Foreign Investment, Export, and Greener Production in Emerging Economies – Evidence from Shanghai

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Abstract

Do international linkages through foreign investment and export help make firms' production greener in emerging economies? In contrast to the Pollution Haven Hypothesis, the Trade-Up Hypothesis holds that international integration helps improve firms' environmental performance in emerging economies. Using unique firm-level data from Shanghai, this paper examines how international linkages, in the form of foreign direct investment or international trade, affect firms' environmental compliance and performance. We find that firms that receive foreign investment exhibit better compliance with environmental regulation and emit less pollution than firms with no international linkage. We also find that firms with international linkage via market exposure are more likely to exhibit better compliance with environmental regulation than firms with no international linkage, but find no evidence that the former emit less pollution than the latter. These results provide a piece of empirical evidence for the Trade-Up Hypothesis and present policy implications that financing foreign investment into emerging economies could serve a green purpose, leading to better corporate environmental performances.

Key Words: Foreign Investment, Greener Production, Trade-Up Hypothesis, Pollution Haven Hypothesis, Emerging Economies, Corporate Environmental Performance

1. Introduction

Does globalization benefit or harm the natural environment in emerging economies? This question has attracted much attention because of its political as well as economic salience. A widely held view, often coined as the Pollution Haven Hypothesis (PHH) (Walter, 1982), argues that globalization may expedite environmental deterioration in emerging economies. According to PHH, developed economies tend to have strict environmental regulations that will drive up firms' production costs. To save costs, pollution-intensive industries may relocate themselves to emerging economies that prioritize economic development, and therefore have relatively less stringent environmental regulations. As a result, emerging economies may experience "a race to the bottom" and become pollution havens (Cole & Elliot, 2005; Kellenberg, 2009; Levinson & Taylor, 2008; Walter, 1982).

In the last few years, however, an opposite view, often coined as the Trade-Up Hypothesis, has gained momentum. Trade-up scholars contend that international integration can help improve emerging economies' natural environment. The reason is that international economic integration provides firms in emerging economies with an opportunity to learn advanced environmental technologies, standards and management systems that are already implemented in developed countries, and with incentives to adopt them (Drezner, 2000; Prakash & Potoski, 2006; Zeng & Eastin, 2007). These technologies, standards and management systems are normally above and beyond the existing environmental requirements and enforcement in emerging economies, and therefore adopting them will help firms in emerging economies improve their environmental

operations. Not only would firms with close international linkages improve their environmental performance, but also firms without such linkages could achieve improvements due to spillover effects (Spencer, 2008).

Although theoretically appealing, the validity of the Trade-Up Hypothesis is essentially an empirical issue. So far, there are few empirical studies, and we observe little convincing evidence in favor of the Trade-Up Hypothesis. Zeng and Eastin (2007) study the impact of international economic integration via trade and investment on environmental protection with a case study of China. They report that provinces with a higher level of international trade and foreign direct investment (FDI) tend to have lower SO_2, soot, and solid waste emissions. In their analysis, however, international trade volume, FDI, and pollution from all industries are aggregated at the provincial level. As a result, the heterogeneity in industrial composition across provinces is muted, which makes the argument vulnerable to the following alternative explanation: their finding could be the result of the fact that FDI and international trade flow to provinces that host relatively clean industries, instead of their hypothesis that international economic linkages drive firms to be more environmentally responsible.

Using a unique firm-level database from Shanghai, this paper examines the validity of the Trade-Up Hypothesis through investigating whether firms with international linkages have cleaner production than their peers in the same industry in China. The underlying mechanism as to why firms with international linkages want to adopt cleaner environmental practices is theoretically identified and empirically tested. This paper not only has theoretical significance as

it contributes to the ongoing debate between the PHH and the Trade-Up Hypothesis, but it also has practical significance as it sheds light on what factors motivate firms to adopt cleaner production in emerging economies. The importance of this research must be judged against the facts that emerging economies' natural environment has rapidly deteriorated during the process of globalization, and that environmental issues have become increasingly salient in international trade and seem likely to remain so for the near future for reasons examined in more detail below.

The rest of the paper proceeds as follows. Section 2 lays out a framework, which highlights the underlying mechanism concerning why international economic integration motivates firms to adopt cleaner production, leading to our research hypotheses. Section 3 discusses our data and methodology. Section 4 presents our empirical findings. Finally, section 5 concludes the paper with a summary and a discussion of potential future research directions.

2. Theory and Research Hypotheses

Stakeholder theory argues that, in order to achieve sustainable competitive advantage, corporations need to create positive relationships with stakeholders through the appropriate management of their expectations and mutually agreeable objectives (Freeman, 1991; Porter & Kramer, 2006). Stakeholders include a wide range of groups, and can be divided into primary and secondary stakeholders (Clarkson, 1995). Primary stakeholders are those groups, without whose continuing participation, the corporation cannot survive as a going concern, and include shareholders, employees, suppliers, customers, governments, and communities. Secondary

stakeholders include the media, special interest groups, and the public at large. A firm can manage its stakeholder relations in a way that benefit its bottom line (Donaldson & Preston, 1995; Hillman & Keim, 2001; Porter & Kramer, 2006). Hillman and Keim (2001) argue that the natural environment is fundamental to several primary stakeholders for environmentally intensive industries, and managing environmental concerns proactively can therefore lower the costs of complying with existing and future environmental regulations, even though it can increase operating costs in the short term (Russo & Fouts, 1997).

The emphasis on stakeholders has played a critical role in the development of sustainable Operation Management (OM). As Kleindorfer, Singhal, and Van Wassenhove (2005) wrote when reviewing the theme of sustainable OM in the first 50 issues of this journal:

"sustainable OM integrates the profit and efficiency orientation of traditional OM with broader considerations of the company's internal and external stakeholders and its environmental impact." (p.485)

These stakeholders include regulators (Caro, Andalaft *et al.*, 2003), community (Delmas, 2001), employees (Chinander, 2001), media (Angell, 2001) as well as consumers and suppliers (Klassen & Vachon, 2003) in traditional supply chain management (Corbett & Kleindorfer, 2001, 2003). For example, Delmas (2001) discusses how the involvement of distributors, customers, community members and regulatory agencies affects the implementation and impacts of ISO 14001 Environmental Management System (EMS) Certification.

International economic integration expands the scope of the stakeholders that firms need to

manage in our setting in the following two senses (Bouquet & Deutsch, 2008; Strike, Gao *et al.*, 2006). First, multinational firms that operate in a foreign host country need to deal with not one but two sets of stakeholders. They need to address not only the concerns of the stakeholders from their home country but also those of the stakeholders in the host country. Second, domestic firms in the host country are more and more connected to the global economy through increasing international trade. The increasing reliance on international markets has raised the importance of the stakeholders at export destinations in domestic firms' decision making. Below we are going to examine the implications of the expansion of stakeholders that comes with international economic integration on firms' environmental operations in China.

