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National Policies to Attract FDI in R&D
An Assessment of Brazil
and Selected Countries

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Abstract

This paper is part of a project based on a broad data collection of policies in selected countries, with a special focus on the attraction of foreign R&D investments. The purpose of the research is to contribute to effective policy-making, capable of fostering multinational corporations' (MNCs) investments in Brazil. In this context, the paper aims at identifying and examining the main policies to attract MNC technological activities in China, India, Ireland, Israel, Singapore, and Taiwan, in order to illustrate successful experiences and, based on them, to analyse the Brazilian case. The experiences and, based on them, to analyse the Brazilian case. The international experiences are analysed bearing in mind that foreign direct investment (FDI) ...

Keywords: industrial policy, technology, foreign direct investment, MNC R&D activities

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attraction policies are part of industrial and development policies, and should not be assessed or used in isolation. The methodology applied in this work consisted of elaborating country reports, which comprised: (i) economic and technological data; (ii) a brief description of science, technology, and industry (ST&I) policies; (iii) mapping programmes and incentive instruments key to the development of technological activities by MNCs; and (iv) the main MNC R&D activities developed in the country. By analysing the country reports, it becomes evident that for most countries the selectivity, continuity, and coordination of national policies are the key factors in creating a favourable environment for foreign R&D activities, by showing the commitment of national initiatives targeted towards technological activities and other initiatives that improve the competitive structure of a country. In Brazil, despite some recent actions to foster innovation and R&D investments—such as the Innovation Law—it is patent that there is a lack of a strong government policy, committed with continuity and well connected to other policies, as well as an absence of a specific governmental structure targeted to the attraction of such investments.

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Introduction

The internationalization of research and development (R&D) by multinational corporations (MNCs) has been thoroughly debated over the few past decades. Initially, the key question concerned the reasons as to why large companies would locate their activities, especially R&D, in other countries rather than remaining in their home economies. Recently, the main issue has become the choices of location made by such companies. Why are some countries preferred at the expense of others and what are the determining factors that attract intensive FDI for R&D?

The main factors related to the attraction of R&D investments are: an appropriate physical infrastructure for setting up technological facilities, abundance of qualified professionals—mainly scientists and engineers—and proximity to high level universities and research institutes, appropriate intellectual property regimes and fiscal incentives, among others (UNCTAD 2005a; Zanatta 2006). Therefore, a fundamental consideration for countries competing for MNC R&D investments is the influencing and improvement of such factors through effective policies. With this goal in mind, some national policies play a fundamental role in creating, in an articulate and consistent manner, an institutionally appropriate environment, both economically and technologically attractive to such activities.

At present, countries face fierce competition for technological investments. Even though most of these investments go to developed countries, some developing nations are also becoming increasingly important locations for this type of FDI as well, growing their share (individually or as a group) in MNC R&D investments.¹ China, India, and Brazil, among others, have been competing for these investments and seeking to improve their local features in order to win this battle.

This paper is part of a broad research project² that aims to contribute to the understanding of this general context and to the formulation of public policies that could be effective in fostering MNC technological investments in Brazil, especially in R&D. In this sense, the purpose of this paper is to examine policies to attract R&D investments in selected countries: China, India, Ireland, Israel, Singapore, and Taiwan.

¹ Based on Bureau of Economic Analysis data, North American subsidiaries have augmented their R&D expenditures abroad through time. In spite of the increase in absolute terms, developed countries from Europe, Canada, and Japan have lost their share in total expenditures from these firms, dropping from 86.2 per cent in 1994 to 79.7 per cent in 2001. On the other hand, Asian-Pacific countries have increased their share, specifically in R&D expenditures, from 3.4 per cent in 1994 to 11.6 per cent in 2002, reaching a peak of 13.6 per cent in 2001. China has shown a special performance among countries in the region, where American subsidiaries spent 3.1 per cent of total R&D expenditures in 2002, in comparison with 0.05 per cent in 1994. In Singapore, the share has also risen, from 1.4 per cent to 2.8 per cent (Zanatta 2006).

² The project ‘Policies to Develop Technological Activities in Brazilian MNC Subsidiaries’ is sponsored by FAPESP—the Foundation for Research Support of the State of São Paulo. It consists of the study of activities of Brazilian MNC subsidiaries, as well as the examination of policies created by competing nations, including developing countries, to attract these kinds of investments. The originality of the study stems from its analysis of a huge collection of recent data in a broad set of selected countries that create policies with the specific purpose of attracting R&D investments from those companies.

The choice of these countries stems from their success, through effective policy-making, in attracting a significant amount of technological investments, which can be noticed by the number of R&D centres set up in these nations.

The next section describes the methodology applied in the research of selected countries. The paper continues with a brief description of the theoretical background of research for R&D FDI attraction, which emphasises the role of policies in order to benefit more fully from the potential gains of the internationalization of R&D. The subsequent section presents the analysis of each country, in order to provide the basis for drawing a comparative overview of the Brazilian case. The paper goes on to summarize the main findings of the comparative analysis of policies in the selected countries and concludes by presenting final considerations and some critical aspects for successful policy-making in Brazil.

Methodology

The methodology for this study was developed in the context of a broad research framework; the purpose was to verify the strategies utilized by competing nations in order to attract FDI in R&D—the policy instruments applied for the promotion of MNC R&D activities. The examples of successful tools and policies will provide both the background for a critical analysis of the Brazilian case and guidelines for improving the instruments used to nurture and support R&D activities.

Individual country reports have been elaborated with detailed information on: (i) economic data (GDP, population, per capita income, foreign trade, FDI flows); (ii) ST&I data (R&D expenditures, patents, human resource indicators, publications); (iii) a summary of past and recent industrial and ST&I policies; (iv) institutional structure supporting the ST&I system; (v) mapping of key programmes and incentive instruments for the development of technological activities by MNCs; and (vi) examples of MNC R&D activities in the country. By so doing, it was possible to identify recent action undertaken in these countries to enhance their attractiveness to R&D activities, as well as to analyse such policies in the light of a wide economic and technological development trajectory, bearing in mind that strategies for the attraction of FDI are always a part of a broader national plan and industrial policies.

