

Impact on the Environment of Thailand's Trade with OECD Countries

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ABSTRACT

The impact of trade liberalization on the environment is a matter of debate. Two conflicting hypotheses have emerged from the debate. One, the pollution haven hypothesis, suggests that the developed countries impose tougher environmental policies than do the developing countries, which results in distortion of existing patterns of comparative advantage. Thus, the polluting industries shift operations from the developed to the developing countries; developing countries therefore become “pollution havens.” The second hypothesis, the factor endowment hypothesis, predicts that trade liberalization will result in trade patterns consistent with the Heckscher-Ohlin-Vanek theory of comparative advantage based on factor endowment differentials. Rich countries are well endowed with capital. Since capital-intensive goods are often also pollution-intensive, factor-endowment theories of international trade predict that rich countries specialize in polluting goods. Thus, the manifestation of the pollution haven hypothesis is in direct conflict with the factor

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endowment hypothesis. This debate is of great concern among economists, environmentalists and the World Trade Organization.

Among all South and South-East Asian countries, Thailand can be regarded as one of the fastest growing economies. The average annual growth rate between 1980 and 2004 was about 7 per cent (NESDB, 2003). This high economic growth rate was led by the growth in the manufacturing sector. Liberalization of trade has been the main driver and cornerstone of growth in the Thai economy. Countries in the Organisation for Economic Co-operation and Development (OECD) are major trading partners of Thailand and hold a consistent share of the country's total trade: approximately 55 per cent during the period from 1980 to 2000 (Bank of Thailand, various years). Throughout the past four decades, Thailand has been a significant recipient of foreign direct investment (FDI) among developing countries and these inflows boomed in the period 1995-2000. An important proportion of FDI has been from OECD countries. The major receiving sector of OECD investment is industry, the share of which has increased from 52.7 per cent of the total in 1990 to 62.6 per cent in 2000. This paper evaluates the impact on the environment of Thailand's trade with OECD countries, focusing on the two hypotheses during the period 1980 to 2000. Further, it examines the implications of FDI for the environment. The framework of the analysis is based on the input-output approach extended and modified for the purpose of this study. Results show that Thailand was a pollution haven in 2000, which does not support the factor endowment hypothesis. Moreover, FDI promotes exports that have impacts on the environment. Policy implications are discussed in the paper.

1. INTRODUCTION

One of the major policy challenges of the decade is to promote liberal trade while protecting the environment and preserving natural resources. International trade contributes to economic growth and benefits all participating countries, while economic growth, in turn, increases the demand for environmental quality. This complex relationship between trade and the environment has generated debate. Two conflicting hypotheses have emerged from the debate. The first one, the pollution haven hypothesis, suggests that the developed countries impose tougher environmental policies than do developing countries, which results in distortion of existing patterns of comparative advantage. Thus, polluting industries shift operations from the developed to the developing countries; developing countries therefore become "pollution havens". The second hypothesis, the factor endowment hypothesis, predicts that trade liberalization will result in trade patterns consistent with the Heckscher-Ohlin-Vanek theory of comparative advantage based on

factor-endowment differentials. Developed countries are well endowed with capital. Since capital-intensive goods are often also pollution-intensive, factor-endowment theories of international trade predict that developed countries specialize in producing polluting goods. Thus, the manifestation of the pollution haven hypothesis is in direct conflict with the factor endowment hypothesis. This debate is of great concern to economists, environmentalists and the World Trade Organization (WTO).

Thailand is a good laboratory for testing these two hypotheses. Among all South and South-East Asian countries, Thailand can be regarded as one of the fastest growing economies. The average annual economic growth rate between 1980 and 2004 was about 7 per cent. The country's liberalized trade policy has been the main driver and cornerstone of this growth.

Thai exports have increased significantly by 45 per cent in the period 1980-1985, 342 per cent by 1990, 955 per cent by 1995 and a staggering 2,406 per cent by 2003. Just as Thailand's exports experienced rapid growth so have its imports.

OECD countries are major trading partners of Thailand and account for a consistent share of approximately 55 per cent of the country's total trade during the period from 1980 to 2000. Thai exports to OECD countries doubled in value terms with diversification since the mid-1990s, whereas imports from OECD countries followed a less regular trend. In terms of investment, the OECD share was more than 65 per cent in 2000, the most important source of foreign direct investment in Thailand; it was followed by that of the Asian newly industrialized economies. Thailand's intra-industry trade has also grown significantly.

The diversification of the structure of Thailand's trade with OECD countries and the inflow of FDI has important implications for the environment and this matter needs to be researched. The current paper evaluates the impact on the environment of Thailand's trade with OECD countries, focusing on the two conflicting hypotheses (pollution haven and factor endowment) during the period from 1980 to 2000. Further, it analyses the implications for the environment of FDI from OECD countries.

The organization of the paper is as follows: the literature dealing with trade and environment is reviewed in section 2; discussions on the results are presented in sections 3 and 4; section 5 concludes with some policy implications; and information on the methodology and the data are provided in the appendix.