2.1 Multinational Firms

Stakeholder management is more complicated in multinational firms, as the concerns and interests of stakeholders at home may be different from, or even conflict with, those of stakeholders at the host country (Daniels, Radebaugh *et al.*, 2009). However, as far as this paper is concerned, foreign firms operating in China have increased incentives to better comply with or go beyond environmental regulations in China, as they face heightened scrutiny from the Chinese public and regulators and heightened attention from customers and activists at home at the same time.

Theories of FDI contend that foreign firms are often at a disadvantage compared to domestic firms (Hymer, 1976; Mata & Portugal, 2002; Zaheer, 1995; Zaheer & Mosakowski,

1997). Viewed as intrusive aliens, foreign firms sometimes receive additional attentions and special scrutiny. As King and Shaver (2001) argue:

"As a result, foreign firms are more often investigated, audited, and prosecuted than their domestic counterparts (Vernon, 1998). For example, Mezias (1999) finds that foreign firms operating in the United States face more labor lawsuits than indigenous firms. With respect to environmental issues, regulators often single out 'deep pockets' and politically palatable targets for enforcement actions" (p. 1071).

King and Shaver (2001) find that these additional pressures from stakeholders have led foreign firms to make additional efforts to manage their wastes than domestic firms in the United States.

In China, two factors have driven foreign firms to make more efforts to comply with environmental regulations and improve their environmental operations. First, foreign firms, once established in China, have much less bargaining power compared to their Chinese counterparts. As Economy (2004) suggests, the Chinese government has resorted to an approach to environmental protection that emphasizes the decentralization of authority to local officials. When the local government has other priorities (in most cases, economic growth), compliance with related environmental regulations is often subject to negotiation (Child & Tsai, 2005). Wang *et al.* (2003) highlight the fact that firms with different ownership structure have different bargaining power concerning the enforcement of pollution control regulations such as pollution charges, fines, etc. Unfamiliar with local political context, foreign firms apparently have the weakest bargaining power with governments among their industry peers. Scholars have shown

that firms with different bargaining power may receive different levels of informal regulation and community pressure on pollution abatement (Pargal & Wheeler, 1996; Wang, 2000). This is the very reason that state-owned enterprises (SOEs) have consistently been found to be the worst environmental performers in China (Wang & Jin, 2007). As foreign firms have the least bargaining power compared to their domestic counterparts, we would expect them to be the target of the most stringent enforcement of environmental regulations, which in turn forces them to pay greater attention to environmental operations.

Second, customers and the general public may have much less tolerance with wrongdoings of foreign firms than with those of domestic firms. Although foreign firms have been welcomed recently as drivers of economic growth, distrust and hostility to foreign firms is persistent as a historical legacy in China (Graham & Lam, 2003). For example, many multinational companies, including Nokia, Coca Cola, and McDonald's, faced fierce criticism for their slowness or stinginess in philanthropic giving after the 2008 Wen-chuan Earthquake; McDonald's restaurants in many cities were forced to close temporarily due to angry demonstrators (Xu, 2009). Therefore, arguments such as PHH and economic exploitation have emotional appeal for Chinese customers, media and the general public. For example, Timberland has faced criticism by many Chinese environmental NGOs for being environmentally irresponsible because it buys its supplies from FuGuo Leather, which has been found out of compliance with environmental regulations (Li, 2009). In fact, many multinational companies, for example Pepsi, Bosch and Nissin Food, have been the targets of Chinese environmental NGOs and media. Such bad

publicity can hurt the firms' bottom lines in the short run and their chances of success in China in the long run. To avoid this, foreign firms have strong incentives to maintain high standards in their environmental practices.

In addition to these two pressures from the Chinese domestic market, foreign firms also face pressure coming from the stakeholders in their home country. It is widely recognized that multinational firms' operations in a host country may have significant impacts on its stakeholder management back at home. For example, Nike's labor practices in Southeast Asia in the 1990s put the company under a crossfire from media, labor unions, Christian organizations and human rights organizations in the United States, which culminated in Nike CEO Philip Knight's assessment that Nike's products have been equated with exploitive wages, forced overtime, and labor abuse and that he does not believe American consumers would want to buy the products made by abused workers (Morris & Lawrence, 2001). Similarly, the 1984 Bhopal accident in India has spurred many costly regulations targeting the chemical industry in the United States.

On top of having a good reason to be more careful with their environmental operations compared to their domestic counterparts, multinational firms operating in China are capable of tapping into advanced environmental technologies and environmental management systems available to their parent companies. In fact, many multinational firms in China are playing a leading and exemplary role in the pursuit of sustainable business operations. For example, at its Beijing Sustainability Summit in 2008, Wal-Mart set aggressive goals to become the best-in-class sustainable retailer in China, including an energy saving goal of 40% and a water

usage saving goal of 40% by 2010 compared to the 2005 baseline. In order to achieve their energy saving goals, Wal-Mart has mandated operational changes such as using high efficiency LED lights, adopting high efficiency heating, ventilation, and air conditioning (HVAC) systems, and installing related monitoring and control systems. Wal-Mart stores are also encouraged to install waste water reclamation systems, low-flow faucets, waterless urinals, etc. to achieve their water-saving goals. Similarly, Goodyear, a tire company, won applause for its collaborative efforts with Shanghai GM in improving its environmental operations, including: reducing tread rubber in order to save mixer back-energy consumption, using water-soluble tread liner fluid to replace the organic liquid liner; improving the utilization of air compressor groups in order to reduce power consumption and heat in the water supply system; recycling; and using energy-saving light bulbs to reduce energy consumption (Sustainable Industrial, 2010).

To summarize these arguments and evidence, firms' international linkage via their ownership structure gives them stronger incentives to comply with environmental regulations in China, and it also enables them to perform better environmentally through access to advanced environmental technologies and management systems. Therefore, we propose the following hypotheses:

Research Hypothesis 1*: Firms in China with international linkage via ownership, i.e. foreign wholly-owned subsidiaries or Sino-foreign joint ventures, exhibit better compliance with environmental regulations than firms with no international linkage.*

Research Hypothesis 2*: Firms in China with international linkage via ownership, i.e. foreign wholly-owned subsidiaries or Sino-foreign joint ventures, emit less pollution than firms with no international linkage.*

2.2 Export-oriented Domestic Firms

Since the economic reforms of the early 1980s, Chinese firms have been increasingly connected with the global economy through international trade. From 1990 to 2007, China's export increased from 18 billion USD to 1,218 billion USD, a 67-fold increase. About 60 percent of the export goes to the OECD countries (NBSC, 2008). While concerns for the natural environment and efforts to improve it are worldwide today, it is in the OECD and other developed countries (as reflected in the Environmental Kuznets Curve) where high environmental consciousness is deeply rooted across most stakeholder groups. Consumers in these countries normally are more environmentally conscious and maintain a higher environmental standard for corporate environmental practices.