The criteria used to select the countries for the research sample were the effective results obtained by those nations in attracting FDI in R&D. Selection was achieved through a comprehensive mapping of the main policies and measures established in locations pursuing this specific purpose. Initially, the sample consisted of 11 countries (Australia, Canada, China, Hungary, India, Ireland, Israel, Russia, Singapore, Spain, and Taiwan). Subsequently, other countries also showed the potential to attract FDI in R&D and were therefore included in the sample (Argentina, Chile, Czech Republic, Malaysia, and Poland). Thus, including Brazil, the total number of countries analysed was 17. However, this paper is restricted to the analysis of China, India, Ireland, Israel, Singapore, and Taiwan, due to the fact that those are the most illustrative cases.

Global competition for FDI in R&D and its determining factors

Since the 1990s, several nations have had a growing concern with regard to attracting FDI, leading to increasing competition among countries for those investments. Developing countries are the main competitors in this battle, as several emerging economies have based their strategies for industrialization on MNCs.

Foreign firms, when establishing in a host economy, accelerate and facilitate the transfer of technology and access to management and marketing strategies from the developed world. That was the case, for instance, in Brazil, during the process of industrialization through import substitution. The benefits of FDI to host economies are beyond increases in productive capacity and the enhancing of exports; they also materialise in knowledge spillovers, a result of the interaction by MNCs—traditionally owners of state of the art technologies—with a country's production system as a whole.

The presence of technological spillovers from MNC activities is a frequent argument used to sustain favourable views to the attraction of FDI. MNC activities—production, managerial, marketing or R&D—have a high degree of 'novelty' to the host economy in many cases and, therefore, should afford a myriad of learning opportunities for domestic firms. Currently, not only is the role of MNC firms is taken as a key to technological development, but also specific R&D activities carried out in subsidiaries are crucial for the increase of productivity growth and welfare of host economies (UNCTAD 2005a).

In fact, since the 1960s there have been a considerable number of studies highlighting the benefits of FDI because of technological spillovers, but it was in the 1990s that such studies gained strength. The results, even though different as a consequence of the variety of research methods and of the diverse economic circumstances of host countries, support the hypothesis of higher benefits in terms of technological learning from R&D investments (Fan 2002; Marin and Bell 2003; Reddy 1997). The occurrence of technological spillovers is often linked to certain characteristics of the host economy, such as the level of technological development (which determines the size of the technological gap between local and foreign firms) and human resources capabilities. The accumulation of local capabilities is frequently associated with a better assimilation of the knowledge transferred by foreign firms (Blömstrom and Kokko 2003; Fan 2002).

The internationalization of R&D activities by MNCs, although not new, has been intensified and now incorporates new host countries. In this scenario, developing countries have gained importance as a destination for MNC R&D investments. China has become the main destination in the developing world, while Brazil, India, and Russia have gained favour, outpacing developed countries such as Germany and the UK (EIU 2004; UNCTAD 2005b). Alone, investments from North American MNCs in developing countries have increased ninefold in the period 1989–99, reaching US\$2.4 billion (UNCTAD 2005a). In conformity with this is the growing importance of subsidiaries to the innovative activity of developing host countries (Costa and Queiroz 2002). In Brazil, MNCs are responsible for almost half the private R&D expenditures;

in Ireland the value exceeds 70 per cent, and in Singapore is around 60 per cent (UNCTAD 2005b).³

The driving forces behind global relocation of R&D activities are: increasing global competition, the advance of information and communication technologies and the growing qualification (and costs) of many national systems of ST&I, together with more favourable environments for investment (UNCTAD 2005a). New opportunities for developing economies that possess abundant and qualified labour forces have also brought a variety of new technologies in sectors such as microelectronics, biotechnology, pharmaceutical, chemicals, and software.

The process of relocation (and relative decentralization) of technological activities enhances the likelihood that emerging economies can benefit from learning through spillovers. As a consequence, several countries have made efforts to improve their economic environment in order to attract FDI, especially that related to R&D. This has been achieved, among other measures, through policies aimed at developing essential factors, such as the supply of human resources, improvement of infrastructure, strengthening of the supply networks and development of the science-technology bases (UNCTAD 2005b).

Therefore, an effective framework of policies to attract MNC R&D activities must begin by strengthening the institutional structure that supports innovative activities in a country, such as the development of specific human capital capabilities; the increase in research capacity from both private and public sectors; the improvement of intellectual property regimes; and last, but not least, policies to promote a competitive environment for investments, with favourable arrangements for ST&I (for example, functional tax and incentives systems).

The availability of skilled human capital and adequate facilities for undertaking technologically advanced activities, as well as the state of the art of local technology, are determinants of a greater attractiveness to MNCs to set up their R&D activities offshore. For those reasons, the quality of the educational system of a country is a crucial factor businesses consider in their international expansion (EIU 2004).

Policies to strengthen the R&D infrastructure of host countries not only act positively as a factor to attract technological investments, they are also part of a broader effort to foster innovation and local development. The articulation between general (industrial) and specific (FDI promotion) policies becomes a key factor for the effective achievement of those objectives.

Summing up, R&D policies for the promotion of intensive FDI must be addressed in a scenario of growing competition for specific investments, for the reasons already stated. There are several cases of countries that succeeded in attracting significant R&D investment, such as Ireland, Israel, China, Taiwan, and India, who can bring lessons to be applied to the Brazilian scenario. The positive results obtained by some of the developing countries analysed in our sample confirm that well-planned and efficiently conducted policies can attract qualified investments. This, in turn, can enhance the

³ MNCs do not have the same relevance to R&D in India where they respond to less than 10 per cent of such activities (UNCTAD 2005b).

technological capabilities of the host countries. The analysis of successful histories is a useful tool to reflect on the current initiatives carried out with the same aim.

The role of MNCs in the Brazilian productive structure

The growing share of multinationals in the productive structure of the Brazilian manufacturing industry gives support to the establishment of government measures aimed at fostering a greater contribution of those enterprises to local technological efforts. Moreover, the economic literature stresses the deepening of the internationalization of the productive structure in the 1990s. Of the 500 largest global companies, 405 were operating in Brazil in 2000. The evolution of the share of multinationals among the 500 largest private companies in Brazil is impressive: in 1992, 39 per cent were foreign firms and, in 2000, this share rose to 46 per cent (Hasenclever and Matesco 2000). This evolution also reflects on MNCs' share in the total sales of the 500 largest enterprises. While the group's sales, as a whole, increased 7.7 per cent between 1989 and 1997, MNC sales grew by 10.3 per cent, totalling 50 per cent of all domestic sales (Laplane *et al.* 2001, 2004).

