

SCIENCE, TECHNOLOGY AND INNOVATION
IN THE CARIBBEAN

Presented by:

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INTRODUCTION

The aim of this paper is to assess the role of science, technology and innovation (STI) policies in addressing the challenges of global economic restructuring by small developing states like the Caribbean region. The key observation is that in the last two to three decades the world-economy has experienced a shift in the techno-economic paradigm, the growth of new leading sectors and the transformation of the international division of labour (Perez 2002). These changes in the world-economy have impacted negatively on most developing economies, with a few exceptions, particularly from East Asia.

One of the key challenges with this area of research is the dearth of information on how small developing states (SDS) have responded to techno-economic change. For instance, most of the literature on STI focuses on the larger developing economies. Another issue which is relevant to SIDS but not exclusive to them is that STI literature is largely focused on the manufacturing and agro-processing sectors and less so on the services sectors which is where many SIDS generate a large share of their export earnings and employment.

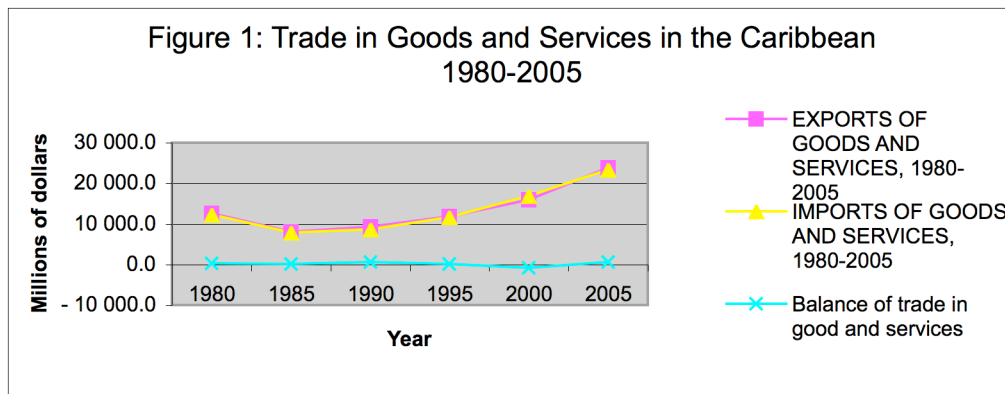
The paper will move beyond the traditional focus on manufacturing, agro-processing and resource-based industrialization to include an evaluation of the services sector in the region. The paper then analyses STI activity and reviews the policy environment. The paper draws on the cases of Jamaica and Trinidad and Tobago, the economies in the region for which there is the best data on STI activity and policies. The paper concludes with an analysis of the region's response to declining global value-added.

CARIBBEAN ECONOMIC CONTEXT

Economic growth in the region over the last two decades has averaged 1.8% per year, compared to annual growth of 3.5% in the world-economy and 4.3% for developing countries (IDB-INTAL 2005). The poor economic performance is reflected in a declining share of world trade in all major markets. For example, in the period 1985 to 2002 the region's share in the EU and NAFTA markets dropped from 0.15% to 0.1% and from 0.71% to 0.27%, respectively (CARICOM 2006).

All countries in the CARICOM region have been running current account deficits with the exception of Trinidad and Tobago in the last decade. In 2005 Trinidad and Tobago posted a merchandise trade surplus of US\$2.7 billion or 21.2% of GDP due to the rise in the value of hydrocarbon exports. So significant is the Trinidad and Tobago surplus that if it is excluded the region's deficit in 2005 would jump from US\$136 million (0.3% of GDP) to US\$2.9 billion (12% of GDP). (UNECLAC 2006: 88).

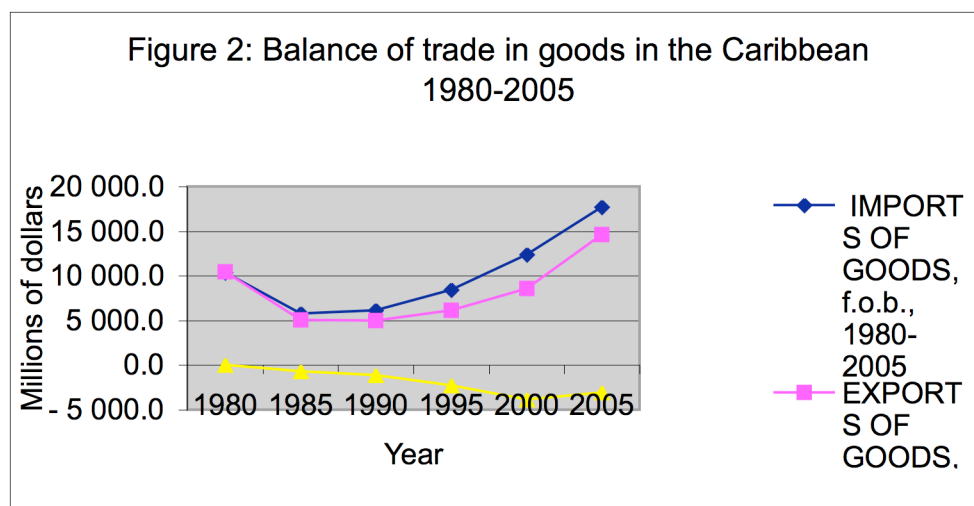
Over the last three decades the region has been able to generate a surplus when both merchandise trade and trade in services are taken into account. However, as figure 1 below illustrates the region has generated low surpluses since the 1980s except for the late 1990s and into the early years of the 21st century. Taken as a whole there has been a relative decline in exports earnings due to the lack of competitiveness, reduction of preferential trading agreements and the lack of technological development in the region.