The literature in sustainable OM has emphasized the role of customers in affecting firms' environmental operations. For example, Klassen and Vachon (2003) study a sample of Canadian firms and find that the level and the form of environmental technologies that plants decide to invest in depend on their relationship with customers, i.e., whether it is more collaborative or evaluative in nature. The increasing reliance on international customers, especially reputable

industrial customers (Melnyk, Sroufe *et al.*, 2003), has created extra pressure for Chinese domestic firms to be more environmentally friendly. Although empirical evidence that exporting firms have better environmental compliance and performance is still largely absent, numerous studies have repeatedly reported that export-oriented firms are indeed more likely to pursue ISO 14001 EMS certification in order to expand international trade opportunities (Corbett & Kirsch, 2001; Delmas, 2000; Prakash & Potoski, 2006). For example, Corbett and Kirsch (2001) study the adoption of ISO 14001 in 63 countries, and find that higher export-propensity leads to higher ISO 14001 counts. In addition, King, Lenox and Terlaak (2005) argue that ISO 14001 is used as an institutional mechanism to control trade partners' environmental behaviors.

Specifically for China, Christmann and Taylor (2001) present evidence that export-oriented Chinese firms are more likely to adopt ISO 14001 certification and similar self-regulations in general. It is still not entirely clear whether ISO 14001 certification will result in environmental performance improvement in general (Yin & Schmeidler, 2009). However, Yin and Ma (2009) argue that in countries that have weak enforcement of environmental regulations such as China, ISO 14001 certification is a powerful mechanism to move firms from non-compliance to compliance with environmental regulations, and thus improve firms' environmental performance. The reason is that compliance with existing laws and regulations is the bottom-line requirement for obtaining the certification. Non-compliance with environmental regulations is a fairly common phenomenon in emerging economies in general and in China in particular. For example, Ma and Ortolano (2000) find that 64 percent of firms surveyed in Changzhou and Shunde are out

of compliance with effluent standards. Pressure from export destinations for ISO 14001 certification may motivate at least part of these firms to achieve compliance and therefore result in improvement of their environmental performance.

ISO 14001 certification is only one channel through which stakeholders at the export destination may exert environmental pressures on Chinese domestic firms. In recent years, stakeholders at export destinations tend to impose environmental requirements more directly. For example, a growing number of companies, including Alcoa, Dow Chemical, Johnson & Johnson, and General Motors (GM), initiated the "Greening the Supply Chain" program to impose stricter performance requirements and operational control over their extended supply chains in emerging economies (Yosie, 2008). For example, the GM Green Supply Chain (GSC) project in Shanghai aims to motivate and facilitate automotive parts suppliers in the city to reduce their environmental footprints – saving energy and raw materials, reducing emission and waste, and conserving natural resources. In 2009, the project involved 125 Tier-1 suppliers and identified 498 projects, among which 263 projects addressed cleaner production, material savings and production efficiency and 235 projects addressed energy efficiency. These projects have resulted in over 55,400 tons per year of Greenhouse Gas reduction, over 1,070,700 tons per year of water usage reduction, over 9,300 tons per year of solid waste reduction and over 137,000 Kiloliters per year of liquid waste reduction (Yosie, 2010). As part of its sustainability agenda, Wal-Mart also set up environmental requirements for its global suppliers: all suppliers must meet regulations by 2010 and the largest 200 factories must reduce energy consumption by 20% per

unit of production by 2012. In order to achieve these goals, Wal-Mart created an independent audit system, based on which non-compliant factories would be removed from the supplier list.

To summarize, firms that export, driven by concerns about stakeholder reactions in their international markets, may exhibit better care in dealing with environmental issues in the production process. As a result, we propose the following hypotheses:

Research Hypothesis 3: *Chinese domestic firms that export exhibit better compliance with environmental regulation than firms with no international linkage.*

Research Hypothesis 4: *Chinese domestic firms that export emit less pollution than firms with no international linkage.*

3. Research Methods

Based on the discussions in the previous section, the key empirical questions this study aims to answer are 1) whether firms with FDI exhibit better environmental compliance and performance than firms with no international linkage; and 2) whether exporting induces firms to pay more attention to their environmental behavior and performance. In order to answer these questions, we collected a sample of 565 firms in Shanghai. Although our data does not keep track of firms' operational changes such as adoption of systematic environmental management systems or use of a certain type of equipment or technology, we do have information on environmental

compliance and performance that directly reflect firms' efforts in changing their environmental operations[1]. Regression analysis is used to investigate how these firms' environmental compliance and performance can be explained by their foreign ownership status and export status, after controlling for size, pollution abatement capacity, and industry sector.

3.1 Data

The pollution data from 2007 was kindly provided by the Shanghai Environmental Protection Bureau (SEPB). Shanghai is the largest city and the most important economic center in China. Over the last decade, Shanghai's industrial output has increased at an average rate of about 12.3% annually (SBS, 2008). This rapid economic growth is at least partially fueled by FDI and increasingly strong demand for exports, as demonstrated in Figure 1.

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Insert Figures 1, 2, and 3 about here.
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In spite of rapid economic growth, industrial pollution in Shanghai has been successfully kept under control. Figure 2 shows that the total discharge of Chemical Oxygen Demand (COD) has declined during the period between 1995 and 2007. Figure 3 demonstrates that the total

[1] We believe that our dependent variables (environmental compliance and performance) reflect a firm's environmental practices very closely, since they are constructed based on firms' onsite Chemical Oxygen Demand (COD) discharges and Sulfur Dioxide (SO_2) emissions. It is hard to find a measure that describes a firm's environmental operations directly because they are highly variable as a result of firms' pursuit of cost-effective operations to achieve their environmental goals.

emission of Sulfur Dioxide (SO_2) has decreased, albeit slightly, from the 1995 level during this period. Chemical Oxygen Demand (COD), measured by the amount of organic pollutants found in surface water, is a widely used indicator for water pollution. SO_2 is a major byproduct of fuel combustion and other industrial processes, and a major precursor of acid rain. According to SEPB, COD and SO_2 are their prime regulatory water and air pollutants, respectively[2].