2. REVIEW OF THE LITERATURE

The literature linking trade and environment is growing (Tobey, 1990; Lucas and others, 1992; Low and Yeates, 1992; Mani and Wheeler, 1998; Cole and Elliott, 2001; Xing

and Kolstad, 2002; Eskeland and Harrison, 2003; Copeland and Taylor, 2003; Javorcik and Wei, 2005; Waldkirch and Gopinath, 2004). Several attempts have been made to use input-output models to address the issue (Wyckoff and Roop, 1994; Gale and Lewis, 1995; Antweiler, 1996; Proops and others, 1999; Machado and others, 2001; Munksgaard and Pedersen, 2001). However, only a few have addressed the pollution haven hypothesis and factor endowment hypothesis using the input-output model (Mukhopadhyay and Chakraborty, 2005a and 2005b).

The brief review of the literature suggests that the empirical evidence is still far from clear (Copeland and Taylor, 2004). The methodologies employed to test the hypotheses widely vary as do the results. Discussions about Thailand's trade-environmental relationship has received some attention in recent years (UNCTAD/UNDP, 1994; TDRI, 1996 and 2000; Jha and others, 1999; TEI, 2000). Unfortunately, no comprehensive work has been done in Thailand involving these issues together, in particular using input-output techniques.

3. DISCUSSION OF RESULTS OF THE MODEL

(a) *Does a pollution haven matter for Thailand?*

Japan, the United States and the European Union are Thailand's main trading partners. Since the pollution haven hypothesis originates from the North-South debate, the evidence on Thailand's trade with OECD countries will throw insight on the debate. An index known as the pollution terms of trade (equation 6) has been used to capture the pollution haven effect. The results are presented in table 1.

Table 1. Pollution terms of trade of Thailand with OECD countries for emissions of carbon dioxide, sulphur dioxide and nitrogen oxides from 1980 to 2000

<i>Emission</i>	<i>Thousands of tons of carbon dioxide</i>			<i>Thousands of tons of sulphur dioxide</i>			<i>Thousands of tons of nitrogen oxides</i>		
	<i>1980</i>	<i>1990</i>	<i>2000</i>	<i>1980</i>	<i>1990</i>	<i>2000</i>	<i>1980</i>	<i>1990</i>	<i>2000</i>
Pollution embodied in exports	4 120.11	2 711.49	8 579.35	41.55	26.14	83.11	9.13	11.76	35.47
Pollution embodied in imports	8 433.57	3 014.48	5 573.90	82.79	27.29	50.72	19.58	19.87	35.34
Pollution terms of trade	0.4885	0.8994	1.5392	0.5018	0.95786	1.6384	0.4664	0.5917	1.003
Pollution terms of trade*100	48.85	89.94	153.92	50.18	95.78	163.84	46.64	59.17	100.39

Source: Results are calculated by the author based on equation 6 in the methodology section in the appendix.

The values of the indices as displayed in table 1 show dramatic changes. The pollution terms of trade reveal an increasing trend of the indices during the period from 1980 to 2000 for all three pollutants. The values of the pollution terms of trade were below 100 during the 1980s and 1990s. In contrast, the values of the pollution terms of trade for 2000 were above 100 for all three pollutants. These results imply that Thailand exports dirty goods and imports clean goods. This finding seems to support, or at least not contradict, the pollution haven hypothesis for Thailand in the year 2000. In other words, Thailand's trade with OECD countries has had varied implications for the environment over the period 1980-2000. In the 1980s, the environmental impact was moderate but with the passage of time its severity increased; by the end of 2000, Thailand's trade with OECD countries created unfavourable impacts on the environment, thus turning Thailand into a pollution haven. Why has this happened? This question is explored in the following paragraphs.

The most prominent sectors in respect of the shares of exports and imports during the study period are presented in tables 2 and 3, respectively. Table 2 reveals a significant change in the composition of exports. The structure of Thailand's exports in the 1990s has diversified into a wide variety of products compared with those in the 1970s and 1980s.

Table 2. Share of exports of Thailand to OECD countries for the top 10 sectors
(Percentage)

<i>Major sectors</i>	<i>1980</i>	<i>Major sectors</i>	<i>1990</i>	<i>Major sectors</i>	<i>2000</i>
Food and food products	34.17	Food and food products	15.85	Radio, television sets, communication equipment	24.01
Non-ferrous basic metals	16.64	Miscellaneous services	14.12	Electrical and electronic appliances	14.77
Rubber products	9.90	Radio, television sets, communication equipment	12.44	Industrial machinery	10.09
Jewellery and related articles	6.22	Jewellery and related articles	8.56	Food and food products	9.97
Textiles	5.83	Leather and leather products	7.25	Miscellaneous manufacturing industries	6.95
Agricultural products	5.75	Other transport services	5.85	Other transport equipment	4.45
Electrical and electronic appliances	4.93	Textiles	5.57	Miscellaneous metal products	4.33
Miscellaneous services	3.29	Miscellaneous manufacturing industries	5.29	Jewellery and related articles	3.05
Miscellaneous manufacturing industries	2.67	Electrical and electronic appliances	4.85	Iron and steel	2.88
Other transport services	1.57	Industrial machinery	4.21	Wood and wood products, including furniture	2.84

Source: The share of exports and imports has been calculated by the author from input-output table of Thailand, 1980, 1990, 2000.