Source: UNECLAC Statistical Yearbook 2006

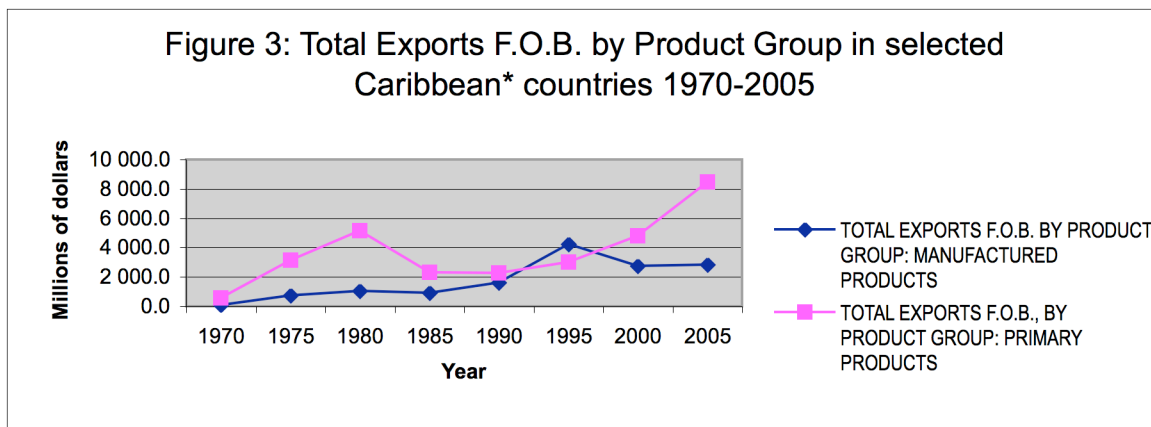
Merchandise Trade

A critical feature of the region's economic and export performance is in the area of merchandise trade. In the last decade or so CARICOM's balance on merchandise trade has been negative since 1980 and has widened except for in the last five year period where there was a modest improvement from US\$ -3,830 to \$ -3,080 million, over the period of 2000 to 2005 (see figure 2).



Source: UNECLAC Statistical Yearbook 2006

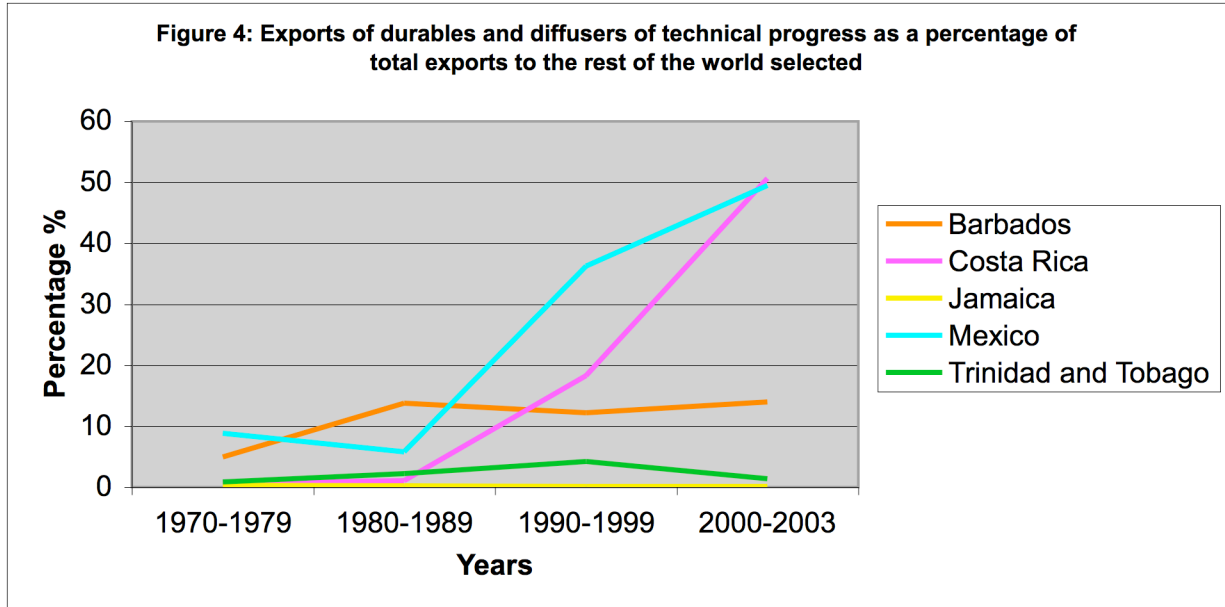
The region's merchandise export performance has seen some dramatic shifts and reversals in the last three decades (see figure 3). The first shift was from primary to manufactured exports over the period 1970 to 1995. In this timeframe the share of primary exports dropped from 82% to 42% while manufactured exports rose from under 20% to a peak of 58%. The growth of manufactured exports was short-lived and experienced a rapid decline in merchandise share to 25% in the ten-year period from 1995 to 2005. Primary exports rebounded in share to approximately 75%. This scenario is attributed to the decline in value of manufactured exports as well as the rise in the value of primary exports, principally hydrocarbons from Trinidad and Tobago. Indeed, Trinidad and Tobago increased export earnings from this sector accounts for more than 100% of the rise in primary exports for the region in the period. This is against the context of a significant drop in traditional primary exports like sugar, bananas and rice that have seen an erosion of trade preference in the EU market on account of WTO liberalization (CARICOM 2006: 77 – 87).



Source: UNECLAC Statistical Yearbook 2006

*Note: Barbados, Belize, Dominican Republic, Guyana, Haiti, Jamaica, Panama and Trinidad and Tobago

Reducing the concentration of primary goods in total exports is an important indicator of diversification. An increase in industries that utilize higher technology levels and produce export goods that have higher technological content suggest improved competitiveness. In terms of high value-added exports (i.e. high tech) most countries export less than 10%, indicating that the region has not yet developed or attracted such capabilities and industries (The World Bank 2004).



Source: UNECLAC Economic Survey of Latin America and the Caribbean 2005 – 2006.

Figure 4 compares the export of durables and diffusers¹ to total exports for CARICOM and Central American countries from 1970 to 2003. What it shows is that countries like Jamaica, Trinidad and Tobago and Barbados have maintained a high dependence on traditional low-value added, low technology exports and thus have experienced limited diversification over the last three decades. It also shows that these economies are underperforming relative to other economies like Costa Rica and Mexico. In conclusion, the merchandise trade has seen a rapid decline outside of extractive industries, which largely applies to the Trinidad and Tobago economy.

Services

A key element of the region's economic performance is the shift towards services exports. Services exports have been the key driver of Caribbean development in the last decade or more both in terms of share of GDP, employment and export earnings. As table 1 illustrates, in 2002 services accounted for 47% of total exports. However, when Trinidad and Tobago is excluded CARICOM share of services in exports jumps to 62%. The picture is even more dramatic for the smaller economies of the OECS where services exports approximate 80% of total exports. This indicates that the region, with the exception of Trinidad and Tobago, has moved increasingly away from merchandise trade to trade in services, the bulk of which are tourism earnings.

