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[†] School of Economics, The University of Queensland, Brisbane QLD 4072, Australia

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<u>For more information</u> write to Emeritus Professor Clem Tisdell, School of Economics, University of Queensland, Brisbane 4072, Australia.

TRADE AND ENVIRONMENT: EVIDENCE FROM CHINA'S MANUFACTURING SECTOR

Joseph Chai, Department of Economics, The University of Queensland, Brisbane 4072 Australia

Abstract

This paper uses the manufacturing sector in China to consider whether globalization of the Chinese economy over the past two decades has contributed to the decline in environmental conditions. The results show that China's experience with the trade liberalization-environment nexus is consistent with international evidence. On one hand, trade liberalization has had various positive effects on the environment. Firstly, it promoted specialization in areas of comparative advantage, which, in general, included industries that contributed less to environmental degradation. Secondly, it allowed China to access and adopt the best international practices in pollution abatement technology. Thirdly, it enabled China to transfer environmental costs to other countries by importing intermediate products whose production contributed to environmental degradation. On the other hand, these positive effects were overwhelmed by a negative scale effect, which was the result of a huge increase in the demand for Chinese exports. The paper concludes that if China is to prevent pollution from reaching a critical threshold, environmental regulations need to be tightened.

Trade and the Environment: Evidence from China's Manufacturing Sector[‡]

Joseph C.H. Chai
Department of Economics
University of Queensland

1. Introduction

China has embraced the globalization process since 1979 through extensive liberalization of its foreign trade and investment regimes. The rate of globalization of its economy has been spectacular. The share of exports and imports in China's GDP has shot up from 11% in 1979 to 33.8% in 1998 (Chai, 1998, p.148; *ZGTJNJ*, 1999, p.32). By the mid-1990s China had become the largest recipient of foreign direct investment among developing countries (Lardy, 1995, p.1065). Globalization of the Chinese economy, together with its program of domestic economic reform, enabled China to achieve a double-digit rate of growth during the period 1979-1997. But what has been the impact of this globalization on its environment? The rapid environmental degradation in China during the last twenty years has been well-documented (See Smil, 1993, Tisdell 1997 and *China Quarterly*, No. 156, 1998). However, so far there have been very few studies done on the contribution of China's globalization to the degradation of its environment[1].

The purpose of this study is to provide some answers to the above-mentioned question. Following the introduction, the paper is divided into three parts. The first part (section 2) presents the general findings of both theoretical and empirical literature on the

[‡] This study is part of a joint research project on Globalization, Trade, Environment and Sustainable Development: Implications for China and WTO, sponsored by IDP Education Australia and managed by Hassal International Research Associates. The author thanks James Laurenceson for his valuable research assistance.

effects of trade liberalization on the environment. The second and third parts (section 3 and 4) offer some historical evidence on how trade liberalization has influenced China's environment through export and import expansion. This study is limited in several respects. Firstly, to narrow the analysis to a manageable proportion, this paper focuses only on the manufacturing sector. Secondly, due to data constraints, it focuses only on China's domestic pollution problem. No attempt is made to look at the problem in a global context. Finally, the paper focuses only on pollution emissions in the production of final products. No attempt is made to use input-output analysis to take into account the pollution emissions arising from the production of intermediate products used in final products.