Table 3. Share of imports of Thailand from OECD countries for the top 10 sectors
(Percentage)

<i>Major sectors</i>	<i>1980</i>	<i>Major sectors</i>	<i>1990</i>	<i>Major sectors</i>	<i>2000</i>
Industrial machinery	15.59	Industrial machinery	24.81	Radio, television sets, communication equipment	21.10
Iron and steel	9.40	Other transport equipment	16.73	Industrial machinery	10.41
Miscellaneous services	8.38	Iron and steel	11.69	Miscellaneous metal products	8.83
Basic chemicals	7.71	Electrical and electronic appliances	9.75	Other transport equipment	8.17
Other transport equipment	6.99	Miscellaneous metal products	6.97	Electrical and electronic appliances	7.54
Miscellaneous metal products	6.79	Non-ferrous basic metals	4.04	Iron and steel	6.96
Other chemicals	6.30	Basic chemicals	3.65	Basic chemicals	5.33
Electrical and electronic appliances	4.62	Radio, television sets, communication equipment	3.46	Miscellaneous manufacturing industries	4.05
Fertilizers	4.17	Plastic products	2.31	Jewellery and related articles	3.43
Textiles	3.61	Textiles	2.23	Food and beverages	2.94

Source: The share of exports and imports has been calculated by the author from input-output table of Thailand, 1980, 1990, 2000.

Thailand's major exports in 1980 comprised food and food products, with a 34.17 per cent share. It dropped to 9.97 per cent in 2000. During the 1970s, agriculture was the main contributor to GDP and agricultural exports remained the main driving force behind the country's overall economic growth. From the late 1980s, the situation went into reverse and farm acreage shrank (Phongpaichit and Baker, 2003). The population directly supported by agriculture dropped by almost 4 million. Agriculture's contribution to GDP also declined. This rapid decline was partly a result of falling prices, faltering global trade and competition in the global rice market. Once the export-led industrial boom began in the mid-1980s, both public and private investment began to be concentrated in the urban economy to the detriment of agriculture. During the 1980s and 1990s, the orientation was more on textiles, rubber products and leather. On the other hand, radios, television sets, communication equipment, industrial machinery and electrical and electronic appliances together captured market shares of 21.55 per cent in 1990 and 48.87 per cent in 2000. Demand for these goods is favourable in the international market. These figures reveal how with the passage of time Thailand has become an exporter of manufactured goods to OECD countries, while the role of agriculture is declining. Another interesting feature observed in Thailand's trade with OECD countries is intra-industry trade. For example, Thailand imports from the United States and Japan raw materials for manufacturing electrical and electronic appliance products; it then exports the final product after assembly. For some

industries, Thailand acts as a component supplier; assembly of the final product is provided by the developed country.

The composition of the imported commodities has not changed significantly. The major sectors predominantly are basic chemicals, radio and television sets, communication equipment, other transport equipment, electrical and electronic appliances, iron and steel, and industrial machinery (see table 3). A large part of Thai imports are capital goods and intermediate products and raw materials which are used in expanding industrial capacity and supply inputs for many of Thailand's export industries.

The high value of the pollution terms of trade (more than 100) in 2000 was due to the high level of pollution generated by export-intensive sectors. Several questions might arise in this respect. Why has the composition of the traded commodities in Thailand changed? Why is Thailand exporting pollution-intensive goods at the cost of the environment? Are government policies not stringent enough to tackle these problems? To address all these issues it is necessary to take a critical look at the government policies, especially those relating to trade and environment.

Thailand's first national economic development plan was launched in 1961; it focused on import substitution in order to promote industrialization. The use of tariffs was the major instrument to influence the country's development path and Thailand effectively began in 1974 to promote domestic industry. A shift in the country's trade policy of export promotion has taken place, resulting in a reduction in tariff since the mid-1980s. The maximum rate was reduced from 100 per cent in the early 1990s to 30.24 per cent by the end of the 1990s, to 21 per cent in 1995 and to 17.01 per cent in 1997.

To promote exports, the Government of Thailand adopted several measures, especially after the 1980s (for example, lifting of export quota, reducing export duties on several commodities, providing business tax exemptions, promoting investment in manufacturing industries with strong export potential, such as those producing automobiles and parts, and extending export credit).

