 2007, 43 per cent of the industry's revenues came from exports. However, the export sector is concentrated in a few firms. Only 60 production locations are certified by the World Health Organization as compliant with the standards of the US Food and Drugs Administration (FDA). This is still the largest number in a single country outside the US, but it gives an idea of the concentration of quality in a small number of firms. Of the top five companies in the Indian pharmaceutical sector, three are Indian: Cipla, Piramal Healthcare and Sun Pharmaceuticals. The other two are GlaxoSmithKline and Ranbaxy which was recently bought by the Japanese company Daiichi. Despite rapid

growth, India is projected to lose market share in Asia to China which is likely to establish its position as the biggest player in the Asian pharmaceuticals market (Perlitz 2008).

The Indian states gaining most from the reverse engineering phase of pharmaceutical development that began after 1970 were mostly in the west and the south. This reflected the strengths of southern universities and the agglomeration advantages that Mumbai had already acquired by the 1980s for attracting high quality human capital. Despite competition from other states, towards the end of the 2000s, Maharashtra accounted for 40 per cent of the pharmaceutical turnover in India and 11 per cent of the total value of formulations in the industry. The Maharashtrian bulk drugs industries are clustered around Mumbai, Pune, Tarapur and Aurangabad, and the formulations industry is clustered around Mumbai and Pune. Mumbai and Aurangabad are also centres of pharmaceutical R&D. In contrast, West Bengal lost out despite having some of the earliest pharmaceutical companies. One of India's pioneering pharmaceutical investments was Bengal Chemicals, set up in 1930 by the visionary scientist Prafulla Chandra Roy. But it ran into difficulties before the opportunities created by the 1970 patent laws could be realized and it did not participate in the reverse engineering phase. By the 1970s Bengal Chemicals had become a loss-making enterprise and it was nationalized in 1980. It slowly moved down the value chain, and ended up producing veterinary formulations.

India'a pharmaceutical sector had its beginning in 1954 when the Indian government set up the Hindustan Antibiotic Ltd. with technical assistance from the World Health Organization and UNICEF (the UN's children's fund). A few years later the government set up the Indian Drugs and Pharmaceuticals Ltd. (IDPL) with Soviet assistance. IDPL was the cradle for many of the future leaders of the Indian pharmaceutical industry, including K. Anji Reddy, the founder of Dr. Reddy's Laboratories (DRL), a major player in the contemporary Indian pharmaceutical industry. Indian universities and technical colleges contributed strongly to the creation of formal capabilities. The investment in top-end education by the state throughout the 1950s and 1960s paid dividends in the form of large numbers of chemists and biologists leaving university every year. Currently, Indian universities and higher education institutions produce more than 100,000 chemists and biologists annually. Nevertheless, till the late 1960s multinational companies still controlled 68 per cent of the pharmaceutical market in India.

The real shift in the fortunes of the pharmaceutical industry came with the passing of the 1970 Patent Act. This allowed Indian pharmaceutical companies to break into the (Schumpeterian) technology rents of multinational pharmaceutical companies by allowing and indeed encouraging reverse engineering of known molecules. The Patent Act of 1970 ended the multinational monopoly in the Indian market by abolishing product patents and only allowing process patents and that also for a period of seven years. By allowing innovations of different processes for producing a known molecule, Indian pharmaceuticals companies could legally produce any known molecules. As product patents were not recognized, Indian firms were free to try and make any existing molecule using an entirely new process, or wait for seven years till the process patent expired, and then use reverse engineering to work out how to make that molecule.

Effectively, the Indian law invited Indian pharmaceutical companies to eat into the Schumpeterian technology rents of their advanced country competitors. The price of a pharmaceutical product under patent consists mostly of an arbitrarily large technology rent whose magnitude depends on the strength of IPR protection (and demand for the formulation) (Khan 2000b). By allowing Indian companies to figure out a way to produce the molecule at cost, the law effectively granted them a share of these Schumpeterian rents if they were successful. Thus by accident or design, the 1970 Act implicitly created a *'financing instrument'* that transferred rents to any Indian pharmaceutical company who succeeded in reverse engineering the production of known molecules. Fortunately for the Indian pharmaceutical industry, the design of this instrument and the governance rules that allocated it turned out to be very effective for creating incentives and compulsions for high levels of effort in capability development.

First, the implicit *governance agency* allocating the rent was not an agency at all in the usual sense, but simply market-determined success in reverse engineering. Only successful capability development was rewarded and that too *ex post*. Only companies that succeeded in developing internal R&D capabilities and human capital and therefore succeeded in reverse engineering benefited. And they benefited by being able to legally sell the product at a price anywhere between the relatively tiny cost of production and the monopolistic market price set by the patent holder, thereby potentially earning substantial market-based rents. This created strong incentives for firms to put in high levels of effort in developing their capabilities. It also created strong compulsions for entrepreneurs to achieve results because they had to first invest in capability development and the reward was contingent on success.

For many of the chemist-entrepreneurs who had already emerged in India by that time, this was a viable bet to take. In other words, here again was a sector where the gap between capabilities developed in the formal education sector and the tacit knowledge and capabilities required for global competitiveness was not large to begin with. The knowledge gap that had to be traversed, described as $s_{Q,}$ in eq. [10] was low in this sector too. The public sector investments in pharmaceuticals and in universities explain why the gap was low. The best chemist-entrepreneurs in the country could reasonably believe that they would be able to crack the capability development problem with investments that would be worthwhile given the large rewards that could potentially be captured. Secondly, the implicit governance rule that rewarded success *ex post* also ensured that *firm structure* and the *political settlement* did not particularly matter for determining efficiency for this form of loss-financing. As the rents transferred did not directly come from state allocative decisions or the budget, there was no political lobbying or special interest pleading that was relevant. The success of this 'financing instrument' is therefore not mysterious. We would expect these incentives and compulsions to lead to rapid capability development provided a range of entrepreneurs existed close to the capabilities required for effective reverse engineering.

An even more dynamic aspect of this method of financing catching up and technology development was that the successful company which managed to raise their technological capability then had very significant income streams coming in precisely because they were then able to capture a part of the technology rents associated with that product. These significant captured technology rents coming into the most

capable companies had a further effect in spurring more than just the development of reverse engineering capabilities. It allowed the development of R&D capabilities and product development capabilities. The technology rents not only justified the initial investments in learning, but financed subsequent rounds of learning and capability development in a number of dynamic and rapidly growing companies.

Capability development through this financing mechanism was indeed extremely rapid. Companies like Ranbaxy, Sun Pharma, Cipla, DRL and others grew rapidly in this way. Initially the sights of Indian pharmaceutical companies were set on their domestic market. By 2004 the share of foreign players in India had come down to 23 per cent. But in 2001 the global consequences of India's catching up became obvious when Cipla, the country's second largest pharmaceuticals company offered an AIDS drug to African countries for US$300 when the global price of the drug was US$12,000. Some of these companies also began to develop new products in an R&D pipeline. They planned to achieve new drug discoveries and in a few cases came close. The big players like Ranbaxy, Sun and DRL had new molecules in the pipeline with R&D financed by their cash flows from their technology rents.

Not surprisingly, US pharmaceutical companies went all out to enforce the protection of their technology rents by lobbying the US to focus on IPRs in the context of global trade negotiations. To the extent that US patent protection of pharmaceutical products may well be excessive not only from the point of view of global development but also for sustaining a high level of innovation in the US, the legalized Indian capture of pharmaceutical technology rents under its 1970 Act may actually have been a global good. Some of the important issues in this area were discussed earlier in Section 2 on IPRs. Revisiting TRIPS may be difficult but it is a vital global policy issue for the years ahead.

This growth trajectory was fundamentally transformed by WTO rules, under which India had to pass its Patent Amendment Act of 2005. India was persuaded to recognize patent protection in TRIPS compliant ways. The Indian act of 2005 recognizes a twenty year period of protection of patents. There are a few loopholes for the time being because this applies only to drugs patented after 1995. On the other hand, there are likely to be serious problems in the future over the possibility of 'evergreening' whereby a multinational patent holder can re-apply for a patent after twenty years on a marginally modified molecule, or on the basis of some new application of an old molecule.

The result of the 2005 Act has already been a series of fundamental changes in strategies of indigenous capability development in India's pharmaceutical sector. In particular, the change in the IPR environment dramatically altered the projected cash flows of the leading pharmaceutical companies. As the captured technology rents dried up, the financing of capability development and investments to make new discoveries also slowed down significantly. It is possible to argue that the 1970 Act allowed Indian pharmaceutical companies to eat into too many of the technology rents of the advanced country pharmaceutical giants. But it is equally possible to argue that a twenty year patent law and possibilities of evergreening create a system of technology rents that damage mechanisms for capability development in developing countries and may even slow down innovation in advanced countries.

The rapid catching up in the 1980s and 1990s in the Indian pharmaceutical sector is likely to slow down and new entrants within India will find it very difficult to finance their capability development in the future. The existing Indian pharmaceutical companies will also have to change strategies to comply with a strict patent regime. The most important strategic response that is already observed is a shift of focus of Indian pharmaceutical companies towards lower value-adding contract manufacturing for foreign multinationals. This can be described as the adoption of β-strategies by most Indian pharmaceutical companies. If this consolidates as the new dominant strategy, India is also likely to face an 'inverse-U shaped squeeze' in this sector in the years to come. New lower cost entrants will threaten at lower quality levels, while movements into higher value addition through technological capability development will be constrained unless new financing instruments can be devised.

TRIPS-Induced 'Beta Strategies'

The 2005 Act hit Indian pharmaceutical companies hardest if they had significant R&D in the pipeline because their expectations of rent-based cash flows to finance this research suddenly dried up. A number of responses followed, including selling out, shifting focus to contract production and research, and separating the R&D activities from the more mundane generics production and seeking venture funding for the former. But overall it is likely that the dominant response for many Indian pharmaceutical firms will be to focus on what has come to be described as Contract Research and Manufacturing Services (or CRAMS). This is an arrangement where multinationals outsource aspects of manufacturing and even research to companies in developing countries like India, but they continue to own the knowledge (hence the term contract research). The broader research component could also include the conduct of trials, which are an extremely expensive part of overall drug development if conducted in an advanced country. But trials could be much cheaper and bigger in scale if conducted in a developing country like India. Examples of each of these responses can already be found.

The first response, selling out, is obviously the most dramatic. In 2007 US-based Mylan bought out Matrix Laboratories, one of the largest Indian manufacturers of antiretroviral drugs for developing country markets. But it was the late 2008 sale of Ranbaxy to Daiichi that stunned most Indians. Ranbaxy was a trailblazing pharmaceutical company and had several promising products in the R&D pipeline. But its owners felt they could not finance these any more.