In the 1990s, the share of foreign firms rose in all Brazilian industrial sectors, especially in capital intensive sectors and/or in industries with higher technological dynamism (Laplane *et al.* 2001; Moreira 1999; Nonnemberg 2003; Rocha and Kupfer 2002), sectors in which foreign presence was already significant. Rocha and Kupfer (2002), using a sample of 300 firms, show that foreign firms have increased their hegemony in technology diffusion sectors, with 86 per cent of the revenues of such sectors in 1999 (this share was 60 per cent in 1991), while national firms' share shrank from 40 per cent in 1991 to 13.1 in 1999. State enterprises, which held 1 per cent of such revenues in 1991 (as, for instance, Embraer), left those sectors in 1999 as a result of a huge privatization process.

The importance of MNCs in Brazil, as highlighted, justifies the efforts directed to a deeper commitment of these firms to technological activities in Brazil and, since many of such firms are already established in the country, the technological focus of their investments is also a matter of providing for them a favourable economic environment (including ST&I).

An analysis of selected countries: illustrative cases

This section analyses each country selected in this study separately, in order to compare their experiences with the Brazilian case. The chosen nations can illustrate the building of a proper institutional setting that can foster MNC technological investments.

China

Since the 1990s, China has stood out from other countries as a major destination of world FDI inflows. In 1994, FDI inflows to China accounted for approximately US\$34 billion, reaching US\$60 billion in 2004 (UNCTAD 2007). In spite of being a recent example of a rapidly changing economy, current Chinese performance in the attraction

of foreign investments, including those in R&D activities, has as its major cause the modernization measures and the recent opening of the country (economic, political, cultural, and so on) to foreign investors, as well as the economic, industrial and S&T policies that have been implemented since Mao's demise in 1978.

In the beginning of this new era, the four main policy priorities were: industry, agriculture, S&T, and the military sector. Since 1979, China has established a series of bilateral agreements with several countries, including the USA, in order to advance that China's technological knowledge and training. In the same year, special economic zones (SEZs) were created. These had a very important role in China's technological catch-up, and also represented the first government attempt to open the country to FDI and foreign technologies (Walsh 2003).

In 1984, the Chinese government further improved those policies, creating new types of economic zones—economic and technology development zones (ETDZs)—for the development of high-tech sectors, with a focus in specific industrial projects and the building of an export based economy. According to the government, the ETDZs might be seen as launch pads to open up the economy, stir up capital inflows, increase exports, develop high-tech sectors, and support the transformation of regional economies (Invest in China 2003). The results of such policies are evident in the growth of exports of high-tech products from China (Table 1).

Table 1 China: imports and exports of high-tech products (2000–05) (in US\$100 millions)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|--|-------|-------|-------|---------|---------|---------|
| Exports of high-tech products | 370.4 | 464.5 | 678.6 | 1,103.2 | 1,653.6 | 2,182.5 |
| Share in total exports (%) | 14.9 | 17.5 | 20.8 | 25.2 | 27.9 | 28.6 |
| Share in industrial manufactured exports (%) | 16.6 | 19.4 | 22.8 | 27.3 | 29.9 | 30.6 |
| Imports of high-tech products | 525.1 | 641.1 | 828.4 | 1,193.0 | 1,613.4 | 1,977.1 |
| Share in total imports (%) | 23.3 | 26.3 | 28.1 | 28.9 | 28.7 | 30.0 |
| Share in industrial manufactured imports (%) | 29.4 | 32.4 | 33.7 | 35.1 | 36.3 | 38.6 |

Source: S&T Statistics, Ministry of Science and Technology (2006).

In 1985, the government announced the 'Decision on Reform of the Science and Technology Management System', which oriented development policies towards industrial technologies, attempting to improve the relationship between R&D potential and the production system in China. This change required the collaboration of research

institutions, universities, and firms in order to accelerate both R&D and the commercial application of its results. The government also promoted some new institutional reforms to foster these relationships, such as the creation of the National Natural Science Foundation in 1986, clearly inspired by the American National Science Foundation (NSF). In 1992, the National Engineering Research Centre (NERC) was created; since then, the Ministry of S&T (MOST) have often assessed its activities

The government also developed important measures to improve general and specific education as well as training, achieving extraordinary outcomes. Since the 1990s, the numbers of scientists and engineers working in S&T activities has grown steadily, from 2.3 million in 1991, with engineers comprising 57.7 per cent of that number, to 3.3 million in 2003, with engineers comprising 68.6 per cent. Such policy measures directed towards education and the training of human resources were directly related to the long-run goal of promoting high-tech sectors.

There are also important policies to attract MNC FDI in China by means of several fiscal incentives. Moreover, there are studies on the adoption of lower taxes on MNCs,⁴ which can be complemented by special taxes for investments in sectors and/or regions with high priorities.⁵ The open door policy for FDI and the creation of the special economic zones have had enormous success in attracting foreign investments and directing them to various regions of China. Not only Shanghai and Beijing are now important national and regional centres for MNC R&D, but also Tianjin and Guangdong have joined this new trend. As is well known, the enormous availability of world class human and physical resources for S&T activities is a very important factor for the concentration of these investments in those locations, besides the incomparable and growing dimensions of the Chinese domestic market (Sergers 2006).

The electronic and telecommunication sectors have recorded huge investments in MNC R&D in China. Motorola is an MNC with very important activities in China, having opened its first office there in 1987. In 1992, the firm set up Motorola China Electronics Ltd in Tianjin. Some authors consider that, in the beginning of 2004, there were 200 MNC R&D centres in China (Von Zedwitz 2004), which will probably have increased to 250–300 by the time of writing.⁶

4 The current policies directed toward tax reductions or exemptions mean that MNCs can be exempted from income taxes in the first two years after obtaining the first profits in the country, and they can also receive a reduction of 50 per cent on the same taxes in the three following years. This period is extended to six years in case of high-tech firms. Furthermore, if the firm activities are explicitly directed towards exports, this tax reduction of 50 per cent will persist until these exports comprise more than 70 per cent of the total receipts.

