

# RESEARCH NOTE

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## Biotechnology foreign direct investment in Singapore

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In recent years, Singapore has become a major recipient of biotechnology foreign direct investment (BFDI) in Asia. This article argues that the inflow of BFDI to Singapore, which is mainly for bulk pharmaceutical manufacturing, can be explained by a combination of (global) market conditions and firm strategies, along with the biotechnology policies of the Singapore and other Asian governments. These factors have allowed Singapore to capture a niche in the global biotechnology economy. This article also finds that BFDI in Singapore resembles its earlier process of becoming a manufacturing hub for the electronics industry two decades earlier. It concludes that explanations of FDI flows should not just focus on firm strategy or government policy alone, but consider how the two sides are constantly in interaction and are mutually reinforcing.

**Keywords:** Biotechnology foreign direct investment, biotechnology transnational corporations, Singapore, policy competition

### Introduction

By 2005, Singapore had become one of the largest recipients of biotechnology foreign direct investment (BFDI) in Asia. For the purpose of this article, FDI is defined as “the

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process whereby firms from one country (the source country) acquire ownership of assets for the purpose of controlling the production, distribution and other activities of a firm in another country (host country)” (Moosa, 2002, p.1). BFDI in Singapore refers to investment in the biotechnology, biomedical, pharmaceutical and related industries made by business entities not legally domiciled in Singapore. In 2003, Singapore attracted over \$500 million<sup>1</sup> in biotechnology related manufacturing fixed asset investments (Beh, 2004, p. 36); in 2004, it rose to \$700 million (*Singapore Investment News*, December 2004 Special Supplement, p. 9). Also, in 2004 alone, several biotechnology transnational corporations (TNCs) made large investments (table 1).

**Table 1. Selected cases of BFDI in Singapore**

Company	Amount of investment pledged <sup>a</sup>
Schering-Plough Ltd (Multi-Product Bulk Pharmaceutical Plant and R&D Facility)	\$1 billion
GlaxoSmithKlien (3 <sup>rd</sup> production facility)	\$1 billion
Novartis AG (Bulk Production Plant)	\$200 million
Welch Allyn (R&D Facility)	..
Pfizer (Active pharmaceutical Ingredient Plant)	\$375 million

*Source:* *Singapore Investment News*, February 2004, p.3; July 2004, p.4; September 2004, p. 4; October 2004, p. 5; October 2004, pp. 6-9.

<sup>a</sup> Figures reported may be spread over a period of time; hence, they do not necessarily reflect “realized” investment.

According to the Singapore Economic Development Board, the manufacturing output of Singapore’s “biomedical sciences” industry was almost \$10 billion, of which pharmaceuticals contributed \$8.5 billion and medical technology \$1.9 billion (*Singapore Investment News*, December 2004 Special Supplement, p. 9). Singapore’s Deputy Prime Minister, Tony Tan, announced that the target for Singapore’s biomedical

<sup>1</sup> All monetary figures have been converted to the United States dollar, using the exchange rate of \$1=S\$1.66 (as of 31 December 2005).

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sciences industry was \$15 billion in manufacturing output and an employment of 15,000 by 2015 (*Singapore Business Times*, 14 April 2005).

It is difficult to find accurate publicly available data on BFDI elsewhere. However, most industry magazines, newsletters and journals, such as *FDI Magazine*, *Corporate Location*, *Business Week*, have frequently highlighted how Singapore has become a hub for biotechnology production for large pharmaceutical firms.<sup>2</sup> This article seeks to explain the recent inflows of BFDI into Singapore. A common approach - the analysis of Singapore's BFDI policies alone - would not be sufficient. This article takes into account market conditions, firm strategy as well as government policy. Furthermore, it argues that the recent large inflows were also influenced by the biotechnology policies of other Asian countries.

### **Biotechnology FDI**

The literature on FDI is vast and wide-ranging. However, despite their theoretical differences, most theories of FDI - including the eclectic theory (Dunning, 1998) and the product cycle approach (Vernon, 1994) - acknowledge the role of government policy in influencing firm strategy. As will be discussed in detail later, governments have the ability to control access to markets as well as to manipulate the "cost" of various local resources, such as labour (Moran, 2002). Therefore, in such a conceptual framework, firms that have the intention of investing abroad are viewed as "customers" that demand resources or market access, while host countries are viewed as "suppliers" who provide them. By focusing both on the demand-side (firm strategy) and on the supply-side (government policy), the emergent process of FDI can be seen as a form of exchange and competition.

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<sup>2</sup> The only other Asian country with significant BFDI is India. It was recently reported that FDI in India's biotechnology industry cumulatively reached \$2 billion and was heading for a target of \$10 billion by the end of the decade (*Biospectrum*, 10 June 2004).