The second and more common response has been to focus on contract manufacturing for foreign multinationals. Contract production of drugs implies the payment of significant license fees to the patent owner or it implies producing the drug for the patent owner on a cost-plus basis. Either way, the Indian company can expect significantly lower income streams in the future compared to the past. Contract research is equally unlikely to result in broad-based capability development. Multinational pharmaceutical companies are likely to take good care that the technology is controlled and owned by them. In areas like biotechnology where process knowledge is vital, contract research is even less likely. However, some areas of labour-intensive and repetitive research activity may well be outsourced to countries like India. Another area that broadly comes under research is conducting trials. These are expensive in advanced countries and India is likely to become an attractive outsourcing area for clinical trials.

These types of strategic responses can be described as β-strategies. Contract manufacture in particular is relatively simple given the technological capabilities that the major Indian pharmaceutical companies have already demonstrated. Examples of these types of contracts include Aurobindo Pharma which has a licensing agreement with Pfizer to manufacture 60 generic drugs for distribution to other markets. Dr. Reddy's Laboratories is entering a similar agreement with GSK to produce around 100 branded drugs for global distribution. As a low cost venue for manufacturing licensed drugs, the Indian pharmaceutical sector could see significant growth. But Indian pharmaceutical companies may also start looking for even cheaper venues for assembling the more basic formulations. The most important consequence of the contracting route is that while Indian pharmaceuticals will be able to survive using this strategy, the revenue stream for financing significant in-house product development is unlikely to be assured through this route.

A third response is more ambitious and involves separating the generics manufacturing part of the business from the ongoing R&D in product development. This is now necessary given the more constrained cash flows from the generics business and the risks and cash requirements of investing in product development. A number of the big Indian players have spun off R&D ventures out of their main business and looked for venture capital to finance the development work. In other words, the cash flow of the generics can no longer sustain investments in high level capability development and R&D, and one way of recognizing that is to separate the two businesses out. Examples include Sun Pharma, which created the Sun Pharma Advanced Research Company (SPARC) in 2007 to do product development separately, to be financed by risk-tolerant venture capitalist investors. Glenmark and DRL provide other examples of this strategy. However, venture capital groups operating in developing countries, like ICICI Ventures are criticized by industry insiders for investing only when revenue streams are assured, cashing in on growth, not aiding growth.

The probability of relatively small R&D operations funded by venture capital leading to major breakthroughs is relatively small. It is more likely in the specialized field of bio-technology rather than in pharmaceuticals proper. This is because bio-technology is more about process knowledge and relatively small laboratories can keep on attacking a problem with a reasonable chance of eventual success. Innovative and relatively small firms like Bharat Biotech, founded in 1996 may therefore do relatively better in the new environment. It is still privately held and has 450 employees but is working on innovative ideas on vaccines like the Rotavirus vaccine with grants from the Bill and Melinda Gates Foundation, and malaria vaccines. It is now in the process of conducting the largest Phase III clinical trial in India for the Rotavirus vaccine.

Thus, while pockets of high-capability research continue to find funding for their R&D, one consequence of TRIPS was to sever the internal financing that was driving α-strategies in the broad-based pharmaceuticals sector. While these changes are relatively recent, industry insiders think that the future trajectory of the sector will be driven to a much greater extent by contract production (the β-strategy in this case) with isolated pockets of high-end research. The latter is likely to be contract research, financed by multinationals or other financiers in more advanced countries. As in the

Thai electronics sector, there is a longer-term possibility that foreign financing of higher end capability development will face challenges. The calculations of multinational investors to minimize their costs of research and development globally may not always coincide with that of individual countries seeking to enhance their technological capabilities.

The parallel with Thailand's electronics sector also includes the possibility of an inverse-U shaped capabilities squeeze emerging in the Indian pharmaceutical sector over time (as in Figure 7). The capabilities to manufacture drugs under contract are medium-technology capabilities in most cases. Other even lower cost countries are likely to enter over the next decade, and Indian pharmaceutical companies may themselves be induced to relocate some of the assembly operations to cheaper locations. Unless the higher end capability development is proceeding at an equivalent pace, growth within India in this sector may eventually be squeezed.

While the pharmaceutical sector is a relatively advanced one in India, its experience demonstrates very general problems facing catching up in developing countries. The emergence of an appropriate financing instrument was critical for the acceleration of capability development in the sector. Equally, the clawing back of technology rents by global multinationals under TRIPS has had equally serious implications for long-term capability development. Moreover, the pharmaceutical sector is not just a sector that is of interest for its export earnings potential. In a poor country it can potentially play an important role in human development if it acquires the capability to develop cheap high quality drugs required by the poor. The constraints on the development of technological capabilities in the pharmaceutical industry in countries like India is therefore of even broader relevance. Both the auto and the pharmaceutical sector in India demonstrate very clearly the vital role played by capability development strategy of the past. Describing these successes as the expected results of a wise liberalization that now simply needs to deepen does not capture very significant aspects of the historical reality. Nor does it provide policy-makers with the understanding to address significant market failures that continue to constrain broad based capability development in countries like India.

6. Bangladesh: Learning to Produce Garments with MFA Rents

The dramatic acceleration of growth in Bangladesh in the 1980s and the role of the garments and textile industry were described in an earlier paper in this series (Khan 2008b). The rapid growth of the garments industry has meant that the share of manufacturing in GDP in Bangladesh is comparable to that in India. Indeed, the share of manufacturing in Bangladesh is higher than is expected given Bangladesh's overall economic characteristics (ADB 2007: 294). But the bulk of Bangladesh's manufacturing is labour intensive and low technology. Moreover, globally competitive production is almost entirely specialized in garments even three decades after the country's breakthrough in this sector. This is indicated by the fact that around 70 per cent of the country's total export earnings still comes from the garments sector in the late 2000s.

The standard economic explanation for the breakthrough in garments is that this growth was based on comparative advantage and flexible labour markets in Bangladesh. But this is not entirely convincing. Why did Bangladesh's comparative

advantage in labour intensive industries not emerge before 1980? There do not appear to have been any significant labour market or other reforms exactly around that period. Nor did any other labour intensive industries take off in quite the same way. The main problem for a purely comparative advantage-based explanation is to account for the role played by the MFA (the Multi-Fibre Arrangement) that emerged in 1974. This was a global system of protection that was set up to protect the interests of garments and textile manufacturers primarily in the USA, but ended up creating opportunities for a number of developing countries that previously did not have global competitiveness in this area. Did countries like Bangladesh simply follow their comparative advantage or was the special assistance provided by the MFA important in developing capabilities that did not exist before? And if the MFA was important, what role did it play and what are the policy implications?

Clearly, there were market failures that had prevented the acquisition of technological capabilities even in the least technically sophisticated types of manufacturing like garments. It is widely recognized at least by economic historians that the MFA may have contributed in some way to relaxing some of these market failures, thereby allowing Bangladesh to enter this market. But what type of market failure did the MFA address? The answer to this question has significant policy implications for countries like Bangladesh if they want to devise policies to move into other sectors of manufacturing, labour intensive or otherwise. In particular, can the experience of the Bangladesh garment industry under the MFA be fitted into the metaphor of 'discovery' suggested by Hausmann and Rodrik (2003)? Perhaps entrepreneurs had not invested in trials in new sectors fearing that their discovery rents would be lost if new entrants rushed in. In that case the role of the MFA may have been to reduce the cost of trials, resulting in discovery.

The problem with this apparently plausible explanation is that the MFA was not a fund that allowed many 'trials' to be organized through which Bangladeshi entrepreneurs discovered what the country was good at doing. The MFA created rents in just one sector, garments. It brought in just one South Korean company, Daewoo, in collaboration with one Bangladeshi entrepreneur who set up just one factory called Desh Garments in 1979. Everything followed from that. If this was really a case of a singular trial that discovered a huge latent capability in Bangladesh, it would truly be a case of incredibly good luck. The coincidence would be even more remarkable because somewhat earlier in its history other 'trials' were conducted in Bangladesh, often assisted by public policies of protection and subsidy. These ranged from protection and subsidies for production in moderate technology sectors like textiles and chemicals to low-technology sectors like leather products and agro-industries but no other sector like garments had emerged. Something rather special was going on in the singular trial organized by the Desh-Daewoo investment.

A more plausible explanation and analysis is possible using our learning approach. The learning approach suggests that low-wage countries like Bangladesh could potentially engage in many different types of labour-intensive or low technology activities and achieve global competitiveness. What constrains them is the absence of the appropriate tacit knowledge. The absorption of tacit knowledge requires investments in learning-by-doing and while the learning is being absorbed, investors will not be making profits. The fundamental problem is that if sufficient *effort* is not put into the learning exercise, the investments in learning are wasted. The reason why

other trials failed is because inadequate effort was put in. It is not plausible that Bangladeshis had no innate capabilities to produce any of those other labour-intensive products. So the really interesting question is: what was the structure of incentives and compulsions that ensured high levels of effort in this particular project?

The role of a full or partial public financing of learning in our explanation is that in many cases, without a partial financing strategy, the risk facing private investors in learning may be too great. Nevertheless, as we have seen, if initial capabilities are high enough and effort can be assured, private financing of learning can well drive capability development. On the other hand, public financing of learning may fail and has often failed in the past, if effort is not forthcoming. The key determinant of success in the learning explanation is *effort*, not the source of the financing. This is very different from the discovery analysis, where public financing of discovery is important because the market failure stems from a positive externality that results in a loss of rents for the successful entrepreneur after a successful sector or capability has been discovered.

This does not mean there are no positive externalities in new startups, but in many technologies, these positive externalities are minor and would not, on their own, prevent investments. Compare the risks for the investor coming from the difficulty of ensuring high levels of effort with the potential losses that could follow as a result of positive externalities. The risk that follows from the difficulty of ensuring effort is that private financiers cannot predict *ex ante* how long it will take to achieve profitability. This is not because innate capabilities are not known, but rather because success in enforcing effort is difficult in most developing countries where typically investors cannot fully rely on either formal contracting or informal enforcement mechanisms. The more confident investors are in their own abilities and of the relevant governance agencies to ensure effort, the less important the cost-sharing with government becomes. We see strong evidence of this in the garment sector in Bangladesh.

The risk is highest for the first investors because tacit knowledge is most difficult to adopt and adapt when it is not known locally. But once the tacit knowledge has been transferred to a locality, it becomes relatively easy for other producers and investors to understand the routines. Once the knowledge becomes ‘local’ subsequent investors take a lesser risk. The routines are now locally known and *can be observed in operation*, benchmarks of effort exist and one or two key personnel can even be poached from successful enterprises The required training becomes more and more ‘codified’ and uncertainty about learning times and required investments reduces dramatically. This is a positive externality, but it is almost in the nature of a public good because the loss to the first investor can be rather small, and too small to explain why investments do not happen in the first place. Again, we will see strong evidence of this in the garment industry. One indication of the dramatic reduction of risk when tacit knowledge becomes ‘local’ is that local commercial banks suddenly become willing to lend because the required ‘investment in learning’ can now be more readily quantified. Yet the same banks may be very unwilling to play a ‘developmental’ role by coming forward to finance learning in sectors where the tacit knowledge does not exist locally. This is exactly what we observe with banking practices in the Bangladesh garments industry.

