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Beyond Pollution Haloes: The Environmental Effects of FDI in the Pulp and Paper and Petrochemicals Sectors in Brazil

Luciana Togeiro de Almeida

Sueila dos Santos Rocha

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Luciana Togeiro de Almeida is currently a Visiting Scholar at GDAE. She is a former President of the Brazilian Society for Ecological Economics (ECOECO) and current member of the ECOECO and ISEE boards. She holds a Doctorate in Economics from the Sao Paulo State University at Campinas and is Assistant Professor in the Department of Economics at the São Paulo State University at Araraquara, Brazil. She currently teaches *Economics of the Environment, International Economics, Social and Economic Development, and International Trade and Sustainable Development*. She is presently researching environmental issues in the WTO negotiations and in MERCOSUR. Her recent books include *Globalization and the Environment: Lessons from the Americas* (edited with Kevin P. Gallagher and Hernan Blanco), and has published widely trade and sustainable development issues in general. In addition, she has served as a consultant and advisor to the Brazilian Ministry of the Environment and to numerous environmental NGOs.

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Sueila dos Santos Rocha

Abstract

Among the most environmental sensitive sectors are pulp and paper and petrochemicals. In a historical perspective, FDI played an important role in the establishment of the petrochemicals industry in Brazil in the 1970's when it was driven by strategic state policies to develop the domestic intermediate goods industry. In the pulp and paper sector, FDI has becoming prominent just after the year 2000 and it has been exclusively driven by market forces. Here is presented a comparative analysis of the environmental issues related to FDI in these two sectors in Brazil and extensively focusing on the importance of the international context to foster domestic environmental commitments. One conclusion is that, in general, domestic firms in these sectors are just as environmentally friendly as foreign firms. What would explain such convergence? Firstly, the stringency of the domestic environmental regulations has pushed for higher environmental standards in both sectors; secondly, and specifically in the case of the pulp and paper sector, international market environmental requirements also corroborated to this trend. Last but not least, the technological competencies accumulated by the domestic firms in both sectors, which are closely related to the strategic state industrial policies applied to them, strengthened their capability to entry into an environmental technological path. One policy lesson drawn from these case studies is that attracting FDI is not a guarantee of a higher level of sectoral environmental control, while an integrated policy approach to environmental, technological and industry capacity to enhance national environmental control at the industry level is highly recommended.

Introduction

Two conflicting views stand out in the literature on the environmental effects of FDI. On the one hand, it is widely emphasized that transnational corporations (TNCs), the major players in FDI, are supposed to have positive environmental effects on the host countries by means of transferring environmentally friendly technologies and advanced environmental management systems, pushing for higher environmental standards and being ahead of domestic firms' environmental performance. On the other hand, it is pointed out that TNCs can strategically locate their FDI in countries where they face less stringent environmental regulations, i.e., they can search for "pollution havens" in developing countries. Aiming to protect the environment, the policy approach to TNCs is radically distinct depending on which of these views prevails. According to the first one, the more liberalized is the economy to FDI, the best for the environment, while according to the second view, regulating the environmental performance of TNCs is crucial.

Beyond these two extreme conflicting views, considering that the effects of FDI in host economies are very varied, case-specific and sectoral case studies are recommended as an adequate methodology to assess their environmental impacts (Zarsky, 1999; UNCTAD, 2004; Araya, 2005).

Departing from the questions addressed in the literature on the environmental effects of FDI and the above recommended methodological approach, this paper brings a comparative analysis of these effects of FDI in Brazil's pulp and paper and petrochemicals sectors aiming to draw out some policy lessons. The main reasons for addressing these sectors are: their potential for environmental impacts; the worldwide importance of FDI in these sectors; and their contribution to the Brazilian economy (high share of national production and exports).

The Context: a historical perspective of the FDI in pulp and paper and petrochemicals sectors in Brazil

It is worth to notice that there is a sharp contrast between the two sectors concerning the share of FDI in a historical perspective.

The establishment of the petrochemicals industry in Brazil can be traced back to the beginning of 1970's, as a governmental initiative that adopted the "tripartite model" for joint ventures: 1/3 of the capital belonged to a state owned firm under the control of Petroquisa (the petrochemical holding of Petrobras) that was the supplier of the raw material (naphtha) and basic petrochemicals; 1/3 belonged to a Brazilian partner; and the remaining 1/3 belonged to a foreign partner, usually the supplier of the technology. This means that the establishment of the petrochemicals industry in Brazil was marked by strong State and FDI participation.