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Concerning government policy, it has been argued that, especially after the 1980s, there has been an ideological shift away from state *dirigisme* towards more liberal market-oriented national economic policy (Sachs, 1999). Now, more governments have accepted that transnational capital can bring about benefits, both economic and social. This acceptance might not be with great enthusiasm, for many governments have reluctantly entered the “game” for the fear of losing out. As many governments now have FDI-oriented strategies as part of their development or industrial policies, the result is an ever-increasing competition for FDI in the global economy (Oman, 2000; Thomas, 2000, UNCTAD, 2004). There have been some attempts at regulating this competition and agreeing on some multilateral rules for FDI. However, these are not currently viewed as being effective (Young and Tavares, 2004).

Obviously, governments that have FDI-oriented development strategies will have to design specific measures for attracting FDI. These might be direct policies, offering specific incentives - subsidies, tax breaks, infrastructure provision, access to domestic markets - to potential investors; or indirect policy. For example, education policy could increase the number of tertiary education workers. Policy on social and political stability could also indirectly create an environment conducive to FDI. In what is commonly known as the “competitive advantage” perspective, the sites that will receive most FDI are those that allow TNCs to set up competitive facilities that are capable of withstanding global competition. “This means that the host country has to provide competitive immobile assets - skills, infrastructure, services, supply networks and institutions - to complement the mobile assets of TNCs” (Lall, 2002, p. 75).

The importance of government policy notwithstanding, it is impossible to ignore firm strategy or market factors when examining FDI flows (Dunning, 1998). It is important to remember that the TNC is a for-profit entity. Hence, it will do whatever it takes to maximize profits, including not only searching the world for the most efficient site for production,

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but also negotiating with various governments for the best investment conditions. TNCs might even play several governments against one another in order to extract greater concessions. Thus, while governments might view FDI as a developmental tool, TNCs will only invest if they foresee benefits and returns.

In many ways, it becomes clear that it is impossible to separate the demand (firm) and the supply (government) side processes. Perhaps even more important is the relationship between the two sides. It can be argued that FDI flows results from “collaboration” between governments and TNCs (Pereira, 2000). Although there is (usually) no formal agreement between the two parties, they “use” each other in a mutually beneficial relationship to achieve developmental goals (for the government) and enterprise viability (for TNCs). This arrangement has also been termed “adaptive partnership”:

“Both states and TNCs can mutually gain from entering into such an arrangement, working with each other to respond to new challenges presented by globalization” (Dent, 2003, p. 247).

“While TNCs seek to extract policy concessions from states, and influence state economic policy-making processes, they also view those states endowed with sufficient technocratic capacities as adaptive partners, whereby both agents gain by working in conjunction to respond to the mutual challenges presented by globalization” (Dent, 2003, p. 271).

By balancing demand and supply side perspectives on FDI flows, this article argues that Singapore’s case can be explained by an unusual and somewhat unexpected combination of (global) market factors, firm strategy and government policy.

### **The global biotech industry**

As suggested earlier, the biotechnology industry, like any other industry, has its own unique characteristics and specific

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needs. The United States Office of Technology Assessment (OTA) defines biotechnology as:

“...all potentially commercializable technologies that are based on the life sciences – biology, botany, entomology, physiology, genetics and their overlaps with physical sciences such as chemistry, physics and materials science” (United States OTA, 1991).

The characteristics of commercial biotechnology production, including research and development (R&D), create specific needs for this industry. For example, firms involved in biotechnology production necessarily require large amounts of investment capital due to the nature of its production processes. Also, due to its heavy reliance on science and technology, personnel in the industry need to be suitably qualified. Finally, for biotechnology firms to be competitive, a heavily regulated institutional framework must be in place, including intellectual property laws, anti-trust laws as well as health, safety and environmental regulations (Chase-Dunn, Lara-Millan and Niedmeyer, 2004, p. 2). Of course, the availability of high-grade raw materials, infrastructure and utilities are of central importance to the biotechnology firms. Therefore, the biotechnology industry can be characterized as being extremely capital-, knowledge- and infrastructure-intensive.

However, the global biotechnology industry also has specific constraints. It has been argued that a set of local and regional regulations prevent biotechnology and pharmaceutical companies from adopting a truly “global strategy”, unlike, for example, the electronics or automobile industry (Rugman, 2005, p.114). The reasons behind this include the disproportionately large size of the United States market for pharmaceuticals; the heavy dependence on patents and intellectual property rights; and the reliance on R&D (Rugman, 2005, p.118). In addition, pharmaceutical giants are discouraged from adopting a global production approach because drugs are always heavily regulated by governments through approval processes and price controls (Rugman 2005, p.119). Thus, although the biotechnology industry has been shown to improve trade and industrial

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performance (OECD, 1996a, 1996b), to help reduce poverty as well as to increase food security (ADB, 2001; UNCTAD, 2004), it has not become a “globally-oriented” industry.