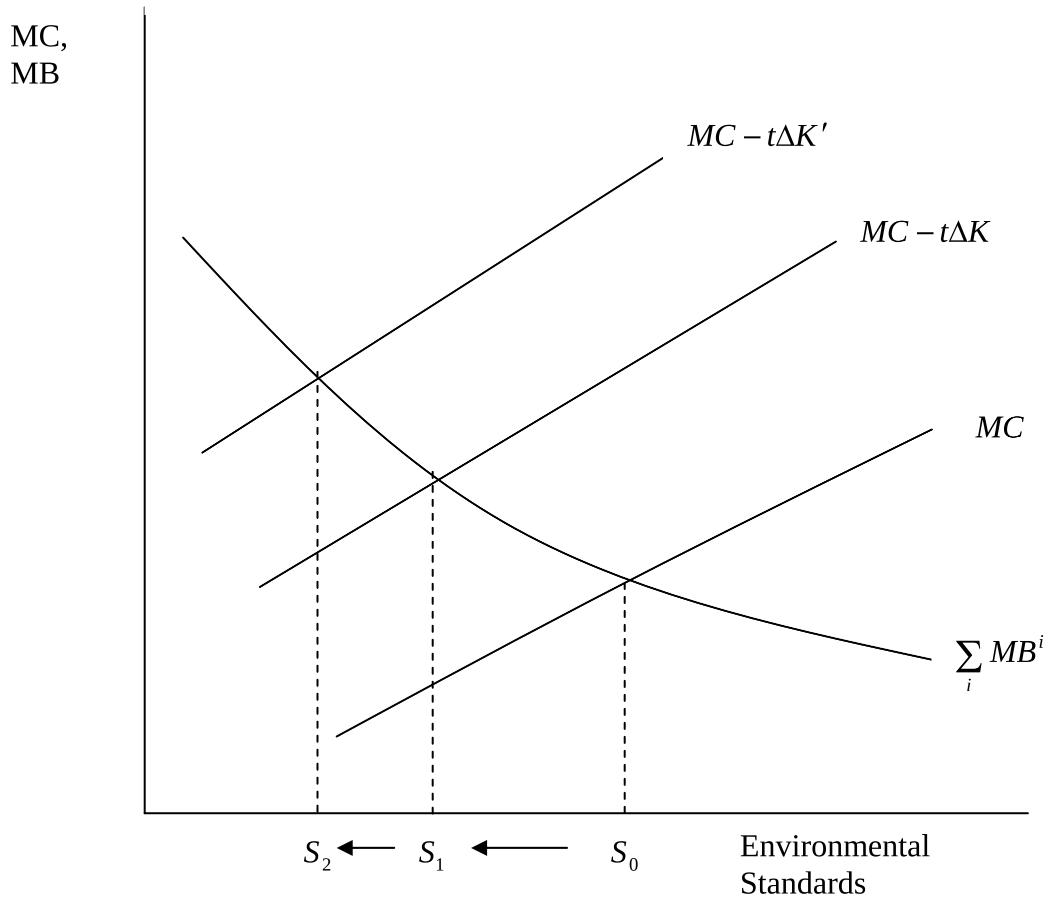
2. Literature Survey

There has been a growing body of literature discussing the trade liberalization-environment nexus. For an excellent survey of this literature, see Tisdell(2000), Beghin and Potier(1997), Ferrantino(1997), Levinson(1996) and Dean(1992). The findings of this literature are mixed. Basically there are two schools of thought. The first school, environmental optimists, believe that trade liberalization and the environment are complimentary. They believe that trade liberalization will enhance the environment through (a) its positive composition effect and (b) technical effects. The composition effect refers to the fact that free trade allows countries to specialize in the manufacturing activities in which they enjoy a comparative advantage. As a result, the output composition of a country's industry will change. This change may have either a positive or negative impact on the environment. The impact is positive if a country has a comparative advantage in the production of less pollution intensive industries. As a result, its output composition will become cleaner after trade liberalization. Technical effects refer to the fact that openness to trade enables a country to access cleaner production techniques. In addition, the increased demand for a cleaner environment, which often accompanies rising per-capita incomes due to trade liberalization, will lead to the eventual adoption of these techniques.