In the nineties, under the liberalizing economic reforms implemented by the Brazilian government, the structure of the Brazilian petrochemicals changed deeply due to privatizations and several mergers & acquisitions, coinciding with a worldwide concentration process in this sector. According to Miranda & Martins (2000) 76% out of the total value of assets negotiated for the privatization of the petrochemicals sector from 1991 to 1997 were acquired by domestic firms or consortia with very little engagement of foreign companies. Following the international trend, foreign companies initiated a process of concentration of their investments on higher aggregated value chemicals, leaving basic chemicals for the domestic companies (Mercado & Antunes, 1998). Consequently, the number of TNCs in the Brazilian petrochemicals was substantially reduced¹.

The establishment of the pulp and paper sector in Brazil was also strongly supported by government incentives, initiated at the end of the 1950's, but exclusively towards national private companies.

Table 10. 1. FDI to the Brazilian Pulp and Paper Industry, from 1980 to 2006

Year	FDI, <i>thousands of dollars</i>
1980	0.37
1981	0.44
1982	0.46
1983	0.45
1984	0.49
1985	0.55
1986	0.56
1987	0.60
1988	0.61
1989	0.74
1990	0.76
1991	0.78
1992	0.74
1993	0.75
1994	0.76
1995	3.92
1996	21.94
1997	0.00
1998	0.00
1999	12.50
2000	10.31
2001	150.01
2002	10.77
2003	348.30
2004	177.32
2005	158.62
2006	1,797.38

Source: Brazilian Central Bank.

Until recently, the presence of TNCs in the Brazilian pulp and paper sector had not been significant, but since the year 2001 this sector has been receiving increasing influx of FDI. Foreign investment in this sector increased from US\$ 8.1 millions per year between 1995-2000 to US\$ 440.4 millions on average per year between 2001 and 2006ⁱⁱ. This recent trend of the FDI into the Brazilian pulp and paper sector is probably connected to the general international trend for substituting long for short-fiber pulp that has been observed in the world pulp industry. The international producers are searching for new mixtures of the two fibers aiming to increase the content of short-fiber pulp, which is the cheapest one. Consequently a huge increase in the international demand for short-fiber pulp is expected. This trend implies that Brazil has become a

preferential destination for the big pulp and paper TNCs investments, because this is a water and land resources abundant country and, above all, because it is highly competitive in the production of short-fiber pulp, controlling the eucalyptus technology production and the paper production based on short-fiber pulp.

The Research Approach: questions addressed

Besides secondary research sources, both case studiesⁱⁱⁱ were based on field research, dated on different periods - 1999-2000 for the petrochemicals sector and 2005-2006 for the pulp and paper sector -, marked by: increasing rates of growth of domestic production in both sectors; restructuring including privatization in the case of the petrochemicals sectors; and an increasing influx of FDI in the pulp and paper sector.

The pulp and paper sector case study involved a sample of nine companies (see Table 10.2), including five national and four foreign firms, seven branches of pulp and paper sector labor unions and six regional offices of the environmental control agency of the state of Sao Paulo (CETESB). In 2004 these nine companies were responsible respectively for 81.4% and 52.3% of pulp and paper production in Brazil. The four TNC subsidiaries in the sample represented 98.4% of the pulp production and 46.2% of paper production by foreign firms in Brazil in 2004 (BRACELPA, 2005)^{iv}.

The pulp and paper production has high potential for environmental impacts because it is an energy and natural resources intensive activity, consuming high levels of timber and water, generating toxic chemical substances that can pollute water and causing a characteristic unpleasant smell. These are reasons why this sector has been constantly supervised by government authorities, environmental NGOs and consumers (Dalcomuni, 1997). Since evidences of dioxins wastes that are cancerous substances were found in paper packages in the decade of 1980, the pulp and paper sector has been under increasing environmental pressure (Corazza, 1996).

The comparison of the environmental performance between domestic and foreign companies in the pulp and paper sector took into account the specifics of their production processes. Most of the sampled firms have integrated plants, i.e., plants that produce paper and pulp (see Table 10.2). The exceptions are Aracruz (Brazilian) and Cenibra (TNC) that produce only eucalyptus short-fiber pulp and so they were compared to each other. The firms with integrated plants were grouped by similar production processes as it follows: i) Votorantim, Suzano Bahia Sul and Ripasa (Brazilian firms) and International Paper (TNC) are integrated producers of pulp and writing and printing paper; ii) Klabin (Brazilian) and Rigesa (TNC) produce pulp and mainly packaging papers and corrugated paperboard package; iii) Norske Skog stands alone once it is the only manufacturer of newsprint paper in Brazil, besides its own pulp production.

The pulp and paper sample encompassed companies with plants located in several Brazilian states, and concentrated in the Southeastern states, mostly in Sao Paulo and Santa Catarina (see Figure 10.1).

The petrochemicals sector case study was based on a sample of 17 companies, including 13 Brazilian firms, 3 foreign firms and one shared-owned (half foreign-national capital) (see Table 10.3). These companies encompassed 33 out of 57 plants concentrated in the three major petrochemicals complexes located in Camaçari, Capuava, and Triunfo (respectively in the state of Bahia, São Paulo, and Rio Grande do Sul – see Figure 10.2), including their respective large-size crackers (Copene, PQU-Petroquímica União, and Copesul).