5 The income taxes in China are 15 per cent in Economic Zones, High-Tech Industrial Zones, and Economic and Technological Development Zones, but 24 per cent in the much more developed and attractive coastal areas and provincial capitals.

6 According to data from UNCTAD (2005b), these figures are higher than 700 MNC R&D centres. However, some experts consider these figures overblown, since not all formal MNC R&D centres are in full activity; many have only a few engineers representing a formal fulfilment of the requirements of the Chinese government (Sergers 2006). Nevertheless, we must stress that 250 to 300 effective MNC R&D centres are an impressive asset for any country in the world.

India

India has made huge investments in higher education and domestic research institutes since its first years of its independence in the late 1940s. Since the 1980s and 1990s, these efforts have brought forth effective results, as shown by the extraordinarily rapid development of some high-tech industries and the active role of the Indian diaspora, mainly in the USA, UK, Canada, and Asia (Mitra 2006). Currently, India has the second largest pool of engineers and scientists in the world (only behind the USA). In 1990, there were 339 institutions offering education in engineering in India, admitting 87,000 new students per year. In 2003, this figure increased to 1,208 faculties, with a potential to admit 360,000 new students per year.

An amendment to the Indian Law of Patents carried out in 2002 framed it accordance with the Trade Related Intellectual Property Rights Agreement (TRIP). Other measures capable of attracting FDI were those aimed the improvement of interactions between public research laboratories and private firms, making R&D efforts more oriented to commercial outcomes, therefore increasing the records of registered patents within India, as well as in the United States Patent and Trademark Office.

FDI has been liberalized in India in almost all sectors since 1991, but the Indian government has a clear interest in greenfield investments. The geographic localization of FDI is subject to regulations—not being permitted in cities with more than one million inhabitants, with the exception of those previously pointed out as industrial cities and the foci of specific investments. There are also no geographic restrictions to investments in electronics, informatics and telecommunication, printing and any sectors that do not produce pollution.

Another attempt to attract FDI involved allowing industrial plants to relocate from abroad to India without the need for a licence, provided the value of these plants does not exceed US\$10 million. The preference is for those plants whose equipment is less than 10 years old. India has also been promoting trade through the implementation, in some regions, of special export zones (SEZs), similar to the Chinese special economic zones, as well as through incentives for the creation of export processing zones (EPZs). One must also stress that there is no discrimination between Indian and foreign corporations, with the exception of some minor restrictions regarding capital expansion (in the case of joint ventures between foreign and Indian corporations) and activities related to equity issues and/or sales.

The Indian government has a series of mechanisms to support R&D, including fiscal exemptions: capital yields as well as capital investments in R&D can receive 100 per cent exemption from income tax; deductions of 125 per cent of taxes are allowed for research with the support of laboratories and/or research or education institutions approved by the government; exemptions can even increase to 150 per cent when spendings are made in selected sectors. Firms strongly specialized in R&D are exempt from income taxes for three years, which can be extended to a maximum of 10 years. These incentives can be accompanied by accelerated depreciations for equipment produced with domestic technologies, and exemptions for tariffs and taxes on equipment and inputs destined for R&D.

In the pharmaceutical industry, there are many joint initiatives for investment in R&D by MNCs and other parties, resulting in the creation of international marketing networks

and research projects in government laboratories, with governmental support and funding.⁷ Concomitantly, the modifications in the Patents Law, after the signing of the WTO agreement, put pressure on this industry to avoid mere imitative R&D, despite the inclination of some successful entrepreneurs to innovation activities even before liberalization.

Israel

Israel is an extremely peculiar example of FDI attraction in technological activities, for its pioneering role in sheltering MNC R&D centres as a consequence of its well-known S&T infrastructure, as well as the antiquity of its incentive policies for these kinds of activities. This particularity, as is well known, is caused mostly by the political history of Israel and the Middle East—a region fraught with wars and disputes over territories—but also by the special political and economic relations of Israel with the USA.

This political environment designed the Israeli industrial and S&T policies. Since its independence, in 1948, there has always been the need to occupy the frontiers of that small country and, thus, national and foreign companies that set up their plants and offices in designed places have received the largest incentives; for instance, the legislation for the encouragement of capital investment was promulgated in 1950 and is still in force.

Until the mid-1980s, the S&T policy was concentrated on the improvement of Israeli defence apparatus, strongly determining the type of domestic industrial activities. That is to say, these measures helped that country to build up and improve its absolute and comparative advantages (Dosi *et al.* 1990). The combination of large public spendings on defence, a high participation of people with strong education capabilities—also among the immigrant population—and the quest for world class universities (even before the foundation of the country),⁸ contributed to the result that Israel today has, proportionately, the greatest number of scientists and technicians in the world: 140 per 10,000 inhabitants (Ministry of Industry, Trade, and Labour 2005).⁹

Thus, Israel, since the first years after its independence, has developed a broad and strong S&T base, mainly in the information technologies (IT) and in medical equipment. The country even developed its own digital computers in the late 1950s. These developments attracted high-tech corporations since the end of the 1970s, stimulated by the abounding human capital, the elevated demand for sophisticated security products and by Israel's high-tech complex. In 1974, Intel established its first

⁷ This is the case of the Dr Reddy's Laboratories Ltd (DRL), which licenced three molecules for big foreign corporations (two for Novo Nordisk and one for Novartis), with total revenue of US\$ 8 million.

⁸ The Technion (Israel Institute of Technology) was founded in 1924 in Haifa, and in 1948, the year of Israel's independence, had 680 alumni in a series of faculties, such as civil, mechanical and electrical engineering; architecture; and city planning. The Hebrew University was founded in April 1925 and, in 1947 its 1,200 alumni were distributed in faculties and institutes such as microbiology, chemistry, medicine, agriculture, sciences, humanities, and so on.

⁹ A strong presence of highly educated immigrants, since before independence and especially since the 1980s, contributed to these high shares.

development centre in Israel (the first outside the USA), with an initial investment of just US\$300,000 and a team of five employees. However, the corporation now has two manufacturing plants and five R&D centres, with a total of 6,100 employees in Israel. Several processors, including Intel Centrino, were developed in Israel.