The environmental pessimists, on the other hand, believe that trade liberalization is likely to damage the environment for various reasons. Firstly, trade liberalization will have a negative impact on the environment if the composition effect is negative. A negative composition effect refers to the fact that trade liberalization may result in a country specializing in pollution intensive industries due to its factor endowments. Secondly, the scale effect caused by an expansion in output as a result of trade liberalization is detrimental to the environment. Thirdly, trade liberalization coupled with the increased international mobility of capital is likely to result in a race to the bottom in the setting of environmental standards. This race-to-the-bottom hypothesis refers to the fact that low-income countries will engage in a competitive lowering of environmental standards in order to attract foreign investment that has been driven out of high-income countries because of their stringent environmental regulations. In the process, they transform themselves into "pollution havens". The basic assumptions underlying the theory of the race-to-the bottom hypothesis are illuminated in Wilson(1996). In Fig. 1, environment standards are considered equivalent to a local public good. The demand curve for environment standards represents the sum of individual derived marginal benefits (MB_i) for a given willingness to pay for varying environment standards. The supply curve of environment standards represents the marginal cost of maintaining environment standards. The optimal level of environment standards is determined by the Samuelson rule, according to which

$$\sum_i MB^i = MC. \qquad (1)$$

Figure 1. Determinants of an optimal level of environmental standard



However, in equation 1, the marginal cost of maintaining a given environment standard does not take into account the additional cost incurred as a result of setting a higher environment standard, namely the capital flight induced by tighter pollution standards. The additional cost can be measured by the decline in the supply of capital that results from a marginal tightening of standards, $-\Delta K$, multiplied by the net value of an additional unit of capital for a country in the form of higher income and employment foregone, t. If this opportunity cost of stricter environment standards is taken into account, equation 1 is modified as follows:

$$\sum_i MB^i = MC - t\Delta K \qquad (2)$$

With capital outflow being treated as an opportunity cost for setting a higher environment standard, there is a tendency for a country to water down its environment standards from S_0 to S_1 in Fig. 1. As other countries engage in the same practice, the opportunity cost of a higher environment standard for the reference country rises. As a result, the $MC - t\Delta K$ curve shifts further to the left leading to a race to the bottom in environment standard setting.

From the above, it is clear that the existing theoretical literature with respect to the effects of trade liberalization on the environment is somewhat ambiguous. The net effect of trade liberalization on the environment depends very much on the following factors:

(a) Whether the positive composition and technical effects of trade liberalization are larger or smaller than the negative composition and scale effects; and

(b) Whether a race-to-the bottom in setting environment standards is at work or not.

With regard to the race-to-bottom hypothesis, Levinson(1996) reviews extensively the empirical literature in this area and finds that there is no empirical evidence to support this hypothesis. Most of the studies confirm that the stringency of environment regulations is not importantly correlated with the pattern of trade or the location of foreign investment. The lack of influence of environmental factors on the location of industry can be explained by the fact that pollution abatement costs often comprise only a small share of total production costs, particularly when compared to other costs such as labor. Consequently, environment standards typically play an insignificant role in a firms location decision.

With regards to the relative size of the composition, technical and scale effects, Beghin and Potier(1997) and Cole, Rayner and Bates(1998) extensively review recent empirical studies in this area. Most studies find that while trade liberalization may give rise to positive composition and technical effects, these positive effects are dominated by a negative scale effect. Hence, trade liberalization ultimately results in some degree of environmental damage.

3. Export Expansion and China's Environment

a. Analytical Framework

Over the last twenty years, China's manufactured exports have expanded by almost 13% a year as a result of the open door policy (*ZGTJNJ*, 1999, p.580). How did this impact on China's environment? As demonstrated in some studies (see, for example, Beghin and Potier (1997), and Grossman and Krueger 1993) the pollution impact of trade liberalization can be decomposed into three sources: a composition effect, a scale effect and a technical effect. Accordingly, the pollution effect of China’s manufactured export expansion can also be decomposed into these three sources. To begin with, the aggregate pollution caused by China's manufactured export expansion, *Y*, can be described by the following simple equation:

$$Y = \sum_i s_i e_i X \qquad (3)$$

where s_i is sector *i*'s share in total exports, e_i is the pollution intensity of sector *i* and X is total exports. The change in aggregate pollution can be described as

$$\dot{Y} = \sum_i \dot{s}_i e_i X + \sum_i s_i \dot{e}_i X + \sum_i s_i e_i \dot{X} \qquad (4)$$

where a dotted variable represents that variable's time derivative. The first term on the right hand side is the composition effect. It represents the change in pollution levels due to change in China's export composition. The second term is the technical effect, which indicates the change in pollution levels caused by a change in China's sectoral pollution intensity. The third is the scale effect. It represents what China's growth in pollution levels would have been due to export expansion in the absence of changes in export composition and sectoral pollution intensity.