A sample of 565 firms was randomly selected by SEPB from its master database. Among them, we have 406 firms with COD data and 429 firms with SO_2 data. SEPB data track each firm's COD discharges and SO_2 emissions using two sets of measurement: (i) the *absolute* total amount of COD discharges and SO_2 emissions and (ii) the level of COD discharges and SO_2 emissions *relative* to the level specified by regulations (namely, the amount of discharges or emissions above the corresponding regulatory standards). The data also have information on firms' capacities in water and air pollution abatement, which measure how much waste water and air could be cleaned up per day with firms' installed abatement equipment, as well as the amount of abatement of COD and SO_2 in 2007.

The data was then merged with the Annual Industrial Survey Database of the Chinese National Bureau of Statistics (NBSC) to obtain information on output, the number of employees,

[2] COD and SO_2 are the major pollutants that China's environmental regulations have targeted for the last five years. In 2006, the central government set goals to reduce the discharge of COD and SO_2 by 10 percent from the 2005 level with 2 percent of reduction each year in the 11th five-year plan period (2006-2010). In particular, the 11th five-year plan aims to cut China's national discharge of COD from 14.14 million tons in 2005 to 12.73 million tons in 2010, and to cut the national emission of SO_2 from 25.49 million tons to 22.94 million tons. In implementation, the national goals of total pollution control are decomposed into provincial sub-goals, and then into municipal and county-wide sub-goals, and finally into firms' sub-goals. For instance, in Shanghai, COD discharge is to be cut by 14.8% and SO_2 emissions by 25.9% from their 2005 levels by 2010. Therefore, COD and SO_2 represent the major pollutants that regulatory agencies and firms are concerned about.

location, sector, ownership and exports of the firms provided in the SEPB data. With these variables, we were able to examine whether foreign invested firms and export-oriented domestic firms in Shanghai have better environmental compliance and performance compared to firms with no international linkage.

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Insert Table 1 about here.
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Table 1 provides the descriptive statistics. Table 1 shows that for the 565 sampled firms, the average value of output is 1.2 billion Chinese yuan (about 180 million US dollars) and the average number of employees is 893. About one quarter of the firms in our sample are located in urban areas. Domestic firms with no international linkage account for 26.7% of the sample, domestic firms that have international linkage via export account for 17.4% of the sample, and foreign-invested companies account for 55.9% of the sample. The sampled firms are distributed across nine industrial sectors including food and beverage (7.43%), textile (9.91%), furniture (2.30%), paper (6.37%), chemical (16.82%), rubber (4.07%), metal (9.03%), machinery (40.88%) and concrete and ceramics (3.19%). Summary statistics on firms' environmental performance indicators can be found at the bottom of Table 1. Our final sample after matching with the National Industrial Survey yielded 406 observations that have COD discharge data and 429 observations that have SO_2 emissions data. Collectively, these firms account for 56.41% and

73.26% of the total emissions of COD and SO_2 in Shanghai.

3.2 Variables and Model Specification

The central task of the paper is to investigate whether foreign invested firms and export-oriented domestic firms exhibit better environmental compliance and performance compared to firms with no such international linkages. To answer this question, we ran the following regression models:

$$y_i^* = \alpha_0 + \alpha_1 DomExport_i + \alpha_2 Foreign_i + Sector_i\Gamma + X_i\mathrm{B} + \varepsilon_i \ , \ y_i = I(y_i^* > 0) \qquad (1)$$

$$TE_i = \beta_0 + \beta_1 DomExport_i + \beta_2 Foreign_i + Sector_i\Theta + X_i\Pi + \mu_i \qquad (2)$$

We measure firms' environmental performance based on two major pollutants (COD and SO_2) and in three different but related ways: environmental non-compliance (y_i), above-standard emissions (y_i^*), and firms' total emissions (TE_i). Environmental non-compliance is an indicator variable that takes the value of 1 if the firm's total emission exceeds the regulatory standard, and 0 otherwise. In 2007, 60 out of 406 firms (14.8%) for which we have COD data exceeded the water pollution standard, and 23 out of 429 firms (5.4%) for which we have SO_2 data exceeded the air pollution standard. Above-standard emissions is a continuous variable censored at 0, which represent the amount of emissions over the standard in 2007, measured in kilograms of COD in the case of water pollution, and kilograms of SO_2 in the case of air pollution. Total

emissions (TE_i) is the total amount of water / air pollution that the firm emitted in 2007. It is measured in kilograms of COD in the case of water pollution, and kilograms of SO_2 in the case of air pollution. In order to address the skewness issue in emission variables and achieve better fit, we use the natural logarithm of the emission variables in our regression analysis[3].

The variable $DomExport_i$ is a dummy variable that indicates a domestic firm's export status in 2007. It is equal to 1 if a domestic firm exports and 0 otherwise. $Foreign_i$ is a dummy variable, which is equal to 1 if a firm is either a foreign wholly owned subsidiary or Sino-foreign joint venture, and 0 otherwise. These two dummy variables capture the impact of a firm's international linkage compared to the reference group of domestic firms with no international linkage at all. $Sector_i$ is a vector of 9-sector dummies to control for sector fixed effects in emissions, with the first sector (food and beverage) omitted in order to avoid multicollinearity.

The vector X_i represents a vector of control variables, including the following:

Firm size: firm size is measured by the natural logarithm of the value of total output in 2007 and controls for the impact of firm size on their environmental performance.

Water (or air) abatement capacity: the capacity of pollution abatement is an important factor that affects firms' environmental compliance and performance. It is measured by the natural logarithm of the amount of waste water (unit: ton) that firms are able to treat in case of COD, and by the natural logarithm of the amount of waste air (unit: cubic meter) that firms are able

[3] For above-standard emission, which is censored at 0, we added one before taking the natural logarithm.

to treat in case of SO_2.

Abated COD (or SO_2): we include the natural logarithm of abated emissions in order to control for the level of abatement effort by the firm. It is measured by the amount of abated COD discharges or SO_2 emissions.

Urban: this is a dummy variable that is equal to 1 if a firm is located in urban areas of Shanghai and 0 if it is located in suburban areas. Presumably, firms in urban areas may face larger pressure from local community and government for cleaner operations because the impact of pollution in urban areas is larger due to high population density around the facility.

All regressions include sector fixed effects, with our nine-sector classification. We ran a logit model with the specification shown in (1) to test for factors explaining environmental non-compliance, where the error term is assumed to follow an extreme value distribution. In addition, we ran the Tobit model with the above-standard emission as our dependent variable. Finally, we ran an OLS regression model shown in (2) in order to test the environmental impact of having an international linkage. The error terms are assumed to be uncorrelated with our explanatory variables. We calculated robust standard errors in reporting the standard errors (White, 1980).

4. Findings

We present two sets of results in Table 2. Columns 1 through 3 report the regression results

with water pollution, and columns 4 through 6 report the results with air pollution. Two sectors in our sample, sector 6 (Rubber) and sector 9 (Concrete and Ceramic) have no firm violating the standards in both categories. As a result, the 24 observations belonging to these two sectors are dropped in the logit estimation results shown in column 1, and 33 observations belonging to these two sectors are dropped in the logit estimation results shown in column 4.