The present global biotechnology economy has been described as “a complex network of corporate players, dominated by large firms with strong marketing capabilities, and start-up firms that focus on research and development” (UNCTAD, 2001, p. 7). Among the 20 largest biotechnology companies, none were “global” (defined as having its sales and production equally distributed around the “Triad” of North America, Western Europe and Japan), five were bi-regional (any two of the Triad), two were (single) regional, and the rest were home-country oriented (Rugman, 2005, pp.115-116). Thus, unlike the electronics or automobile industry, biotechnology firms cannot be described as truly “global players” in terms of sales and production. However, as mentioned at the beginning of this article, many of the largest global pharmaceutical companies have been establishing manufacturing operations in Singapore, apparently bucking the trend to remain within the Triad. The following sections will propose an explanation for this phenomenon.

### **The Singapore Biomedical Sciences Initiative**

The Government of Singapore has been promoting FDI ever since the country gained independence in 1965 (Mirza, 1986; Pereira, 2000; Dent, 2003). The government’s main logic behind this strategy has been entirely pragmatic. The island city-state, which is less than 700 square kilometres in total land size, has no natural resources other than labour (Schein, 1996). As there have been many studies on the role of FDI in the economy, there is no need to discuss the processes here again. It is, however, necessary to remember that the Government of Singapore has been correctly described as being an archetypal “developmental state” (Huff, 1994; Perry, Kong and Yeoh, 1997). It takes a highly interventionist role in the economy, constantly identifying new niches in the global economy where Singapore can gain a competitive advantage. At the beginning of the 21<sup>st</sup> century, the Government of Singapore intervened once again

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with a new national industrial policy, officially known as the Biomedical Sciences Initiative.

On the surface, this Initiative might appear to follow the recent trend of many national governments to introduce biotechnology-related industrial or economic policies, not just for economic but also for social reasons. Despite some concern over the ethical aspects of biotechnology, it is seen by many governments as being a highly desirable employment-creation engine, especially for highly skilled workers (Pownall, 2000). Singapore's Biomedical Sciences Initiative is similar to biotechnology policies in nearly all other countries in that it was an obvious strategy to encourage economic growth and improve social development. Furthermore, as in many other countries (especially developing countries), it attempts to harness FDI for the development of this industry. According to Da Silva, Baydoun and Bardan (2002), most governments – especially those in the developing world – have been promoting the biotechnology industry as a response to local needs, such as those arising from weakness in the local agricultural sector. However, the governments of many developing countries do not have sufficient resources for supporting domestic biotechnology enterprises. Hence, some governments have turned to FDI. In most cases, the FDI-oriented biotechnology policies seek to attract TNCs to transfer technology and expertise to domestic firms, usually through the formation of joint-ventures.

On paper, the Biomedical Sciences Initiative is a typical set of policy instruments consisting of incentives, subsidies and institutions to encourage the development of an industrial sector. In theory, any firm, from anywhere in the world (including Singapore), can take advantage of the Initiative. Officially, in order to qualify for tax breaks, government subsidies or grants, the investing firm - which may even be a wholly-foreign owned entity - can be involved in any aspect of the biomedical sciences, including logistics management, regional headquarters operations or sales operations. However, from 2000 to 2005, the Government's main target was "Big Pharma", i.e. very large biotechnology or pharmaceutical TNCs.<sup>3</sup> This is the main

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difference between Singapore's Biomedical Sciences Initiative and the biotechnology policies of other developing countries. In Singapore, the development of the domestic biotechnology industry is a secondary concern for the Government. Instead, the Initiative resembles the country's earlier industrial policy, which allowed TNCs to "utilize" Singapore as an export-processing zone (Mirza, 1986; Pereira, 2000).

For 30 years between 1965 and 1995, Singapore's FDI-oriented development policy was primarily aimed at generating employment and economic growth rather than developing domestic enterprises. As such, the Government had designed specific policies to attract TNCs to establish large-scale manufacturing (usually in the electronics industry) on the island (see Lim, 1988). However, since the 1980s, manufacturing costs in Singapore were rising fast, and TNCs were seeking to relocate production to countries, such as Indonesia, Malaysia, Thailand, and even China and Viet Nam, which had introduced FDI-oriented development strategies by that time. As they were at an earlier stage of development, the costs of the factors of production were significantly lower than those in Singapore. In addition, most of these countries could offer TNCs something that Singapore never had - a large domestic market. Thus, in the 1980s and 1990s, many TNCs were shifting production - especially those with lower value-added activities - to these emerging economies. The Government of Singapore realized that it was impossible to compete with them to retain low value-adding segments of production; instead, it targeted higher value-added manufacturing, mainly because Singapore's highly skilled workforce was still comparatively cheaper than its peers in Japan, the United States or Western Europe. As a result, in the 1990s, Singapore became the largest hard disk drive producer in the world (McKendrick, Doner, and Haggard, 2000). It did not take long before the expertise and technological capabilities of the neighbouring countries improved; even high technology production, including the hard disk industry, was shifting out

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<sup>3</sup> This phrase is used by many within the biotechnology industry. See for instance the headline in *Business Week*, 'Little Island, Big Pharma,' 17 February 2003.