Thus, the Thai economy changed gears after the mid-1980s. As a result, the export of manufactures and services grew almost sixfold in six years. In the latter half of the 1980s, major Japanese firms transferred production processes to Thailand. Foreign investment in Thailand accelerated considerably from 1988 to 1990. The first stage of growth in export industries was focused mostly on labour-intensive and resource-based industries and led by domestic or joint ventures with Thai firms which had originally been established to supply the domestic market. By the end of that decade, foreign investment had begun to change the export mix towards technology-based products. Textile firms from Japan and garment firms from Hong Kong, China and Taiwan Province of China had relocated production to Thailand and other overseas sites since the 1970s. Such firms were

highly pollution intensive. Several major gem- and diamond-cutting businesses relocated to Thailand. After the 1990s, over half of the total exports increased basically from technology-based industries, especially automotive parts, computer parts and electrical goods which are highly pollution intensive (Lucas and others, 1992). By the late 1990s, Thailand had become one of the world's largest assemblers of disk drives for computers, and emerged as a regional centre for automobile manufacture. The three subsectors of automotive vehicles and parts, electrical goods and computer parts contributed significantly to total exports. Thailand's trade history reflects how the pollution-intensive industries relocated to Thailand. In this context, it may be said that Thailand always followed the strategy of "grow first, clean up later".

Thailand's proactive and ambitious trade policies aggressively pushed to increase the country's share of the global export market by means of establishing a healthy collection of bilateral and regional free trade agreements with its trading partners. Thailand signed the General Agreement on Tariffs and Trade/World Trade Organization protocol concluding the Uruguay round. The development of the North American Free Trade Agreement (NAFTA) has had an impact on Thai trade patterns with the United States. While NAFTA gives Thailand access to a larger market (United States, Canada and Mexico), Thailand also faces increased price competition from Mexico in some product lines. Another issue affecting Thai exports is the use of antidumping measures and countervailing duties on Thai products, as initiated by United States producers and carried out by the Government of the United States. However, United States investment has resulted in significant technology transfer to Thailand, which has created a great impact on the country's economy. Further, a "free trade area" under the framework of ASEAN was initiated by Thailand in June 1991; its goal was to integrate production structures towards improving the export outlook of ASEAN in the global market.

Although the above-mentioned trade strategies and policies relating to trade liberalization helped Thailand to diversify and boost its exports, this situation was not favourable to the environment. This adverse outcome has been made worse by the weakness of, and non-compliance with, environmental regulations.

Environmental regulations: To combat environmental deterioration resulting from trade-oriented growth, several pieces of environmental legislation were introduced in the past few years. The first such legislation was passed in 1975. However, a more comprehensive piece of environmental legislation is the 1992 Enhancement and Conservation of National Environmental Quality Act, which provides for a strong command-and-control regulatory framework to set standards and to monitor and enforce them. That Act strengthens existing laws within a policy framework outlined in the Seventh National Economic and Social Development Plan (1991-1996), which emphasized environmental standards. Another important legal instrument is the 1992 Factories Act, which regulates waste discharge from industrial plants. Similarly, the 1992 Hazardous

Substances Act provides control over the production, import and export or possession of hazardous substances that could become hazardous waste in the future. The Government introduced the Energy Conservation and Promotion Act in 1992 in order to promote and initiate energy conservation among all parties.

In addition, several policies were introduced for improving air quality. Two main government agencies have direct responsibility for monitoring air quality. The Pollution Control Department has established networks for monitoring air quality in five regions of Thailand and a total of 52 air quality monitoring stations are in operation.

A number of measures have been enforced to reduce ambient carbon monoxide concentrations. New automobiles must be equipped with specific pollution-control devices, such as catalytic converters, and fuel for vehicles must contain certain levels of oxygen in order to reduce the generation of carbon monoxide. The Government has also taken some steps to lower the sulphur content in fuel. For example, an order was issued in July 1994 to lower the sulphur content in fuel oil residues used in Bangkok and surrounding areas; sulphur content is not to exceed 2 per cent of the fuel by weight (TDRI, 2000). The same order was restructured in 1998 and again in 1999 to limit nationwide the sulphur content of fuel oil residues.

In spite of all these efforts, the implementation of the regulations has been far below expectations, as described in a report providing a detailed analysis of the reasons (TDRI, 2000). Lack of enforcement is a basic problem in Thailand. The degradation of the environment is the result of institutional failure, among other reasons. The policies, rules and organizations created to protect the environment also are not effective. One of Thailand's major strategies has been to encourage the private sector to play a key role in the economy. However, the private sector does not always support and promote environmental quality by adopting environment-friendly production processes. Moreover, although the country has no suitable environmental tax, Thailand proceeded to apply some tax measures to control pollution as of May 1997. Nonetheless, the December 2002 Environmental Sustainability Index, which was calculated by the World Economic Forum 2000 to show the state of the environment and how it is affected by human activities, ranked Thailand 46th out of 56 countries in terms of environmental sustainability. In a recent study, Rock (2002) discussed in detail the pollution management strategies in East Asia, comparing the performance of several economies (China, Indonesia, Malaysia, Singapore, Taiwan Province of China and Thailand) concluded that "to date, Thailand has had the least success in reducing industrial pollution and improving ambient environmental quality". Lax environmental regulations and non-compliance have thus distorted the pattern of comparative advantage in Thailand. The differences in the cost of complying with environmental regulations in Thailand compared with OECD countries have resulted in OECD countries relocating some industries in Thailand, thus pushing Thailand further towards being a pollution haven.

