TECHNOLOGY TRANSFER IN THE CARIBBEAN: A CASE STUDY APPROACH

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INTRODUCTION

Industrialisation is an essential component of the development process. Technology seems to be the principal stimulus and an effective source for this process of industrial growth. It can be argued that spillovers from invention and innovation at the international level generate technological changes, which can be effectively employed, by the developing countries or newly industrialising nations. This process of acquiring technology from a country, which has substantially improved technological knowledge, is known as technology transfer. This issue of technology transfer has infused much exploration in the field of productivity analysis, market operation, corporate learning and overall growth of the economy. In this context, there can emerge two principal ways of utilising transfer of technology, namely, leapfrogging and gradual learning. In comparison to leapfrogging, gradual learning is incremental, painstaking, long-term and cumulative.

The general features of East Asian development are well known. Fast economic growth over three decades has been accompanied by a very rapid pace of capital accumulation and a strong rise in exports as a share of output. All these together have helped to shift the dynamic of the economy towards industrial activity. Measures aimed at the free mobility of labour, capital and technology, and the free entry and exit of firms are regarded as having played a contributory role in the spread of knowledge and technical change in East Asia. The aspects are to some extent recent in the context of China and India (Banik and Subbayamma 2000; Chen Hu Kee 2002). In contrast, the condition of human labour and knowledge development in the context of the Caribbean requires a specialized kind of production structure due to supply constraints of labour[1]

It is thus possible to verify the validity of the standard product cycle model in adopting technology by the exporting countries from the importing countries. On average, countries that

[1] There may be a myriad of other factors at play here which differentiate this region from others- these include the vestiges of slavery which are blamed (correctly or incorrectly) for low productivity, low

import largely from high-knowledge countries should normally import more and better differentiated input varieties than countries importing largely from low-knowledge countries. The term "better differentiated product" may be applicable to low-knowledge countries.

The above argument explains a standard product cycle and its completeness. However, this case is unlikely to be stronger under the regime of globalisation and cost competitiveness of a firm. Sometimes, the firms in low- knowledge countries leapfrog the standard cycle in order to make final product competitive. In this context we are more likely to observe the factors explaining trade and investment flows embodying new technology in low-knowledge countries. The micro views considered here contradict the standard product cycle model. Quite differently a few small economies with relatively low wages (as compared to developed economies), stable macro regimes, ideal Export Processing Zone (EPZ) facilities, English speaking workers and attractive FDI incentives were able to attract investments relocating from the developed economies with particular reference to U S A. In the Caribbean, we don't see much in the way of US business moving here. More often these are Canadian firms. The reason may be twofold:

1. The US IRS is far-reaching and effectively controls the extent of off shoring by retaining jurisdiction where it can over companies that go offshore
2. The tax structure in US is relatively low burden, whereas the cost of employing people in Canada, Europe etc is a much higher proportion of production costs. Therefore there is more incentive to offshore manufacturing from a high tax environment

The objective of the paper is to review the existing literature of technology transfer and its link with FDI under the above scenarios. Based on this foundation our aim is to portray the historical behaviour of technology adopted in the Caribbean firms with high export contents. We have considered two firms that are efficiency-seeking type of foreign direct investment in a specific human labour development condition. In this setting, we examine the nature, direction and determinants of technological learning of the Caribbean firms. Our purpose is to locate case material with historical evidence and generate further questions for analysis.

Section II reviews the existing literature in the areas of technology transfer and its link with the developing countries. Section III portrays the cases while IV interprets the cases. Section V concludes the paper.

populations (therefore low local demand) and access to capital. These are least as important factors-as labour constraints- quantity and quality.

II

REVIEW OF THE LITERATURE ON TECHNOLOGY TRANSFER

Some economists have emphasized that technology should be accumulated through a gradual process of assimilation and learning. However, modern technology analysts suggest that leapfrogging by developing countries might enable them to catch up in any field. The explanations of international trade assume a constant technology. The basis for trade is attributed to factors like labour productivity, factor endowments, and national demand structures. In a dynamic world, however, technological changes occur in different nations at different rates. Technological innovations commonly result in new methods of producing existing commodities, or in the production of new commodities. The recognition of the importance of dynamic changes has given rise to the product life cycle theory. The focus of this theory is on the role of technological innovation as a key determinant of trade patterns in manufactured products. The introduction stage of the trade cycle begins, when an innovation establishes a technological breakthrough in the production of a manufactured good. At the initial stage, mass production is not possible due to technological uncertainties and small local market. In spite of these facts the manufacturers will operate close to the local market in order to gain quick feedback on the quality and overall appeal of the product. During the next stage, the domestic manufacturer might have similar tastes and income levels. Now the manufacturer expands production and eliminates inefficient production techniques. Over time, the manufacturer realises that he or she must locate production operations closer to foreign markets to protect its export profits. Thus the domestic industry enters its mature stage as the innovating business establishes branches abroad. The innovation finds the foreign market large enough to permit mass production operations.