b. Pollution Intensity of Chinese Manufactured Industry

Central to any attempt to decompose the pollution impact is the estimate of e_i, the pollution intensity of the manufactured sector. Due to data unavailability, most studies of industrial pollution problems rely on a database constructed at the World Bank by Lucas, Wheeler and Hettige(1992), which is based on US technology and environment standards of 1987. Since the pollution intensity of manufacturing sectors varies across countries because of their divergence from US technology and environmental standards, studies relying on the US database are necessarily biased. In this study, the database of pollution intensities of China's manufacturing sector collected by China's State Environmental Protection Agency (SEPA) is used.

These data are collected from a sample of industrial enterprises, the number of which varies from 68715 in 1993 to 54909 in 1997 (*China Environment Yearbook 1994*, p.420 and *1998*, p.562). These sample enterprises refer to "industrial enterprises at or above the county level which cause various pollution.” The main weakness of SEPA's database is its incompleteness in coverage. In particular, it does not cover industrial enterprises below the county level, which include seriously polluting township and village enterprises (TVE's). TVE's have accounted for about half of China's industrial output in recent years (see Vermeer 1998, p.959& 983).

Table 1. Pollution Intensity of China's Manufactured, 1993.
Unit: tons per million RMB

Industry	Water Pollutants [1]	Air Pollutants [2]	Solid Waste Pollutants [3]	Total Emission	China's Rank	US Rank
1. Food, Beverage and Tobacco	10.1	6.4	40.1	56.5	9	18
2. Textile	2.0	3.0	23.7	28.7	13	11
3. Leather Furs, & Down	4.6	2.0	15.4	21.9	14	2
4. Paper Making and Paper Products	100.0	17.0	121.2	238.1	3	7
5. Printing	0.4	1.0	8.3	9.7	18	6
6. Petroleum Processing & Coking	1.5	5.1	102.7	109.2	7	12
7. Chemical	8.5	10.7	200.7	219.9	4	1
8. Medicine	6.8	3.4	29.9	40.1	10	9
9. Chemical Fiber	6.0	4.1	55.1	65.2	8	10
10. Rubber Products	0.7	2.9	25.3	28.9	12	15
11. Plastic Products	0.2	1.2	9.7	11.1	17	3
12. Nonmetal Mineral Products	1.5	62.7	82.5	146.7	6	13.5
13. Among them: Cement	0.8	122.8	57.3	180.9	5	13.5
14. Metallurgy & Rolling of Ferrous Metals	5.2	14.1	563.2	582.5	1	5
15. Metallurgy & Rolling of Non-Ferrous Metals	1.6	13.8	371.1	386.5	2	4
16. Metal Product	1.2	2.2	15.5	18.9	15	8
17. Machinery, Electric & Electronic Equipment	0.3	1.4	14.7	16.4	16	17
18. Other manufactures	2.1	4.0	32.5	38.6	11	16

Notes:
1 Water pollutants: sum of 11 types including HG, Cd, Cr^{6+}, Pb, As, volatile phenol, cyanide, petroleum, COD, suspended substance, and sulphide.
2. Air pollutants: sum of 3 types including sulphur dioxide, industrial soot and dust
3. Solid Waste pollutants: sum of 7 types including dangerous wastes, metallurgical slag, coal ash, slag, coal gauges, tailing, and radio active waste

Sources: China Environment Yearbook, 1994, pp.419 and Lucas, Wheeler and Hettige(1992), Table 5.1.