The real constraint on the first investors is that they take a big and unquantifiable risk because the transfer of the first tranche of tacit knowledge is most exposed to the uncertainties of inadequate effort. The entry or otherwise of subsequent imitators has no plausible bearing on this calculation even if minor positive externalities exist. Their appearance is not likely to have any significant effect on profits in labour surplus economies. The Desh-Daewoo investment performed a vital function for Bangladesh precisely because it successfully organized the critical *initial* transfer of tacit knowledge. The MFA helped critically in two ways, but the MFA alone cannot explain the success of the technology transfer process in terms of effort. First, the MFA reduced the requisite private loss-financing by creating quota rents for Bangladesh. By imposing quotas on exports from more competitive countries, MFA resulted in higher global prices for qualities subject to quotas as soon competitive countries reached their quotas. This implicitly improved the competitiveness of other developing countries for as long as the quotas were in place. Secondly, the MFA created compulsions for the South Koreans to actively seek to transfer some sites of production to countries like Bangladesh. Quotas on South Korean garments exports not only affected their garment industry but also sales of fabrics and accessories that were indirectly exported through garments. If they could find alternative sites like Bangladesh, they would be able to keep more of their textile industries going. This was the context in which Daewoo was looking for partners in developing countries to invest in developing a modern garments industry.

The MFA therefore created a 'public' subsidy for countries like Bangladesh, and incentives for some private foreign investment in learning as well. But all of this would have gone to waste if the firm that was set up failed to put in high levels of effort in learning. Without that, the subsidies for setting up garment firms would be no different from countless other subsidies that have been available for trials in other sectors. We would then have discovered that Bangladesh cannot make garments either. From the perspective of a learning-based explanation of the success of the garment industry, the most critical issue therefore is to understand how high levels of effort were sustained to make this particular exercise a success. We will argue that this can be explained in terms of the features of the interactive variables identified as determinants of effort in Figure 5 and eq. [11].

Drawing on our earlier discussion in (Khan 2008b), the important features of the MFA experience in Bangladesh are summarized in Figure 8. The initial capabilities in the garments and textile sector were low in terms of what was required to achieve international competitiveness. There were of course some small-scale operations consistent with a low technology garment industry going back many decades in Bangladesh, but there was nothing on a global scale. The MFA provided an implicit financing instrument for learning by raising global prices of qualities subject to quota. This temporarily raised the competitiveness of quota-free countries like Bangladesh, shown by the dotted competitiveness curve. To simplify, we assume that quotas were imposed for all qualities, and that prices for all qualities increased by the same factor. This is obviously not how MFA operated, but the simplified diagram captures key aspects of the story. The implication is that a quota rent of s^{MFA} became available as temporary loss-financing as a result of MFA.

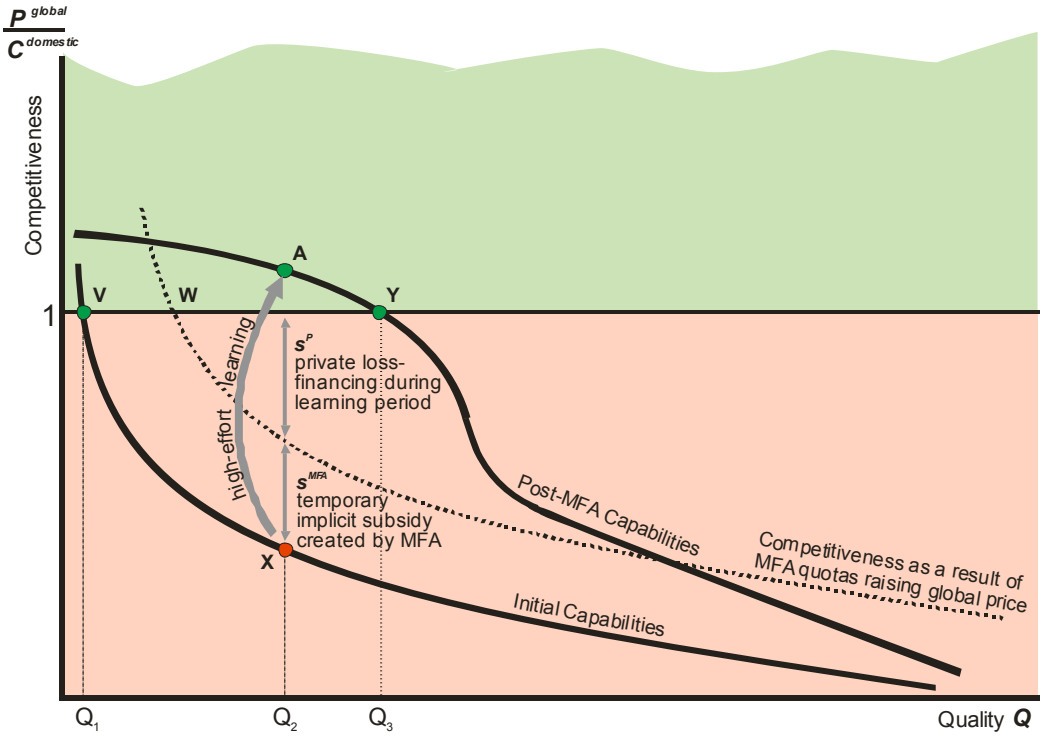

Figure 8 High-Effort Learning under the MFA in Bangladesh

The problem for countries like Bangladesh was that even with this improvement in competitiveness, a large number of garments operations did not immediately become viable. Tacit knowledge was still too low. This is shown in Figure 8 by an initial capabilities curve that is so low that the improvement in competitiveness would have allowed an improvement in qualities from V to a marginally better position at W. For a significant improvement in prospects, private investment was required to raise capabilities to a globally competitive level. Indeed, every developing country that was quota free under MFA did not experience export growth. But MFA clearly helped by effectively reducing the private cost of financing the requisite learning.

The Desh-Daewoo partnership began production of quality Q_2 in Figure 8, which represents the quality that could sell in mid-level retail outlets in the US and other global markets. This required a period of partial private loss-financing (shown as s^P in the figure) *in addition to* the 'public' financing (of s^{MFA}) which was the quota rent that was inadvertently and temporarily made available by the MFA. This private investment was organized by the unexpected partnership between a Bangladeshi bureaucrat-turned-entrepreneur and the South Korean conglomerate Daewoo. The curious details underpinning that partnership were discussed in our earlier paper (Khan 2008b). The successful characteristic of the learning was that overall capabilities in the sector rapidly moved up, allowing not just competitive production of the qualities initially introduced by Desh, but the improvement of capabilities in this region very soon allowed the production of higher qualities like Q_3 as well. Why was this investment so successful in achieving rapid learning?

Effort, Learning and the Success of Desh Garments

The Desh-Daewoo collaboration emerged in 1979. This was not a joint venture but a collaboration, where Desh purchased technical knowhow from Daewoo, including

training for managers, supervisors, and some production line workers in Daewoo's Pusan plant in South Korea, purchase and set-up of modern machinery, access to inputs at world market prices and assistance with marketing. Daewoo would be making some up-front investments, including hosting and training the Bangladeshi visitors at Pusan, but would be paid in the form of a royalty of three per cent of sales for the technical training and another five per cent of sales for marketing (Rhee 1990). All investments in machinery, salaries and the project costs in Bangladesh were covered by Desh. Clearly, both sides were taking some risk for an appropriate share of the return. The collaboration was initially expected to last for five years, but so successful was the learning and technology transfer that Desh was able to cancel the collaborative agreement in 1981, after just one and a half years. Within a year the collaboration succeeded in transferring large parts of the requisite tacit knowledge required to actually produce garments using modern production techniques. It would not have succeeded if it had simply produced garments using existing capabilities under the protective barrier created by the MFA. The fact that tacit knowledge was actually acquired and brought to the local economy is proved by the fact that *once the new production routines had been established and understood*, many new garments factories opened up in Bangladesh within two or three years. So dramatic was the growth, that the USA imposed quotas on Bangladesh in 1985, just a few years after Desh Garments actually began exporting. But very high growth rates continued beyond the new quota entitlements proving that new competitive capabilities had been established.

The quotas imposed in 1985 on Bangladesh defined the quantities of different categories of garments that could be exported to the US without paying tariffs. These quotas were generous, but for a variety of reasons, many producers even at this early stage of the business did not receive an export quota. This was sometimes because some producers were not part of the 'in-group' of the BGMEA, the Bangladesh Garments Manufacturers and Exporters Association that was responsible for distributing the quota between different garments producers. In addition, quotas for popular lines were soon fully allocated so new producers could not have got an allocation anyway. Thus, within two or three years of the garment industry coming on stream, probably as little as one third of all producers were 'quota protected'. But growth continued rapidly. By the time the MFA was effectively removed in 2007 Bangladesh had a diversified garments industry that was engaged in some amount of backward and forward linkages as well.

A number of conditions help to explain the successful acquisition of technological capabilities by Desh and its transfer to the emerging Bangladesh garments sector. First, the *'financing instrument'* involved here was a combined part-'public' quota rent subsidy and part-private investment in technology transfer and learning. This co-financing of learning characterized not just the Desh investment, but also the investments that were made by all the new entrant companies in a number of other product lines immediately following Desh. All of these companies were beneficiaries of quota rents and yet had to make relatively uncertain investments in learning to produce different types of garments to global standards. Co-financing in this form meant that the investor had very strong incentives to put in high levels of effort because the quota rent was not sufficient to achieve global competitiveness with existing levels of capabilities. If the quota rent had been sufficient, we would not have had to wait for the success of the Desh enterprise for a growth takeoff, but equally,

most of these enterprises may later have collapsed with the disappearance of the quota rents. The partial boost provided by the quota rent proved to be sufficient to induce private investment but also ensured that private investors would only be successful if genuine capability development happened at the outset. This was a very fortunate aspect of the levels of protection provided by the MFA.

Second, the *governance agencies* responsible for allocating the MFA rent were initially entirely exogenous to the internal political structures of rent-management in Bangladesh. Initially, the quota rents were available to every producer exporting garments of the requisite quality. A permanent export subsidy of this type may not have had the desired effect, but everyone knew that there was no reason to expect the MFA to be a permanent feature of the global economy. Indeed, within a few years, Bangladesh had its own quotas and the allocation of these quotas by the BGMEA became important. If quota rents had still been important for learning at that stage, the management and allocation of the quota rents by the BGMEA would have been an important determinant of subsequent learning success. Aspects of the political settlement that determined the bargaining within BGMEA would then become critical. As it turned out, by the time quota rents were allocated by the BGMEA, the core capabilities required for achieving global competitiveness had already been absorbed by the first firms and second and third tier entrants had already started imitating them. New entrants already knew how to become globally competitive on the basis of their private investments in learning, even if they no longer benefited from quota rents. This is proved by the fact that many new entrants after 1985 did not receive any quotas from the outset.