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of Singapore. In this context, pursuing the biotechnology industry was a strategy to upgrade Singapore's workforce further. However, the Government could not create the jobs in the biotechnology industry by itself. As Singapore did not have any domestic biotechnology enterprises, as far as the Government was concerned, the only suitable partners were TNCs.

This was "the grand design", as portrayed by the Government of Singapore, to make the biomedical sciences a "key pillar" of the economy, alongside electronics, engineering and chemicals.<sup>4</sup> The Initiative would generate growth (mainly through exports) and bring development to the people (mainly through the high skills jobs created in the industry). Such highly ambitious proclamations are common in Singapore. The Government is the dominant (domestic) economic agent in Singapore and has consistently made broad-ranging and long-term strategic plans, usually without much resistance from other segments of society (Huff, 1994). One of the reasons for this success is that the Government has a great deal of domestic credibility as an efficient manager of the economy. Furthermore, in the case of the biomedical sciences, few domestic firms would suffer as a result of the large inflows of BFDI, since there are almost no domestic biotechnology enterprises in Singapore.<sup>5</sup>

### **Government strategy**

Despite Singapore's reputation as an excellent manufacturing hub, the new focus on biotechnology faced a few obstacles. Big Pharma had hardly ever established large wholly owned production sites in the developing world. As mentioned earlier, Big Pharma had previously concentrated its production in the Triad (Rugman, 2005). The main reason for this was the nature of drug production and regulation. The main market - which also happened to be the Triad - would insist on "first

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<sup>4</sup> <http://www.biomed-singapore.com>

<sup>5</sup> Indeed, one could argue that there are very few Singaporean industrial enterprises in general, other than the Government-linked corporations (Low, 2001).

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world” standards of production (ibid.). In cases in which Big Pharma did invest in developing countries, it was in the form of joint ventures with domestic biotechnology firms. The reason behind this was to penetrate and expand into new markets, such as the huge consumer markets of China and India, which was otherwise impossible. In contrast, Singapore did not have a large domestic market, with a resident population of only four million people. The country did not initially have a high level of human resources to engage in biotechnology activities either, particularly when compared to the Triad countries.

To overcome these obstacles, Singapore actively sought to become more competitive in attracting biotechnology TNCs. First, the Government of Singapore invested a large amount of resources in the training of personnel ready to work in the biotechnology industry. For example, between 2001 and 2004, 276 postgraduates were awarded overseas and local government scholarships to pursue doctoral programmes in various aspects of biomedical sciences (A\*Star, 2005, p.8). According to the director of A\*Star,<sup>6</sup> which is a statutory board tasked with promoting - among other activities - the Biomedical Sciences Initiative, each scholarship recipient is expected to cost the government about \$0.6 million (*FDI Magazine*, 5 August 2003). More generally, the Government of Singapore has publicly announced that it would spend at least \$720 million on public biomedical research to support the broader initiative (Lim and

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<sup>6</sup> According to A\*Star’s official website, it “comprises the Biomedical Research Council (BMRC), the Science and Engineering Research Council (SERC), the Corporate Planning and Administration Division (CPAD), the A\*STAR Graduate Academy (A\*GA) and the commercialisation arm, Exploit Technologies Pte Ltd (ETPL). Both BMRC and SERC promote, support and oversee the public sector’s R&D research activities in Singapore. A\*GA supports A\*STAR’s key thrust of human capital development through the promotion of science scholarships and other manpower development programmes and initiatives. ETPL manages the Intellectual Property created by the research institutes and facilitates the transfer of technology from the research institutes to industries. CPAD supports the two Research Councils, A\*GA and ETPL in performing the functions of Finance, Human Resource, Corporate Policy and Planning, Corporate Communications, Legal, Information Technology and Audit” (<http://www.a-star.edu.sg/>).

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Gregory, 2004, p.353) Although the Government has created many opportunities for young Singaporeans to train to become health sciences experts, it has even gone ahead with a very liberal immigration policy for experts (as well as postgraduate students) in the biotechnology field, despite the concerns expressed by the local population. The Government understood that biotechnology TNCs required qualified specialists and they would not particularly care about their nationality.