By the mid-1970s, R&D incentive measures were extended to foreign high-tech companies and were maintained with few modifications. In 1984, technological activities (of national or foreign companies) were favoured with the legislation encouraging capital investment, enlarging the scope of the S&T policies. There are now additional incentives to foreign investors, such as a longer period of tax exemptions and reduced interest rates, primarily for those areas near Israel's boundaries. Nevertheless, as Israel now concentrates a great IT technology cluster, the propensity of these high-tech industries to agglomerate has diminished the efficacy of spatial incentives, despite Israel's reduced dimensions.

Finally, other distinguished measures are the incentives for 'start-ups' (many have been even acquired by MNCs) and for the development of venture capital funds (managed, to a large extent, by foreign investors), in an effort to turn these accumulated S&T assets into new companies (the actual focus is biotechnology) rather than merely attracting foreign investments. Many MNCs have been fostered by these pre-competitive investments. Intel, for example, has invested a total sum of US\$100 millions in twelve 'start-ups'.

Ireland

Ireland is also known for its pioneering role in building up an active institutional environment in order to attract FDI. In 1949, the Industrial Development Agency (IDA) was established, responsible for attracting and promoting FDI. For a long time, IDA has stood out for its continuous, consistent, and well-implemented industrial policy. Occasional changes in the political scenario do not imply disruptions in the policies implemented by IDA, understood as a long-term goal of the Irish State (Ruane and Görg 1997).

Since the 1950s, Ireland's economy and industry has been undergoing a process of modernization, for which the attraction of MNC investments was a key element. Until the beginning of the 1980s, these policies were fundamentally composed of tax exemptions on profits over exports and government subsidies for investments in plant and capital goods to be used in the production of those exports. Both programmes were changed in 1982 because of a requirement of the European Economic Community (EEC), when those taxes (formerly of 10 per cent, afterwards increased to 12.5 per cent) were modified to taxes on total profits. However, when compared with European standards, these tax percentages were still considerably lower.

Incentive programmes have been improved throughout the years. The Irish government started demanding counterbalance results to its policies, such as an increase in the number of job positions created, in addition to the simple proof of purchase of capital goods. Without complying with these demands, investing companies would not continue to receive governmental incentives (Ruane and Görg 1997). In the 1970s, these policies became more selective, with the government trying to encourage investments

and attract MNCs to sectors in which the country could broaden its competitive advantages.

At that time, the government identified the pharmaceutical industry and information and communication technologies (ICT) as special policy foci, with the USA as the chief source of investments, mostly for industrial clusters. Furthermore, Ireland intended to establish enduring relations between MNCs and domestic corporations, even if national companies would play a secondary role as specialized suppliers of foreign companies. In the 1980s, Ireland started to build up S&T policies, simultaneously trying to improve the performance of domestic companies in comparison with MNCs (Hayward 1995). Since then, several research centres have been established in Ireland, principally in ITC and agriculture. Consequently, government disbursements in S&T increased 74 per cent in real terms between 1980 and 1993.

After 1992, the Irish government emphasized the strengthening of the National System of Innovation (NSI), starting to give preference to finance investments in technological capabilities. Moreover, it tried to give increasing support to investments in national companies,¹⁰ considered insufficient when compared to that for MNCs. Ireland also started to give some tax exemptions to qualified people in S&T, in order to prevent 'brain drain'. In the 1990s, it also started to stimulate capital goods, medical equipment and technology industries as well as sectors related to life sciences (biotech, bio-engineering, and so on), besides the traditionally underscored ITC and pharmaceutical industries.¹¹

Table 2 R&D expenditures: selected countries, 2000–05 (as percentage of GDP)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|-----------|------|------|------|------|------|------|
| Brazil | 1.01 | 1.05 | 1.00 | 0.97 | 0.91 | — |
| China | 0.90 | 0.95 | 1.07 | 1.13 | 1.23 | 1.34 |
| India | 0.86 | 0.82 | 0.80 | 0.79 | 0.77 | — |
| Ireland | 1.13 | 1.10 | 1.10 | 1.16 | 1.20 | — |
| Israel | — | 4.77 | 4.74 | 4.46 | 4.43 | 4.50 |
| Singapore | 1.89 | 2.11 | 2.15 | 2.12 | 2.24 | 2.36 |
| Taiwan | 2.06 | 2.08 | 2.20 | 2.35 | 2.44 | 2.52 |

Source: Elaborated by the authors based on OECD Factbook (2007) *Economic, Environmental and Social Statistics*.

¹⁰ Through Enterprise Ireland, an agency specially directed to domestic firms.

¹¹ In 2002, Ireland was the first exporter of intermediary and final pharmaceutical products in the world, selling €34 billion abroad. Out of 15 of the largest pharmaceutical MNCs in the world, 13 are in Ireland, some of them with very important R&D projects. GlaxoSmithKline, for instance, will make its Irish branch its world centre for nanotechnologies. On the other hand, we must stress that the Irish federal government also spends, €1 billion in R&D on that sector.

Taiwan

Taiwan has some relevant economic and technology indicators to be illustrated. Its GDP has been growing around 5 per cent per year since the end of the 1990s, despite the decrease registered in 2001. In 2002, its pace of growth was recovered due to the implementation of the National Development Plan.

Since the 1950s, national R&D expenses have gradually increased and reached 2.5 per cent of GDP in 2005, mainly incurred by the private sector (60 per cent) and concentrated in engineering areas (see Table 2). In this sense, it is worth noticing the outstanding number of graduated and expatriated engineers that return to Taiwan to fill the growing demand for specialized human resources, mainly in technological parks such as Hsinchu (created in 1979), a locus of attraction of MNC technological activities.

Taiwan demonstrates that overcoming difficulties related to its geographical restrictions and its political history was a result of well-structured and continuing economic and industrial policies. In this sense, Taiwan's exports reflect its national priorities towards economic development and strategic industrial policy. The country has become a world leader in high-tech products, especially in electronic and petrochemical sectors (Table 3). These positive international results are the consequence of more than three decades' of national development strategy oriented towards exports (Breznitz 2005). For these results, national policies were based on public research institutes and on the incentive to develop small and medium-sized firms, which account for the major share of businesses in Taiwan.