In this connection, it should be noted that differences in pollution policy are only one of many factors that affect trade. Relative production costs are determined not by pollution regulations alone and they are not an important determinant of costs (Copeland and Taylor, 2003). If other factors dominate to outweigh the effects of pollution policy on comparative advantage, trade may not result in a concentration of polluting industries in countries with weak environmental regulations. Developed countries are relatively capital abundant compared with developing countries, which are relatively labour abundant. Traditional factor-endowment effects would give a comparative advantage to high-income countries in dirty industries.

Whether additional motives for trade change these results needs to be examined. In other words, the next task is to investigate the role of factor endowments in determining Thailand's trade with OECD countries during the same period.

(b) Evidence relating to the factor endowment hypothesis

Estimates of capital and labour requirements to produce exports and imports worth 1,000 baht in 1980, 1990 and 2000 respectively, derived by equations 7 to 10, are reported in table 4.

The results show that Thailand's exports required more capital than did its imports in 2000 (imports are 5 per cent less capital intensive than exports). On the other hand, Thailand's imports were 33 per cent and 20 per cent more capital intensive than exports in

Table 4. Capital and labour requirements in exports and imports
(Thailand and OECD countries)

	1980		1990		2000	
	Capital requirements per 1,000 baht of output	Labour requirements per 1,000 baht of output	Capital requirements per 1,000 baht of output	Labour requirements per 1,000 baht of output	Capital requirements per 1,000 baht of output	Labour requirements per 1,000 baht of output
Exports	A _{kx} = 189003680.5	A _{lx} = 1321655.8	A _{kx} = 780161741.8	A _{lx} = 1872121.8	A _{kx} = 1713874498.0	A _{lx} = 1792523.8
Imports	A _{km} = 273144212.6	A _{lm} = 1432131.2	A _{km} = 530122021.1	A _{lm} = 1057617.2	A _{km} = 1165240358.1	A _{lm} = 1272383.7

Source: Results are calculated by the author based on equations 7-10 in the methodology section in the appendix.

Note:

1980

$$K_x = A_{kx}/A_{lx} = 143.005$$

$$K_m = A_{km}/A_{lm} = 190.725$$

$$K_m = 1.33 K_x$$

1990

$$K_x = A_{kx}/A_{lx} = 416.725$$

$$K_m = A_{km}/A_{lm} = 501.241$$

$$K_m = 1.20 K_x$$

2000

$$K_x = A_{kx}/A_{lx} = 956.1236$$

$$K_m = A_{km}/A_{lm} = 915.793$$

$$K_m = 0.95 K_x$$

1980 and 1990 respectively (table 4). According to the theory of factor abundance, Thailand, a developing economy, is supposed to export labour-intensive goods and import capital-intensive ones. However, Thailand was exporting capital-intensive goods in 2000. Thus, the evidence does not support the factor endowment hypothesis for Thailand for the year 2000, while it does for 1980 and 1990.

Why is this so? The shifting of exports from agriculture to manufacturing and from manufacturing to the emerging groups is one of the most important reasons for the change of production technology, from labour-intensive to capital-intensive technology. The scarcity of skilled labour has been another problem (Bank of Thailand, various years). Table 5 shows how Thailand has shifted its export economy from labour intensity to capital intensity.

Table 5. Percentage of labour and capital intensiveness in share of exports

<i>Exports (share of total)</i>	<i>1981-1985</i>	<i>1986-1990</i>	<i>1991-1995</i>	<i>1996-2000</i>
Labour share	15.7	27.8	25.9	16.7
Capital share (technology based)	7.0	20.9	39.9	54.2

Source: Bank of Thailand, *Quarterly Bulletin* (various issues).

During the first half of the 1980s the share of labour was more than that of capital, while in the first half of the 1990s, the share of capital was more than that of labour and in the second half of that decade the share was more than double that of labour. The transfer of technology with huge foreign investments in Thailand started coming from OECD countries (especially Japan and the United States). Industries which were set up in Thailand after the 1990s by other countries were generally large scale and capital intensive, with less employment-generation. Furthermore, the opening of such low-cost locations as China and Viet Nam undermines Thailand's comparative advantage in labour-intensive manufacturing to more skill- and capital-intensive activities. The export sectors with high employment and strong linkages, namely, agriculture, and resource-based and labour-intensive manufacturing, grew minimally. The resources have moved out of labour-intensive agricultural industries into more capital- and skill-intensive manufacturing and services industries. Thus, the above discussion provides an explanation why Thailand's exports were more capital intensive than labour intensive in 2000.