Table 1 presents the pollution intensities of China's manufactured sector for 1993. This table also gives 1987 pollution intensities of the US manufactured sector for comparison. The comparison between the two sets of pollution intensities suggests that it is not justified to apply observed US pollution intensities to China. The rank correlation coefficient between the two sets of pollution intensity is 0.116, which is statistically insignificant. It also reveals that, although the set of pollution intensive industries is broadly similar between the two countries, their rankings and pollution intensities are different. In the Chinese context, the most pollution intensive industries are iron and steel, nonferrous metals, paper making and paper products, chemicals, non-metallic mineral products, and petroleum processing and coking. In terms of water pollution, paper making and paper products have the highest pollution intensity. Construction materials such as cement and other non-metallic mineral products have the highest pollution intensity of air pollutants, and iron and steel have the highest pollution intensity with respect to solid waste.

c. Composition Effect

Matching the pollution intensity data from SEPA with manufactured export data from China's Customs derives the composition effect of China's manufactured export expansion on the environment. Out of the 18 manufacturing sectors, only 14 sectors were found to have both sets of data. Hence, they were chosen for this study. These 14 sectors accounted for about 73% of Chinese manufactured exports during 1996 to 1998. The changing export shares of these 14 sectors are presented in Table 2 for two periods, 1980-1982 and 1996-1998. This table reveals that the open door policy adopted by China since the late 1970s has made its manufactured export composition cleaner. In the early 1980s, Chinese manufactured exports were dominated by pollution intensive products such as petroleum processing, coal products and chemicals, which together accounted for 44% of Chinese manufactured exports. By the late 1990s, the share of these pollution intensive exports declined to a mere 12%. In contrast, the share of the cleanest industries such as garments and machinery rose from 21% to 60% between the two periods.

Table 2. Pollution Intensity of Chinese Manufactured Exports
Unit: 100 million USD

Branches	1980-1982(ave.) Value	Share%	1996-1998(ave.) Value	Share%	Exp. Share Change in %	Poll. Intensity tons/mill. RMB 1993
1.Beverage & Tobacco	0.66	0.49	11.22	0.94	+ 0.45	56.5
2. Textile	25.54	19.11	129.21	10.79	- 8.32	28.7
3. Garment	17.65	13.21	289.63	24.18	+ 10.97	15.2
4. Leather, Fur & Down	0.89	0.67	4.97	0.42	-0.25	21.9
5.Paper Making & Paper Products	1.46	1.09	9.07	0.76	- 0.33	238.1
6. Petroleum Processing & Coking	49.44	37.00	60.33	5.04	- 31.96	109.2
7. Chemical	9.68	7.24	82.50	6.89	- 0.35	219.9
8. Medicine	2.51	1.88	15.81	1.32	- 0.56	40.1
9. Rubber Products	0.53	0.40	8.13	0.68	+ 0.28	28.9
10. Nonmetal Mineral Products	3.47	2.60	36.97	3.09	+ 0.49	146.7
11. Metallurgy & Rolling of Ferrous Metal	4.16	3.11	37.93	3.17	+ 0.06	582.5
12. Metallurgy & Rolling of Non-Ferrous Metal	2.04	1.53	22.67	1.89	+ 0.36	386.5
13. Metal Products	4.97	3.72	58.60	4.89	+ 1.17	18.9
14. Machinery, Electric, Electronic & Transp. Eqms.	10.64	7.96	430.80	35.97	+ 28.01	16.4
Total	133.64		1197.84			

Weighted pollution intensity

1980-82	97.56
1996-98	67.71

Source: Zhongguo Shangye Waijing Tongji Ziliao, 1952-1989, pp.432-7 and 438-443 and China's Custom Statistical Yearbook 1998, p.7-8.

Thus, the Chinese experience with trade liberalization is consistent with the international experience. The race-to-the-bottom hypothesis is not confirmed in China.