In other words, the transition from competitiveness levels of X that had initially characterized the sector to competitiveness levels like A where a firm could be globally competitive *without any quota rent* happened rather rapidly. Once firms learnt how this could be done, they were not afraid to set up production without being allowed a quota. It took them slightly longer to turn a profit, but they knew they could do it because the type and extent of effort was known by then. The fortunate aspect of the technologies that were protected by the MFA was therefore that protection was only required to induce learning in the very first firms where the learning was most risky and uncertain. In later cases, the MFA rents were not essential, and therefore the governance structures allocating the MFA rents were not decisive. The core routines had already been transferred to the local economy. This lucky characteristic was related to the simplicity of the technologies involved in the garments industry. For more sophisticated technologies, the 'public' component of the financing for learning may have to last for longer and the agencies monitoring and governing these investments would be of much greater significance for determining the incentives and compulsions they created for high effort in learning.

The *firm structures* of the early firms involved in the learning were very important for effective learning and high levels of effort. The collaboration between Desh and Daewoo involved significant investments from both sides, but particularly significant from the Bangladeshi side which had to put in most of the effort. The founder of Desh, Nurul Quader Khan provided the bulk of the capital required for investment in plant and machinery for the venture. Daewoo's investment was to invite a large team of Bangladeshis to visit and study its operations in South Korea and understand on-site how production was actually set up and organized. The characteristics of this

firm-to-firm relationship and the internal incentives and compulsions within Desh are perhaps the most critical characteristics explaining the success of the technology transfer. On one side was a relatively small Bangladeshi firm led by a motivated investor who clearly had the capability to motivate his team of enthusiastic middle managers. On the other side was a disciplined South Korean conglomerate that had no interest in retaining commercial secrets in a very mature sector, and every interest in rapidly transferring this technology to its new partners. Moreover, the speed with which it would get a return on its investments in training would depend on the rate at which it could transfer tacit knowledge to the visiting Bangladeshis and assist them in transferring this to their production site in Bangladesh. Much of the tacit knowledge was communicated in South Korea in the form of hands-on experience on the South Korean factory floor and the strong incentives on both sides ensured that this was a rigorous process. It is clear from the subsequent experience of Desh that this hands-on learning experience was decisive for achieving success. Between 1981 and 1987, Desh Garments grew its exports at a staggering average rate of 90 per cent every year (Rahman 2004).

An important factor that also helps to explain the high levels of effort of the early Desh managers is that the sector had relatively small scale economies and motivated managers and even supervisors could expect that if their learning was successful, they could one day be entrepreneurs themselves. The company to its credit did nothing to deny this possibility. Even today, high levels of effort in the garment industry in Bangladesh are sustained by entrepreneurial motivations of middle managers. The scale of their ambition was truly significant. By the end of the 1980s, of the 130 people who were first trained by Desh in Daewoo's factories in South Korea, *115 became entrepreneurs* and set up their own garment firms (Rhee 1990: 341). This apparently did not do much damage to Desh, whose output continued to grow at close to one hundred per cent per annum during this period. The loss the company suffered when it lost a manager was made up many times over by the high levels of effort that these individuals invested in the first place as a result of this implicit incentive. Of course, the nature of the technology was important for sustaining these incentives. The relatively easy transferability of the routines required to maintain competitiveness meant that Desh could sustain its breakneck growth despite almost all its managers leaving and setting up their own companies. As long as some continuity could be maintained between generations of managers, Desh could continue its growth. Moreover, many routines became embodied in the workforce where turnover was much slower in percentage terms. These characteristics of the technology and therefore of the firm structures they supported were important for understanding the incentives for high levels of effort that allowed the sector to grow from virtually a zero base in 1980 to around 3500 firms directly employing upwards of 2 million people by 2005 (World Bank 2005a).

The technology of the garments industry was therefore fortunate in several respects. Relatively minor scale economies meant that many firms could set up, creating strong incentives for effort on the part of middle managers and at the same time the steady loss of managers did not bring companies like Desh to its knees. However, this should not be taken to mean that the tacit knowledge involved in this industry was very simple to absorb. Before Desh there was no medium-to-large scale modern garment industry in Bangladesh. Even after the routines became local knowledge and were widely imitated, the failure rate in the industry was extremely high. Published figures

for failures are not available but industry insiders suggest that between thirty to forty per cent of early startup firms failed to survive. The knowledge required for success is not just about how to set up the factory floor, but also how to manage a complex service relationship with demanding buyers and supply chains in a changing environment. The critical point is not that tacit knowledge was not important here, but rather that features of the technology and firm structure provided very strong internal incentives for effort. In sectors with significant scale economies where managers could not expect to set up their own firms in a few years, internal firm incentive structures motivating middle management would be extremely important.

The success in sustaining effort in the early stages of learning was also assisted by features of the *political settlement* that characterized Bangladesh at that time. Fortunately for Bangladesh the late 1970s were a period when the government was decidedly pro-business. President Ziaur Rahman backed the Desh project at the highest level and by some accounts was instrumental in introducing Desh to the South Koreans. Vital institutional innovations like back-to-back letters of credit which allowed firms to import raw materials on the basis of their export orders and bonded warehouses that allowed duty-free imports of inputs designated for re-export were pushed through at a pace unusual for Bangladesh. The perception that profitability would not be held back by bureaucratic obstruction and red tape was important for encouraging a focus on achieving market competitiveness. This is obviously a relative judgement. Political support at the highest level can at best reduce bureaucratic inefficiency and friction somewhat in developing countries.

Two other structural features of the political settlement are also important for understanding why labour intensive industries emerged here but are so difficult to set up in Africa. We will come back to this in our next section on Tanzania. First, Bangladesh had emerged in 1971 out of two partitions (in 1947 and 1971) which were driven by the fact that the region did not have its own capitalist class and perpetually felt exploited by capitalists from other areas of the subcontinent. As we discussed briefly in a previous paper, (Khan 2008b), initial experiments with 'socialism' were periods of intense and often violent primitive accumulation through which a broad-based class of political accumulators made enough money to be potential capitalists. By the late 1970s, there were enough Bangladeshi individuals from the broadly defined 'middle classes' who had a capital base to be co-investors in small-scale labour-intensive manufacturing. Indeed, the bureaucrat-entrepreneur who founded Desh Garments was an excellent example of this. It was fortunate for Bangladesh that when the opportunities for entering a labour-intensive sector through learning appeared, the human material in the form of a large body of potential entrepreneurs was there to take advantage of this. A problem for many early stage developers is that there are only a handful of entrepreneurs who have the capital to participate in growth. The problems are even more serious if the handful of entrepreneurs comes from the 'wrong' ethnic group.

Secondly, the political settlement in Bangladesh also described a social order in which there was a very large class of poor people who were landless or land-poor and from which a disciplined class of workers could be rapidly created. In an earlier paper Khan (2009) we saw that this type of unequal property rights structure has historically been associated with the imposition of discipline and high levels of effort on a workforce. For reasons to do with demography and the evolution of rural land rights,

Bangladesh had large class of landless poor in the early 1980s. The garments industry went even further and selected women as their primary employee base, further improving the discipline and effort that could be imposed on the workforce. It is easy to forget that labour-intensive manufacturing requires armies of disciplined workers willing to put in high levels of effort in learning radically different methods and paces of working, often for very little pay.

We should not underestimate the hugely disruptive 'learning' that is involved when a rural woman in Bangladesh moves from housework and fieldwork to a disciplined workplace where a high intensity of work has to be maintained for ten hours or more at a time, working on new machines and adjusting to new social environments. The fact that millions of workers made this transition from agriculture and the informal sector to disciplined manufacturing in a couple of decades cannot be understood without reference to the social structure and the political settlement that characterized Bangladesh in 1980. Equally, the absence of some of these social conditions in many African countries explains why the extraction of high levels of learning effort has been much more difficult in those countries, particularly in labour intensive sectors. Both these features of Bangladesh's political settlement in 1980 need to be kept in mind for understanding how so many factories could enforce such high levels of effort in the emerging garment sector.

Thus there were good reasons at the micro and macro level why the configuration of incentives provided by the MFA resulted in high levels of effort. The compatible characteristics of technologies, firm structures, financing instruments, governance structures and the political settlement worked together to ensure high levels of effort in learning in this sector. The outcome was by no means accidental, once we know what we are trying to explain. In sectors where the technology is different, and where accidental trade-related rents do not exist to the appropriate extent, it may be much more difficult to create a new ensemble of policy instruments and governance structures that ensure high levels of effort in learning. But that is precisely the challenge of development and the reason why mechanisms of financing learning only appeared to have worked very rarely.

From a policy perspective, it matters very much whether we describe the success of the garment industry using the metaphor of 'discovery' or of 'learning'. If the absence of effort in learning explains the failure of previous trials, then carrying out a number of further trials using public funds is unlikely on its own to 'discover' further sectors like the garments industry. What is needed is policy that can invest in the transfer of tacit knowledge in other sectors *and ensure effective learning through high levels of effort*. Subsidies without mechanisms of enforcing high levels of effort have failed in the past and are likely to do so again. The Desh-Daewoo experiment succeeded because it achieved high levels of effort, and the policy lesson is to try and design further rounds of learning with appropriate financing instruments and associated conditions that ensure similarly high levels of effort.

The metaphor of discovery may allow us to be too sanguine and argue that failure simply shows that innate capabilities were missing for producing a particular product in a particular country. The policy implication that follows from the discovery metaphor is that we only need the credible capacity to terminate subsidies for discovery in time and try again in another sector. The learning model says that we

need to probe more deeply into success stories and design new policies with greater attention to the interplay of factors that determine the level of *effort* put into the learning. The challenge for policy in Bangladesh, even within the garments and textile sector, is to follow up on the implications of the importance of learning and to consciously design policies to accelerate further moves up the technology ladder.

Technology Upgrading in the Garments Sector

Thirty years after the garment sector's growth began the sector is still rapidly growing. However, technical progress has been slow, while lateral expansion has been very rapid. This does not mean that a broadening of the technical base has not happened. There has been significant growth in backward and forward linkages. By 2005, roughly 45% of export value was added in the domestic economy demonstrating the growing backward linkages in spinning, weaving, dyeing and accessories (Bhattacharya, et al. 2002; World Bank 2005a; Ahmed and Hossain 2006). But discussions with entrepreneurs in the sector revealed a number of systematic problems that are closely related to our analysis of learning. Moreover, with the garment industry accounting for roughly 70 per cent of exports, there is a strong case for greater diversification. This requires transferring lessons from the successful experience of learning in this sector to devise policies for other sectors.