National policies in Taiwan have a strong selectivity. Industrial policy is focused on strategic sectors such as semiconductors and biotechnology, implementing a permanent monitoring process of the potential growing sectors. MNCs do not receive any different treatment and there is some evidence that national companies might benefit from the linkages with foreign firms, who also share technological learning mechanisms with local agents. In this sense, incentives are offered for businesses to develop R&D activities, human resources training and the acquisition of new technologies.

Table 3 Taiwan: products that ranked within the world's three largest producers, 2006

| 1st place worldwide | | 2st place worldwide | | 3rd place worldwide | |
|---------------------|-------|---------------------|------|---|------|
| Product | % (*) | Product | % | Product | % |
| 1. Mask ROM (1) | 91.4 | 1. Glass fibre (1) | 37.0 | 1. Small and medium-sized TFT-LCD panel (1) | 14.6 |
| 2. Foundry (1) | 66.7 | 2. OLED panel (1) | 25.9 | 2. PCB (1) | 14.0 |
| 3. IC testing (1) | 60.3 | 3. IC substrate (1) | 25.7 | 3. PTA (2) | 13.8 |
| 4. Optical disc (2) | 53.0 | 4. DRAM (1) | 25.0 | 4. Nylon fibre (2) | 10.5 |
| 5. IC Packaging | 47.8 | 5. IC design (2) | 21.2 | 5. PU leather (2) | 6.7 |

Notes: (*) Taiwan's market share; (1) = production value; (2) = production volume.

Source: Taiwan Statistical Data Book (2007).

In 2002, a national policy focused on the attraction of MNC R&D and business centres was implemented, which resulted in the attraction of 23 of these facilities to Taiwan. Among the companies were Ericsson, Dell, and IBM, which are keeping an eye on the relative importance of these centres within their global corporations. Ericsson's centre is one of the four major regional company centres in Asia, specializing in third generation communication technologies. Dell's R&D centre produces approximately half of the notebooks and providers for the entire corporation, with 30 new designs. The 'IBM Series Taiwan Development Centre' is IBM's first centre outside the USA to perform activities related to innovation and interaction of local development with the global corporation platforms.

Singapore

Over the past few years, Singapore has exhibited a prominent economic performance, with average economic growth rates of 6 per cent. Regarding technological development, the changes are even more illustrative. The share of R&D expenditures on GDP climbed from 0.3 per cent in 1980 to 2.3 per cent in 2005 (Wong and Ho 2005) (see also Table 1).

Since the 1960s, measures to liberalize trade and attract FDI have been key tools used to change this scenario. The government has undertaken efforts to highlight the strategic geographical localization of the country as a trade centre and to develop telecommunication and transport networks in order to attract foreign investments. The late independence of Singapore in 1965 has not limited its economic performance, as its national planning and the adoption of FDI policy focused on labour-intensive activities (the radio and TV industry), essential pillars to the first period of the national economic development process (Koh and Wong 2003).

In the early 1980s, with the growing regional competition, the government abandoned the strategy of attracting low-cost investments and started targeting high value-added investments. To achieve this aim, several programmes were implemented to turn Singapore into an IT reference in the East Asian region.¹² From the middle of this decade onwards, efforts can be seen towards the diversification of the sectors benefited by FDI, also including the service sector (Coe 1999).

Singapore's FDI experience has some similarities to the Irish case due to the political effort and the constitution of an investment promotion agency (IPA) dedicated to leverage the kind of investments to be developed in the country.¹³ Under the auspices of the Economic Development Board (EDB), FDI has been continually entering the country. The board is responsible for conducting national industrial policy based on the concession of incentives to develop its IT industry. It is now aiming to consolidate a biomedical sector in Singapore. Concomitantly, the government has conducted a policy focused on the development of a chemical cluster, which ranks as the third most

¹² The National Computer Board (1980) and National Computerization Plan (1981) illustrate this goal.

¹³ Some authors cite Ireland and Israel as direct competitors for the attraction of technological FDI. Thus, global competition for investments has been stimulating Singapore's government to seek cost reductions associated with the undertaking of investments; however, recent studies describe the country as one of the most expensive business centres of the Asian region.

important sector in the manufacturing industry of the nation (Xinhua News Agency 2006). Another initiative is to foster linkages with local companies, promoting outsourcing activities, or improving extension services.

The main goal of all national policies has been to implement initiatives that could contribute to industrial and technological growth, and the consequent improvement of national competitiveness. The objective is to assure a safe and efficient environment for foreign investments. The array of incentives, created mainly to support MNCs, has been materialized in the increase of the pattern of established investments and the differentiation of Singapore compared with its competitors. Some authors highlight the flexibility and agility of the national government's response as fundamental factors of this successful model. Nevertheless, the local industry tends to be fragile and some initiatives are being implemented to support this national actor. During the 1990s, several efforts were carried out to strengthen technology infrastructure in an attempt to consolidate small and medium-sized companies that originated from spin-offs (Wong and Ho 2005).

Today, Singapore stands out for its service exports and the emergence of biomedical sciences (comprising pharmaceutical, medical devices, biotechnology and health care services) (Helble and Chong 2004). Besides MNCs, the country has attracted new research talents through some strategic programmes. The stimulus to innovation in technology can be seen in the governmental plan announced in 2006—'Science and Technology Plan 2010'—aimed at increasing national R&D expenditures to 3 per cent of GDP by 2010.

Brazil

Taking into account the international cases previously presented, the Brazilian experience is analysed considering its own efforts to attract MNC technology investments. Brazil has historically been receptive to FDI inflows. In the post-Second World War period, MNCs assumed a decisive role in Brazilian industrial structure by providing its dynamics in several sectors. From the mid-1950s onwards, with the 'Plano de Metas'¹⁴ (1956–61), the national industry developed its advanced sectoral chains and MNC subsidiaries became a determinant part of this structure.

At that time, in the international context, American MNCs, followed by European companies, were in the process of internationalizing production. Domestic private and state capital was added to foreign capital, comprising the foundation of Brazilian 'heavy' industrialization.