This trade cycle is complete when the production process becomes standardised for the use of other nations. Therefore the technological breakthrough no longer benefits the innovating nation. In fact, the innovating nation may itself become a net importer of the product as its monopoly position is eliminated by foreign competition.

We can now summarize the product cycle stages. In stage 1, the product is produced and consumed only in the innovating country. In stage 2, production is perfected in the innovating country and increases rapidly to accommodate rising demand at home and abroad. In stage 3, the product becomes standardized and the imitating country starts producing the product for domestic consumption. In stage 4, the imitating country starts underselling the innovating country in third markets and in stage 5 in the latter's market also (Vernon 1966).

So it can be said that technological accumulation takes place through time, beginning with simple activities such as assembling and then gradually moves toward more complex tasks such as process adoption and eventually R&D .In this context, research on the role and determinants of foreign direct investment and other forms of technology transfer and their developmental impact assumes importance as it could be of considerable value to policy-makers. A large volume of literature has addressed different aspects of FDI and other modes of technology transfers, analysing their determinants and their impact on various parameters of development.

It is often argued that from the standpoint of the diffusion of technology the cost of imitation is smaller than the cost of innovation. This is relevant to certain cases in which a country which was initially technologically backward eventually became the innovator. Some researchers argued that the benefits from backwardness are strong enough to generate not only a convergence effect, but also a tendency for leapfrogging (Brezis, Krugman, and Tsiddon 1993). The authors assumed

that the country with the current technological lead has learned through experience to be highly productive with the existing techniques.The leader's knowledge is assumed not to be accessible by other countries and the returns from experience are diminishing within each country. To quote Barro and Sala- i-Martin (1999) " Fundamentally new technologies appear occasionally; these new approaches offer potential of higher productivity, but not until substantial learning by-doing has occurred. As a consequence, the adoption of the new technique may be unattractive for the current leader-who has the option to continue with the old method of production at a currently high level of productivity-but may be worthwhile for a laggard. Since the new technology is more productive in the long run, the follower eventually becomes the leader, hence, the leapfrogging effect" (p. 280). For example the English passing the Dutch by the 1700s, the United States and Germany overtaking England in the late 1800s, and perhaps Japan surpassing the United States by the end of the 1900s.

It is imperative to mention here that knowledge embodied in the form of technology transfer is pursued internationally by multinational enterprises (MNEs) to businesses abroad using a variety of mechanisms. First, knowledge can be embodied in imported physical goods that are used to produce products or services. Second, a business abroad can purchase knowledge directly from foreign suppliers for a lump- sum payment or by licensing or franchising it and paying a recurring royalty. Third, movement of people, for example, can obtain knowledge from expatriate engineers and managers, from short- term visits of experts from a foreign partner company, or by sending local employees to a foreign supplier or parent company. Finally, knowledge can be acquired from communications media, including written documents or oral conversations using telephones, faxes, e-mails, memos, reports, newsletters, and journals.

However, authors have categorised knowledge into different types depending on their method of transfer and cost of transfer (Winter 1987, Kogut & Zander 1993, Inkpen 1995). For example, explicit knowledge is articulated, codified, and tangible. It can be written down or spoken and communicated by formal language in the form of databases, operating manuals and blueprints. These are disembodied and free standing, but explicit knowledge can also be embodied as performance features of products. Indeed, explicit knowledge is relatively easy to transfer by a variety of methods (Nollen and Brewer 2000). In contrast, tacit knowledge is not fully expressed. It is partly conscious and partly intuitive and is difficult to learn and share with others. It is likely to be part of a larger system of integrated knowledge components. Examples of tacit knowledge are the manual skills of craftsmen and the interpersonal skills of supervisors. In this case a basic knowledge level may be considered as an exogenous factor. This study aims at focusing tacit knowledge-based technology transfer in the context of the Caribbean and then discussing their implications on international business.