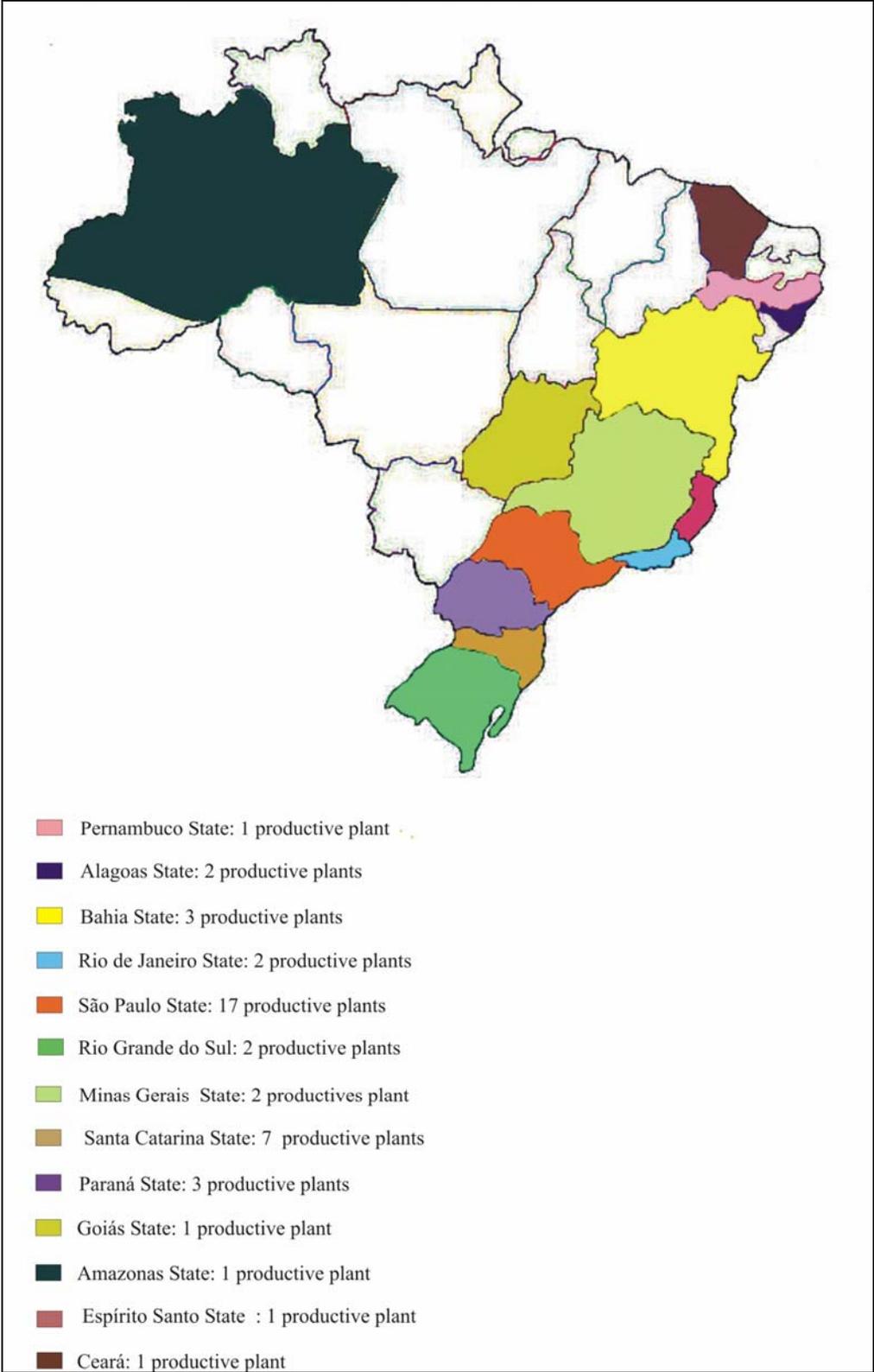
Table 10. 2. Pulp and Paper Companies Sample: production profile