At the beginning of the 1970s, Brazil was already one of the most internationalized economies in the world and MNC subsidiaries accounted for one-third of total industrial production. From 1974 and 1980—the period from the National Development Plan II to PND II (the second and last heavy industrialization plan effectively implemented in all Brazilian history)—the federal government adopted a more selective policy approach based on sectoral targets, conditioning the entrance of MNC investments to certain desired economic benefits. Until then, policy regarding the attraction of FDI had been

¹⁴ Targets Plan.

generic and oriented to maintaining a favourable environment for foreign investments but without predefined priorities. During the PND II, FDI attraction became conditioned to sectoral specialization as part of a broader national industrial policy—focused on basic inputs and capital goods—mainly due to trade imbalances (Nonnemberg 2003).

The 1980s were characterized by an inflection in the Brazilian FDI pattern, with a strong decrease of foreign investments inflows: the Brazilian share in world FDI inflows declined from 0.9 per cent (1982–86) to just 0.2 per cent (1987–91). The main limiting factor was the unfavourable economic environment, with a generalized recession in economic activities and investments due to uncertainties caused by the external debts crisis and the ensuing high inflation.

In the 1990s, FDI inflows began to return to the country, as a result of the commercial liberalization, privatization and deregulation processes that took place in that period. The amount of foreign investments increased from US\$1.3 billion in 1993 to US\$32.8 billion in 2000 (the highest record in Brazilian history). In 2006, US\$18.8 billion of FDI inflows entered in Brazil (BCB 2006). However, these economic structural changes were not accompanied by coordinated instruments of industrial policy; simultaneously, there was no explicit policy to attract FDI aimed at quantitative and qualitative changes in the national industrial structure; that is, in order to obtain competitive gains.

The Brazilian institutional structure of FDI attraction also presents many flaws. Other countries have institutions and organizations (at regional or national levels) clearly responsible for both promoting themselves and the attraction of investments to their territories abroad. In Brazil, this structure was created for a short time (1999–2002) by the so-called ‘Investe Brasil’, which has been deactivated. Brazil is one of the few countries without an agency acting in support of these goals, and which is not well coordinated with the federal and/or state government (Ricupero and Barreto 2007). Today, Brazilian initiatives to promote FDI are quite timid and uncoordinated; such as the APEX-Brasil (an agency oriented mainly towards the promotion of exports) and the RENAI (National Network of Investment Informations) (which works as an information vehicle about investment opportunities in Brazil and about how to accomplish them).

The presence of IPAs is taken as an important factor in the attraction of investments, as they might influence decisions by enterprises on where to invest, contributing to the creation of a positive image of the country abroad. The recent outbreak of IPAs worldwide, as already shown, is evidence of their significant role in the attraction of FDI, as well as of the fierce worldwide competition for such investments (Morriset 2003; Zanatta *et al.* 2006).

The lack of coordination among federal government institutions to formulate and implement FDI policy in Brazil, including FDI in R&D, is quite apparent. As Suzigan and Furtado (2007: 19) highlight ‘the problem of technology and industrial policy institutions is precisely not to have sufficiently and coherently accompanied the industrial and the science and technology development [in Brazil]’. Therefore, the current institutional structure, uncoordinated and fragmented in different government levels, is inadequate. This signals the need to create new instruments that link the existing institutions and the current industrial policy measures (including those directed towards FDI, chiefly in R&D)—and also the development of new policies and/or (probably more important) new agencies—in a more centralized and connected governance structure.

Among the recent policy measures that might have some effect on the attraction of FDI to R&D activities is the Innovation Law (Law 10.973/04). This legislation establishes incentives for innovation, interactions with the public (universities and research institutes) and private sectors, as well as the concession of financial resources to the productive sector, under the guise of subsidies, finance, or partnerships. It is aimed at the development of innovation in products and processes (Zanatta 2006). However, this initiative is very recent and its effectiveness is dependent on a long-term evaluation.

In addition, recent legislation (Law 11.196)¹⁵ reduces the Industrialized Products Tax (IPI, a value-added tax) in the presence of acquisitions of R&D equipment, and also allows an accelerated depreciation of the related capital goods. However, most firms do not use these legal instruments in their R&D activities, and are even unaware of their existence. Thus, while these initiatives could have significant results, in the long term it is necessary to disseminate and maintain them throughout several governments, as happens in the most successful countries analysed in our research.

Brazil has also displayed impressive progress in its building up of human resources: in 2006, the numbers of MSc and PhDs were around 40,000 and 10,000, respectively (Capes 2006). Nevertheless, this qualified workforce is not absorbed by the private sector, remaining strongly concentrated in the academic area, probably justifying the efforts of the Innovation Law to increase the interaction between the public and private sectors.

A comparative analysis of the selected countries

Throughout the analysis, one can notice common elements in some national policies, indicating a relevant regional element of this analysis. In this way, some countries were aggregated according to both their geographical region and to similarity in characteristics, as can be seen in Table 4.

One can observe that selected Asian countries (China, Singapore, and Taiwan) have long-term, continuing and articulated policies that influence national economic and industrial development. These policies are also selective, both in terms of corporate activities (R&D) and industrial sectors (technology intensive). Israel and Ireland have similar policy characteristics, consequent on their success in attracting R&D intensive FDI. Table 5 summarizes some of the main policies towards specific R&D investments in the countries studied.

Finally, Brazil, except for the long-term policies, is nearer to the experiences of Latin American countries, such as Argentina, Mexico, and Chile. This is to say, the favourable characteristics described were not observed in its policies as well as in the effective results of FDI in R&D. In this sense, the evidence provided by the present analysis is that disarticulated policies and the absence of a defined focus (sectoral or corporate activities) seem to be less effective in attracting MNC R&D activities.

¹⁵ This law has been modified by Law 11.487, which includes new incentives for technological innovation, and changes the rules related to accelerated amortization of R&D investments.

Table 4 Characteristics of policies attracting FDI, selected countries

| Countries/regions | Long term | Continuity | Consistency | Selectivity | |
|-------------------|--------------------|------------|--|--|---|
| | | | | Corporate activities | Industrial sectors |
| Asia | Less than 30 years | Existent | High | Existent, with effective results on attracting R&D investments | Pharmaceutical, biotechnology and ICTs |
| Brazil | More than 30 years | Inexistent | Low, macroeconomic policy opposes industrial and FDI policy objectives | Non-existent | General FDI. PITCE:* capital goods, semiconductors, pharmaceuticals, software |
| Israel, Ireland | More than 30 years | Existent | High | Existent, with effective results on attracting R&D investments | Pharmaceutical, biotechnology and ICTs |

Notes: * Industrial, technological and foreign trade policy.