During the late 1960s, the standardisation of a wide variety of technologies, and hence increasing competition, coupled with the improved bargaining position of host country governments, provided arm's length licensing of intangible assets as an alternative to FDI. The presence of location advantages and ownership of tangible assets are still necessary conditions for FDI but these advantages needed to be complemented by some incentives for internalisation of the markets of intangible assets. Thus transfer of technology, either intra- firm or through FDI, is considered as the most relevant in the present context. The literature on FDI and technology transfer is extensive[2]. The findings of some of these studies are discussed later.

Technology is imported either in the form of technology licensing contacts or as part of an FDI package with technology adapted to the local environment. Both are complex. Three strands of

literature have tried to approach this. One strand of literature has looked at the nature of the interface between technology imports and local R&D. Another group of studies has examined the diffusion of imported technology to the rest of the economy through knowledge and productivity spillovers, vertical inter-firm linkages, and employee mobility.

In recent development literature, a contentious issue is the nature of the relationship between technology imports and local in house R&D. One school of thought describes technology imports and local in-house R&D as substitutes, whereas the other school of thought looks into the relationship as complementary. Bluementhal (1979) argued that the technological level of a country is a function of indigenous R&D, technology imports and the relation between the two. Her empirical exercise for six countries namely Australia, France, West Germany, Italy and Sweden this is only five countries, led to no firm conclusion. Evidence of complementarity is observed only for three countries i.e. Australia, Japan and France. However, no significant relationship was found in the case of the other three countries.

The literature has investigated the relationship between technology imports and in-house R&D in India using firm and industry level observations. Desai (1980) and Lall (1983) have mentioned that Indian R&D is basically adaptive and consequently importation of technology would encourage in-house R&D. A number of empirical exercises including Lall (1983), Katrak (1985, 1989), Siddharthan (1988, 1992), confirmed the complementary relationship between imported technology and local R&D. Kumar (1987) argued that the nature of the relationship between imported technology and local R&D is also influenced by the mode of technology import besides other factors. Kumar (1994) examined the effect of technology imports on the probability and intensity of in-house R&D activity for a sample of 291 firms. The data obtained from the Reserve Bank of India (RBI) survey was analysed in the framework of Probit and Tobit models. The empirical result of Fikkert (1993) depicts that (i) technology imports and R&D have a significant negative relationship; (ii) firms having foreign equity participation have an insignificant direct effect on R&D but they tend to depend significantly more on foreign technology purchases which in turn tend to reduce R&D; and (iii) trade restrictions have induced adaptive R&D. In view of these findings, he concludes that India's closed technology policies with respect to foreign direct investment and technology licensing had the desired effect of promoting indigenous R&D.

Lall (2001) has simplified the list of drivers of technological learning in the light of successful countries such as Singapore, Korea and Taiwan. The governments in these economies emphasised the need for building local capabilities (to different extents and in different combinations). Some of them are, trade policy and domestic, credit policy to influence resource allocation; infrastructure development; firm size and cluster formation; skill development; technological activity and promotion; FDI attraction, targeting or restriction. However, the present structure of international trade and finance greatly limit the ability of countries to practise the above forms of industrial policy today. But it is possible to reason the supply- side determinants of competitiveness in this context such as skill development, technological activity and FDI.

Acquiring new technology may not be considered as a one-time task. The process is continuous in the light of the structure of dynamic human labour conditions, institutions and the role of the government. A competitive firm may loose in the long run due to a competitor's continuous upgrading of technology. It is thus argued that countries or firms must move into more advanced technologies in order to sustain development with rising costs. Herein lies -governments' role to indirectly supports firms by providing incentives, factors and institutions. Each can suffer from market failure if not integrated. It is interesting to note that during the late eighties many firms were successful in the Caribbean (Girvan 1990; Banik and Bhaumik 2004) by taking advantage

[2] For example see Teece (1981,1983); Blumemthal (1979); Fikkat (1993); Hobday (1994);Katrak (1985, 1989); Lall (1983, 2001); and Siddharhan (1988, 1992).

of a protected environment but in the long run the firms were unable to survive because of the static nature of technological transfer (or technological uptake/upgrading).