Dirty industries are in general found to be relatively intensive in capital, energy and land, whereas the cleanest industries are relatively intensive in labor (Mani & Wheeler, 1998, p.219). Since China's comparative advantage lies with labor intensive products, trade liberalization enables China to reallocate its resources away from capital, land and energy intensive dirty industries to labor intensive cleaner industries. Hence, the composition effect of trade liberalization in China is positive. This is evidenced by a drop in its manufactured exports aggregate pollution intensity from 97.6 to 67.7 tons per million 1993 RMB between the early 1980s and the late 1990s. As a result of this export compositional change, China experienced an overall decrease of 31% in its manufactured export pollution level between these two periods.

d. Technical effect

The opening up of China to the outside world increased public awareness of industrial pollution problems in China. It also enabled China to gain increased access to the best international practices in environmental control technology. At the same time the government has also stepped up its efforts to control industrial pollution by adopting industrial pollution control measures through SEPA. For an excellent survey of these pollution control efforts and of their limitations, see Xie Jian, et al(1999), and Vemeer(1998). As a result, there has been a significant drop in the pollution intensity of China's manufactured sector in the recent years.

Table 3. Technical Effects of China's Export Expansion

Branches	1980-82 Value [1] (100 mill 1993 RMB)	Share	Pollution Intensity 1993 (tons per mill RMB)	1997	% change	Change in total emission (100tons)
1. Beverage & Tobacco	3.80	0.49	56.5	22.4	- 60.4	- 129.6
2. Textile	147.16	19.11	28.7	17.2	- 40.1	- 1692.3
3. Garment	101.69	13.21	15.2 [2]	9.1 [2]	- 40.1	- 620.3
4. Leather, Fur &Down	5.13	0.67	21.9	8.6	- 60.7	- 68.2
5. Paper Making & Paper products	8.41	1.09	238.1	143.7	-39.7	- 793.9
6. Petroleum Processing & Coking	284.87	37.00	109.2	26.3	- 75.9	-23615.7
7. Chemical	55.78	7.24	219.9	97.3	- 55.8	- 6838.6
8. Medicine	14.46	1.88	40.1	20.6	- 48.6	-282.0
9. Rubber Products	3.05	0.40	28.9	18.9	- 34.6	- 30.5
10. Nonmetal Mineral Products	20.00	2.60	146.1	95.7	- 34.8	- 1020.0
11. Metallurgy & Rolling of Ferrous Metals	23.97	3.11	582.5	364.7	- 37.4	- 5220.7
12. Metallurgy & Rolling of Non-Ferrous Metals	11.75	1.53	386.5	197.1	- 49.0	- 2225.5
13. Metal Products	28.64	3.72	18.9	11.2	- 40.7	- 220.5
14. Machinery, Electric, Electronics & Transp. Eqms.	61.31	7.96	16.4	8.1	- 50.6	- 508.9
Total	770.00	100.00				- 43266.7

Notes:

1. To eliminate the influence of exchange rate fluctuation, the 1993 USD exchange rate, which is 5.7619 RMB/dollar is used to measure Chinese trade values in RMB throughout this study (see *ZGTJNJ*, 1998, p.578).
2. Official data not available. The figure is estimated based on the assumption that pollution intensity of garment is 0.53% of that textile as in US (see Lucas, Wheeler and Hettige, 1992, Table 5.1).

Sources: Table 1 and Table 2 and China Environment Yearbook 1998, pp. 580-1, 586 & 588.