¹ These types of goods were selected due to their dynamic natures, high technology content and the potential for increasing value, export potential and links to the world economy.

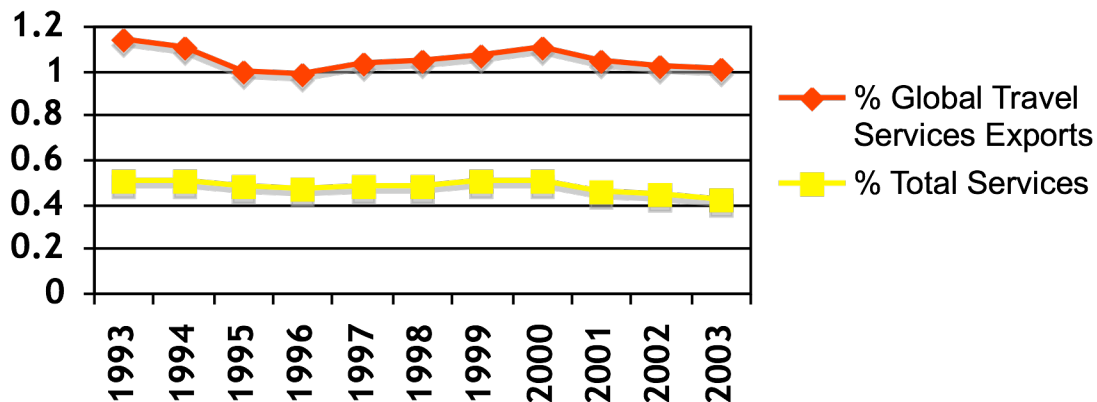
Table 1: Goods and Services, Share of Total Exports, 2002

REGION	GOODS	SERVICES
CARICOM	52.8	47.2
CARICOM (-) T&T	38.3	61.7
OECS	20.3	79.7

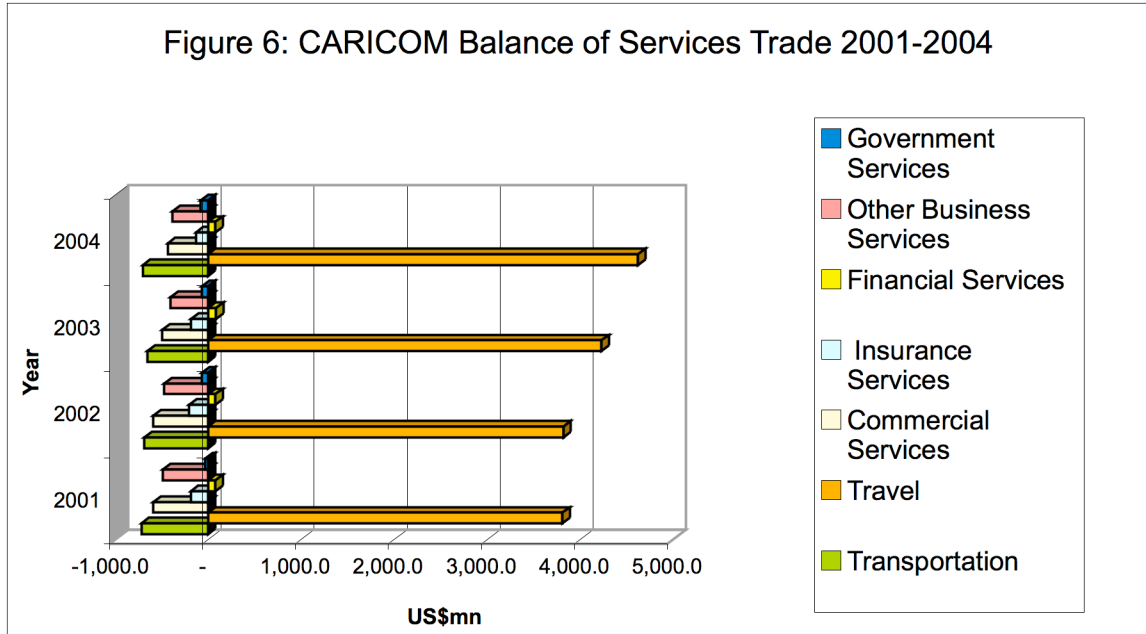
Source: IDB-INTAL 2005: 82.

The region generates a surplus on services exports, principally on account of tourism and travel with net earnings rising from US\$2,083 to 2,872 million between 1993 and 2003. Over the period average annual growth has been 4.6%, two percentage points below world and LDC growth rates (INTAL 2005: 60). The relative decline in the region's competitiveness is illustrated in figure 8. It shows the drop in global shares in total services exports from 0.51% to 0.42% and in travel services from 1.14% to 1.01% over the period.

Figure 5: Share of Total and Travel Services Exports, 1993 - 2003

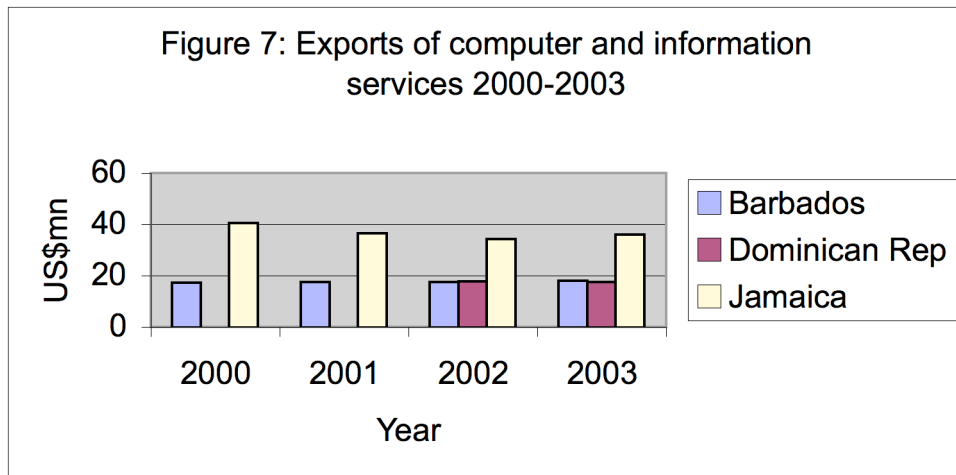


The other area of services exports in the region is that of transport and in this sector most CARICOM countries outside of Jamaica and Antigua and Barbuda are net-importers. As can be seen in figure 6 below the balance of services trade in the region outside of travel have been in a deficit over the period 2001 - 2004, showing the dependence on tourism as the key driver of services exports.