A widespread observation in the industry is that once the learning requirements for a particular technology become known, banks are willing to lend freely (though the real interest rate for investors has been high in Bangladesh). The difficulty is that for new technologies and sectors, banks understandably have no metric for estimating their exposure to risk. In fact the entrepreneurs themselves do not know how successful the learning exercise will be. The fixed return and collateral requirements characteristic of bank loans can deter investors who are not sure about the length of time learning in new sectors will take. Nor can the absorption of new technologies be easily financed by profit sharing agreements with outside investors because the latter are deterred by poor guarantees of disclosure, weak contract enforcement and weak mechanisms for compelling effort on firm level managers. Thus, there were significant market failures constraining investments in learning, which in turn constrained rapid acquisitions of new technological capabilities. While supporters of market-enhancing argue that this is one reason to improve contract enforcement, the realistic possibility of making a significant impact on that in the medium term is very limited. Other governance approaches therefore have to be devised to address these market failures.

Nor does our analysis imply that significant new technologies are not being adopted. New technologies and investments *are* coming in but only when supported by very specific financing mechanisms. One variant in the industry is of enterprising entrepreneurs who are willing to reinvest profits from their existing businesses despite the much higher levels of risk new technologies imply. A second variant is of investments in technologies supported by foreign partnerships based on established relationships of trust. But there is widespread recognition within the industry that if appropriate instruments of financing for new technologies could be developed while ensuring incentives for high levels of effort, the adoption of new technologies and investment in the absorption of the relevant tacit knowledge would be much accelerated.

The companies who were able to absorb the risks of financing investments in technology upgrading were typically bigger companies with strong modern managements. They had already established positions in other segments of the market that could generate the profit stream for financing learning and technology absorption in new segments of the market. Examples include the expansion of the Bengal Jeans and Bengal Denims group into denim manufacture in the mid 2000s. With private investment strong incentives for effort clearly existed. The firm achieved 80 per cent of the rated productivity of its new denim weaving machines within a year. But integration across all inputs and differences in costs of inputs meant that Chinese imports of denim with all the transport costs were US$1.50 per yard compared to their internal cost of production of US$1.70. Thus, an implicit internal loss-financing of learning was continuing after a couple of years.

Still the use of the Bangladeshi fabric was viable because the group had its own jeans stitching business and in-house production allowed better quality control and quicker response times for their jeans manufacturing. Moreover, Bangladeshi inputs enjoyed GSP advantages as Bangladesh was an LDC (least developed country) and this gave users of local fabrics a cost advantage of up to 12.5 per cent in some markets. They were taking a bet that achieving scale economies in their domestic production and rising costs in China would eventually make the denim production globally competitive. Clearly, without their integration into jeans production (and GSP privileges) the backward linkage would have been unviable given the time it was taking to compete with the Chinese.

Another example of a modern factory that had become sizable through incremental internally financed investments was Far East Knitting and Dyeing Industries. This had around 1300 workers in low value-added garments making, but the stream of income from that was financing sustained moves into higher value-adding knitting and dyeing. Around 800 workers were employed in these more technically advanced areas in the late 2000s, and these numbers were growing. The company's strategy was to retain 5 per cent of its gross export earnings for reinvestment in technology upgrading. The owners and managers were individuals with a long exposure to western markets, had good relations with buyers and understood how to create incentives for high levels of effort by their workers. The firm had devised internal incentive schemes like a rolling fund where the firm paid in around 300,000 taka every month (around US$5000) which accumulated into a sizable fund over the years. Employees who stayed with the firm more than five years were entitled to a per capita share of the fund when they left, creating incentives for staying on. This was to reduce the perennial problem of leakage of trained workers.

Firms in Bangladesh are obviously aware of the 'positive externality' problem, which means that new entrants or other existing firms have an incentive to poach on the training efforts of firms that engage in skilling up new workers or workers in particular segments of quality. But it appears that firms have adjusted to these positive externalities and are not excessively constrained by it. A mechanism that is widely used is to force workers to share some of the initial training costs by hiring them as 'helpers' in the first place. They often have rates of pay that are below the market wage because the assumption on both sides is that the training has a value which can be lost to the firm if the worker leaves. The bargaining power of firms in a labour surplus economy has meant that this arrangement has been widely adopted, though

there is increasing pressure to implement minimum wage laws. Clearly, firms can and have misused these arrangements, but it is one mechanism through which the external benefits of training can be internalized by the firm in the form of initially lower employment costs.

The other model sustaining investments in new technologies has been partnerships with foreign partners. This requires strong relationships because foreign partners providing some of the capital or technology for upgrading have to be assured that the Bangladeshi firm will put in high levels of effort. In the small scale garments sector where corporate reputation still has limited value, personal relationships and industry knowledge have been very important. There are examples such as K.S. Embroidery where personal relationships between Chinese investors and a Bangladeshi entrepreneur allowed a small investment and some technology transfers in new segments of the industry.

A potentially very interesting model of foreign partnerships driving technology acquisition is the Danish Business-to-Business (B2B) programme run by the Danish development agency DANIDA (Ministry of Foreign Affairs Denmark 2006). This programme identifies viable and reputable Danish companies and introduces them to developing countries and potential local partners with whom joint ventures or partnerships could potentially be set up. The Danish programme vets high quality Danish technology providers, finances their visit to the developing country and sets up meetings with domestic entrepreneurs. Its main purpose is to cover the costs of potential Danish companies to come to a developing country that they do not know and where they might otherwise not have come. In other words, the programme covers only the coordination costs and does not currently contribute to the investment and learning costs faced by the joint venture.

But consistent with our argument of risk, this limited support has resulted in new investments with relatively sophisticated technologies. One of our surveyed groups, the International Trade Connection, was implementing a project setting up a composite textile knitting factory at Bhaluka with German and Danish technicians providing assistance in this way. It is quite possible that many of these upgrading investments may otherwise not have taken place. As a result of the official linkages established, there was also a private Danish investment with a 33 per cent stake in the project. The Danish programme is obviously restricted to Danish companies, and this significantly limits the range of technologies and sources of financing Bangladeshi firms can access through this programme. Nevertheless, it is a good example of how relatively small investments in coordination and information provision can help bring about investment in new technologies in developing countries. It is a model that other development partners could consider, and indeed there is no reason why the government should not consider coordinating development partners to provide this service in a coordinated way.

A successful scaling up of the Danish B2B experience would need to take into account possible factors that account for the relative success of the programme. It does not seem to waste a lot of resources in pointless foreign visits and coordination activities that do not go anywhere. Waste is apparently minimized because the remit of the programme is very narrowly defined: it is restricted to Danish companies, and the programme is answerable to Danish taxpayers who would presumably be worried

if very few deals were completed with Danish companies. In scaling up such a programme, it would be important to ensure that a broader agency had clear targets so as to ensure that resources that were spent in facilitating coordination met targets. If targets were appropriately defined, there would also need to be credible compulsions on managers of the agency to meet these targets.

Our interpretation of the causes behind the rapid growth of the garment industry in Bangladesh casts doubts on the argument that Bangladesh's success was based on cheap labour and labour market flexibility. It is true that Bangladesh scores much higher than India on labour market flexibility (it is easier to fire workers compared to India). Indeed both Pakistan and Bangladesh score higher than India on the overall ranking of 'Doing Business Conditions' of the World Bank. But the specific mechanisms through which the garment industry developed suggests that cheap and flexible labour by itself did not help Bangladesh till the market failures constraining investment in this sector were overcome. The implication must be that low wages and labour market flexibility are not sufficient for a manufacturing takeoff to happen. There are significant market failures that need to be addressed even to adopt simple technologies. The Indian experience suggests that in sectors where market failures impeding capability development and technology acquisition can be addressed, low wages and excessive labour market flexibility may not even be necessary conditions for manufacturing growth.

7. Tanzanian Challenges

Tanzania has not yet latched on to a significant globally competitive success story either in manufacturing or in agriculture. In terms of our capability diagram, this suggests that in most sectors, the domestic capability curve is entirely or almost entirely below the global competitiveness line. But the real cause for concern is that there do not appear to be robust financing strategies with appropriate conditions for effort that are likely to rapidly push up capabilities in some sectors to allow a sustained takeoff based on global competitiveness, either in manufacturing or in agriculture. Moreover, there are a number of structural features of the political settlement which make the achievement of such catching up strategies more challenging. This simply means that we have to be more ambitious in thinking through catching up strategies in Africa.

A significant growth sector in Tanzania is the mining sector, aspects of which were discussed in earlier papers (Khan 2008b, 2009). However, mining is rather different because investment in this sector does not have the same implications for domestic capability development or for potential employment generation. Technology strategies in mining are likely to be based on the commercial decisions of multinational mining companies. In addition, the use of particular technologies in the mining sector typically has little technological spillover effects on other sectors of the economy. We will therefore not focus on technology strategies in the mining sector.

Some of the general features of the transition from Ujamaa socialism to strategies of liberalization and privatization after 1985 were also discussed in an earlier paper in this series (Khan 2008b). The process of liberalization that began in the mid-1980s resulted in the size of the manufacturing sector initially shrinking as many domestic producers could not survive the competition from imports. The process of

deindustrialization that was initiated by Tanzania's opening up continued till around 1997 when a gradual turnaround began. By 2006 the share of the manufacturing sector had recovered to around 9.2 per cent of GDP and manufacturing was growing at around 8 per cent a year.

It is too early to say definitively if the sectors that are beginning to grow again, such as some food industries, textiles and garments, are on learning trajectories that will take them to global competitiveness. If the productivity growth that has been observed over the last few years is based on the absorption of new tacit knowledge and capabilities, the productivity growth may eventually take Tanzanian manufacturing to global competitiveness levels in some sectors. If so, Tanzanian manufacturing will be able to keep growing by capturing a growing share of global markets. However, if the productivity growth that we have recently observed represents mainly a bounce back from the deindustrialization of earlier years, the growth may not be sustainable.

It is reassuring that some of the productivity growth is taking place in sectors where new plant and machinery are being imported. The import of machinery has become easier because of a more liberal import regime and there is evidence of greater imports of plant and machinery in the last five years of the 2000s. But achieving global competitiveness depends not just on the import of appropriate plant and machinery and low wages, but much more critically on the capabilities of enterprises to achieve high levels of effort at all levels of the firm to acquire the necessary tacit knowledge. Thus, even in the case of these new investments in plant and machinery, the real test will come in a few years when success in converging to global competitiveness levels will be tested. It is here that the evidence is less reassuring. We did not find obvious evidence of incentives and compulsions that could be driving accelerated capability building in firms.

On the basis of what we know about the conditions that were required to achieve high levels of effort in learning in other countries, there are challenges that it appears Tanzania has not yet adequately addressed. Moreover, there does not yet appear to be any policy structure, planned or accidental, that is inducing accelerated learning strategies on the part of Tanzanian enterprises. On the contrary, much of the fiscal and trade benefits are resulting in locational decisions of some foreign companies to reduce their tax liabilities or to enter protected local markets, rather than creating incentives for them to invest significantly in raising Tanzanian capabilities to global levels. The Bangladesh experience with its garments industry suggests that unless intense learning dynamics can be set up, tax and trade based incentives for setting up firms may fritter out after a while.