III
CASE STUDIES

Case 1: Lenstec Inc.

Lenstec's parent company is headquartered in St. Petersburg, Florida, in 1991. The company developed and sold technology for production of high quality intraocular lenses to organisations in Africa, Asia (India, Nepal, Indonesia) and several other developing economies. In 1996, Lenstec Inc. made a strategic decision to move away from technology transfer and into direct production of the finished product. The company opened a facility in Barbados to manufacture and distribute a precision product, namely high-quality intraocular lenses for surgical replacement of cataracts in human eyes. Several factors encouraged the company to move to Barbados. These included an educated workforce and fiscal incentives offered by the government of Barbados. The company in the tiny island nation overcame the perception that a precision product could not be produced in Barbados by focusing on quality and service. In the medical device industry, high quality is a given – a company must produce a high quality product to survive – but to thrive the company had to compete on other bases. Lenstec elected to compete on service and currently exports its product to every region of the globe. It is able to service orders from markets in Europe faster than many European companies are able to and it has done this by focusing on an internal imperative for speed and accuracy of delivery, and by utilising external factors such as the excellent courier service available from Barbados to Europe.

Lenstec, which employs 85 people, achieved revenues of about US$ 6.5 million in 2003 (compared to US$ 5 million in 2002), 99% of which was generated from exports to more than 30 countries, including all fo Western Europe, Eastern Europe, the Middle East, Asia, and Africa. Lenstec devoted a lot of effort to technical training with in-house specialists, but also realised that a well-functioning customer service could provide the company with another competitive edge. Alcon is the major competitor in this product category and their major manufacturing unit is based in Texas. Lenstec is able to compete effectively by:

1. being a niche player and not directly competing head-to-head with Alcon;
2. continuously striving to move towards products at the technological barriers of ophthalmology
3. basing its R&D activities in the US, but with input from all members of the management team in US, Barbados and the company's direct sales branch in UK. The company terms R&D as "Reconnaisance and Development", which mirrors the way the company stays close to, and involved in, clinical developments in ophthalmology;
4. being a low-cost manufacturer by virtue of basing its manufacturing facility in a relatively high productivity jurisdiction, but one that does not carry with it a connotation of third-world quality standards

The obstacles to exporting that Lenstec faced included non-tariff restrictions in importing countries (principally regulatory requirements), lack of access to working capital and capital for expansion, and the absence of a network of distributors.

Table 1: Lenstec in the Global Market-2003

(number of lenses)

Country/Region	Total sold	% to total
Africa	2757	1.21
Asia	30734	13.50
Caribbean	4684	2.05
Eastern Europe	18298	8.05
Latin America	10358	4.55
Middle East	24039	10.56
North America	27628	12.14
Germany	53157	23.36
France	14043	6.17
Italy	29194	12.83
Spain	300	0.16
U K	8448	3.71
Rest of the Western Europe	3894	1.71
Total	227534	1.71

Source: Lenstec., Barbados

To enable it to grow, Lenstec reinvested all its revenues and sold a stake in the firm to Japan's largest ophthalmology company, Santen. These funds were used to:

1. increase production capacity
2. develop, commission and commercialize new production technologies
3. develop and commercialize new intraocular lens types
4. market the company's products and in turn build and international distribution network.

The sale of equity to Santen helped to increase distribution of the company's products, by assuring a long-term source of demand from its Japanese stakeholder/investor. The persistence of Lenstec's sales team and it's world-class products have also done much to improve distribution. Lenstec Inc. measures its success as an exporter by the rapid expansion of its sales and workforce. The company is now considered a major employer in the quality jobs sector in the Caribbean and competes with companies from the United States and Europe.

Case 2: Doyle Offshore Sails Ltd. – Barbados

Doyle Offshore Sails Ltd., of St Philip, Barbados, founded in 1987, manufactures sails for sailboats and tarpaulins in an area where there is plenty of water, but no sail making industry. The company's principal business is the manufacture of sails for cruising boats ranging from 20 feet to 70 feet in length. This category accounts for about 95% of the company's products. Besides sails, the company also supplies a small number of racing boats for the local and regional sailing regatta markets. In addition to sails, Doyle Offshore also makes canvas awnings on a customized basis, and water-proof tarpaulins for the Bridgetown Port.