Table 3 compares the annual pollution intensities of China's manufactured sectors. Since no official pollution intensity statistics are available prior to 1993, the comparison in Table 3 is limited to two years, namely 1993 and 1997. Between 1993 and 1997, as Table

3 shows, all manufactured sectors in our study have experienced a decrease in their pollution intensities. The rate of decrease ranges from a low of 35% for rubber products and non-metallic mineral industries to a high of 76% for petroleum processing and coal products. The resultant change in emission, as the estimate in Table 3 shows, lowered China's manufactured exports emission in 1996-8 by almost 58% as compared to that of 1980-82. The largest contributors to this emission decline were petroleum processing and coal products, chemical, metallurgy and rolling of ferrous and non-ferrous metals, which altogether accounted for almost 90% of the total emission reduction related to the technical effect.

e. Scale Effect and Aggregate Impact

The scale effect of Chinese manufactured export expansion on the environment depends solely on its rate of expansion (see equation 4). Over the last 16 years, based on our sample of 14 manufacturing sectors, China's manufactured exports expanded by 796%. Thus, any positive composition and technical effects of Chinese manufactured export expansion on the environment were overwhelmed by its huge negative scale effect. Table 4 gives an overview of the aggregate environment impacts of China's manufactured export expansion and its decomposition into water, air and soil pollution.

Table 4. Aggregate Impacts of China's Manufactured Export Expansion
Unit: % of total 1980-2 emissions

	Composition Effect	Technical Effect	Scale Effect	Aggregate Impact
Water Pollution	- 24.0 [1]	- 34.2	796.3	738.1
Air Pollution	- 16.1 [2]	- 50.2	796.3	730.0
Solid Waste Pollution	- 31.4 [3]	-59.1	796.3	705.8
Total Emission	- 30.6	-57.6	796.3	708.1

Notes:

1. The weighted water pollution intensity has been reduced from 3.287 to 2.510 between 1980-2 and 1996-98.
2. The weighted air pollution intensity has been reduced from 6.22 to 5.22 between 1980-2 and 1996-8.
3. The weighted solid waste pollution intensity has been reduced from 88.09 to 60.45 between 1980-2 and 1996-8.

It shows that although China experienced a significant reduction in the emission of water, air and soil pollutants as a result of the positive composition and technical effects due to export liberalization, these positive effects were offset by its large negative scale effect. The rate of increase of water, air and soil pollution went almost hand in hand with that of Chinese manufactured export expansion between the early 1980s and late 1990s.

However, the above estimate should be regarded as tentative as there are reasons to believe that it may be either underestimated or overestimated. It may be overestimated as many Chinese manufactured exports are based on processing trade arrangements, whereby many pollution intensive components, parts or materials contained in those exports are not produced in China but imported instead. It may be underestimated due to the limitation of pollution intensity data provided by SEPA, which, as mentioned earlier, fails to account for the pollution caused by TVE's. These rural enterprises have accounted for an increased share of China's manufactured exports in recent years. It may also be underestimated as it takes into account only the direct negative scale effect and fails to consider the indirect negative scale impact induced by the growth of Chinese GDP as a result of increased manufactured exports.

4. Effluent Content of Chinese Imports

Any discussion of the impact of trade liberalization on the environment would not be complete without considering the effects of imports. Trade liberalization enables a country not only to specialize in products which it holds a comparative advantage in production, but also provides a channel to transfer environmental effects to other countries through imports.

The concept of embodied effluent trade (EET) was first introduced by Lee and Roland-Holst(1997). It captures the idea that traded commodities embodied an environmental service, i.e. the amount of pollution emitted when goods are produced domestically. By comparing the pollution content of exports (E_x) and imports (E_m) one can arrive at a country position in the effluent trade balance. If E_x/E_m is larger than unity, this implies that a country's overall exports are more pollution intensive than their overall imports. If a country's trade is balanced, this also entails that a significant amount of environmental costs are transferred to this country from its trading partners, and vice versa.