Source: CARICOM Statistics – <http://www.caricom.org>

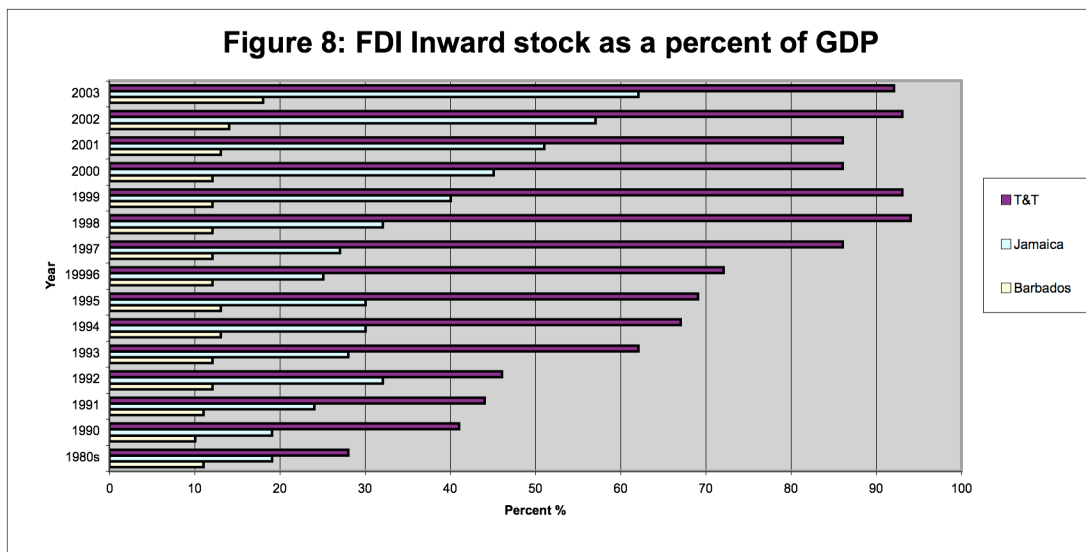
Based on ICTs indicators, some countries in the region such as Jamaica and Barbados are seeing some levels of growth in computer and information services with Jamaica exporting \$36m and Barbados \$18m in 2003, however, in the case of Jamaica, levels of exports have shown a gradual decline between 2000 and 2003 and for Barbados and the Dominican Republic, the growth is minimal (see figure 7).



Source: UNCTAD *Information Economy Report 2006*

Foreign Direct Investment

There has been a continuous and significant increase in the flow of FDI to the region since the 1990s (see figure 8). Indeed, it is estimated that the average FDI to Gross Fixed Capital Formation in CARICOM is twice that for LAC and four times that for the world and developing economies (CARICOM 2005: 144). Countries like Jamaica and Trinidad and Tobago showing high FDI/GDP ratios. FDI to the Caribbean is concentrated in a few countries and in a few sectors. Trinidad and Tobago is a large recipient of FDI due to heavy TNC investments in the hydrocarbon sector. Jamaica is also a major recipient and enjoys a more diversified sectoral distribution of FDI. These two countries together with a third-placed country (e.g. Bahamas 2004; Grenada 199- 2001; Antigua 2003) have accounted for approximately 70% of the FDI inflows to the CARICOM region in the last decade.



Source: CARICOM Report, IDB-INTAL, 2005

In terms of sectoral distribution the investments have remained principally in the extractive industries (e.g. mining, chemicals, petroleum). For example, over 90% of FDI flows to Trinidad and Tobago, which accounted for 40% of FDI flows in 2004, go to this sector. For many of the smaller economies the FDI flows go to the tourism sector along with other services like insurance, banking and telecommunications.

Another key feature of FDI in the Caribbean is that the outflow of profits has grown appreciably, especially in the case of the Dominican Republic. In addition, there is no indication that the rise in FDI is having an impact on the development

of higher value-added exports. These observations are echoed in the World Bank (2005: 48) publication, "Time to Choose" which notes that:

Focus has been on low value, low technology intensity activities. FDI had contributed little to dynamic specialization in higher value-added production due to limited knowledge transfers and weak research and development spillovers. The relatively low quality of regional production and exports is reflected in the technological intensity of exports.

In summary, the Caribbean region is faced with the reduction in value of its products on the global market and the concurrent reduction in share of global trade with major partners. The negative balance of trade in goods and services in the region since the mid-1980s can be considered an indication of the inability of Caribbean industries to innovate and increase the competitiveness and appeal of Caribbean products on a global scale. This inability to maintain market share and industry competitiveness can be linked to the region's lack of focus on science, technology and innovation and hence inadequate STI policies to engender the quality of innovation needed for these sectors.

STI INDICATORS IN THE CARIBBEAN

There is increasing recognition of the need for STI policies to meet the challenges of the global environment and to enhance the existing human resources and institutional capacity for innovation and research and development. Policy-makers are becoming more interested in exploring how STI policies can be used to upgrade the region's industrial and export capabilities. There is also a widening appreciation of the role of STI in everyday life as indicated by recent studies conducted on public perceptions of science and technology in Barbados² and Trinidad and Tobago.³

Caribbean countries invest little in research and development (R&D). Throughout the region R&D expenditures are estimated to be an average of 0.13% of GDP. Table 2 below shows the case of Trinidad and Tobago. It shows that although R&D expenditures have been rising in absolute terms the share of GDP has remained low. This level of investment is considered extremely low by developing countries standards. Indeed, the Caribbean Council for Science and Technology recommends that Caribbean governments should spend at least 3% on active R&D programmes which is the median between that of Small Island Developing States and developed countries (CCST 2006: 5).

² See study by Barbados National Council for Science and Technology:
<http://www.commerce.gov.bb/fyi/news00a.asp?artid=233>.