At the same time, the Government of Singapore has invested heavily in two “mega infrastructure projects”, the Tuas Biomedical Park and Biopolis. The Tuas Biomedical Park, developed and managed by the Jurong Town Corporation (a Singaporean statutory board), is a 183 hectare site at the westernmost tip of Singapore dedicated to support the growth of the biomedical industry. Costing around \$331 million to develop, it is designed for “bulk active pharmaceutical and biopharmaceutical manufacturers, with special provisions for unique power, water and sewer requirements”.<sup>7</sup> Biopolis, developed by Ascendas - a for-profit government-linked corporation - was designed to be a:

“...world-class biomedical sciences research and development (R&D) hub in Asia. This campus is dedicated to providing space for biomedical R&D activities and it is an environment that fosters a collaborative culture among the private and public research community. Biopolis Phase 1 is a 185,000 square metre (2.0 million square feet) biomedical complex of 7 buildings slated for completion from June 2003 to March 2004. Several key government agencies, publicly-funded research institutes and R&D labs of pharmaceutical and biotech companies will be located here”(http://www.one-north.com/pages/lifeXchange/bio\_intro.asp).

Biopolis Phase 1 cost around \$301 million to develop (Singapore Economic Development Board, press release, 1

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<sup>7</sup> www.jtc.gov.sg/Products/industry+clusters/tuas+biomedical+park.asp

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December 2003). The Government of Singapore is hoping that over 1500 scientists will be involved in biomedical R&D at the Biopolis within 10 years. In many ways, Singapore's Biomedical Sciences Initiative resembled the country's earlier industrial transformation policy. The Government not only created tax incentives to attract TNCs, but also intervened heavily in the economy and society at the same time, particularly in the sphere of providing adequate infrastructure and human resources. This is best summarized by the Chairman of A\*Star, who is tasked with attracting BFDI:

“These days a BSc (Bachelor of Science) qualification only means test tube cleaner and an MSc (Masters of Science) is an advanced test tube cleaner. What you need today is a PhD (doctor of philosophy). I can't go to [a large pharmaceutical company] and say we have cheap land. They can find cheaper land elsewhere. Singapore has to lead in skills and infrastructure” (Philip Yeo, Chairman of A\*Star, quoted in *FDI Magazine*, 5 August 2003).

Although there are government provisions for supporting domestic biotechnology entrepreneurs,<sup>8</sup> it is clear that the main beneficiary, at least in the initial phase of the Initiative, has been Big Pharma. One key pre-emptive strategy was the formulation of a very strict intellectual property regime and a very explicit and clear “bioethics code”. Both of these were drawn up with foreign investors in mind. The intellectual property regime is considered to be important, because large biotechnology firms do not want to face a situation where their products might be pirated or face competition from generic drugs. For bioethics issues, the Government had appointed a top-level committee known as the Bioethics Advisory Committee<sup>9</sup> to draft a comprehensive set of guidelines and to make recommendations

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<sup>8</sup> For example, the Government of Singapore has announced that domestic biomedical firms can apply to a fund of around \$30 million (*Singapore Straits Times*, 11 January 2005).

<sup>9</sup> The Bioethics Advisory Council is a broad organization that encompasses several subcommittees. Members of each subcommittee include legal experts, biotechnology industry personnel, scientific and academic community members, as well as religious leaders.

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for changes to the law (where necessary) on various aspects, such as stem cell, human tissue and genetic research.<sup>10</sup>

Singapore's bioethical position has already been criticized (mostly on the internet) by various anti-globalization and anti-cloning groups. Most criticisms claim that Singapore has an extremely liberal bioethics policy; others who acknowledge the existence of the guidelines claim that these only serve as a smokescreen. Thus, a common refrain is that Singapore's high level of BFDI was because it has a competitive advantage in lesser morality, encouraging scientists and companies involved in stem cell research, which is banned in developed countries, to locate on the island.<sup>11</sup> In reality, given that most of Singapore's BFDI is in bulk pharmaceutical manufacturing, it is impossible to argue that lax ethical rules were the reason behind the inflows. However, the Government's response has mainly been to ignore these protests and criticisms, much like the response of other Asian governments. The logic, for most of these governments, for supporting biotechnology research has always been pragmatic and economic.

For the Government of Singapore, having a clear and enforceable set of laws on biomedical research was essential for improving the country's competitiveness, both as a pharmaceutical production hub and as an R&D centre. According to some scientists interviewed by the *Wall Street Journal Europe*, they (and biotechnology companies) have chosen to come to work in Singapore, not because there is weak legislation or a poor bioethics standard but, instead, because bioethics are clearly stated so that scientists (and companies) know exactly where they can or cannot go with their research (*Wall Street Journal Europe*, 26 January 2005).