Columns 1 and 4 report the logit regression results, looking at the compliance behavior of firms with international linkage via foreign ownership or export compared to that of firms with no international linkage after controlling for firm-level variables such as size, location, abatement capacity, total abated amount, and sector. Reported coefficients are marginal effects. In each regression, the estimated coefficient for $Foreign_i$ is negative and significant at the 1% level. The results suggest that foreign firms have 10.2% lower chance of violating the COD discharge standard, and 8.1% lower chance of violating the SO_2 emission standard, compared to domestic firms that have no international linkage.

Since the severity of non-compliance can also be of interest, we ran Tobit regression models with the amount of above-standard emission as dependent variable. Column 2 and 5 report Tobit regressions results, and the results are consistent with those from the logit regressions. Foreign firms tend to have lower amount of above-standard COD discharges and above-standard SO_2 emissions compared to domestic firms that have no international linkage after controlling for firm-level variables such as size, location, abatement capacity, total abated amount, and sector. Both coefficients are significant at the 1% level. These results provide empirical evidence that

supports research hypothesis 1.

Similarly, domestic firms that export are found to have 4.9% lower chance of violating the COD emission standard, and they have 3.2% lower chance of violating the SO_2 emission standard, compared to domestic firms that have no international linkage. These estimates are statistically significant, at the 5% level and at the 1% level, respectively. In addition, from Tobit estimation results in columns 2 and 5, we find that domestic firms that export tend to have lower levels of above-standard COD discharges and above-standard SO_2 emissions, compared to domestic firms that have no international linkage. Both coefficients are significant at the 5% level. As a result, research hypothesis 3 is empirically supported.

From these results, we conclude that firms with international linkage via foreign ownership or export exhibit better compliance with environmental regulatory standards than firms with no international linkage, confirming research hypothesis 1 and research hypothesis 3.

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Insert Table 2 about here.
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In columns 3 and 6, we investigate whether having an international linkage is helpful in reducing overall emission of pollutants. It turns out that foreign firms emit 53% less COD and 89.7% less SO_2 than domestic firms with no international linkage, after controlling for firm-level variables such as size, location, abatement capacity, total abated amount, and sector. Both coefficients are

significant at the 5% level. This confirms our hypothesis 2 that multinational firms in China emit less pollution than firms with no international linkage.

On the other hand, domestic firms that export achieve no significant reductions in either COD discharges or SO_2 emissions compared to firms with no international linkage, after controlling for the firm-level variables. Therefore, our hypothesis 4 that Chinese domestic firms that export emit less pollution than firms with no international linkage is not supported empirically. Actually, domestic firms that export and domestic firms that do not export show no significant differences in COD discharges or SO_2 emissions. We conjecture that this might be due to the fact that, although they have a stronger incentive to produce with a cleaner operation, domestic firms that export do not have significantly higher capabilities to achieve deeper cuts in pollution relative to regulatory standards than firms with no international linkage. In comparison, foreign firms that operate in China have both a stronger incentive and better capabilities in pollution abatement.

When it comes to control variables, we have the following observations. First, firms in urban areas are significantly less likely to violate environmental regulations. Consistent with our stakeholder argument, these firms may face larger pressures from local community and government for cleaner operation because of the high population density around the facility. Second, large firms often cause more severe environmental problems as demonstrated in columns 3 and 6 in Table 2. They are more likely to violate SO_2 regulations although they do not perform significantly worse in COD standard compliance. Third, we can see from columns 3 and

6 of Table 2 that firms with larger amounts of pollution abatement often end up also being the ones with more emissions. Coefficients for sector dummies and goodness-of-fit measures are presented at the bottom of Table 2.

5. Conclusion

In contrast to the Pollution Haven Hypothesis advanced by Walter (1980), the Trade-Up Hypothesis formulated by Dresner (2000) and Prakash and Potoski (2006) holds that international integration helps improve firms' environmental performance in emerging economies. Using unique firm-level data from Shanghai, this paper provides a piece of empirical evidence that is supportive of the Trade-Up Hypothesis. We find that foreign invested firms are more likely to comply with environmental regulations than firms with no international linkage. We also find that domestic firms that export are more likely to comply with environmental regulations than firms with no international linkage. The source of this compliance for foreign firms is clear: foreign firms actually emit much less pollution than firms with no international linkage, since they can access advanced technologies and procedural know-how that the foreign owner can provide. However, domestic firms that export have a strong incentive to comply with environmental regulations while lacking the resources of foreign firms. As a result, they are less likely to violate the COD/SO_2 standards even though their actual emissions are at similar levels to their non-exporting peers. These results suggest that international linkages via ownership, in the form of FDI, motivate firms to improve their environmental compliance and also provide

them with the means to achieve that goal, therefore enabling them to produce with cleaner operations. International linkages via market exposure only, via export, motivate firms to pay more attention to environmental compliance while providing them with little know-how of pollution reduction, enabling them to lower their probability of violating the COD/SO_2 standards without much improvement in actual reductions in pollution. Having no international linkage at all, of course, leads to the poorest environmental performance.

However, our findings only provide partial evidence for the Trade-Up Hypothesis. The proponents of the Trade-Up Hypothesis claim that not only firms with international ties exhibit better environmental performance, but firms with no international ties would also achieve improvement through a mimetic effect or a competition effect. A mimetic effect means that firms with international linkages serve as a transmission belt which introduces advanced environmental technologies and management systems that other firms would learn from and follow (Chang and Xu, 2008). A competition effect means that as sustainability becomes a new competition frontier (Kleindorfer, Singhal and Van Wassenhove, 2005), firms with bad environmental records have an incentive to match up with firms with better environmental performance, which are more likely to be those with international linkages. This paper only provides evidence that firms with international economic linkages (in the form of either FDI or international trade) exhibit better environmental performance than firms without such linkages. It is an interesting future research question, to be explored with the help of panel data, whether firms with no international linkages can also improve their environmental performance as a

result of international economic integration through such spillover effects.

We would like to caution the readers further that the generalizability of our results is still to be tested. Our research used rare firm-level environmental data, but the data we have is only a one-year snap shot of the firms in Shanghai. As a city with substantial political and economic clout, environmental protection in Shanghai often receives special attention in China. It would therefore be interesting to investigate if we can observe the same phenomenon in other regions of China, where overall environmental conditions may be deteriorating. We would like to compile a panel dataset encompassing more Chinese cities and provinces in our future research.