The company produces a range of canvas shopping bags in two sizes, the motivation for this being a desire to assist with a reduction in the use of non-biodegradable plastics in the supermarket and other retail trades. Doyle Offshore also carries out repairs to sails and other canvas products for third party customers.

Doyle Offshore Sails Ltd. is an independent company and is the Caribbean licensee of Doyle Sailmakers Inc. of Marblehead, Massachusetts in the United States which in turn is the world's second largest sail making group, encompassing sails for racing and cruising. Doyle Offshore has

affiliates throughout the Caribbean, located in Trinidad and Tobago, Grenada, St. Vincent, St. Lucia, Antigua, St. Maarten, St. Thomas, USVI, Puerto Rico and the Republic of Panama, all of whom it supplies with sails manufactured in Barbados. Some shipments have also been made to the South Pacific and Hawaii.

According to Mr. Andy Watts, the Managing Director of the company, "In the early 1980s when we were considering setting up a new company in the Caribbean, we were interested in an area where we could obtain trainable staff supported with high quality local infrastructure and stable government. These were elements we were sure were needed to ensure the success of our company."[i]

Historically, sail making was completely new in the Caribbean in general and Barbados in particular. The product was initially thought to be inferior to a North American product. It was really a challenge to the company to establish its credibility. Over the years the company has been able to hire local staff for its production line and train them to possess the necessary skill to offer the customers a top quality product. This required training from the very basics and providing other related incentives to the work force as sailmaking was foreign to the average Caribbean citizen. However, the current demand for their products has validated both the original concept of the viability of a sailmaking unit and the success of the training imparted to its workers.

The company's main competition comes from South Africa, Sri Lanka, Hong Kong, mainland China and Taiwan. The market for sails is an intensely competitive one, with lead times, product customization, price, quality, and on-time delivery ranking as major competitive factors. The company feels that Doyle Offshore has a significant advantage over the competition in product customization. The other contributory factor in explaining the success is the product quality within an appropriate time-frame demanded by the industry. Another beneficial decision was aligning itself with the name Doyle, known the world over for quality sails, and displaying the name at boat shows.

The company's organizational structure comprises a Managing Director, a Production Manager, a Floor Manager, three (3) Assistant Supervisors and some 39 sail makers or production floor workers, making up a total of 45 full-time staff members. Some 98% of the company's products are exported to the Caribbean (CARICOM), USA, Canada, Europe, Puerto Rico, USVI and St. Maarten among others.

Doyle Offshore Sails Limited is essentially a large format apparel-type operation. It has all of the compartments of a standard garment manufacturing entity but everything is a lot larger and a lot more heavy-duty. The canvas or plastic raw material itself is more bulky, thicker and stronger and requires large working surface areas for assembly into the finished product, sails.

Given the extensive amount of floor space required, Doyle Offshore actually occupies three buildings, comprising a total of 21,000 square feet. The company currently has fifteen heavy-duty sewing machines, specially designed for the sail making business. Several of the machines are of the Swiss and German Adler types, which have been customized by Jentschmann, and fitted with the necessary pneumatic controls by Ontario Sewing Automation of Ontario Sewing Machine Company. Most of the machines are around 14 years old and capacity utilization during the past three years has ranged from 70 – 85%.

The cutting table where the raw material is first laid out has a surface area two to three times that of a standard garment factory. The heavy-duty sewing machines and their operators are countersunk in 'cut-outs' in the concrete floor of the factory to facilitate the use of the floor itself as the working surface for the assembly operations. In addition, all of the sewing machines are highly specialized and outfitted to handle the canvas and other tough fabrics from which the sails

and other components are made.

Doyle Offshore makes a profit every year. Market share declined somewhat in 2001 due to the fall out from the events of September 11th in the USA. However, the company still made a profit in 2001. Labour accounts for about 9-10% of total costs and is relatively constant. Although market share is currently stable, customer satisfaction ranks high. Product costs are very competitive and this is reflected in very positive financial performance in terms of cash flows and net return on assets. The company's performance over the past two years has been stable, with little change in sales turnover, number of employees, profitability, product range, number of customers or number of suppliers. Over the past five years, sales have been in the region of Bds$3 million.