So far the paper has evaluated the impact of liberalized trade on the environment, focusing on two hypotheses: pollution haven and factor endowment. In this connection it has investigated the role of environmental regulations, factor endowments, trade policies and environmental energy policies and so on. It is important to note that the impact of trade flows on the environment can also be influenced by FDI other than the above-mentioned factors. The implications of FDI on the environment in Thailand will now be considered.

4. FDI AND ITS IMPACT ON THE ENVIRONMENT

The role of FDI has been widely recognized as a growth-enhancing factor in developing countries. Various studies have focused on the contribution of FDI to the economic development of Thailand (Pupphavesa and Pussarungsri, 1994; Siamwalla and others, 1999; Kohpaiboon, 2003).

In Thailand, the liberalization of trade and the ability to attract foreign investment have moved hand in hand. Foreign direct inflows of investment to Thailand boomed in the period 1995-2000. They increased from around \$515 million during the period 1970-1975 to over \$17,416 million during the period 1996-2000. The share of FDI in gross domestic investment (GDI), which was about 2-3 per cent in the 1980s, reached about 20 per cent in 2000. Further, over the years the share of total FDI entered mainly the manufacturing sector.

An important proportion of FDI has been from OECD countries (about 67.8 per cent in 1987, increasing to almost 75.7 per cent in 2000). The major receiving sector of OECD investment has been industry, the share of which increased from 52.7 per cent in 1990 to 62.6 per cent in 2000 (table 6). Electrical and electronic appliances, machinery and chemicals deserve mention. Japan was the major player in FDI in Thailand in the years prior to the crisis. Throughout the 1990s major investment from Japan was in electrical appliances, machinery and transport equipment. Along with Japan, the United States and the European Union have also been important sources of FDI. The attractions of investing in Thailand were varied: macroeconomic stability, rapid expansion of the domestic market (GNP growth of more than 6 per cent per annum during the period 1985-1995) and low labour cost, which provided a platform for exports and devaluation of the baht in 1984. There has been migration of dirty industries to Thailand from developed countries such as Japan. The appreciation of the Japanese yen resulted in relocation of production bases from Japan to Thailand in order to take advantage of the comparative advantage of Thailand.

FDI was predominant in import-substitution industries in the late 1970s. However, an increasing share of FDI was directed to more export-oriented activities, with a shift towards the manufacturing sector in the late 1980s and 1990s. The earlier analysis (section 4) clearly indicated that there has been a dramatic change in the composition of exports from agro-based ones to manufactures over the period 1980 to 2000. FDI played an important role in this shift.

What has been the effect of FDI on the environment? As is the case for trade, the environmental effects of FDI can be positive or negative. FDI helped to spur Thailand's competitiveness in international trade. The increase in competition for goods has prompted investors from high-cost production countries to relocate their production to low-cost countries. This relocation trend contributed not only to the structural development of the manufacturing sector in Thailand but also has an impact on the environment.

Table 6. Share of net inflow of FDI from OECD countries among sectors
(Percentage)

<i>Sectors</i>	<i>1987</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>
1. Financial institutions	8.70	5.62	0.34	7.96
2. Trade	17.26	16.12	23.13	10.91
3. Construction	12.68	6.47	1.94	0.77
4. Mining and quarrying	3.08	1.62	2.87	0.15
5. Agriculture	2.86	1.45	0.74	0.02
6. Industry	45.94	52.72	58.64	62.64
6.1 Food	2.21	2.95	1.27	1.05
6.2 Textiles	4.97	1.75	3.46	0.65
6.3 Metal-based and non-metallic	9.83	6.41	5.95	6.27
6.4 Electrical appliances	11.80	20.78	24.12	16.22
6.5 Machinery and transport equipment	2.06	5.65	9.02	20.34
6.6 Chemicals	8.63	7.04	5.28	13.95
6.7 Petroleum products	0.01	2.43	5.32	0.01
6.8 Construction materials	0.08	0.02	0.17	1.44
6.9 Other industry	6.35	5.68	4.05	2.70
7. Services	6.25	3.08	2.68	4.63
8. Investment	0.00	0.00	0.88	0.39
9. Real estate	3.22	11.81	8.78	1.33
10. Others	0.00	1.11	0.01	11.21
Total	100	100	100	100

Source: Computed by the author from the published and unpublished data of the Bank of Thailand.

To assess the impact, the pollution content of FDI from OECD countries was computed following equation 11 in the technical appendix for the year 2000. The results are 428.49 tons of carbon, 3.54 tons of sulphur and 4.07 tons of nitrogen oxides for carbon dioxide, sulphur dioxide and nitrogen oxides, respectively.

Moreover, FDI can be treated as an input in the economy for enhancing its productive capacity. This in turn has influenced the export performance of the economy and generated pollution. This has been modelled in equation 4*. Computations show that the pollution content of exports fuelled by FDI were 343.14 tons of carbon for carbon dioxide, 3.09 tons of sulphur for sulphur dioxide and 3.06 tons of nitrogen oxides for nitrogen oxides during 2000. These values clearly indicate the contribution of FDI (more than 80 per cent) to the generation of pollution from the export sectors.