The last thrust of the Singapore's Biomedical Sciences Initiative was known as the co-investment scheme. The

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<sup>10</sup> <http://www.bioethics-singapore.org/>

<sup>11</sup> See, for example, "Biomedical science: a liberal regime", *Far Eastern Economic Review*, 9 January 2003; "Asia is stem cell central", *Businessweek*, 10 January 2005 ([http://www.businessweek.com/magazine/content/05\\_02/b3915052.htm](http://www.businessweek.com/magazine/content/05_02/b3915052.htm)).

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Government of Singapore has set aside large sums of capital for disbursement, not just for small and medium-sized biotechnology enterprises but even for Big Pharma. For example, in 2005, the Government's biotechnology investment arm known as BioOne Capital signed an agreement to form a joint venture with Lonza Group AG (legally domiciled in Switzerland) to produce "biologics" or vaccines in Singapore (*Asian Wall Street Journal*, 17 August 2005). Just the day before, A-Bio - another Government-linked corporation - announced that it was tying up with GSK Biologics, a subsidiary of GlaxoSmithKline, also to produce vaccines (*Singapore Straits Times*, 17 August 2005).<sup>12</sup> It could be argued that the co-investment scheme was crucial in convincing Big Pharma that the Government was committed to the Initiative and was willing to put its money where its mouth was. However, it is equally possible that the co-investment simply serves as a subsidy, especially since, in most of these ventures, the new name of the venture is derived from Big Pharma. In either case, the Government demonstrated that it was willing to host Big Pharma on the island. In comparison to many joint ventures established between Big Pharma and domestic biotech enterprises in other Asian countries, what is evident is that the joint ventures in Singapore are not primarily aimed at penetrating the domestic market. Instead, all of the end products are intended for export.

Based on its experience in investment attraction, the Government of Singapore, along with state agencies, such as the Singapore Economic Development Board and the Ministry of Trade and Industry, realized that policies alone were not enough to attract investors. They went to the biotechnology TNCs and "marketed" Singapore heavily. It could capitalize on its relatively high level of international credibility as an efficient, honest and pro-business administrator.

Moreover, from a global perspective there were some other factors that made biotechnology investment in Singapore

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<sup>12</sup> These were just a few of several launches or announcements that were made as the Government of Singapore officially opened the 'BioLogics Hub' on 17 August 2005, which is located within the Tuas Biomedical Park.

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attractive. This included the biotechnology policies of countries, such as Japan, the United Kingdom and the United States, which had ethical issues with certain forms of biotechnology research. Singapore, on the other hand, had comparatively few regulations. Also, while the biotechnology policies of developing economies, such as China, India, the Republic of Korea and Taiwan Province of China, heavily favoured domestic biotechnology firms and often required joint venture tie-ups, Singapore was one of the few locations in the world in which biotechnology TNCs could operate wholly foreign-owned entities that had relative autonomy over their own business activities.

Despite the broad thrust of the Biomedical Sciences Initiative, it was evident that the Government's initial focus was to position the island as a "bulk pharmaceutical manufacturing" centre. Bulk manufacturing in the pharmaceutical industry refers to the processing of raw material to create an intermediate material in bulk form, which will be further processed or formulated into the final product.<sup>13</sup> From a business viewpoint, Singapore's bulk manufacturing capability made financial sense. Big Pharma could continue producing drugs in the major markets to satisfy regulatory requirements while reducing the costs of production by utilizing high quality but low cost intermediary products made in Singapore. In the current global economic environment, there are few locations in which biotechnology TNCs can remain wholly foreign-owned and involved in bulk pharmaceutical manufacturing.<sup>14</sup> Within Asia, Singapore appears to be the only location where such activities are taking place apart from Japan.<sup>15</sup> Other Asian economies, such as China, India, the Republic of Korea and Taiwan Province of China, are politically or economically unable to adopt Singapore's

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<sup>13</sup> Definition as given in Glennon (1997).

<sup>14</sup> The Republic of Ireland is one of the largest recipients of BFDI for bulk pharmaceutical manufacturing. It is within the EU and firms can enjoy access to the EU market.

<sup>15</sup> In Japan, bulk pharmaceutical manufacturing is actually done by large Japanese biotechnology and pharmaceutical firms (such as Takeda and Sankyo) for the domestic market.

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strategies. First, these economies have a sizable domestic biotechnology industry that would lobby against any “invasion” of biotechnology TNCs. Second, these economies have relatively large domestic markets for biotechnology products, and their governments are aware that they can take advantage of this situation by using access to their domestic markets as a leverage for making the investing TNCs “transfer technology” through the formation of joint ventures.