Companies	Main Products	Production Capacity, 2005 <i>ton/year</i>		Number of Plants, 2005	Export, Average for 2002-2004 <i>percent of yearly production</i>	
		Pulp	Paper		Pulp	Paper
National						
Aracruz	pulp	3,000,000	40,000	3	97	-
Klabin	pulp, eucalyptus and pinus logs, improved seeds of eucalyptus and pinus, packaging paper, corrugated box, boards, craft paper for sacks and envelopes, sacks	1,200,000	1,500,000	18	-	55.7
Ripasa	pulp, industrial base paper, cut size, coated and uncoated paper and paperboard	570,000	380,000	4	-	46.7
Suzano Bahia Sul	pulp, cut size, coated and uncoated paper and paperboard	1,290,000	1,350,000	3	36.1	40
Votorantim	pulp, cut size, coated and uncoated paper and chemical papers	1,300,000	635,000	4	44.3	28.7
Total 1	-	7,360,000	3,905,000	32	-	-
Foreign						
Cenibra	pulp	940,000	-	1	95	-
International Paper	pulp, eucalyptus and pinus chips, improved wood of pinus, coated and uncoated paper.	450,000	600,000	2	^a	^a
Norske Skog	newsprint paper	170,000	185,000	1	-	1.33
Rigesa	packaging paper and corrugated paperboard packages	220,000	320,000	9	^a	^a
Total 2	-	1,780,000	1,105,000	13	-	-
Total 1+ 2	-	9,140,000	5,101,000	45	-	-

Source: Rocha and Almeida (2007).

^a Data is not available.

Figure 10.1. Pulp and Paper Industry: sample geographical distribution



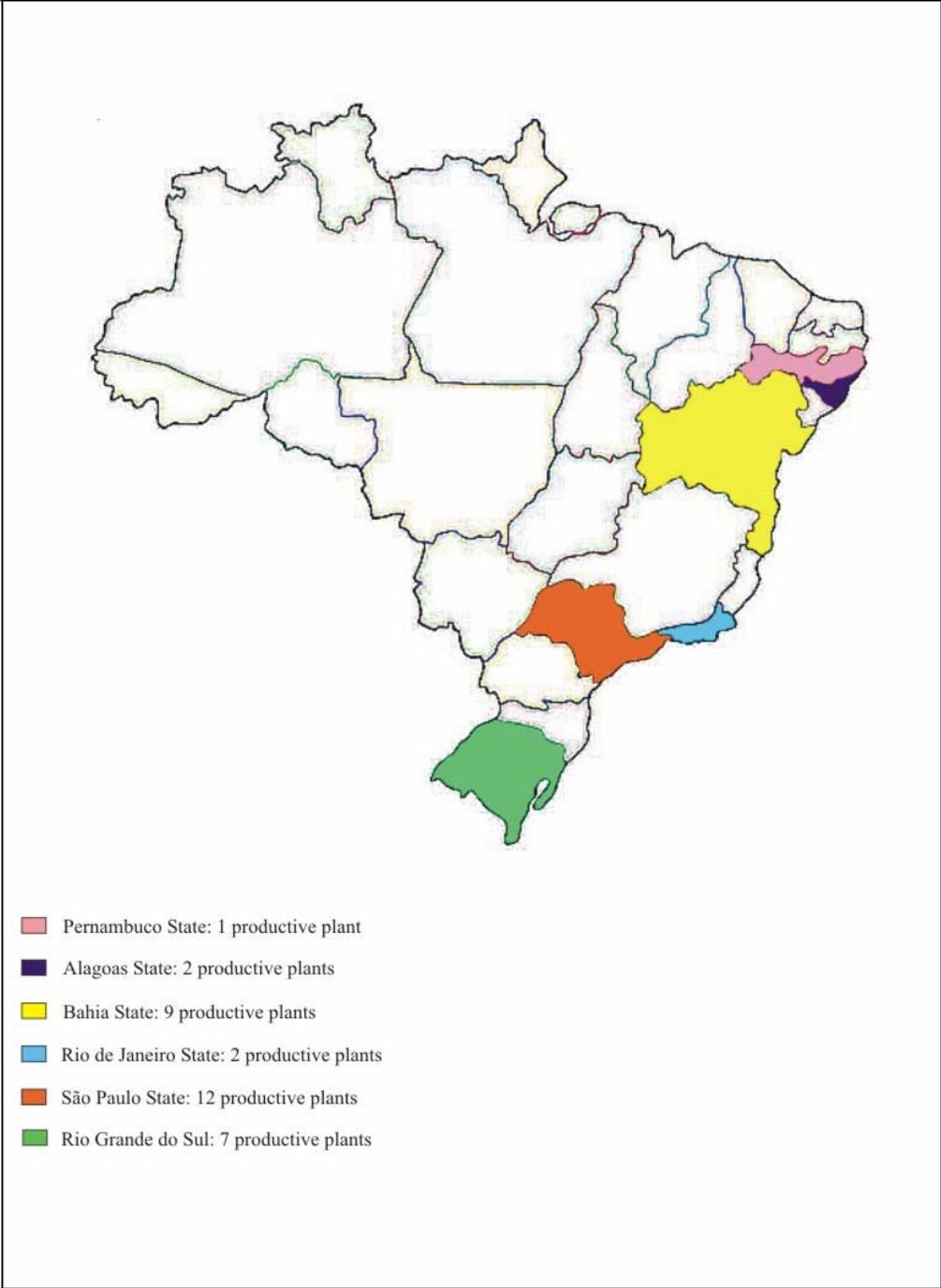
Source: our elaboration based on Rocha and Almeida (2007).