Table 1: Descriptive Statistics

Variable and Definition	Mean	Standard Deviation
Value of Output (Million Yuan)	1,206.53	6,450.52
Number of Employees	892.81	1,713.30
Firms Located in Urban Area (%)	24.96	
Firms' Export & FDI		
Domestic Firms without Export (%)	26.73	
Domestic Firms with Export (%)	17.35	
Foreign Wholly Owned Subsidiary or Sino-foreign Joint Venture (%)	55.92	
Sector		
1 Food and Beverage (%)	7.43	
2 Textile (%)	9.91	
3 Furniture (%)	2.30	
4 Paper (%)	6.37	
5 Chemical (%)	16.82	
6 Rubber (%)	4.07	
7 Metal (%)	9.03	
8 Machinery (%)	40.88	
9 Concrete and Ceramic (%)	3.19	
Total Number of Firms	565	
Environment Performance		
Total COD Discharges (kg)	38,346.16	250,829.40
Above-permit COD Discharges (kg)	1,360.85	5,832.09
Capacity of Waste Water Abatement (ton/day)	6,289.12	105,093.10
Total Abated COD (kg)	205,364.80	1,235,356.00
Total Number of COD-discharging firms in the sample	406	
Total SO_2 Emissions (kg)	850,194.10	7,805,610.00
Above-permit SO_2 Emissions (kg)	1,831.66	14,886.33
Capacity of Waste Air Abatement (m^3/hour)	127,497.10	750,808.20
Total Abated SO_2 (kg)	517,771.40	7,358,470.00
Total Number of SO_2-emitting Firms in the Sample	429	

Table 2: Regression Results

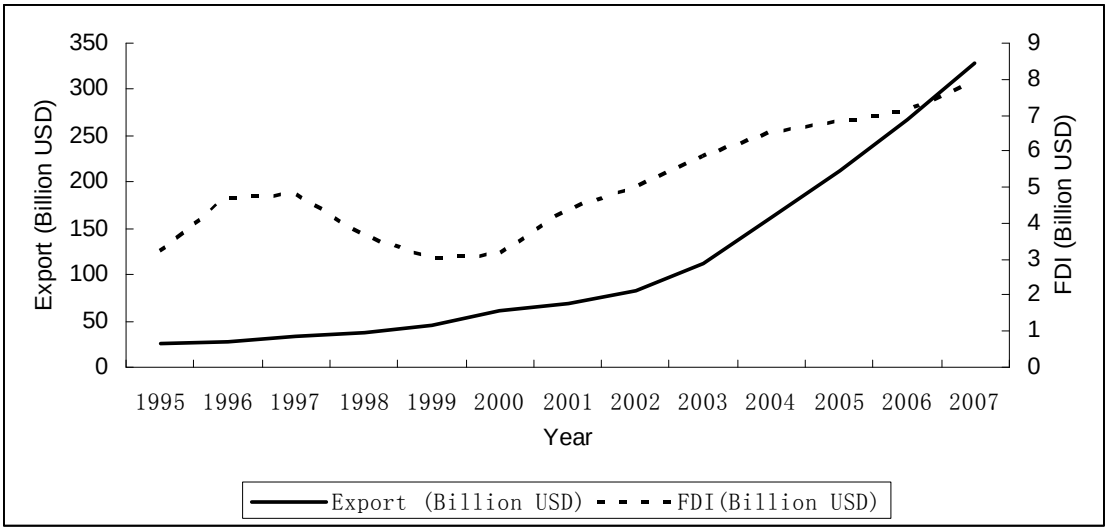
	1	2	3	4	5	6
Model	Logit	Tobit	OLS	Logit	Tobit	OLS
Dependent Variable: / Independent Variables	I(Above Standard COD>0)	Log (Above Standard COD)	Log (Total COD Discharge)	I(Above Standard SO_2>0)	Log (Above Standard SO_2)	Log (Total SO_2 Emission)
Domestic Exporter	-0.0497*	-4.2313*	0.1177	-0.0317**	-8.4629*	0.3484
	(0.0203)	(2.1118)	(0.2288)	(0.0086)	(4.0330)	(0.3556)
Foreign	-0.1015**	-6.7818**	-0.5308*	-0.0806**	-13.8420**	-0.8966**
	(0.0241)	(1.6774)	(0.2155)	(0.0287)	(5.2313)	(0.3368)
Log (Output)	-0.0185	-1.0731	0.2964**	0.0162**	3.5133**	0.3639**
	(0.0104)	(0.6955)	(0.0573)	(0.0038)	(1.1394)	(0.0890)
Urban	-0.0896**	-7.0442**	0.2484	-0.0437**	-12.7058**	-0.2166
	(0.0235)	(2.0710)	(0.1945)	(0.0094)	(3.9330)	(0.3317)
Log (Water Pollution Abatement Capacity)	-0.0112	-0.6866	0.0871			
	(0.0063)	(0.5078)	(0.0450)			
Log (Abated COD)	-0.0076*	-0.4634	0.1013**			
	(0.0034)	(0.2440)	(0.0152)			
Log (Air Pollution Abatement Capacity)				-0.0003	0.0659	0.0692*
				(0.0017)	(0.3623)	(0.0294)
Log (Abated SO_2)				-0.0031	-0.5277	0.1466**
				(0.0024)	(0.5256)	(0.0372)
Sector 2 Textile	-0.0120	0.1292	0.5667	0.0241**	5.8730*	-0.1382
	(0.0115)	(0.9611)	(0.3880)	(0.0075)	(2.4435)	(0.4159)
Sector 3 Furniture	0.0725*	2.6182	-0.0951	0.0925**	9.0331**	-0.9380
	(0.0333)	(1.5832)	(0.4404)	(0.0236)	(1.1290)	(1.0736)
Sector 4 Paper	0.0689	4.1402*	-0.2224	0.0010	1.0259	-1.0734
	(0.0430)	(1.9174)	(0.4386)	(0.0048)	(1.4027)	(0.5707)
Sector 5 Chemical	-0.0461**	-3.9746**	-0.2086	-0.0251**	-7.9414**	-0.8839*
	(0.0073)	(0.3864)	(0.3785)	(0.0031)	(1.2624)	(0.3920)
Sector 6 Rubber			0.1414			-0.9781
			(0.5547)			(0.7624)
Sector 7 Metal	0.0494	2.7643	-0.3154	-0.0213**	-5.6842**	-0.9125
	(0.0275)	(1.4086)	(0.3900)	(0.0027)	(1.0202)	(0.5783)

(Continued on next page)