Recognized Constraints Facing Manufacturing

While Tanzania has significant potential in agriculture and mining, in the long-run, analysts believe that the growth of manufacturing is most likely to provide higher wages and sustainable jobs (Chandra, et al. 2008). This may seem like a tall order given that in 2001 manufacturing accounted for 245,000 jobs, or a mere 1.5 per cent of employment. Nevertheless, these were the better paid employees in Tanzania and the typical incomes of many workers in agriculture were below the poverty line (Chandra, et al. 2008: 143-4). But regardless of sector, if we agree that productivity growth is essential for achieving sustainable improvements in income, then technological progress and learning will be required in any sector that is attempting to

upgrade. As Tanzanian agriculture will also have to address significant problems with property rights if it is to sustain growth, there are probably even more significant challenges for an agrarian growth strategy in the medium term (Khan 2009).

Tanzanian manufacturing is broadly spread across three groups: agro-processing, food and beverages; textiles and light industries like furniture and heavy industry producing metals (aluminium and iron sheets), cement, paints and plastics. Ownership is concentrated in a number of large business groups which had their origins in trade, but benefited by buying up parastatals during the privatization process. The leaders of these groups often have close relationships with the leading party, the CCM. Exports are predominantly to other African countries, and only the larger firms are engaged in exports.

Overall, labour productivity is low in Tanzanian manufacturing as we would expect given its per capita income, but it has been dropping compared to the OECD level. For instance, labour productivity was 5.8 per cent of the US level in 1984 but dropped to 3.9 per cent in 1990 (Ishengoma 2004: Table 2.1). The history of protection and public sector investments through parastatals did not appear to create capabilities that were close to global competitiveness. The close political connections of the parastatals to the political regime meant that they had little compulsion to achieve efficiency gains. Even after signing the IMF Structural Adjustment Agreement in 1985, parastatals managed to continue to expand the funding they received. Instead of going through the Ministry of Finance, sometimes they received funds directly from donors. By the end of the 1980s, Tanzania had the second largest parastatals sector in Africa, second only to Mozambique, with 413 parastatals. Up to the early 1990s, the majority were loss-making (Temu and Due 2000).

In 1992 the Parastatal Sector Reform Commission (PSRC) was established to oversee the privatization process and the Loans and Advances Realization Trust (LART) was set up to take over the debts of privatized companies. After 1995 growth in the manufacturing sector was driven by a small group of privatized firms in the food and beverages sector as well as by cement, steel and tobacco. Large multinational firms bought out low-value-adding manufacturing where they had a secure domestic market. As the Tanzanian state had been in all kinds of activities, from hotels to rice milling, there were actually relatively few parastatals which could be justified in terms of public financing of capability development or the acquisition of significant technological capability. The food and beverage parastatals that did a little better under private management were probably still far away from the global competitiveness frontier in these sectors. A notional test of global competitiveness would be that most of these privatized firms would probably not yet be able to export to global markets. To that extent, liberalization did not result in any significant α or β-strategies (as defined in Figure 6) through which privatized Tanzanian firms achieved global competitiveness in some qualities of output. Privatized parastatals by and large either closed down or served the domestic market, and in some cases regional African markets, in a somewhat more efficient way.

More recently, between 2000 and 2004, some studies suggest productivity growth in manufacturing increased by around 10 per cent a year (Mbelle 2005). But the time period is too short to asset the sustainability of such growth rates. The increase in productivity growth rates may be related to an increase in capital goods imports.

According to the Mbelle study, capital goods were 35.7 per cent of imports in 1995 and grew to 42 per cent in 2004. Even if new machinery was driving some growth in productivity, if global competitiveness is primarily a function of achieving learning and the successful transference of tacit knowledge, we should look for any policies sustaining high levels of effort. So one way of digging deeper into the challenges faced by Tanzania would be to look at the evidence of how global competitiveness was or was not being achieved in its directly export-oriented sectors.

At best, the evidence here is mixed. In 2002 an Act of Parliament established the legal framework for Export Processing Zones (EPZs). Firms in EPZs are required to export 70 per cent of their output. Till 2006 the government had granted nine licences to developers. These were the Millenium Business Park Ltd, Nida Textiles, Hifadi Ltd, Mwananchi Gold Company, Gomba Development Ltd, Net Health Ltd, Vector Health International, Fruit Kin Concentrates Ltd and Unnat Fruits Processing Ltd. The government has also announced that it wants to establish 30 EPZs by 2015. The EPZ policy was amended to some extent by the introduction of the concept of the Special Economic Zone (or SEZ) with the launch of the Mini-Tiger Plan of 2004. The SEZ, as in China or India, is a more ambitious promotion strategy giving an entire area the benefit of fiscal incentives for exports as well as local production. The plan was for EPZs to become an element of the overall SEZ framework.

It is early days still, but the EPZs have suffered from significant teething problems. The quality and reliability of infrastructural services remained weak. By 2005, of the three EPZs established in Dar es Salaam, only one had sufficient infrastructure while basic facilities such as electricity and roads were lacking in the other two. Unreliable power and water supplies and poor infrastructure, expensive administration costs and expensive raw materials limited investments (World Bank 2005b). The performance of the firms located within the EPZ has also been disappointing. In 2003 Star Apparel, a garment factory owned by the Sri Lankan company Tri-Star started production at an EPZ in Dar. It was one of the most successful companies exporting under AGOA, but closed down in 2005. The company also had operations in Uganda, which also closed down. Labour disputes were listed as one of the reasons for its failure in Tanzania.

Since garments and textiles are obvious sectors that should benefit from EPZs and tariff concessions like AGOA, the competitiveness issues in the garments and textile industry are important to examine. Tanzania grows its own cotton, making the textile industry important in terms of forward linkages from agriculture. The textile industry in Tanzania was one of the five strongest on the African continent in terms of output, including South Africa and even up to 1990 there were around a hundred firms in different forms of textile related manufacturing activities in the country. After food processing, textile manufacturing employs the largest numbers in the manufacturing sector. In 1980 public sector firms produced 90 per cent of textiles but by 1990 this was down to 51 per cent (Mbelle 2005). Import liberalization in the mid 1980s led to a massive influx of imported textile goods and the domestic industry almost totally collapsed. By 1988, 90 per cent of textile consumption was imported. Growth started to pick up slowly only in 1995 (Ladha 2000).

By 2005 there were 14 sizable textile companies operating in Tanzania, from spinning and weaving to finishing. Four of these firms export to Europe and the US, one to other countries in the region, while the others produce for the domestic market. But

apart from parastatals that were privatized, most of the new firms are process plants that import bleached fabric and print them for the local market. Many of these firms were previously involved in importing finished textile goods from India and have subsequently brought in Indian technology to start production units in Tanzania. Textiles were identified as a sector eligible for EPZ status but their performance within EPZs has been disappointing. Tanzania qualified for the wearing apparel provision of AGOA in 2002 and also has least developed country status which provides additional tariff advantages. But nearly all the garments shipped from East Africa under AGOA are made with material imported from Asia. Overall, AGOA has not performed satisfactorily in Tanzania. It has achieved a moderate supply response and has achieved limited growth in dollar earnings, even in comparison to neighbouring Kenya, Uganda, Malawi and Ethiopia (Gibbon 2003).

The relatively poor performance of Tanzania in export-oriented sectors, despite the benefits of AGOA and setting up EPZs suggests that the absorbing the capabilities for achieving global competitiveness has not been easy in any of the obvious labour-intensive sectors. It is relatively easy to look at a country that is performing less well and come up with a list of missing factors (that can be verified as missing in the local environment) and which could plausibly explain the poor performance. It is important to resist this temptation and to focus on factors that can be shown to have actually explained growth in more successful countries. This takes us to the vital issues of learning and effort that we have been discussing, but before we turn to that we will summarize the types of issues that are frequently raised in Tanzania to explain its manufacturing performance.

Both the policy literature and many entrepreneurs in Tanzania will identify an overlapping set of well-known problems. These include the price and availability of bank loans (with only twenty per cent of domestic firms reporting they had access to bank loans), the difficulty of acquiring the machines and technologies that can raise productivity, poor infrastructure, low labour productivity, typically attributed to low levels of education, a poor 'investment climate' which includes usual good governance issues like corruption and contract enforcement, but also infrastructure issues like how long it takes to get a phone line (Chandra, et al. 2008; Utz and Aubert 2008). In the case of many Asian businessmen, a further problem is a subtle hands-off attitude on the part of the political system which deprives them of strong political support for solving problems.

Most of the issues identified are plausible problems constraining the achievement of global competitiveness. The question really is about the extent to which addressing these particular issues will help to achieve global competitiveness. For instance, suppose the government of Tanzania made more loans available to startup companies, would that ensure the emergence of globally competitive firms? It would surely help, but on its own this does not ensure the acquisition of the appropriate formal and tacit knowledge. Nor does it ensure high enough levels of effort to justify the investments. Making machinery imports easier is very helpful but suffers from the same problem. Low labour productivity is indeed *the* problem, but is unlikely to be solved by a few more years of schooling. Improving schooling is highly desirable in all developing countries, but will not on its own result in productivity growth unless strategies of financing learning-by-doing and the ensuring appropriate effort levels are also forthcoming. We have discussed the inadequacy of the good governance and

investment climate approaches in earlier papers. Good governance is very desirable as a goal, but it is not clear to what extent significant improvements in good governance are achievable in the medium term, and to what extent any of these improvements will solve the market failures constraining technology acquisition (Khan 2007a).

Policy Implications of Focusing on Learning

Our focus on learning and tacit knowledge points to a different set of fundamental constraints that may be limiting the achievement of competitiveness. If we begin to look for the kinds of factors that may be responsible for Tanzania's relatively slow progress in learning and the acquisition of global competitiveness, we are led to identify a different set of problems constraining technological development. We can structure the discussion in terms of the variables we identified as jointly determining the efficacy of catching-up processes in Figure 5. That analysis was based on the insight that a significant part of the investment in catching up is actually not in plant and machinery but is implicitly financing a gap in competitiveness till sufficient knowledge, tacit or otherwise, is acquired. The key question then is to understand the likelihood of success, which we argued depends on a number of interdependent variables: the financing instruments, the associated governance agencies, the structure of firms engaged in the learning process and the political settlement.

The *financing instruments* that are available in African countries to finance catching up are insufficient for the challenges they face. This is despite the fact that a number of instruments have been designed to provide incentives for developing labour-intensive industries. For instance, AGOA has similarities with the MFA that helped Bangladesh's entry into the garments industry. However, the difference is that today other least developed countries like Bangladesh have almost the same type of tariff exemptions but their technological capabilities are significantly higher. Tariff exemptions can only create a rent if they create a significant wedge between the global price and the cost of production in the privileged country. This is very difficult to achieve today given that many very poor countries have entered low quality manufacturing sectors like garments. And even when a rent is created, we have seen in the Bangladesh case that a host of other conditions are required to translate that opportunity into a self-sustaining learning drive. In any case, creating significant rents for African countries using trade policy would be very discriminatory against other poor developing countries that have worked hard to achieve competitiveness. It is not surprising that AGOA has not had the effect in any African country that MFA did in Bangladesh, and the impact in Tanzania has been very limited indeed.