Thus, the above discussion shows that the environmental implication of FDI from OECD countries in Thailand has not been favourable. On the other hand, the rapidly growing economies of Asia, such as China and Malaysia, have been successful in attracting FDI flows during the 1990s and these have had no negative impacts on the environment (Rock, 2002).

5. CONCLUSIONS AND POLICY IMPLICATIONS

The complex interrelationship between trade and the environment has become a focal point for international as well as national policymakers. With this in mind, the current research has assessed the impact on the environment of Thailand's trade with OECD countries during the period 1980-2000, focusing on the contradictory hypotheses, i.e., the pollution haven and factor endowment hypotheses. The environmental indicators for this work concentrate only on air pollution (emissions of carbon dioxide, sulphur dioxide and nitrogen dioxides) from fossil fuel combustion. It measures Thailand's environmental gains or losses from trade with OECD countries.

The findings of the study emphasize two aspects, i.e., why a pollution haven matters for Thailand and factor endowment does not. The analysis of the effect of FDI on the environment has demonstrated that, although the role of FDI helped to promote exports for Thailand, it has not been environmentally friendly. These effects have been caused primarily by the shift in the trade policy, from exports of agricultural products to manufactures, lax environmental regulations with ineffective implementation and the increased capital intensity of exports.

The current findings can be compared with those of other studies. The results are in line with those of Low and Yeats (1992) and Waldkirch and Gopinath (2004), but contradict those of Busse (2004) and Mukhopadhyay and Chakraborty (2005a and 2005b). On the other hand, Mani and Wheeler (1998), Cole and Elliott (2001), Copeland and Taylor (2003) provide mixed results. Our findings provide stronger evidence concerning the two hypotheses and thus are thought-provocative.

The current study has important implications for other developing countries in the region. For example, China, Malaysia and the Philippines, which are also following a similar export-driven growth path induced by FDI, would likely be enduring similar types of environmental impacts. Although these countries may have stricter environmental regulations compared with those of Thailand, they are far below OECD standards. Thus, the possibility of these countries being pollution havens cannot be ruled out. However, determination of such a status would require a thorough investigation.

From this study several policies involving trade and the environment can be suggested. The Government of Thailand should put proper emphasis on the environmental

quality of exported goods that will create sustainable trade in the future, as the country's economy is now highly dependent on exports. "Greener" trade should be given preference continuously by the Government.

- (a) Instead of too much emphasis on the export of capital-intensive goods, a balanced export strategy combining labour- and capital-intensive goods could be considered;
- (b) To maintain environmental quality the Thai Government should adopt trade-restricting measures for pollution-intensive export goods: (i) to achieve this, implementation of taxes or tariffs based on the environmental impact of the production of the goods, known as **eco-duties**, may be considered; (ii) instead of command-and-control policy, economic instruments (for example, fuel user charges, emission charges and pollution management fees) might be applied in order to manage industrial air pollution. An **energy tax** based on the estimated consumption of energy during the production of goods might be levied as another policy option;
- (c) Technological improvements in producing "green" products would require greater expenditures on research and development. For that the Government could provide financial incentives in the form of tax rebates/exemptions for the firms. In this context, the Government could also consider providing subsidies for the users of imported technology necessary for the production of so-called green products;
- (d) A large number of small and medium-sized enterprises involved in export activities are less interested in developing and procuring new technologies that have the least adverse impact on the environment. The Government should take the initiative in promoting research and development of technologies and management techniques suitable for small and medium-sized enterprises;
- (e) Last but not least, the Government of Thailand should adopt a more proactive stance concerning foreign environmental regulations affecting Thai producers. Stricter standards are in the offing, so early action by the Government would be helpful to Thai firms to enable them to adjust to external regulations.

Thus, the study suggests that the Government of Thailand should integrate both trade and environmental policies in a coherent manner (trade-related environmental measures and environment-related trade measures) in order to realize gains from trade while protecting the environment.

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Appendix

Methodology and Data

The methodology of the study is based on the input-output framework of Leontief (1951). The structure of the input-output model can be framed as follows:

$$X = A_d X + Y \dots\dots\dots(1)$$

or

$$X = (I - A_d)^{-1} Y \dots\dots\dots(1a)$$

Here X defines the vector of domestic output and A_d , the matrix of the domestic input-output coefficient and $[I - A_d]^{-1}$, the Leontief domestic inverse matrix. Now the emission model can be formulated through (1a).

Emission model

The total amount of an emission from fossil fuel combustion can be calculated as a function of the output of industries:

$$F_{pd} = CL1X_d = C L1 (I - A_d)^{-1} Y \dots\dots\dots(2)$$

Here F_{pd} is a scalar giving the total quantity of an emission from fossil fuel combustion. The emissions in this study are carbon dioxide, sulphur dioxide and nitrogen oxides, defined as pollution type p. In equation (2) CL1 carries only direct and $C L1 (I - A_d)^{-1}$ gives the direct as well as indirect requirement of pollution from industries.