	1	2	3	4	5	6
Model	Logit	Tobit	OLS	Logit	Tobit	OLS
Sector 8 Machinery	-0.0278	-1.9776	-0.2674	-0.0276**	-6.2414**	-1.7821**
	(0.0197)	(1.4893)	(0.3194)	(0.0033)	(0.5621)	(0.3379)
Sector 9 Concrete and Ceramic			0.4431			3.3388**
			(0.6261)			(0.6489)
Constant	2.3755	11.1300	4.4809**	-6.7516**	-55.7449**	4.9029**
	(1.4005)	(8.4039)	(0.7061)	(1.8892)	(11.9046)	(0.9960)
Observations	382	406	406	396	429	429
R-squared			0.3112			0.2985
Psuedo R-squared	0.185	0.0970		0.127	0.0761	
Log Likelihood	-135.4	-315.8		-76.64	-148.4	

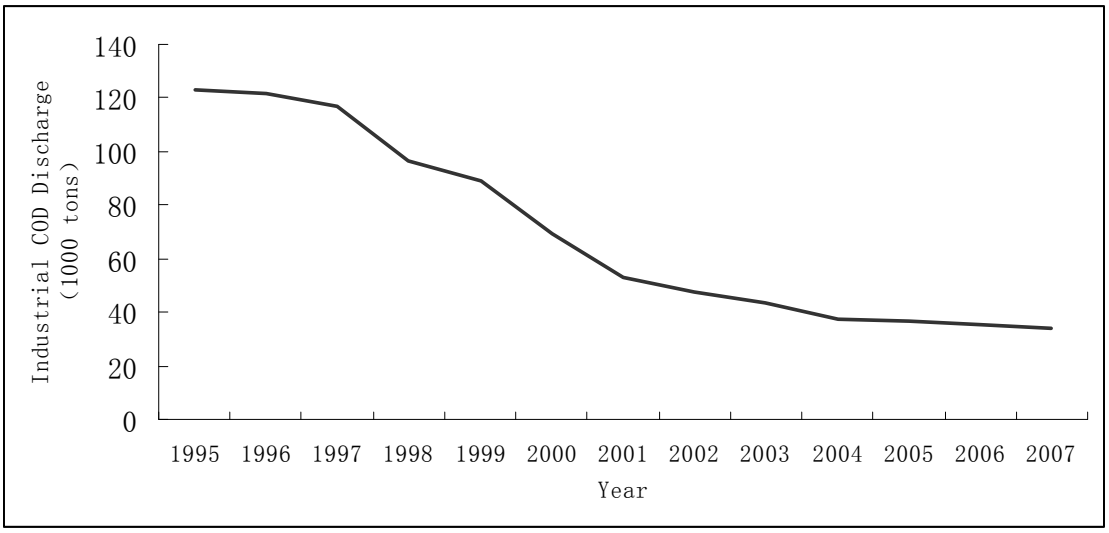
Robust standard errors in parentheses; * p<0.05, ** p<0.01

Figure 1: Growth of FDI and Export in Shanghai: 1995-2007



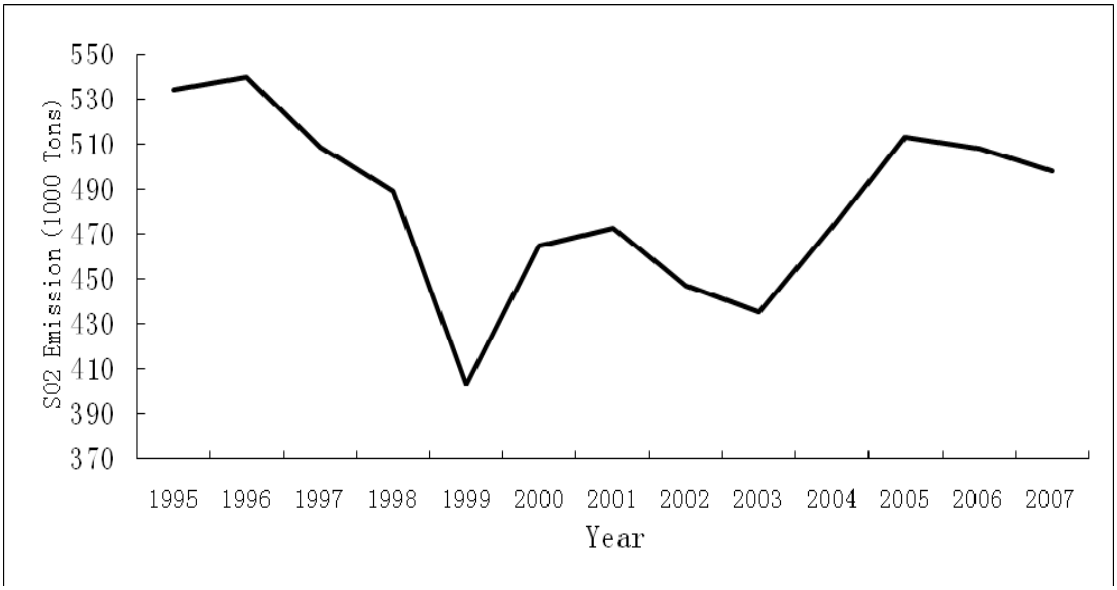
Source: Shanghai Statistical Yearbook, available at http://www.stats-sh.gov.cn/2004shtj/tjnj/tjnj2009.htm.

Figure 2: Trend in Industrial COD Discharge in Shanghai: 1995-2007



Source: Shanghai Statistical Yearbook, available at http://www.stats-sh.gov.cn/2004shtj/tjnj/tjnj2009.htm.

Figure 3. Trend in SO_2 Emission in Shanghai: 1995-2007



Source: Shanghai Statistical Yearbook, available at http://www.stats-sh.gov.cn/2004shtj/tjnj/tjnj2009.htm.

References

Angell LC. 2001. Comparing the environmental and quality initiatives of Baldrige Award winners. *Production and Operations Management* **10**(3): 306-326

Bouquet C, Deutsch Y. 2008. The impact of corporate social performance on a firm's multinationality. *Journal of Business Ethics* **80**: 755-769

Caro F, Andalaft R, Sapunar P, Cabello M. 2003. Evaluating the economic cost of environmental measures in plantation harvesting through the use of mathematical models. *Production and Operations Management* **12**(3): 290-306

Chang S-J, Xu D. 2008. Spillovers and competition among foreign and local firms in China. *Strategic Management Journal* **29**: 495-518

Child J, Tsai T. 2005. The dynamic between firms' environmental strategies and institutional constraints in emerging economies: evidence from China and Taiwan. *Journal of Management Studies* **42**(1): 95-125

Chinander KR. 2001. Aligning accountability and awareness for environmental performance in operations. *Production and Operations Management* **10**(3): 276-291

Christmann P, Taylor G. 2001. Globalization and the environment: determinants of firm self-regulation in China. *Journal of International Business Studies* **32**(3): 439-458

Clarkson MBE. 1995. A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance. *The Academy of Management Review* **20**(1): 92-117