By 2005, Singapore’s biomedical industry accounted for nearly 10% of total manufacturing output. While employing only 2.6% of the industrial workforce, the value-added per worker was the highest at over \$65,771 (appendix). It was reported that Singapore’s biotechnology industry grew 33% over the previous year to reach \$9.51 billion in 2004. “Value-added” of this industry grew 48% to reach \$6.08 billion, and employment in the industry grew 6.7% to 9,225 (table 2). Within the industry, pharmaceutical production, of which the majority was in bulk manufacturing, contributed \$8.69 billion, accounting for 88% of the industry (ibid.). In 2004, the biomedical industry attracted \$512.5 million in manufacturing asset investments, and \$66.3 million in total business spending. In addition, it is expected that more than 1,900 new jobs will be created when the projects are fully implemented (Singapore Economic Development Board, press release, 31 January 2005). Interestingly, a large proportion of the jobs currently available (and soon to be generated) will come from the so-called “med-tech” sub-industry. According to Philip Yeo, the Chairman of A\*Star, Singapore wants to focus on “medtech”, because it is a “steady hirer”, suggesting that the industry is slightly more labour-intensive than biotech and can be a good source of employment generation.<sup>16</sup> As of 2005, medtech accounted for 60% of employment in the whole biomedical sciences industry, but only contributed 15 per cent of output (*Singapore Business Times*, 14 April 2005).

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<sup>16</sup> *Singapore Business Times*, 16 August 2005.

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**Table 2. Summary of Singapore's biomedical science industry**

Industry	Manufacturing output (millions of dollars)			Employment		
	2003	2004	% growth	2003	2004	% growth
Pharmaceuticals	6 096	8 049	37.9	3 584	3 581	7.4
Med-tech	1 062	1 126	6.0	5 058	5 374	6.2
Total	7 158	9 175	33.2	8 642	9 225	6.7

*Source:* (Singapore) Agency for Science Technology and Research (A\*Star) "Singapore's biomedical sciences industry recorded exceptional 33% growth in manufacturing output for 2004" Media Release, 31 January 2005 ([http://www.a-star.edu.sg/astar/about/action/pressrelease\\_details.do?id=0fb4e42369Mm](http://www.a-star.edu.sg/astar/about/action/pressrelease_details.do?id=0fb4e42369Mm)).

### **The long-term outlook**

It appears that Singapore's biotechnology policy, even though it has mainly attracted bulk pharmaceutical manufacturing, has so far been successful. However, can the rest of the Government's "grand design" - to make the biomedical sciences a pillar of Singapore's economy - be realistically achieved in the long run?

There are two factors that will determine Singapore's long-term biotechnology outlook. The first is endogenous or domestic. Despite all the infrastructural, financial and institutional advantages that the Government of Singapore has created, the biggest impediment to the realization of the "grand design" is the quality of Singapore's human resources. Tony Tan, Singapore's Deputy Prime Minister and Chair of the Ministerial Committee on Research and Development commented in 2005 that:

"The Ministerial Committee on Research and Development concluded that there is an urgent need for bold reforms to transform Singapore into an R&D-driven innovative knowledge-based enterprise economy, where we compete on knowledge and talent, in addition to

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efficiency and cost-effectiveness. Singapore needs to refocus its research and innovation agenda to keep up with international developments”.<sup>17</sup>

The Government of Singapore and its key bureaucrats evidently do not have any illusions about Singapore becoming a real biotechnology hub, like those in San Diego, New Jersey, Ontario Province (Canada) or in various parts of Switzerland, which invent and patent new biotechnology products regularly. This extract from the *Singapore Straits Times* sums up the current situation:

Ask Mr Philip Yeo how the Biopolis is shaping up and the chief architect of Singapore’s biotech ambitions bristles with indignation. “For heaven’s sake, it has only been two years,” he chides. “It takes longer to do a PhD.” The buildings may be up, but it will be years before trained Singaporeans can assume positions of scientific leadership that the biomedical industry is dependent upon” (*Singapore Straits Times*, 13 August 2005).

The Government is thus fully aware of the problem. It is in this light that it has created various schemes to encourage talented and qualified personnel to move to Singapore to work in the biotechnology industry. The Government has also invested heavily in the training of domestic human resources for the biomedical sciences. If both of these strategies are successful, then there is hope that Singapore will eventually have the level of human resources required for supporting other activities in biotechnology.

However, Singapore’s biotechnology future does not solely lie in its Government’s hands. Central to Singapore’s long-term outlook is the continuously evolving global biotechnology economy. Here, (global) market factors, the strategies of the biotechnology firms and, perhaps most importantly, the

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<sup>17</sup> Speech by Tony Tan at the conference “Looking to the next 100 years in physics and its impact on engineering, life sciences and technology”, 11 August 2005 (<http://app.sprinter.gov.sg/data/pr/20050811990.htm>).