Table 5. Pollution Intensity of China's Manufactured Imports(100 Mill.USD)

Branches	1980-1982(ave.) Value	Share%	1996-1998(ave.) Value	Share%	Import Share Change in %	Pollution Intensity (tons/mill RMB 1993)
1. Beverage & Tobacco	1.26	1.07	3.32	0.29	- 0.78	56.5
2. Textile	9.72	8.28	117.77	10.39	+ 2.11	28.7
3. Garment	0.11	0.09	10.79	0.95	+ 0.86	15.2 [1]
4.Leather,Fur & Down	0.90	0.77	21.23	1.87	+ 1.10	21.9
5. Paper Making & Paper Products	3.13	2.67	31.35	2.77	+ 0.10	238.1
6. Petroleum Processing & Coking	1.44	1.23	74.19	6.54	+ 5.31	109.2
7. Chemical	27.90	23.76	187.83	16.56	- 7.20	219.9
8. Medicine	0.27	0.23	4.05	0.36	+ 0.13	40.1
9. Rubber Products	0.07	0.06	3.15	0.28	+ 0.22	28.9
10 Nonmetal Mineral Products	1.15	0.98	13.20	1.16	+ 0.18	146.7
11. Metallurgy & Rolling of Ferrous Metal	18.68	15.91	67.98	5.99	- 9.92	582.5
12. Metallurgy & Rolling of Non-Ferrous Metal	4.77	4.06	32.19	2.84	- 1.22	386.5
13. Metal Products	0.71	0.61	18.98	1.67	1.06	18.9
14. Machinery, Electric, Electronic & Transp. Eqms.	47.30	40.29	547.93	48.32	+ 8.03	16.4
Total	117.41	100.00	1133.96	100.00		

Weighted pollution intensity E_m		E_x / E_m
1980-82	179.21	0.54
1996-98	109.89	0.62

Note:

1. Official data not available. Estimated based on assumption that pollution intensity of garment is 0.53% of that textile as in US.

Source: same as Table 2.

Table 5 presents estimates of implicit pollution contents of Chinese manufactured imports for 1980-2 and 1996-8. Chinese manufactured imports are basically dominated by two categories: One is dirty products, which are mainly industrial materials. The other is cleaner products, namely machinery. In the early 1980s, the aggregate pollution intensity of China's imports was almost twice as intensive as that of its exports due to the overwhelming share of industrial materials in its total imports. In the recent years due to the increased share of machinery imports, the pollution content of Chinese manufactured imports has been reduced significantly. Yet, compared with its export counterpart, it was still greater than 60% more pollution intensive. This implies that in a long-term situation of relatively balanced bilateral trade, import trade has had a beneficial effect on China's environment as it enabled China to transfer a significant amount of environmental costs to other countries.

5. Conclusions and Implications

The most important result of this paper is that the Chinese experience with the trade-environment nexus over the last two decades is consistent with international evidence. The Chinese experience shows that trade liberalization does not necessarily result in a developing country specializing in dirty industries. To the contrary, freer trade has made a significant positive contribution to Chinese environment. It enabled China to specialize according to its comparative advantage and relocate its resources away from capital, land, and energy intensive dirty industries to labor intensive cleaner industries. As a result its current export composition is about 30% cleaner than two decades ago. It also enabled China to gain access and adopt the best international practice in pollution abatement technology leading to a significant drop in the pollution intensity of its manufacturing industry. Finally, trade liberalization also enabled China to transfer a significant amount of environmental costs to other countries by importing intermediate products involving dirty processes instead of producing these domestically.

Nonetheless, China's experience also shows that the scale effects of trade liberalization on the environment overwhelmed other sources of pollution change and offset other environmental gains from specialization and increased access to international best practice in pollution control. As a result, over the last two decades, water, air and soil pollution expanded at a rate not much dissimilar to that of manufactured exports. This suggests that China needs to take the trade off between the environment and trade liberalization more seriously. To prevent pollution from reaching a critical threshold (see Tisdell, 2000) China needs to tighten up its environmental regulations and adopt a more cost-effective pollution abatement strategy.

Notes

1. The CCICED (1999) and Xia (1999) studies are among the few examples. These studies found that trade expansion and an increased inflow of FDI have been detrimental to the Chinese environment as export expansion was accompanied by increased pollutant emission and FDI did transfer pollution-intensive industries into China.

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