**As a methodological issue it is worth stressing the qualitative character of the systematization above, mainly regarding the results of attraction of FDI in R&D. The relevance and originality of this exercise relays on the attempt to sistematize information collected in a vast array of sources for each of the selected countries, trying to establish similarities and differences among them.

Source: Elaborated by the authors based on the comparative analysis of the selected countries.

Table 5 Main policies directed at MNC R&D investments

| Country | Policy description | Since |
|-----------|--|------------|
| China | R&D is a requirement for some FDI. Technological parks benefit from tax exemptions in R&D activities. Imports of equipments for technology-intensive activities are tax free. | 2000s |
| India | Fiscal exemptions of up to 150%; focus on selected sectors. Investments are exempt from income tax. | 1991 |
| Israel | Focus on high value-added and high-tech sectors – especially biotechnology. Funding of up to 50% of R&D projects of foreign or domestic firms, <i>vis à vis</i> royalties payments of 2–3 % of sales revenues of related products. | 1970s |
| Ireland | Focus on high-tech sectors; preferred financing of technological investments. Incentives granted via IDA. | 1990s |
| Taiwan | Industrial policies focused on semi-conductors, displays, and biotech, with no differentiation between capital origins. | late 1970s |
| Singapore | Focus on high value-added investments; active role of IPA to pursue such investments. Development of industrial clusters. | 1980s |
| Brazil | Innovation law – incentives to partnerships, concession of financial resources to innovative activities. PITCE – (industrial, technological, and foreign trade policy) has, as its guidelines, innovation, technological development, industrial modernization, foreign markets competitiveness, higher scale, and productive capacity. Strategic (high-tech) sectors are a priority. | 2004 |

Conclusion

Based on the analysis of selected countries, we are able to stress that selectivity and continuity, together with the articulation (interconnections and flexibility) of national policies, are fundamental factors in building up an attractive environment for MNC R&D activities, as they signal a steadfast compromise of the national governments with regard to technological activities.

Some of the international experiences studied stress the strategic role assumed by policies in order to promote FDI and industrial and technological activities. Ireland, for example, has created a governmental structure responsible for its industrial policy under the auspices of the IDA, which had carried out this function for over 50 years. This is the main reason why Irish industrial policy is recognized for its consistency and continuity.

Generally, the analysis of these countries permitted identification of the most important factors in attracting MNC R&D activities and the policies that influence these factors, showing that each country has some advantages and handicaps when compared with others. Ireland and Israel, for instance, stand out for the continuity and selectivity of their FDI policies, including in R&D activities. For a similar reason, India, Taiwan, and Israel are well known for their high quality S&T infrastructure, with technology institutes and world-class universities. China and India are known for their abundant technically and scientifically well-trained workforce, and for the strong commitment of their governments to the augmentation and improvement of human resources. The effectiveness of these factors is conditioned by many economic, political, social and historical events, and also by the coordination of these elements with ST&I policies.

One could say that there is no easy recipe for countries to follow—increasingly, the developing ones—in order to participate more actively in this process of worldwide R&D dissemination. The competition and attraction of these technological activities comprise many factors in complex and previously undetermined systems. Thus, a general recommendation to those countries interested on winning the competition for R&D intensive FDI is to improve the the factors of attraction with continuous, consistent and well-developed policies, strongly connected to their industrial strategy.

The analysis of international experiences also reveals the extent to which Brazil is still handicapped in the global competition for technology FDI. Table 6 shows numbers of recent R&D projects by MNCs in the selected countries: Brazil attracted less R&D investment in a number of projects. The absence of an investment promotion agency, which could act in a coordinated manner with other policies, is evidence (at least, currently) of the lack of priority regarding such issues. Brazil needs more focused and selective FDI policies in terms of sectors and activities, with higher priorities and support. The countries described provided evidence that their governments have selective FDI policies—mainly in the IT, pharmaceutical and biotech sectors. In this sense, despite some recent initiatives towards innovation and R&D investments in Brazil—such as the Innovation Law—one can notice the absence of state policies that are definitely committed to the continuity and coordination of those policy measures.

Table 6 R&D projects by MNCs, selected countries

| Country | Number of R&D projects | Some firms investing in R&D |
|-----------|------------------------|--|
| China | 416 | Nokia, Microsoft, Intel, Nortel, Motorola (Serger, 2006) |
| India | 635 | Microsoft, Intel, Cisco, GM, GE, ABB, Ericsson, Adobe, Google, Texas Instruments, Alcatel, Lucent Nokia |
| Israel | 12 | Intel, IBM, Siemens, Motorola, AMAT, HP, Microsoft, GE, BMC Software, Unilever, SAP |
| Ireland | 55 | Microsoft, Motorola, Ericson, Pfizer, GlaxoSmithKline (Mazzoni and Strachman, 2009) |
| Taiwan | 56 | HP, Dell, Microsoft, IBM, Intel, Life Sciences CoE, Honeywell, Dupont, Sony, Atotech, NEC, Alcatel, Glaxo SmithKline, Ericsson |
| Singapore | 86 | Eli Lilly, Novartis, BASF, Intel, General Electric, GlaxoSmithKline, Bosch, Sony |
| Brazil | 28 | Motorola, Freescale, Bosch Johnson&Johnson, Whirpool, General Motors, Fiat, Ford, Voith Siemens, Siemens |

Source: LOCOMONITOR Database, www.locomonitor.com

Summing up, Brazil is still lacking two main elements with which to attract FDI in R&D: coordinated governmental actions and institutions responsible for this attraction. Despite the fact that Brazil has made strong advances in its human resource policy—registering significant increases on numbers of MSc and PhD qualified personnel, as well as on international scientific publications—this qualified workforce still seems to be out of touch with regard to needs of the private sector. It is essential to reinforce scientific, technological and engineering competences, for these qualifications are crucial inputs to the innovation processes and, thus, to MNCs’ strategic decisions.

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