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biotechnology policies of other countries will directly affect Singapore's biotechnology ambitions. At the moment, Big Pharma has been willing to "use" Singapore mainly as a bulk pharmaceutical manufacturing hub. The investors are clearly taking advantage of Singapore's infrastructure and intellectual property rights regime but, at the same time, it is also true that bulk manufacturing does not require the same level of human resources as research and design activities. The destination for nearly all of the products is in the Triad countries. Due to Singapore's policies and institutions, the made-in-Singapore intermediate products will pass the stringent quality control measures required by the developed country governments. More importantly, production in Singapore is seen as being more cost effective than production in the industrialized countries. Like any other TNC, Big Pharma is searching for the most cost effective location. Its earlier lack of "transnationalization" was not because of a lack of motivation but because of structural constraints, such as not having the adequate infrastructure, legal frameworks and quality control in developing countries where costs savings can be realized. Now that there is a location with favourable and cost effective structures, Big Pharma has responded as expected.

However, there is considerable movement and change in the overall global biotechnology economy, which will create various uncertainties for Singapore. The biggest unknown is whether the governments of other Asian countries will decide to compete to capture the niche that Singapore currently dominates (i.e. bulk pharmaceutical manufacturing). At the moment, as mentioned earlier, the biotechnology policies in other Asian countries have the aim of fostering domestic biotechnology enterprises. Many Asian economies, including China and India, have incorporated FDI as part of their biotechnology policies (as opposed to the policies of Japan, the Republic of Korea and Taiwan Province of China, which are, at best, "neutral" to FDI). However, the FDI sought is not the same as the type for Singapore. The policies of China and India are aimed at attracting biotechnology TNCs to establish joint ventures with domestic enterprises. In this sense, Singapore does

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not face much direct competition within Asia for BFDI. Indeed, it could be further argued that the quality of the infrastructure and the regulatory institutions in some other Asian countries would probably not pass the requirements of the Triad countries. However, this does not discount the possibility that other Asian governments might decide to emulate Singapore's strategy in the future. If and when this takes place, it is possible or even likely that Singapore will lose its niche. This ought not to come as a surprise to the Government of Singapore, as it has experienced this very process (several times) in the past, particularly in the electronics industry. The Government, if it wants to keep Singapore at the forefront of the biotechnology race, should therefore focus on moving higher up the biotechnology value-added ladder

## **Conclusion**

Singapore's biotechnology FDI inflow has been in part due to the Government's strategy. It focused on attracting bulk pharmaceutical manufacturing and medical devices production to Singapore. This has enabled the island to capture a niche in the global biotechnology economy. Another reason why Singapore was able to capture this niche was because the BFDI policies of other Asian countries were much more focused on the formation of joint ventures, with a view to developing domestic biotechnology firms. In other words, left to market forces alone, BFDI would not have flown to Singapore. It was heavily influenced by the government policies of both Singapore and other Asian economies.

Hence, the case of BFDI in Singapore demonstrates that FDI flows, including "new" FDI flows, can be significantly influenced by government policy. Research has shown that Big Pharma was reluctant to engage in large scale FDI, especially in bulk pharmaceutical manufacturing (Rugman, 2005). The reason behind this reluctance was the poor infrastructure and institutions outside the Triad countries. When the Government of Singapore, which already had a great deal of credibility among TNCs as a trustworthy government, was able to provide high

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quality infrastructure and strict regulations, Big Pharma was prepared to invest. It is possible that other Asian governments might choose this path in the future. If and when they do, the effect would be to expand the FDI market for bulk pharmaceutical manufacturing (i.e. more suppliers). This suggests that the “collaboration” or “adaptive partnership” between governments and TNCs can be understood as follows. Governments need to be pro-active (via policy interventions) to create opportunities for TNCs to enhance their own business competitiveness. However, governments should expect policy competition for FDI and they should also expect TNCs to be selective. Hence, there will be a great deal of interaction and transaction - not just between the two sides but also within each side (e.g. states in policy competition) - that will ultimately determine FDI flows. ■

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## Appendix

### Principal statistics of manufacturing (in Singapore), by industrial cluster, 2004

Industry	Employment	Total output (millions of dollars)	Remuneration per worker (thousands of dollars)	Value-added per worker (thousands of dollars)
Electronics	90 094 (25%)	44 356.9 (38.8%)	24.5	99.8
Chemicals	22 809 (6.5%)	31 709.3 (27.7%)	41.1	198.8
Biomedical	9 225 (2.6%)	10 360.9 (9.1%)	28.1	657.7
Precision Engineering	89 859 (25.4%)	11 542.7 (10.1%)	20.5	40.3
Transport engineering	54 477 (16.3%)	7 469.0 (6.5%)	22.1	46.0
Other manufacturing	83 680 (23.7%)	8 891.8 (7.8%)	18.0	30.9
Total	353 144 (100%)	114 330.6 (100%)		

*Source:* Singapore Ministry of Trade and Industry, 2005, p.173.