So other financing instruments have to be devised, and aimed at a broader set of labour-intensive industries. For instance, the high cost of finance referred to in the Utz study is relevant and reducing this could provide one way of assisting the financing of learning (Chandra, et al. 2008). However, the authors in the Utz study assume that financing costs can be reduced through macroeconomic policies and financial deepening. This is not plausible except to people who still continue to believe that competitive financial markets are fundamentally efficient. The feasible way of reducing the financing costs of long-run investment in developing countries is through the creation of new institutional arrangements like development banks. But whatever the financing instrument, the critical condition of success is the parallel development of *governance agencies* that can ensure that the financing instrument creates incentives for high levels of effort, in particular that withdrawal is credible if effort is

not forthcoming. If we believe that the financing is required primarily to finance learning, then our focus shifts to these governance arrangements for ensuring effort. If on the other hand, we believe that financing is primarily about enabling imports of machinery, or subsidizing discovery, we may fail to give learning and effort the significance they deserve.

When we look at the two other 'higher-level' variables, *firm structures* and the *political settlement*, the prognosis for Tanzania is more challenging. These variables suggest that rapid growth through labour-intensive industry is less likely to happen in Tanzania for a number of *structural* reasons that are not immediately amenable to policies. It is important to understand these problems so we recognize that even lower levels of growth in these contexts could represent significant success. First, consider the distribution of potential capitalists in Africa and their identity, which is one way of understanding potential firm structure and distribution. The striking characteristic of many African countries is not just that the actual number of black African capitalists is small, but the *potential* group is still very small. The potential group is not defined by already existing entrepreneurial capabilities (which can be developed) but primarily by the minimum asset base that allows someone to even consider scraping together a half-to-one-million dollar project which is about what you would need to set up a small globally competitive garments factory. Clearly some of this could come from bank loans but banks are unlikely to lend to individuals with little capital and no track record in exporting garments. It is possible that many African firms are owned by individuals who simply do not have the personal stakes in their projects that would induce commercial banks to lend to them.

These are of course *relative* judgements. The primitive accumulation that has happened in many Asian countries and which produced a broad base of potential capitalists appears not to have progressed *quite so far* in most African countries. Tanzania with its collective and egalitarian political history is even less developed in this respect than others, though the indications are that this is changing. Therefore, the challenge in many African countries is not just about raising the technological capabilities of capitalists, but more fundamentally, creating the capitalists as well. The weakness of the potential capitalist base could explain why commercial bank lending does not drive growth even to the extent it does in Asia. If this was simply a problem of the banks being difficult, it would be a relatively simple problem to fix. If the problem is that there are not many people who the banks can lend to given standard collateral and risk assessment procedures, it is a different and more difficult problem. The need for 'development banking' where new entrepreneurs can be nurtured and created is likely to be even stronger in Africa. But this requires a lot of attention to the institutional design and governance of such banks so that some of the mistakes of the past are not repeated.

The second feature of the African political settlement is even more difficult to address, but is relevant for any analysis of effort and learning. In general, Africa (with a few exceptions) does not have the population pressures, the institutionalized landlessness and therefore the large populations of landless urban poor that we find in Asia. It is not surprising that in discussions with Tanzanian entrepreneurs, labour discipline and the enforcement of effort often emerge as significant problems. One entrepreneur in a long-established labour-intensive food processing business described significant and persistent difficulties in increasing productivity or sustaining

high levels of effort in his workforce despite having similar machinery as his competitors in India and elsewhere.

In 1999, the family agro-business invested in a new cashew nut processing plant, Premier Cashew Industries. At its peak it employed 1800 people and processed 6000 tonnes of cashews. Although the labour-intensive machinery was similar to that in use in India and Viet Nam, labour productivity was very low. Even with lower cashew prices compared to its competitors, the labour productivity issues made the factory unviable. Eventually, the business invested in more capital-using machinery so that the workforce could have been reduced to 500. But in 2009, the plant was shut down, together with all the other agro-businesses of the group. The apparent cause was the continuation of labour conflicts, and also uncertainty as to whether the new production facility would be viable given possible policy changes of the government. As a Tanzanian of Indian origin, the entrepreneur faced obvious additional problems in dealing with his workforce.

After many years in manufacturing, the group found that the most valuable asset it had was the land where the factories used to be. The business has eventually been converted into a real estate business, with one plot leased out to a Turkish company intending to make plastic window frames. While no case is necessarily 'typical', the structural differences between African and Asian labour markets may actually be significant. The willingness to put in high levels of effort is not in any simple way a function of legal rules and what is often described as 'labour market flexibility'. India and Bangladesh are very different in their labour market regulations and flexibility as measured by costs of hiring and firing. Nevertheless, as we have seen in earlier sections, they are very similar in the social pressures and options facing their workers and these can induce very high levels of effort in learning in both countries in sectors where other conditions are right for capability development.

It is not possible to address the problems of enforcing effort by passing anti-labour legislation. Apart from the regressive social implications of such legislation, it may simply not work. Legislation is unlikely to work if it does not reflect the demographically and socially determined bargaining power of different categories of workers. If the underlying balance of power is such that workers will not accept workplace discipline imposed by capitalists (particularly if the capitalists are from a different ethnic group or tribe), more legal powers for capitalists can be counterproductive. Indeed, in some contexts, the solution to achieve higher levels of effort may be through more inclusive rights for the workforce which gives them an institutional stake in the value added by the firm. This does have obvious problems, including the problem of free riding, and the Ujamaa history of collectivism and of parastatals with excessive employment is not a happy one. Collectivist approaches of inducing effort only work if there are strong checks on inevitable free-riding tendencies within the group. These can be reduced through trust, institutional checks or in other ways. But these solutions are likely to be culturally and politically specific. It would be foolish to suggest there are simple solutions.

These considerations suggest that we have to recognize that the learning process is likely to be more difficult in some societies than others and more difficult in African countries in general for a number of structural reasons. In these cases, the financing instruments need to be even more robust in the sense that the learning process is likely

to suffer from lower effort. Reaching global competitiveness levels can therefore be expected to take longer. It follows that the returns expected for any financing instruments that are devised have to be defined appropriately.

8. Conclusions and Policy Implications

The problem of catching up is at its core a problem of learning how to use modern technologies to create jobs and prosperity in poor countries. The knowledge at issue is not just, or even primarily, the formal knowledge that can be taught in schools and colleges, though formal education can be an important contributor to the ability to absorb the relevant knowledge. The most vital aspect of this knowledge is the *tacit knowledge* of knowing how to engage in competitive production. This can typically only be learnt by actually doing things in disciplined factories and understanding by doing what globally competitive production means. It is often hard to understand the importance of tacit knowledge sitting in advanced countries where most people are at work, and unconsciously absorb the relevant tacit knowledge without thinking.

In poor countries, the critical minimum mass of people with the appropriate tacit knowledge is not available to set up new firms and industries, even using the most basic technologies. When technologies become more sophisticated, the problems of absorbing the missing tacit knowledge are compounded. The significant policy implication of tacit knowledge is that when firms set up production in developing countries, they typically take a longer time to become profitable, despite the fact that wages may be very low, and despite the fact that the machinery and other inputs may be freely available at world market prices. The extra time that it takes to become profitable is not just *long*, it is also *uncertain*, because the pace at which tacit knowledge can be absorbed depends on the success of the firm and its investors to ensure high levels of *effort* on the part of its workforce and managers.

These observations are used in this paper to argue that the most important market failure affecting the absorption of new technologies is caused by the difficulty of ensuring high levels of effort in the process of learning-by-doing. Even the poorest developing countries cannot simply rely on cheap labour to be able to participate in the global economy. To set up production, some combination of private and public investment has to finance a period of implicit losses while the firm absorbs the requisite tacit knowledge to achieve global competitiveness. The market failure is *not* that private financing is not potentially profitable for some reason, making public financing necessary. The problem is that the first investors in every sector take on high and unquantifiable levels of risk. This is because the degree of *effort* that is required to transfer new routines of working and organizations of work is high. Success in sustaining high levels of effort cannot be predicted and so the period of financing can be long or short, and if effort is too low, global competitiveness may never be achieved. Success in achieving high levels of effort in learning is therefore a vital and necessary precondition for any policy that aims to address this market failure.

Firms in contemporary developing countries are therefore different from firms in early stage developers at an equivalent stage of their development. Firms in late eighteenth century England participating in the industrial revolution did not have to organize significant investments in loss-financing learning. The optimal firm structure

at that time can therefore be described by the internal incentive mechanisms of the 'capitalist' firm. However, firms even in very poor developers are likely to be involved from a very early stage in complex public and private financing arrangements that enable the learning phase to be financed. The institutional incentives that ensure high levels of effort in these cases are structurally more complex, and we need an appropriate analysis to understand why some institutional and firm structures worked in achieving learning, but many others apparently quite similar, failed. Understanding these differences is clearly relevant for governance policy in developing countries.

The level of effort that participants in a firm put in when the firm is engaged in financing learning depends on the interdependent effects of a number of variables. We focus on just four critical variables, and show through extensive case studies how these interdependencies can help explain success in different types of learning processes. The four variables are the *financing instruments*, by which we mean the types of arrangements, both private and public through which capability development has been financed, the capability, credibility and role of the *governance agencies* responsible for enforcing the rules implicit in the financing, the *firm structures* describing the types of firms involved in the learning process and the market they are operating in, and the *political settlement*, which describes the distribution of power between relevant actors involved in the learning process. We show through our case studies that a variety of privately and publicly funded technology upgrading exercises that succeeded actually make sense in terms of our model. Success in achieving global competitiveness depended on particular firms and sectors deliberately or accidentally 'solving' the market failure that had prevented technology acquisition in the past. Their degree of success was closely based on the interplay of factors that determined levels of effort in the learning process.

The methodology suggested here can provide policy-makers with a way of assessing if particular financing arrangements are likely to help in moving a country towards global competitiveness in particular sectors. The methodology suggests an interactive analysis to examine whether a particular financing arrangement makes sense in terms of sustaining high levels of effort in specific contexts defined by the specific capabilities of relevant governance agencies, the type of firm and market structures that are in operation and the broad political settlement in which they are located. In a longer-term framework, the methodology provides us with a way of iteratively exploring the likely effects of more significant reforms that may deliver results over time. Here policy could examine the likely implications of changing the capabilities of critical governance agencies. We could even explore in a systematic way the likely implications of policies that can influence firm structures and the 'political settlement' over even longer periods of time.