Table 10.3. Petrochemical Companies Sample: production profile

Companies	Main Products	Production capacity, 2000 <i>ton/year</i>	Number of plants, 2000	Export, Average for 1999-2000 <i>percent of yearly production</i>
National				
Acrinor	acrylonitrile	88,000	1	49.0
Copene	ethene, benzene and propene	1,200,000 ^a	1	8.6
Copesul	ethene, benzene and propene	1,135,000 ^a	1	11
Deten	alkilbenzenes	170,000	1	nd
Metacril	Ammonium sulfate and methyl methacrylate	45,000 ^b	1	19.3
OPP-Triken	resins, polypropylene, low-density polyethylene, high-density polyethylene, linear low-density polyethylene, Ethylene vinyl acetate copolymer, vinyl polychloride, chorine and sodium hydroxide	1,390,000	9	51.0
Oxiteno	ethene oxide, polyethyleneglycol and fatty acids ethoxylated	302,000 ^c	5	25.1
Petroflex	polybutadiene and styrene-butadiene rubber	275,800 ^d	3	4.2
Petroquímica Triunfo	<u>Ethylene copolymer, vinyl acetate</u> and low-density polyethylene	150,000 ^e	1	66.7
Petroquímica União	ethene, benzene and propene	500,000 ^a	1	8.7
Polibrasil	polypropylene	430,000	3	15.3
Policarbonatos	polycarbonate	13,500	1	24.3
Unipar	cumene and isodecanol	183,000 ^f	1	17.50
Total 1	-	5,882,300	29	
Foreign				
Bayer	acrylonitrile	88,000	1	11.6
Columbian	carbon black	173,000	1	5.0
DSM	EPM/EPDM rubber	25,000	1	50.0
Total 2		286,000	3	
National/Foreign				
Carbocloro	chorine and sodium hydroxide	253,000 ^g	1	6.0
Total 3		253,000	1	
Total 1+ 2 +3	-	6,421,300	33	-

Source: Our elaboration based on Almeida (2001)^y.

Figure 2. Petrochemical Industry: sample geographical distribution



Source: Our elaboration base on Almeida (2001).

The petrochemicals sector is one of the most addressed by environmental regulations due to its high potential for environmental impacts, since it is also a natural resources intensive activity, making use of high levels of non-renewable fossil resources (oil and natural gas) and water, resulting in a high potential of pollution. Moreover, the environmental control in this sector is

crucial because the petrochemicals products are used as intermediate goods by a great variety of final manufacturers, presenting a huge potential for spill-over effects of environmental impacts.

The environmental impacts of the petrochemicals production depend on the technical specifics of each petrochemicals complex configuration, each firm and plant, and obviously on the local environmental absorption capacity. Anyway, it is possible to identify the main environmental problems potentially generated by the petrochemicals production as atmospheric emissions, liquid effluents and solid wastes. Especially of concern are the hazardous wastes for which specific disposal treatment is required otherwise they can cause soil and water contamination with serious consequences for the environment and public health.

The sampled petrochemicals firms operated in different segments of the petrochemicals production – basics, intermediate and final goods (see their products in the Table 10.2) – and had plants in different locations (see Map 2). So,

considering all the specifics involved, the analysis of the empirical findings of this case study were carefully contextualized.

Besides the information provided by the companies themselves and by the Brazilian Chemical Industry Association, this case study also was based on reports from the main offices of the environmental control agencies in the three states where these petrochemicals complexes are located (Sao Paulo, Bahia and Rio Grande do Sul).

It must be pointed out that the petrochemicals case study was originally conducted as an illustrative case of a doctoral thesis^{vi} that was not exclusively focused on comparing environmental performance of domestic and foreign companies, but generally focused on the importance of the international context to foster domestic environmental commitments. This is one of the reasons for the reduced number of foreign companies in this sample. The other reason is that, as mentioned above, the petrochemicals case study was developed in the context of the privatization and concentration process in this sector that resulted in a reduced number of foreign firms in the Brazilian petrochemicals industry.

The main questions addressed in the study cases on pulp and paper and petrochemicals sectors in Brazil were:

1. Which was the level of the environmental control system in these sectors? Was there any evidence of falling behind international standards in the sense of the “pollution havens” hypothesis?
2. Which was the profile of the leading companies in environmental management systems? Were they big, exporters, foreign companies?
3. Which were the driving forces to firms’ commitments towards environmental improvements? Were they most related to international environmental requirements or domestic environmental regulations?