³ See study by National Institute for Higher Education, Research, Science and Technology:
<http://www.niherst.gov.tt>

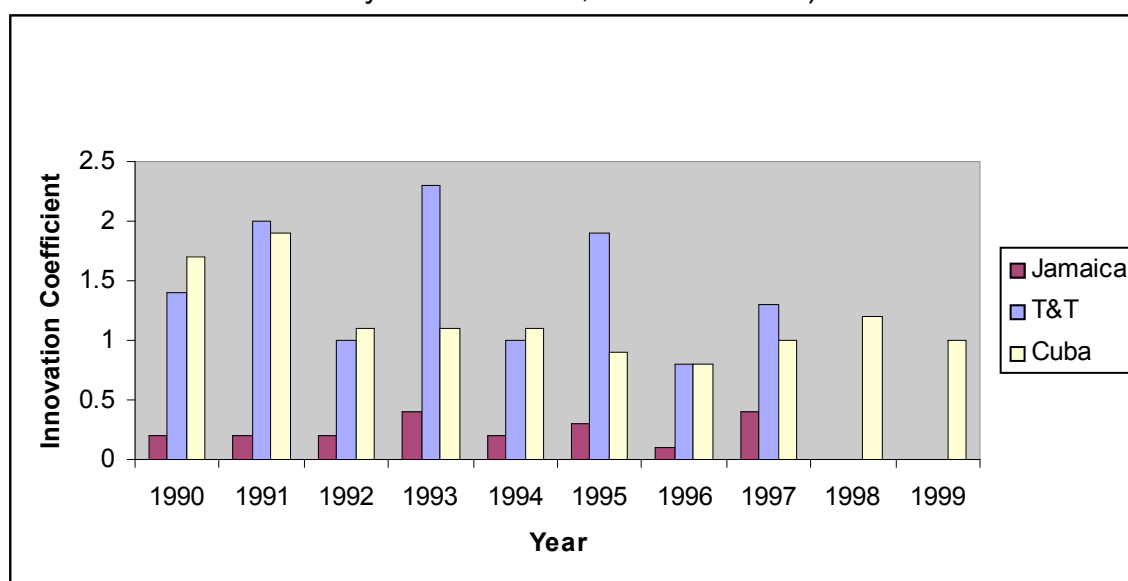
Table 2: Research and Development in Trinidad and Tobago, Expenditures and Percentage of GDP, 1999 - 2004

	1999	2000	2001	2002	2003	2004
R&D Expenditures (US\$m)	8.4	10.4	10.4	12.1	13	15
R&D/GDP (%)	n.a.	0.13	0.12	0.14	0.12	0.13

Source: NIHERST 2006.

Another key indicator of progress in STI capabilities is the level of patent registration by residents. Based on the available statistics for the period 1990 – 1999, the innovation coefficients in three countries (Jamaica, Trinidad and Tobago and Cuba) are lower than the average for Latin America and the Caribbean, which has averaged 2 per 100,000 inhabitants (see figure 9). The innovation coefficient for the Caribbean countries has also fluctuated and dropped such that levels in 1999 are lower than at 1990, except in the case of Jamaica, which has the lowest ratio when compared with Trinidad and Tobago and Cuba.

Figure 9: Innovation Coefficients in the Caribbean (patent applications by residents/100,000 inhabitants)



Source: UN Information Economy Report 2006

Table 3 shows more specific data on the number of patent applications by residents and non-residents in Trinidad and Tobago. Over 95% of the patent applications are from non-residents. This suggests that there is a low level of R&D occurring nationally and at the level of the local firm. It is also noted that patent registration by non-residents is part of a complex of strategies by transnational firms to protect intellectual property rights as well as exercise monopoly rights thereby limiting competition in foreign markets (Stewart 2000).

On this basis it can be argued that the potential for STI is restricted by the behaviour of both foreign and local firms.

Table 3: Patent Applications in Trinidad and Tobago by Residents and Non-Residents, 2000 - 2004

Applicants	2000	2001	2002	2003	2004
Residents	6	4	2	0	3
Non-Residents	148	235	221	231	205
Total	154	239	223	231	208

Source: NIHERST 2006

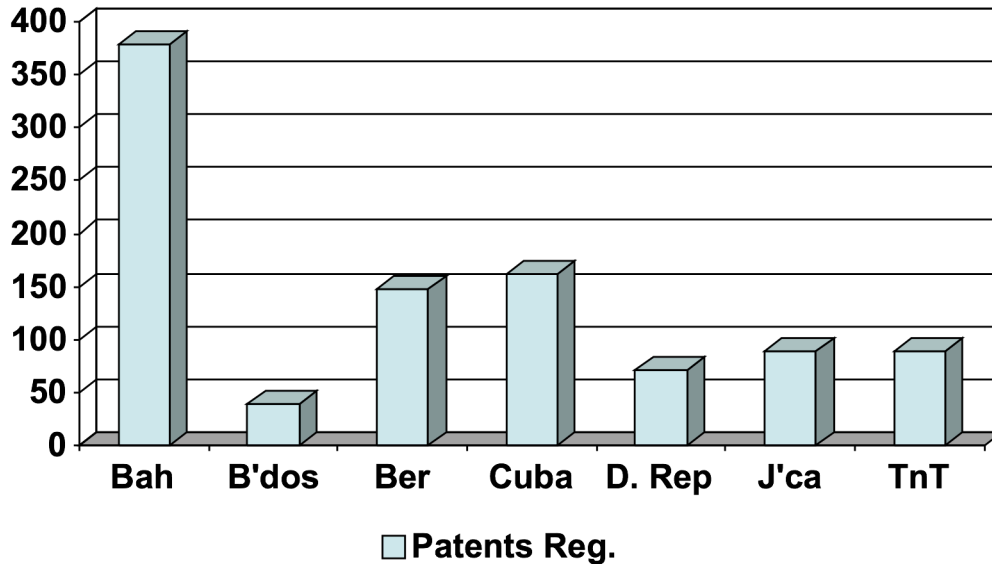
An alternative means of measuring the level of Caribbean investment in STI is to look at the registration of patents abroad by Caribbean nationals, for example, in the US. The US has been the main target market for foreign patent holders in the last few decades and a useful basis to compare countries, especially in a context where there is limited data generated and published by national agencies.

The registration of patents by Caribbean countries in the US has grown in the last five decades but has been low at a total of 1,333 from 1965 to 2006. In the period 1965-1969 the region had a combined total of 50, which increased to 262 in the 1970s, dropped to 193 in the 1980s, rebounded in the 1990s (340) and rose again to 488 in the 2000 to 2006 period.