Market failures constraining technology acquisition and industrialization have come back into prominence in a context where the global development community is more aware of the possibilities of significant market failures. Our analysis provides a logical framework for looking at the relative importance of the likely market failures affecting technology acquisition. These include 'positive externalities' that can result in inadequate investment in skills, failures to protect the IPRs of MNCs that may prevent them from investing in developing countries, the potential reduction of profits of pioneer investors 'discovering' new possibilities as a result of imitation that can

slow down investment in discovery, and market failures that prevent coordination across sectors. We argue that some or all of these market failures may have some relevance in some contexts, but for logical reasons, if the market failure in ensuring effort in firms directly or indirectly benefiting from assistance to learn is not addressed, policies spending public resources to address market failures of other types will be wasted. This recognition is relevant for designing appropriate policies and for identifying and focusing on the most critical governance capabilities for sustaining growth through technological improvements in developing countries.

The extensive case studies reported in this paper provide a detailed application of the analytical method. In addition, they demonstrate a number of features of post-1980s growth in our sample countries that is of broader significance. We identify a number of different patterns of growth in these countries, with different challenges for technology acquisition.

Thailand, the richest country in our sample, has achieved a moderately high level of technological capability but now faces serious constraints limiting its ambition to move into upper income status. Its growth has been driven by multinationals whose willingness to invest in Thailand has been based on the strict protection of intellectual property rights, the adoption of a very liberal free trade regime and the allowing of full foreign ownership of companies. In many respects, Thailand represents the dream combination of policies that would be advocated by a globalizing multinational. Indeed, these policies have delivered high levels of growth for Thailand. Multinationals have invested in technological capability building in Thailand and these have been effective because of the characteristics of the investments. Multinationals have focused their local capability development in middle technology areas to support their local assembly and manufacturing, where the capability gap was low because of Thailand's long history of investment in industries like electronics and automobiles.

The financing instrument for capability development within multinationals is internal financing, which creates strong incentives for monitoring effort. The relevant governance agencies are general contract enforcement ones in Thailand, together with the agencies protecting the technology rents of multinationals through the enforcement of IPRs. The firms involved were high capability multinationals in most cases. The political settlement was consistent with maintaining the credibility of the governance agencies because it was generally favourable towards multinational investments. Thus, in Thailand, the potential market failure was removed for a particular segment of investments in capability development. But it is important to remember that multinationals were in Thailand in the first place because large pools of moderately capable workers in the electronics industry had been created by two decades of protected development before the economy opened up.

In looking deeper at the country's technology challenges, it became clear that significant market failures are preventing investments at higher levels of the value chain. These concerns are increasingly being identified and articulated by Thai manufacturers and their associations. Our analysis of the sources of the problem can help middle income countries identify viable policy responses. In particular, we show that there is no obvious reason to expect the protection of high levels of technology profits for multinationals to automatically result in the reinvestment of a significant

part of these profits in capability development in the same country. Middle income countries need more explicit policies to offer conditional incentives to multinationals to increase investment in capability development at higher (and currently less profitable) parts of the value chain. In the longer term, there is a lot of merit in revisiting the appropriateness of TRIPS and other agreements that protect very high levels of (Schumpeterian) technology rents. We review the theoretical arguments which question whether greater protection of IPRs is always better than less, not only for broader global development, but also in terms of sustaining high levels of innovation in advanced countries. Our case study evidence of how excessively strong protection of IPRs has adversely affected aspects of development in Thailand and India supports the growing critique of TRIPS coming from economists like Stiglitz and others.

Recent Indian development has been marked by pockets of global competence operating in a sea of humanity that is yet to connect properly with the national economy let alone the global one. Explaining the stellar successes properly is important because this has implications for understanding how the rest might catch up. Our case studies challenge the widespread perception that liberalization was responsible for India's success and that more liberalization, and particularly labour market flexibility is required. We look at India's automobile and pharmaceutical sectors to show how a series of interventionist policies (some of which continued well into the 2000s) created the financing flows for sustaining capability development in these critical sectors *and* the ensemble of variables determining effort were fortunately appropriate for ensuring that significant moves towards global competitiveness were achieved.

In the automobile industry, rapid improvements in capabilities towards the globally competitive level were organized in the 1980s. The players included a number of multinationals who were attracted to invest in India to capture rents in the protected domestic market. These rents constituted the implicit financing instrument inducing the necessary investments in learning. But vitally important was the combination of variables that created strong incentives and compulsions for high levels of effort. The rents came with the condition of increasing domestic content to 70 per cent within three years, and governance agencies for implementing this were credible. The multinationals were willing to accept these conditions given the size of the rents on offer. The credibility of the conditions had the effect of ensuring that rents were converted into local capabilities. There was also a widespread perception that liberalization would continue, implying that the rents in the domestic market were temporary. This induced local components suppliers assisted by multinational investments to put in very high levels of effort to reach international competitiveness. The quality and productivity improvements in the sector were remarkable, with nine Indian auto firms winning the prestigious Deming prize for quality. We describe this type of privately financed improvements in competitiveness as α-strategies, which worked because public strategies had boosted competitiveness to close to the global frontier. The firm structure too was important, as the firms were new ones, not connected to the old industrial policy bureaucracy. But for political reasons, the major investor Suzuki had effective access to political decision-makers at that critical time to facilitate important policy changes. Finally, the political settlement was such that the enforcement of the requisite financing rules by the governance agencies was

credible. Once we understand the interactive effects of these conditions, the high levels of effort and the rapid capability development become explicable.

Capability development in the Indian pharmaceutical industry between 1970 and 2005 was based on a very interesting financing instrument: rents created by the legalization by the Indian government of reverse engineering by Indian pharmaceutical companies. The legalization allowed Indian companies to break into the technology rents of multinational pharmaceutical companies. The design of this financing instrument created strong incentives for effort because it was only possible to capture this rent *ex post* by actually acquiring the capability to reverse engineer valuable formulations. Many Indian chemists were close to global capabilities for doing this (because of a previous history of public investment in knowledge relevant for the sector), and if they had to make private investments in learning *ex ante* this ensured strong incentives for effort. With these conditions, the internal firm structures mattered less, and different types of firms successfully engaged in accelerated learning processes. The political settlement was clearly supportive of this national development strategy, and yet the firm-wise rent allocation was not political, ruling out any distortion of incentives through influence. Once again, using a very different financing instrument, incentives and compulsions were created for very rapid capability development because the overall structure of the determining variables ensured high levels of effort.

This structure was changed radically when India signed TRIPS compliant laws in 2005. Indian pharmaceutical companies were forced into moving down the value chain and becoming contract assemblers for multinationals, a process we describe as a β-strategy. However, pockets of high technological capability have been established in the Indian pharmaceutical sector, and the policy challenge here is to devise financing instruments and appropriate governance agencies for ensuring that the rapid moves into higher value activities can be sustained.

Our case studies of capability development in India show that liberalization helped, and may even have been necessary for some of these moves towards global competitiveness to come to fruition, but it was not sufficient, and indeed failed to have much of an impact on most of the rest of the economy. Liberalization worked in some sectors in the context of very strong policies for capability development which were effective because the underlying variables determining effort were appropriate. The policy conclusion is obviously that capability development in other sectors, regions and for other more labour-intensive technologies is essential for spreading growth. But simply spending public money on technology transfer is not sufficient and indeed has failed on many occasions in the past. The policy challenge is to develop instruments and governance capabilities to effectively build technological capabilities in new areas and in regions that are currently not benefiting from growth.

The Bangladesh case study demonstrates that achieving global competitiveness even in low technology manufacturing requires very specific technological capabilities that will not automatically be transferred simply by creating free trade opportunities. This experience is very relevant for understanding the slow progress of manufacturing in Africa, and indeed in vast parts of the Indian subcontinent, including the slow development of other types of labour-intensive manufacturing in Bangladesh. The successful transfer of the tacit knowledge that allowed the explosive growth of the

garments sector in Bangladesh was based on very specific conditions that ensured high effort. The financing instrument in this case was partly the MFA which created quota rents for countries like Bangladesh, but learning had to be partly financed by private co-investments. The MFA rent was important because it reduced the risks and increased the incentives for investing in learning in this sector. But the real explanation of success is to be found in the factors that ensured high levels of effort by the first investors.

The high effort was sustained by a number of features of the financing instrument and the other variables identified earlier. The level of MFA protection required private co-investments in learning to achieve global competitiveness. This created strong incentives for private monitoring of effort in relatively small firms. The firm structure was also important because the size of the technology meant that managers had a high probability of setting up their own firms within a few years. This created strong incentives for managers to invest in effort and in their own learning. Paradoxically, the very fact that managers could leave and set up competitor companies induced them to put in high levels of effort, making the first firms hugely successful. In a labour-surplus economy and given very high global demand for garments, the setting up of new firms did not affect the profits of the first entrants, while creating strong incentives for effort. Finally, aspects of the political settlement in Bangladesh explain the large supply of potential entrepreneurs, a large and potentially disciplined workforce and a political leadership committed at that time to pro-business policies. Once again, the compatible interaction of our four variables helped to sustain high levels of effort.

The experiences of each country are relevant for the others. In the case of Tanzania a globally competitive high growth sector has not yet emerged, with the exception of mining, which is not directly relevant for our interest in learning-by-doing and capability development. We focused on the performance of Tanzania's labour-intensive industries and the experiences of Tanzanian investors in these industries. We argue that the design of effective policies to enable improvements in technological capabilities to global levels face some additional challenges in Africa. Despite AGOA and a number of other policies like EPZs, rapid growth in labour-intensive manufacturing has not happened. This is not surprising if we understand that even the takeoff of labour-intensive manufacturing requires a significant and intense transfer of technological capabilities and tacit knowledge. The types of financing instruments that are being expected to achieve this have themselves become inadequate because many low wage countries (like Bangladesh) are now involved in labour-intensive manufacturing. As a result, reducing tariffs for new low wage countries does not provide the same rent any more. But in addition, features of the political settlement in Tanzania suggest other causes for concern when we look at the overall conditions that are necessary for determining effort even if appropriate financing instruments emerged.

First, the supply of a large number of potential investors with enough capital to make viable co-investments is smaller in Africa, related to a shorter history of primitive accumulation. Where primitive accumulation takes place very intensively, say in the DRC, it is often related to natural resource exploitation which has other disincentive problems for investments in manufacturing. The challenge in Africa is therefore not just to upgrade potential investors into global competitiveness but to actually create

the capitalists as well. This suggests that policy in Africa should be looking at more robust financing instruments like development banks with the remit of nurturing and creating a small capitalist class. A second problem in Africa is that lower levels of population density, together with other social and property rights differences means that a large disciplined working class cannot be assumed to already exist. As effort and discipline are related to the overall success of learning strategies and global competitiveness, we need to factor in slower progress towards global competitiveness in such contexts. This understanding can help to design financing instruments that maximize the incentives and compulsions for effort, but which are appropriate to the characteristics of particular countries.

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