The assessment of the environmental control system in both sectors was based on emission indicators provided by the companies or the state environmental control agencies^{vii} and several quantitative and qualitative indicators referred to the firm’s environmental management system such as^{viii}: if the environmental department was well integrated to other firm’s departments; if the company had clearly established objectives and goals to environmental control, under ISO 14001 certificate or not; which environmental-related initiatives had been already introduced; the

percentage of environmental investments out of total investments; and which were the firm's procedures to get updates on environmental regulations (through written notifications by the state environmental control agency, through online database on environmental regulations etc.). Taking into account all the indicators – quantitative and qualitative – it was possible to assess the firm's environmental control system, basically if it followed a preventive or corrective approach to environmental impacts, and the firm's environmental management system was classified into three levels as described below:

- *Initial level (I)*: environmental management focused mainly on pollution control through 'end-of-pipe' treatment technologies, which is a curative rather than preventive approach;
- *Intermediary level (II)*: includes efforts to prevent pollution; the firm is continuously making efforts to upgrade its environmental performance, reducing or eliminating wastes and effluents, introducing systems to reuse wastes and effluents to save water, energy, raw material and so on;
- *Advanced level (III)*: besides the introduction of management systems for controlling the environmental impacts of the production process, it includes all the impacts at any point of the product life cycle as well. The environmental impacts are controlled since the selection of raw materials up to the distribution and the final disposal of the product by consumers. The purpose is to recover, reuse and recycle the materials used in the production process and the product after its consumption.

Some firms could also be at a *transitional level*, presenting characteristics of more than one level at the same time, i.e., transiting from the initial to the intermediary level or from this to the advanced level.

Empirical Findings

Concerning the first question addressed - if the environmental control systems in these sectors were falling behind international standards -, the evidences were against this hypothesis.

In the case of the pulp and paper sector, the indicator of environmental management systems showed that all companies were at least at the intermediary level (see Table 10.4). Precisely, among the nine sampled firms, five were at the intermediary level and four at the advanced level. All the sampled companies had at least one plant certified with ISO 14001; seven counted their environmental investments between 2002-2004, showing that they were taking initiatives to control their environmental impacts. Considering emissions indicators for the most important environmental problems of the industrial phase of the pulp and paper sector - such as high demand of water and energy, generation of toxic effluents and malodorous smell -, all firms were complying with emissions regulations or even presenting a better environmental performance^{ix}.

The assessment of the environmental control system of the Brazilian petrochemicals sector also did not corroborate to the hypothesis of "pollution havens". Considering all the evidences, 12 out of 17 firms (71% of the sample) had already overcome the initial level of environmental management system (see Table 10.5). Precisely, among the sampled firms: five (30%) were still at the first environmental management level; seven (41%) were transiting to the intermediary level; one firm (6%) was at the intermediary level; and four (23,5%) were approaching the advanced level. The sampled petrochemicals companies were predicting a regulatory context of more stringent environmental requirements and so they were compelled to catch up with international environmental standards. This trend was evidenced by the following indicators: the

firms presented significant percentage of environmental investments out of total investments (around 10%); 65% of the firms were subscribers of the Corporate Environmental Program of the chemical industry (Responsible Care Program^x) for five or more years; and 41% were certified with ISO 14001.

Table 10.4. Environmental Management System in the Pulp and Paper Sector

Companies	Certification		Environmental investments, average for 2002-2004 ^a , <i>percent of yearly total investments</i>	Environmental management level
	ISO 14001	Certified plants		
National				
Aracruz	yes	2 from 2	1.38	II ⇒ III
Klabin	yes	4 from 18	11.73	II ⇒ III
Ripasa	yes	1 from 4	4	II
Suzano Bahia Sul	yes	1 from 3	7.18	II ⇒ III
Votorantim	yes	2 from 4	9.77	II
Foreign				
Cenibra	yes	1 from 1	2.79	II ⇒ III
Internacional Paper	yes	1 from 2	34	II
Norske Skog	yes	1 from 1	-	II
Rigesa	yes	1 from 9	-	II

Source: Almeida e Rocha (2007).

^a Klabin and Aracruz presented data for years 2003, 2004 and 2005 and Cenibra had data only for 2005.

+In respect to the second question addressed in the two case studies, about the profile of the leading companies in environmental performance, one common finding to both cases is that the TNCs companies were not always ahead the domestic ones. In the case of the pulp and paper sector, the findings were quite the opposite, i.e., in general, the national firms were leading this process. Considering emissions indicators for the most important environmental problems of the industrial phase of the pulp and paper sector, the sampled national firms presented an average of emissions lower than the TNCs in most of the cases, taking into account the specifics of each production segment.

The national firms were also ahead in terms of environmental management system in the pulp and paper sector (see Table 10.5). Among the five local firms, three were moving to the advanced level of environmental management system, while among the four foreign firms only one was moving to this level.