Patent registration for most Caribbean countries started in single digit numbers and increased over time. Steady increases in growth of registration occurred in each decade, however some countries experienced declines in the 1980s, namely Cuba, Jamaica, and the Bahamas.

Of the top Caribbean countries that registered patents in the US the Bahamas with a total of 378 had the highest number of registrations from 1965 to 2006. The Bahamas is followed in rank order by countries like Cuba (162), Bermuda (147), Jamaica (90), Trinidad and Tobago (89), Dominican Republic (72) and Barbados (39). The other countries of the Caribbean that registered patents in the US, registered less than 20 patents over the time period. There is no specific explanation for why the Bahamas has such a high level of patent registration compared to even larger sized countries except that the country has a high foreign-born population.

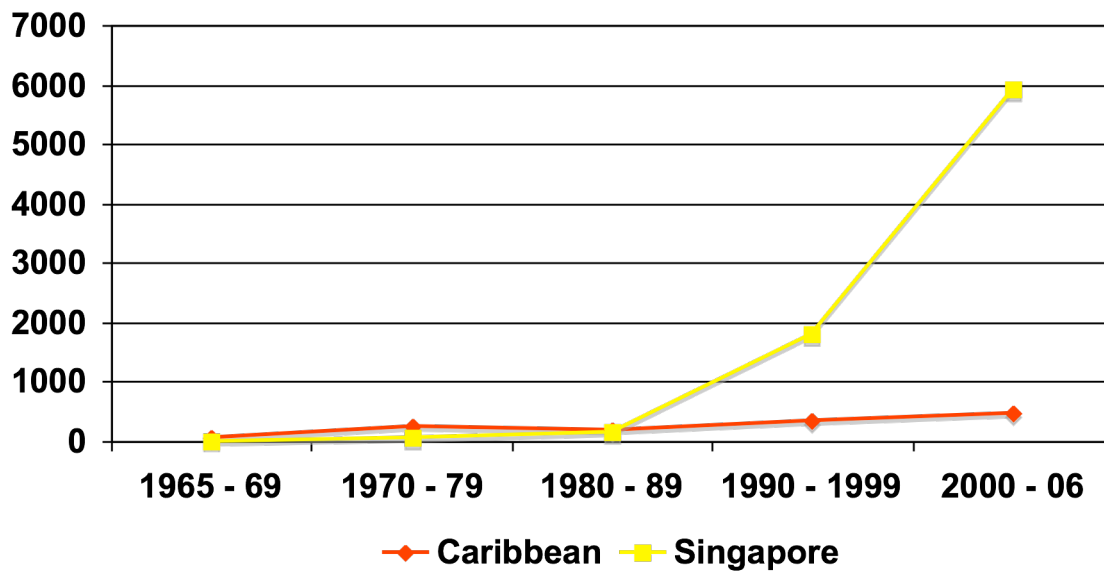
Figure 10: Number of Utility patent Application Filed in the United States by Caribbean Countries 1965-2006



Source: USPTO (2007).

Caribbean patent registration is very low in relative terms when the whole region is compared with Singapore, for example. Singapore like many Caribbean territories had patent registration in the single digit numbers in the early period, 1965-1969, with small increases in the 1970s to 52 and 1980s to 144. Singapore's growth in patent registration occurs in the period 1990 -1999 (1755) and in 2000-2006 period when patent registration triples to a total of 5937.

Figure 11: Utility Patent Registration by Caribbean countries and Singapore in the United States, 1965-2006



Source: USPTO (2007).

Using the case of Trinidad and Tobago what is observed is that over the period 1999 – 2004, relative R&D expenditures has decreased in government departments and grown in the other sectors, which are largely state funded, for example, higher education institutions, research institutions and state enterprises (see Table 4). In addition, by 2004 the expenditure appears to be allocated equally to the four main sectors responsible for science and technology development. Data on R&D expenditures by the private sector are not available.

Table 4: Percentage of Expenditure on Research and Development by sector 1999-2004

Sector	Percentage of R&D expenditure					
	1999	2000	2001	2002	2003	2004
	(1)	(2)	(3)	(4)	(5)	(6)
Total	100.0	100.0	100.0	100.0	100.0	100.0
Higher education	21.6	19.7	19.8	18.2	19.2	21.8
Research institutions	20.5	31.8	29.4	35.3	34.6	29.7
Government departments	50.8	37.6	39.2	36.1	36.1	24.8
State Enterprises	7.2	11.0	11.6	10.5	10.1	23.7

Source: NIHERST 2006

What is known about the private sector is that R&D tends to be a small share of investment. Part of the explanation relates to the operations and business strategy of firms. According to a CARICOM report it is argued that

The culture of 'production under licence' still persists. Several relatively large CARICOM firms have opted to produce foreign-patented products under license when the life cycles of their indigenous product line have matured rather than engage in further product innovation. The sale of these goods is often limited to the domestic market resulting in net outflows of foreign exchange to the patent-holders (CARICOM 2005: 130).

In the context of the Internet economy it is suggested that STI indicators should move beyond the traditional construct of patents. For example, the Network Readiness Index ranks countries based on their abilities to exploit the opportunities associated with increased technological interconnectivity (World Economic Forum). The United States is ranked at number one and out of the top 75 countries in the ranking Trinidad and Tobago is ranked 46, the Dominican Republic 47 and Jamaica at 56 (see table 5). Here again the regional economies are shown to be lagging behind in critical STI investments.

Table 5: Network Readiness Index

Countries	Rank
Brazil	38
South Africa	40
Mexico	44
Costa Rica	45
Trinidad and Tobago	46
Dominican Republic	47
Jamaica	56
China	64
Nigeria	75

Source: The World Economic Forum and Harvard University
The Global Information Technology Report, 2006

STI POLICIES IN THE CARIBBEAN

In 1988, CARICOM Heads of Government adopted a regional Science and Technology policy whose goal was to integrate and harmonize national policies. The Caribbean Council for Science and Technology was designated in 2000 as the agency to coordinate and implement the policy. A regional policy framework for action was formulated and published in 2007 (CCST 2007). The regional policy framework identifies twelve priority policy areas and nine supporting institutions and mechanisms. In the following the paper examines the STI policies in two countries.