Doyle Offshore recognizes the importance of building the finest, most durable and technologically advanced sails possible. The company's principal products, sails, are bulky and are virtually all exported. In addition, the average life expectancy of a sail is 10 years. The company acknowledges, therefore, that there is no room for returns or rejects by the customer and this is reflected in the maxim "get it right first time" adopted by the company. Doyle Offshore's performance on quality vision, product reliability and internal defect levels are all at Best Practice levels and supplier partnerships for raw materials are strong and well established. In order to achieve a good final product, the company upholds the internal customer concept, whereby each production line station is the customer of the preceding line station, and must receive high quality work in progress from that station. This concept is engendered through in-house training.

A great advantage of building sails in the Caribbean, besides first hand knowledge of the conditions the sails are used in, is the ability to produce sails at considerably lower prices. Doyle Offshore's loft in Tortola is the largest in the Northern Caribbean while the loft in Barbados, where all the sails are made, is one of the largest in the world. The low cost of building sails in Barbados coupled with free trade agreements with most other countries allow Doyle Offshore to give their customers the very best sails at savings of 20-40%.

As all their major competitors are in low labour cost areas, it was necessary for Doyle Offshore to focus their efforts on efficiency of production. To this end they have employed the use of computer aided design technology. This has stream lined their product to meet the demands of their market.

IV

DISCUSSION

The above cases suggest a simple framework for analysing the nature, direction and determinants of Caribbean export-driven firms. The cases may be considered as FDI of an efficiency-seeking type. The detailed analyses of the cases are presented under.

(a) From R &D development firm to manufacturing

The Cases are Caribbean specific. FDI is an important way of accessing foreign resources. The host country resources that are in short supply but essential to the maintenance of the competitive advantages are clearly most valuable. Indeed this is only possible by careful selection of firms and their long run sustainability in a globalized world.

Case 1 was a technology transfer firm. As the potential for continued revenue from its core business was expected to reduce due to market saturation (the global small market size was entirely saturated by Lenstec itself), the firm took a strategic decision to move directly into manufacturing. In doing so it transferred its own technology into a subsidiary operating unit in a lower cost economy. It also represents R & D development, firstly with simple activities then gradually toward more complex tasks and finally with collaboration with other firms in order to meet their expansion. R&D was initially (and is still predominantly) based wholly out of its US-based headquarters, but increasingly commercialization of new products is performed at the Barbados entity. Thus the quality of technology assimilation has not progressed to the point that adaptive R&D is done in the host country.

The company has been maintaining a symbiotic relationship with the University of the West Indies, Cave Hill Campus to provide training and employment to their graduates in skills needed in the organisation (predominantly science-based) and also to access the University's infrastructure for several small scale research projects. On the distribution side, the case reflects the transition from developing economies to developed economies. In the commodity end of the business into which Lenstec initially entered, the Product Life Cycle appears to be at Stage 4, with the imitating country starting to undersell the innovating country. On the other hand, Lenstec does not see it being sustainable to compete solely in the commodity end of the business and has made strenuous efforts to move its product range more towards the innovatory end of the market. In this context, Lenstec corporately may be imitating the Asian tiger economies in that consumption of the products is predominantly for export markets. In the company it appears that learning develops in sequence, rather than as a leapfrogging scenario. It appears that the firm took an appropriate decision by locating production to a relatively lower cost country such as Barbados. Interestingly there are not too many competitors in the world market in this product category.

Lenstec represents a case of FDI being made in an intra-firm situation to a host country that provided certain locational advantages (labour- and incentive-based). Technological upskilling of the population has occurred through importation of technology through this mechanism and gradual movement has been made towards R&D being undertaken in the host country.

Case II is also a highly specialized firm and the products' demand conditions are met in a specialized market. Besides government's role in marketing the country, meeting specific needs

of targeted investors played an effective role. Recent studies show that the promotion policies followed by Ireland, Singapore and more recently Costa Rica contributed significantly in raising the inflow of investment and of raising its quality (Spar 1998;Lall op cit.).

A strict linear progression need not occur through time. R&D may begin fairly early on and there may be feedback between early and later stages. It suggests however, that there is a general tendency for firms to begin with simple tasks and accumulate capabilities systematically in the path-dependent, cumulative manner, with skills and knowledge gradually building on each other.

(b) Implications for traditional innovation models

The history of technology frontiers may be depicted with help of the above cases. It is defined here simply as the position of new product or process innovations. This is a moving frontier occupied by leading firms at any given time. In all above cases, substantial investments in R&D are needed to compete with international leaders. At the frontier, standard innovation models will begin to apply as R&D becomes an early and central part of the innovation process and follower dynamics begin.