Cole MA, Elliot RJR. 2005. FDI and the capital intensity of "dirty" sectors: a missing piece of the pollution haven puzzle. *Review of Development Economics* **9**(4): 530-548

Corbett CJ, Kirsch DA. 2001. International diffusion of ISO 14001 certification. *Production and Operations Management* **10**(3): 327-342

Corbett CJ, Kleindorfer PR. 2001. Introduction to the special issue on environmental management and operations. *Production and Operations Management* **10**(2): 107-111

Corbett CJ, Kleindorfer PR. 2003. Environmental management and operations management: introduction to the third special issue. *Production and Operations Management* **12**(3): 287-289

Daniels JD, Radebaugh LH, Sullivan DP. 2009. *International Business: Environments and Operations* (12th ed.). Pearson Prentice Hall

Delmas M. 2000. Barriers and incentives to the adoption of ISO 14001 in the United States, *Duke Environmental Law and Policy Forum*:

Delmas M. 2001. Stakeholders and competitive advantage: the case of ISO 14001. *Production and Operations Management* **10**(3): 343-358

Donaldson T, Preston LE. 1995. The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. *Academy of Management Review* **20**(1): 65-91

Drezner D. 2000. Bottom Feeders. *Foreign Policy* **122**(1): 64-73

Economy E. 2004. The river runs black: the environmental challenge to China's future. Cornell University Press: Ithaca

Freeman RE. 1991. *Business Ethics: the State of the Art*. Oxford University Press

Graham JL, Lam NM. 2003. The Chinese negotiation. *Harvard Business Review* **81**(10): 82-91

Hillman AJ, Keim GD. 2001. Shareholder Value, Stakeholder Management, and Social Issues: What's the Bottom Line? *Strategic Management Journal* **22**(2): 125-139

Hymer S. 1976. *The international operations of national firms: a study of direct foreign investment*. MIT Press: Cambridge, MA

Kellenberg DK. 2009. An empirical investigation of the pollution haven effect with strategic environment and trade policy. *Journal of International Economics* **78**(2): 242-255

King AA, Lenox M, J., Terlaak A. 2005. The strategic use of decentralized institutions: exploring certification with the ISO 14001 management standard. *Academy of Management Journal* **48**(6): 1091-1106

King AA, Shaver JM. 2001. Are aliens green? Assessing foreign establishments' environmental conduct in the United States. *Strategic Management Journal* **22**: 1069-1085

Klassen RD, Vachon S. 2003. Collaboration and evaluation in the supply chain: the impact on plant-level environmental investment. *Production and Operations Management* **12**(3): 336-352

Kleindorfer PR, Singhal K, Van Wassenhove L. 2005. Sustainable operations management. *Production and Operations Management* **14**(4): 482-492

Levinson A, Taylor MS. 2008. Unmasking the pollution haven effect. *International Economic Review* **49**(1): 223-254

Li Y. 2009. The world factory is polluted by multinational enterprises:

Ma X, Ortolano L. 2000. *Environmental regulation in China: institutions, enforcement, and compliance*. Rowman & Littlefield: Lanham, MD

Mata J, Portugal P. 2002. The survival of new domestic and foreign-owned firms. *Strategic Management Journal* **23**: 323-343

Melnyk SA, Sroufe RP, Calantone R. 2003. A model of site-specific antecedents of ISO 14001 certification. *Production and Operations Management* **12**(3): 369-385

Mezias J. 1999. Labor lawsuits: a source of disadvantage for foreign subsidiaries in the United States, Vol. Ph.D. New York University

Morris RJ, Lawrence AT. 2001. Nike's dispute with the University of Oregon. *Case Research Journal* **21**(3): 129-146

NBSC. 2008. China Statistics Yearbook:

Pargal S, Wheeler D. 1996. Informal regulation of industrial pollution in developing countries: evidence from Indonesia. *Journal of Political Economy* **106**(6): 1314-1327

Porter ME, Kramer MR. 2006. Strategy & Society: The Link between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review* **84**(12): 78-92

Prakash A, Potoski M. 2006. Racing to the bottom? Trade, environmental governance, and ISO 14001. *American Journal of Political Science* **50**(2): 350-364

Russo MV, Fouts PA. 1997. A Resource-based View Perspective on Corporate Environmental Performance and Profitability. *The Academy of Management Journal* **40**(3): 534-559

SBS. 2008. *Shanghai Statistical Yearbook*. Shanghai Bureau of Statistics

Spencer JW. 2008. The impact of multinational enterprise strategy on indigenous enterprises: horizontal spillovers and crowding out in developing countries. *Academy of Management Review* **33**(2): 341-361

Strike VM, Gao J, Bansal P. 2006. Being good while being bad: social responsibility and the international diversification of US firms. *Journal of International Business Studies* **37**: 850-862

Sustainable_Industrial. 2010. Goodyear won the Shanghai GM Green Supply Chain Excellent Supplier Award, *Sustainable Industrial*:

Vernon R. 1998. *In the hurricane's eye: the troubled prospects of multinational enterprises*. Harvard University Press: Boston, MA

Walter I (Ed.). 1982. *Environmentally Induced Industrial Relocation to Developing Countries*. Allanheld, Osmun Publishers: Totowa, NJ

Wang H. 2000. Pollution charges, community pressure, and abatement cost of industrial pollution in China, *World Bank Policy Research Working Paper*: Washington DC

Wang H, Jin Y. 2007. Industrial ownership and environmental performance: evidence from China. *Environmental & Resource Economics* **36**: 255-273

Wang H, Mamingi N, Laplante B, Dasgupta S. 2003. Incomplete enforcement of pollution regulation: bargaining power of Chinese factories. *Environmental & Resource Economics* **24**: 245-262

White H. 1980. A Heteroskedasticity-consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica* **48**: 817-838

Xu H. 2009. Wenchuan earthquake and the brand aftershocks of multinational enterprises:

Yin H, Ma C. 2009. International integration: a hope for a greener China? *International Marketing Review* **26**(3): 348-367

Yin H, Schmeidler P. 2009. Why do standardized ISO 14001 environmental management systems lead to heterogeneous environmental outcomes? *Business Strategy and the Environment* **18**: 469-486

Yosie TF. 2008. Greening the supply chain in emerging markets: some lessons from the field:

Yosie TF. 2010. SGM-WEC partnership in greening the supply chain: 2009-2010 project results:

Zaheer S. 1995. Overcoming the liability of foreignness. *Academy of Management Journal* **38**: 341-363

Zaheer S, Mosakowski E. 1997. The dynamics of the liability of foreignness: a global study of survival in financial services. *Strategic Management Journal* **16**(6): 439-464

Zeng K, Eastin J. 2007. International integration and environmental protection: the case of China. *International Studies Quarterly* **51**(4): 971-995