Table 10.5. Environmental Management System in the Petrochemical Sector

Companies	Certification		Environmental investments, average for 1997-1999, <i>percent of yearly total investments</i>	Environmental management level
	ISO 14001	Certified plants		
National				
Acrinor	-	-	17,5 ^a	I
Copene	-	-	0,4	I ⇒ II
Copesul	yes	1 from 1	-	II ⇒ III
Deten	yes	1 from 1	-	I ⇒ II
Metacril	-	-	5,3	I
OPP-Triken	yes	9 from 9	50,4 ^b	II ⇒ III
Oxiteno	-	-	4,5	I ⇒ II
Petroflex	yes	3 from 3	3,0	I ⇒ II
Petroquímica Triunfo	-	-	-	I ⇒ II
Petroquímica União	-	-	0,2 ^c	I ⇒ II
Polibrasil	yes	3 from 3	2,1	II
Policarbonatos	-	-	5,1 ^c	I
Unipar	-	-	9,2	I
Foreign				
Bayer	-	-	21,9 ^a	I ⇒ II
Columbian	-	-	-	I
DSM	yes	1 from 1	-	II ⇒ III
National/Foreign				
Carbocloro	yes	1 from 1	0,3 ^c	II ⇒ III

Source: Our elaboration based on Almeida (2001).

^a Available data just for 1998 and 1999.

^b It also includes the investments in health and work security.

^c Environmental investment/net revenue in 1998 and 1999.

In the petrochemicals case study, among the domestic firms 69% had already overcome the initial level of environmental management, including one large-size cracker (Copesul) that was implementing higher environmental commitments^{xi}. The shared-owned national-foreign firm was transiting to the advanced environmental management level. Among the three sampled foreign firms, one was in transition to the advanced environmental management level, one was in transition from the first to the intermediate level and one was still at the first level. These two foreign firms that were lagging behind were relatively recent cases of acquisitions of national firms by foreign ones, what could explain why they were not yet aligned with the environmental

management system at their respective matrix. Therefore, based on the data provided by the petrochemical case study, it is neither possible to state that TNCs companies were ahead the domestic firms in terms of environmental management system nor that they were deliberately falling behind the domestic firms. It is also important to remind that the presence of TNCs in the Brazilian petrochemicals industry decreased in the nineties and the sample of firms in this case study reflected this trend.

In respect to the size of the leading companies in environmental management, big firms were leading the initiative pro-environmental commitments and the small and medium sized ones were lagging behind in both sectors. Nevertheless, the case studies found different evidences concerning the importance of the international markets to push for environmental commitments of the big companies. While in the pulp and paper sector exporter firms were evidently the leaders, among the firms that were leading the environmental management in the petrochemicals sector there were small exporters, and large exporters at the initial level of environmental management were found (see Tables 10.2 and 10.3 for the firms' export performance). So, contradicting the pulp and paper case, the petrochemicals case study did not corroborate the hypothesis, widely emphasized in the literature, that exporter firms are the leaders in environmental management.

Still on the profile of the leading firms, a common finding to both case studies was that the leaders in environmental management were also ahead in terms of quality management. From the petrochemicals' sample only two firms had not yet been certified by ISO 9000 and coincidentally they were not subscriber of the Responsible Care Program either certified by ISO 14001, and they were at the first level of environmental management. In the pulp and paper sector, the leading companies in environmental management were exactly those ahead in technological innovations.

Summing up, based on data provided by the pulp and paper and petrochemicals case studies, the profile of the leading firms in environmental management included: large sized firms, national rather than foreign ones (in the petrochemicals, this was probably due to the case study context), with advanced quality management systems and varied export performance.

Finally, concerning the third question addressed in the pulp and paper and petrochemicals case studies - about the driving forces to firms' commitments towards environmental improvements -, the importance of the domestic environmental regulations was highly emphasized by the companies from both sectors. Moreover, and particularly in the case of the pulp and paper sector, environmental requirements arising from international markets were also pushing for higher environmental commitments. In this sector, and especially in the pulp segment, national producers are big exporters and since the end of 1980s they had been facing increasing competitive pressure related to environmental requirements. So, to preserve their market shares, they started to invest in forest and industrial certification systems, to introduce updated technologies for controlling and preventing pollution and to implement measures to reduce resources consumption.

While in the petrochemicals sector, contradictory evidence was found, as big exporters lagging behind in environmental issues and leading companies in environmental management system with varied export performance (see Table 10.3). It means that the petrochemicals firms' environmental commitments were not correlated to environmental requirements arising from international markets, i.e., their environmental commitments were regulatory-driven rather than market-driven. Although petrochemicals firms were usually induced by domestic environmental

regulations to introduce environmental innovations in their methods and production processes, they were also envisaging economic opportunities as costs reduction as a consequence of such compliance. Additionally, the sampled petrochemicals firms seemed to be concerned about their external image in the sense that potential investors would not be attracted if they perceived any risk of hidden environmental costs associated with their investments.