The cases should not be considered as a generalized model of innovation, but rather a specific model which attempts to capture the historical catching up. The ideas may well not apply to other types of industry, which do not exhibit the key features of the above cases, including fast export growth and the possibility of an extensive division of labour across national boundaries. Indeed, the highly specialized nature of both Cases indicates that the success of these two companies has been enabled by their ability to identify and occupy specialized market niches. In these niches, economies of scale are possibly not realizable and are therefore not relevant. Small economies do not suit themselves to production where economies of scale are realizable and these industries tend to move to more populated countries. This is perhaps one of the major differentiating factors when considering the Caribbean *versus* Cases from Asian economies where populations are much larger and therefore suitable for location of industries where economies of scale are important. The lesson for the Caribbean therefore is not to attempt to develop "mass production" industries but instead to attempt to identify and attract industries where barriers to entry can be set up based on intrinsic "tacit" knowledge. Educational systems therefore need to be able to teach people the ability to absorb and then develop tacit knowledge.

The low populations of Caribbean countries also hinders technological uptake as it has been shown that the sophistication of the home market is a beneficial factor in driving competitive advantage (Porter 1998).

Innovation is essential for "catching up" to occur. The firm's innovation focuses on complex production processes and reducing manufacturing costs (at least in efforts to improve production processes and reduce manufacturing costs). Later, innovation occurs as firms learn to make incremental changes to product designs and eventually introduce their own new designs. This type of behind the - frontier innovation is probably a necessary condition for firms to narrow the technology gap between themselves and market leaders. In the absence of relatively fast innovation, firms would merely keep up rather than catch up.

The firm's innovation is triggered by profit opportunities provided by fast growing export markets. Firms initially compete with each other for export orders on cost and speed of delivery. Over time they compete on quality, reliability and own design capabilities. Local competition and

imitation generate continues process improvements and the rethinking of business and technology strategies.

Not all firms need to innovate in the above manner. New start-up firms may jump in at advanced levels, missing out the early stages . As the absorptive capacity of the economy increases new start ups may by-pass earlier phases. Spin offs from older firms, diversifications from other sectors, and new experimental start - ups all constitute the growing industrial base. There is no automatic process by which technology accumulation occurs. On the contrary, firms learn to innovate by their own efforts and investments in technology, build up new competences and catch up with market leaders. In addition the host country has to provide competitive immobile assets-skills, infrastructure, services, supply networks and institutions to complement the mobile assets of the above firms.

(c) Understanding exports and learning

In the simple cases, learning occurs not only at the technological level but also at the marketing level. Firms learns to package, distribute and market their goods . Some establish marketing departments at home and then in the advanced countries. Marketing know-how enables firm to diversify their customer base and to increase their growth opportunities and, like technology, involves substantial investments in skills and organisation. Ultimately the firms establish their own brand abroad and may advertise directly in customers.

In other cases there may be concrete connections between market and technology. To increase sale of production capacity to key customers, joint engineering work may be needed as shown in the case studies. Later on, to bring new products to the market, firms may need long-term investments in R & D. Linkages through to either a parent company may be important in reinforcing technology assimilation at the international level and to then provide trickle-down of new technology into the host country.

To sum up, it is useful to target high income-elasticities of demand for exports, maximise technological ‘spreads’ effects, or establish a foothold in important new technologies.

V

CONCLUSION

In this paper we argue that traditional models of innovation have not always been validated. It revealed that the balance between local and foreign sources of technology is closely entwined. Likewise, foreign channels are an essential feature of fast catch-up growth.

The firms would have to develop strong marketing capabilities and invest heavily in creating brand images acceptable to worldwide consumers. Similarly, they would have to create a strong research culture within their companies and considerably increase their investments in basic and applied research to generate significant new innovations. Manufacturing firms would also need the support of a much stronger local capital goods sector and software industry than exists in selected Asian economies. The Caribbean cases reveal the careful and strategic selection of firms that explain that the privileges granted were not wasted or abused. Indeed the privileges were cannot be the sole reason for a company locating in a particular jurisdication, but instead need to form part of a raft of reasons which must include the ability of the host country to assimilate the technology provided. Their choices also at times reflected strategic rather than economic priorities.

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[i] In a personal communication to one of the authors.