Jamaica

At the national level there has been some strategic planning on STI policies. For instance, UNCTAD examined the potential of national innovation systems in Jamaica in the late 1990s (UNCTAD 1999). In recent years Jamaica's National Council for Science and Technology prepared a strategic plan for the period 2005 – 2010 which calls for (1) the improved utilization of S&T for competitive and profitable business; (2) to make S&T efforts for national development more efficient, impactful and environmentally sustainable; to develop local S&T competence and capability; to ensure that the population understands the importance of S&T; to broadly disseminate knowledge and information on S&T. The strategic plan also provides a situational analysis and identifies some select targets (see table 6).

Table 6: Select S&T Benchmarks and Targets

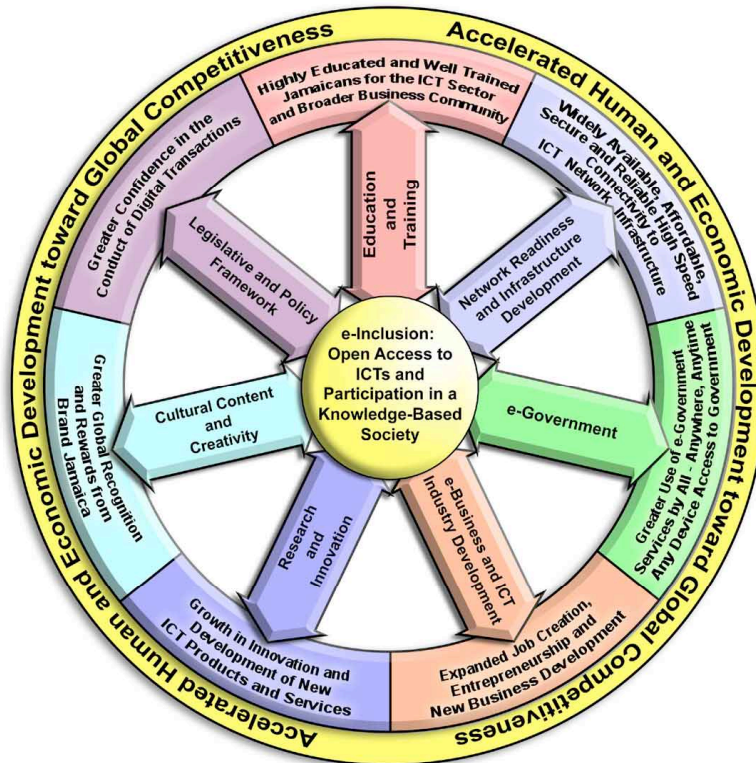
Measures	Current Situation	2010 Target
R&D as a share of GDP (%)	0.2	0.5
Receipts of royalties and license fees (US\$ per 1,000 people)	2.3	4.0
New products brought to market (per year)	32 (2003)	50
Primary exports as a share of merchandise exports (%)	80	70
Post secondary graduates in science, math, engineering (tertiary education (%))	5	10
Number of trained S&T persons employed locally in S&T (per million pop.)	678 (2003)	1,000
Internet users (1,000s)	228.4	500

Source: NCST 2005

In tandem with these efforts Jamaica has also employed foresighting techniques to develop a master implementation plan and strategy for ICTs⁴. The five-year plan, entitled E-Powering Jamaica 2012 - a national information and communications technology strategy, provides detailed objectives and tactics for implementation. Seven key pillars are identified for investment and growth (see figure). The overarching mandate is based on e-Inclusion, i.e. open access to ICTs and participation in a knowledge-based society. The goal is to use ICTs to accelerate human and economic development toward global competitiveness.

⁴ See CITO studies: <http://www.cito.gov.jm/cms>.

Figure 12: Jamaica's National Information and Communications Technology Strategy, 2007 - 2012



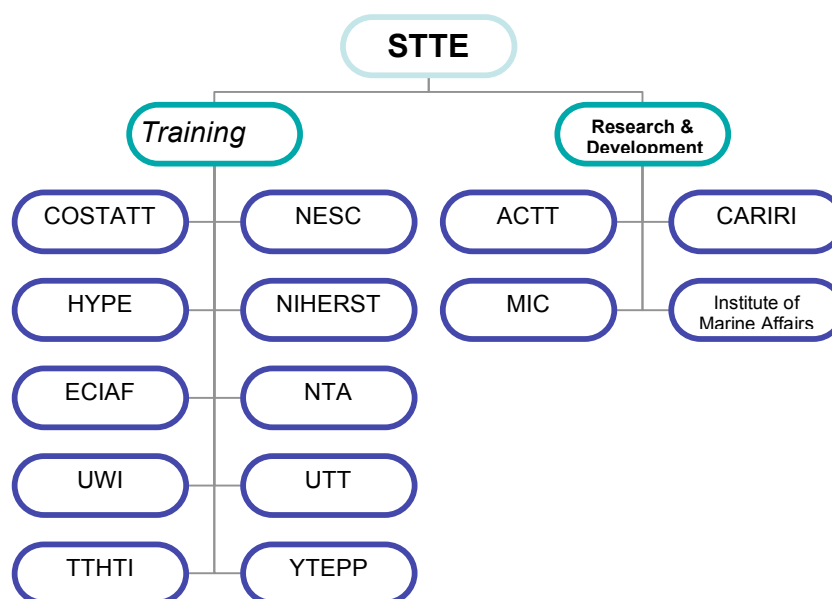
Source: CITO (2007)

Trinidad and Tobago

In the case of Trinidad and Tobago, the NIHERST funded foresighting studies which focused on elaborating pre-feasibility plans for sectors such as the agro-processing, bio-technology, niche tourism and the creative industries. The Government of Trinidad and Tobago has also established Eteck and earmarked sectors for development such as Leisure Marine, Fish and Fish Processing, Merchant Marine, Music and Entertainment, Film, Printing and Packaging and Food and Beverage (Ministry of Trade and Industry 2007).

The promotion of science and technology in Trinidad and Tobago, coupled with the overall management of tertiary education platforms are managed by the Ministry of Science, Technology and Tertiary Education (see figure 13). This Ministry is responsible for ten major educational institutions ranging from the University of the West Indies, St. Augustine campus and the University of Trinidad and Tobago to vocational and skills oriented institutions like the Trinidad and Tobago Hotel and Tourism Institute (TTHTI). In addition, the responsibility for major research and development agencies such as the Caribbean Industrial Research Institute (CARIRI) and the Institute of Marine Affairs also fall under this Ministry.