A summary of the empirical findings for the three main questions addressed in these two case studies is presented in the Figure 10.3.

Figure 10.3. Environmental Control: Comparing Petrochemicals and Pulp & Paper Sectors

Environmental Control	Petrochemicals	Pulp and Paper
Level	Intermediary, against “pollution haven” hypothesis	Intermediary to advanced, against “pollution haven” hypothesis
Leading Firms	National and foreign, large sized, varied export performance	Most national, large sized, exporter
Driving Forces	Regulatory-driven	Market-driven

Final Remarks

In both cases there is evidence neither to support the thesis that TNCs’ environmental performance is ahead of domestic firms’ performance nor that TNCs are using Brazil as a “pollution haven”. It means that, in general, domestic firms in these sectors are just as environmentally friendly as foreign firms.

Several factors can explain this general trend of convergence in environmental performance between domestic and foreign firms, starting with the stringency of environmental domestic regulations towards sectors characterized by high pollution and natural resource consumption potential. Firms in such sectors are compelled to establish and operate effective and efficient environmental management systems to comply with regulations under continuous supervision of local environmental control agencies, customers, and the environmental movement in general. Additionally, and particularly in the pulp and paper sector, demand-driven environmental requirements arising from international markets can also explain such convergence.

Nevertheless, one factor seems to be especially important for policy considerations: both sectors are historically characterized by domestic firms with high level of technological capacity, meaning that there is not a significant technological gap between the TNC affiliates and the local firms. Although technological knowledge is not a guarantee of high level of environmental performance, it seems to be a necessary condition for this. For instance, in both case studies it was found a high correlation between the existence of quality management systems, technological innovations, and environmental management systems. Furthermore, it is well-known that the technological capacity accumulated by the domestic firms in these sectors is closely related to the state industrial policies historically applied to them, through incentives to the private firms, and

especially in the petrochemicals sector where Petrobras played an important role via technological spillover effects.

Drawing on the case studies briefly reported here, attracting FDI is not a guarantee of a higher level of sectoral environmental control, while an integrated policy approach to environmental, technological and industry capacity to strengthen national environmental control at the industry level is highly recommended.

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ⁱ There are no statistically comparable available data on the amount of FDI to the Brazilian petrochemical sector for the period from the 1970's to present, but aggregated data for the whole chemicals sector.

ⁱⁱ In 2006, a single North American company – International Paper - was responsible for US\$ 1.2 billion of the FDI in the Brazilian pulp and paper sector (UNCTAD, 2007, p58).

ⁱⁱⁱ ALMEIDA, L. T. de (2001). *Harmonização Internacional das Regulações Ambientais. Um Estudo da Petroquímica Brasileira*. Doutorado em Economia. Instituto de Economia da Universidade Estadual de Campinas, Campinas, Brasil; ROCHA, S. dos S., ALMEIDA, L. T. de (2007). “Does Foreign Direct Investment Work for Sustainable Development? A case study of the Brazilian pulp and paper industry”. Discussion Paper Number 8. Working Group on Development and Environment in the Americas, GDAE-Tufts University.

^{iv} For more information on the significance of this sample see Rocha & Almeida (2006).

^{v a} Production capacity of ethene.; ^b Production capacity of ammonium sulfate.; ^c Production capacity of ethene oxide; ^d Production capacity of styrene-butadiene rubber; ^e Production capacity of low-density polyethylene; ^f Production capacity of cumene; ^g Production capacity of chlorine; ^h For the year 1997; ⁱ Average for 1998-99.

^{vi} This thesis is entitled *International Harmonization of Environmental Regulations: A case study of the Brazilian petrochemicals industry* (Almeida, 2001).

^{vii} Emissions indicators per company were not available for the petrochemicals sector, but for most companies in the pulp and paper sector.

^{viii} The assessment of the environmental control system in the pulp and paper sector here refers just to the industrial phase, i.e., the forest phase is not included in this study.

^{ix} According to the Environmental Control Agency from the state of Sao Paulo (CETESB).

^x The Responsible Care Program was created in 1985 by the Canadian Chemical Producers Association and adopted by the U.S. Chemicals Manufacturers Association in 1989 in a context of declining public opinion about the chemical industry. After being recommended by the International Council of Chemical Associations, Responsible Care was rapidly worldwide widespread as the Environmental Corporate Program of the chemicals industry (Roberts, 1998).

^{xi} This cracker is located in the state of Rio Grande do Sul (Southern of Brazil) where there is a very active environmental social movement that is also reflected on this state environmental regulations, supposed being more stringent than in other Brazilian states, at least concerning the environmental regulations applied to the petrochemicals sector.