Let $CL1 = S$ and $(I - A_d)^{-1} = R$. Then equation (2) will be

$$F_{pd} = SR_d Y \dots\dots\dots(2a)$$

Pollution Haven Hypothesis

To establish a link between trade and environment, the trade model is developed by extending the equation (2a).

Trade model

Separating the final demand vector as domestic demand (Y_d) and net exports, we obtain

$$Y = Y_d + Y_x - Y_m \dots\dots\dots(3)$$

Where Y_x ($n \times 1$) and Y_m ($n \times 1$) are the vectors of exports and imports respectively. Here we assume identical technology (Heckscher-Ohlin) to determine the pollution content of imports from OECD countries. Thus, the pollution content of exports and imports can be defined as follows:

$$F_{pd} \text{ exp}_{oecd} = SR Y_{x_{oecd}} \dots\dots\dots(4)$$

$$F_{pd} \text{ imp}_{oecd} = SR Y_{m_{oecd}} \dots\dots\dots(5)$$

Equations (4) and (5) are scalar, giving different pollution content of exports and imports. A measure of **pollution terms of trade (PTOT)** for Thailand with OECD countries is derived by equations (4) and (5) as

$$PTOT_{pd \text{ oecd}} = F_{pd} \text{ exp}_{oecd} / F_{pd} \text{ imp}_{oecd} = [SRY_{x_{oecd}}] / [SRY_{m_{oecd}}] \dots\dots\dots(6)$$

This measure (equation 6) of pollution terms of trade indicates the ratio of the pollution content of 1 unit of exports relative to the pollution content of 1 unit of imports. A country gains environmentally from trade in relative terms whenever its imported goods have higher pollution content than its exported goods. When the pollution terms of trade are greater (smaller) than 100, then a particular country's exports contain more (less) pollution than it is receiving through imports. The expression of (6) provides the compositional effect. This indicator has been used to reflect the pollution haven effect.

The explanation of the pollution haven hypothesis will be stronger if the factor endowment hypothesis is discussed in this context, as it offers another view of the impact of international trade on the allocation of environmental burdens across countries.

Factor Endowment Hypothesis

The Heckscher-Ohlin-Vanek model, which focuses on the relationship between production factors and trade, predicts that a country exports services of the factors that are relatively abundant in the country and imports services of the factors that are relatively scarce in the country. To estimate the total labour and capital requirements in exports and imports, equation (2a) has been modified as shown in equations (7-10).

$$L_{\text{exp}} = LR_d Y_{x_{oecd}} \dots\dots\dots(7)$$

$$K_{\text{exp}} = KR_d Y_{x_{oecd}} \dots\dots\dots(8)$$

$$L_{\text{imp}} = LR_d Y_{m_{oecd}} \dots\dots\dots(9)$$

$$K_{\text{imp}} = KR_d Y_{m_{oecd}} \dots\dots\dots(10)$$

Where, L and K symbols indicate sectoral labour and capital coefficients, respectively.

The factor endowment hypothesis holds that a labour-rich country exports labour-intensive goods and imports capital-intensive goods. This can be indicated by the ratio of capital requirements of imports and exports, which will be greater than 1, but will be less than 1 for a capital-abundant country.

Foreign Direct Investment Model

Equation (2a) has been further modified (equation 11) to calculate the pollution content of FDI.

$$F_{pd\ fdi} = SR Y_{fdi\ (oecd)} \dots \dots \dots (11)$$

Where $Y_{fdi\ (oecd)}$ explains FDI from OECD countries.

The model has further investigated how far FDI has induced exports and, in turn, pollution. For that FDI has been treated as an input into the economic activity of Thailand. The pollution content of exports due to FDI has been derived as follows:

$$F_{pd\ (fdi)}^{exp} = S R^* Y_{x_{oecd}} \dots \dots \dots (4^*)$$

Where R^* denotes $(1 - A_d^*)^{-1}$ and A_d^* defines the input-output coefficient matrix, including FDI as an input.

The data sources used for the application of the model are: (a) input-output table of Thailand for the years 1980, 1990 and 2000 (NESDB, 1984, 1994 and 2004); (b) energy consumption data for Thailand for the years 1980, 1990 and 2000 (Department of Energy Development Programme); (c) data on trade with OECD countries for the years 1980, 1990 and 2000 (OECD, 1986; OECD, 1992; and OECD, 2002); (d) international financial statistics for exchange rates (IMF, various years); (e) labour and capital stock data at the sectoral level from the *Report of the Labour Force Survey, Whole Kingdom* and *Report of the Manufacturing Industry Survey, Whole Kingdom* (National Statistical Office of Thailand, various years) and *Capital Stock of Thailand* (NESDB, 2002); and (f) data on foreign direct investment from published and unpublished sources (Bank of Thailand, various years).