Figure 13: Ministry of Science, Technology and Tertiary Education's (STTE) Agencies



Source: Ministry of Science, Technology and Tertiary Education

The major form of investment in STI takes place at the tertiary level educational institutions. According to Trinidad and Tobago Central Statistical Office data on value-added of educational services from 2000/2001 to 2003/2004 the value added of educational services at the other institutions - tertiary level, (see Table 7) the percentage of value added has not been consistent over the period and in some years 2000-2001 and 2002-2003 there has been negative value-added, which suggest some inconsistencies in applications or the lack of a coherent policy for sustained development.

Table 7: Percentage change in value added of Educational Services by Type of Institution, 2000/2001-2003/2004 (At Constant 2000 Prices)

Institutions	Percentage change in value added at constant prices			
	2000-2001	2001-2002	2002-2003	2003-2004
	(1)	(2)	(3)	(4)
Educational services	-0.1	7.1	0.4	1.8
<i>Of which:</i>				
Government/government assisted schools	3.1	-0.7	1.5	0.2

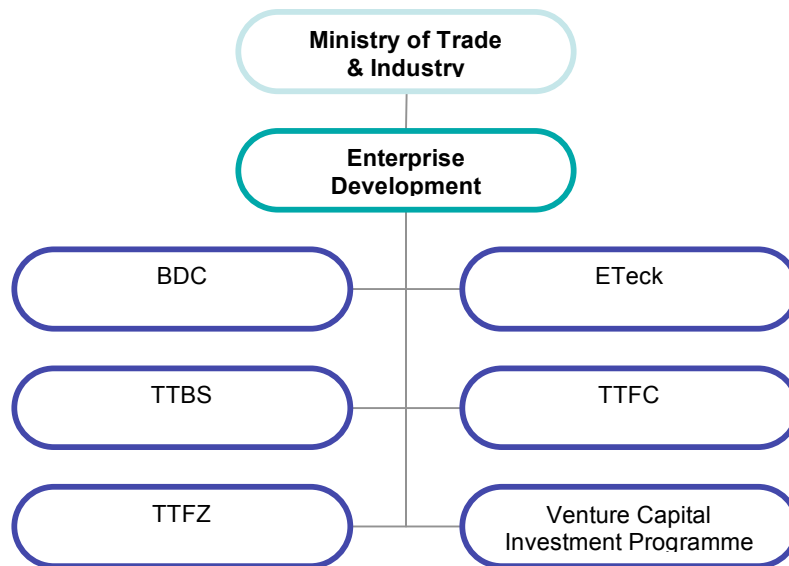
Private schools	3.1	36.0	3.2	1.5
Other institutions*	-10.1	20.4	-3.7	6.6

Source: Central Statistical Office

Note: * UWI, CARIRI, IMA, COSTATT and NIHERST

In the area of Enterprise Development, the Ministry of Trade and Industry in Trinidad and Tobago is responsible for several agencies, which serve to promote and manage resources, which provide the necessary infrastructure and context for growth and development in target industries. Agencies like ETeck, the Trinidad and Tobago Film Company (TTFC) and the Trinidad and Tobago Free Zone Company (TTFZ) are geared towards stimulating growth in technology oriented industries (see figure 14). These agencies work alongside others like the Business Development Company (BDC) and the Venture Capital Investment Programme.

Figure 14: Ministry of Trade and Industry Agencies



Source: Ministry of Trade and Industry

KEY FINDINGS AND RECOMMENDATIONS

The key finding from the analysis is that in the context of deeper global integration Caribbean economies have augmented the levels of vulnerabilities to the world-economy. This is evident in the high levels of FDI and in the severity of the brain drain. The explanation for the poor performance is not just that of the

cheaper wages of key competitors like Mexico and China it is that the levels of local value-added in key economic activities like manufacturing and agro-processing were shallow and so vulnerable to global competition. The value-added levels in the services sectors are also very low and the region is losing global market share. Negative socio-economic factors have followed exemplified by high unemployment, poverty and crime levels.

In the historical development of the Caribbean the dominant economic development strategies (e.g. plantation production, resource-based, import-substitution and export-oriented manufacturing/services) have been externally-propelled models. These approaches have been essentially reactive and dependent upon foreign inflows of capital, technology and management and thus have led to high levels of outflows.

What the above suggests is that economic and social vulnerability is not just a function of small size as it also relates to the mode of insertion of these economies into the world-economy. Caribbean economies have extremely high commodity specialisation of trade, such specialisation usually being in the export of low-value-added raw material and agricultural commodities, which have declining terms of trade and fetch low (and volatile) prices in global markets. Tourism, which is the major service export, also suffers from low levels of local value-added and high levels of external control. Combined with the commodity and service specialisation of exports, is the geographic concentration of markets, competition among other peripheral economies for these markets and the dependence on imported necessities and manufactured products to sustain the society.

It is argued that under-investment in science, technology and innovation in the region is intricately connected to the decline in traditional sectors (e.g. agricultural and mineral exports) as well as attempts to diversify within old and into new sectors. For instance, when it comes to commodities development practice tends to be monofocal in perspective and operate on the “unstated presumption that there is a “single” set of known uses for these products with the consequent relegation of the technological issues” (Thomas 1994: 224). This view is reinforced by the observation that there are limited achievements in STI based largely on individual effort rather than on strategic national or regional investments (Ramkissoon 2007). The argument is that developing country regions like the Caribbean should adopt a multi-focal approach that sees multiple end uses for commodities and creates demand for innovation related investments (Thomas 1994).

Looking at the institutions in place for the management and promotion of STI policies in the region, there is a clear lack of strategic programmes and policies in place for the engendering of innovation at the national or regional levels. This is exemplified by the low levels of expenditure on research and development relative to GDP as well as other indicators such as patent registration at home

and abroad. Little has been done to achieve coherency and collaboration between institutes, policy and programmes across the region.

In various territories such as Trinidad and Tobago, Jamaica and Barbados efforts are underway to boost STI activity. However, the key features of these new initiatives are that they tend to be delinked from the trade policy agenda and the initiatives also tend to be reliant on foreign expertise. In this sense the new approaches to promoting investment are reminiscent of the old “industrialization by invitation” model. Another key issue is that there tends to be a general absence of data for benchmarking and strategic planning. Consequently, what is not clear is how these policy imperatives are to be achieved, in what timeframe and with what resources.

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