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# Foreign Direct Investment and the Environment

Matthew A. Cole, Robert J.R. Elliott, and Liyun Zhang

Department of Economics, University of Birmingham, Birmingham B15 2TT, United Kingdom; email: m.a.cole@bham.ac.uk, r.j.elliott@bham.ac.uk, l.zhang.4@bham.ac.uk



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## Keywords

foreign direct investment, environment, pollution haven, environmental outsourcing

## Abstract

We review the literature that investigates the relationship between foreign direct investment (FDI) and the environment. After reviewing the theoretical literature, we discuss two broad strands of research. First, the impact of environmental regulations on the choice of plant location and second, the impact of FDI on the emissions of various pollutants and the related question of whether we can observe environmental spillovers from foreign to domestic firms. Finally, we review the more recent literature on environmental outsourcing as an alternative to FDI and conclude with suggestions for future research.

## Contents



## 1. INTRODUCTION

A key characteristic of the globalization of the world economy has been the liberalization and expansion of global foreign direct investment (FDI) flows. Inevitably, academics and policymakers have considered the wide-ranging consequences of such a notable economic change, and the implications for the natural environment have featured prominently. The environmental implications of FDI flows have generally taken two forms: First, there has been a concern that attempts to tackle pollution via domestic regulation may influence FDI flows as investors seek to avoid the perceived competitive disadvantages associated with stringent regulation. Second, there is the effect that the FDI itself may have on the local environment in the host country, which could be either positive or negative. On the one hand, if multinationals relocate to regions with less stringent regulations this could increase levels of local pollution (air and water) and damage the health of the local population. On the other hand, FDI from technologically advanced countries may bring with it new technologies and cleaner methods of production that displace less efficient local firms, or if the technology and production techniques used by local firms change in response to the presence of foreign firms. The third possibility is that firms choose to outsource the dirty part(s) of their production process as an alternative strategy to wholescale relocation overseas. Such a move may be less likely to result in the use of cleaner technologies and positive environmental spillovers, although outsourcers may still pressurize arms-length partners to improve their environmental performance as part of efforts to green their supply chain.

Our purpose is to review each of these bodies of literature and to provide a balanced assessment of current thinking within the FDI-environment debate. Section 2 reviews the theoretical contributions to date which, perhaps surprisingly, predict that more stringent environmental regulations can have a positive or negative impact on FDI flows and that, under not too demanding assumptions, FDI is not necessarily attracted to low-regulation regions. Section 3 reviews the literature that empirically estimates the impact of environmental regulatory differences on plant location,

both within a country and between countries, often referred to as the pollution haven hypothesis (PHH). In Section 4, we examine whether the large global flows of FDI affect the emissions of local and global pollutants either positively (the pollution halo effect) or negatively through increased production of pollution-intensive goods. Section 5 summarizes the related strand of the literature that examines whether firms outsource the pollution-intensive part of their production process. Section 6 concludes.

## 2. THEORETICAL OVERVIEW

The first theoretical contributions to the FDI-environment debate (e.g., 1–4) consider the impact of environmental regulatory differences on comparative advantage. Each of these papers predicts that trade and capital will flow from countries with stringent regulations to those with less stringent regulations. Trade and capital flows of this type are consistent with the notion of the PHH, where FDI is attracted to, or imports sourced from, low-regulation havens. To the best of our knowledge, Pearson (5) provided the first paper to consider environmental issues as part of the decision to invest abroad, with environmental services considered a factor of production alongside labor and capital. In this context, the assumption is that developing countries initially have a smaller industrial structure (fewer high-polluting sectors) and as such do not place a high demand on the provision of environmental services, which should translate into a lower price for those services. The result is that developing countries should have a comparative advantage in the production of dirty (pollution-intensive) goods. In a formal setting, Baumol & Oates (1) present a partial-equilibrium two-country model with two sectors that differ in terms of their pollution intensity. They show that, as expected, the developed country has higher regulations and hence a comparative disadvantage in the production of dirty goods, whereas the opposite is true in the developing country. This finding is supported by the theoretical contributions of Markusen et al. (2) and Motta & Thisse (4).[1]

A second approach to modeling the FDI-environmental regulation relationship is followed by a series of papers (e.g., 11–16). These papers model the possibility that FDI may influence environmental policy as well as the other way around. In this literature, which we term the political economy approach, firms are able to influence the development and implementation of environmental policy in the home and/or the host country. Hence, in an open economy setting, environmental differences are shown to be endogenously generated through lobbying by firms for lower environmental regulations or at least to prevent any increases in environmental regulations (15, 17–22). The conclusions from each of these papers, however, are the same. FDI is again predicted to flow from high- to low-regulation countries or regions.

However, contrary to these theoretical predictions, the early empirical studies that we review later fail to find conclusive evidence of FDI being influenced by environmental regulatory differences as predicted by the PHH. This spurred the development of several alternative theoretical models to explain why FDI may not necessarily be attracted to low-regulation regions and on the contrary may actually be attracted to high-regulation regions.

Sanna-Randaccio & Sestini (23) provide one possible explanation for the lack of evidence that FDI is attracted to low-regulation countries by extending Markusen et al.'s (2) theoretical framework of where they consider home market characteristics; however, unlike Motta & Thisse's (4) theory, they allow both countries to change environmental policy. Sanna-Randaccio & Sestini's

[1]Although our review concentrates on FDI and the environment, it is related to the wider theoretical literature that considers the optimal decision of firms to engage in FDI or exports when attempting to access foreign markets. The general argument is that the decision to export or invest is dependent on certain market conditions (see, e.g., 6–10).

(23) key is that if the home country has a large market size then a regulation gap will only result in firms relocating overseas if it is large enough to offset any increase in transport costs that result from having to export the product back to the country of origin.

A more recent explanation for the lack of evidence of PHH-consistent effects is that FDI is motivated by different factors. Specifically, Tang (24) considers whether an environmental policy that changes the cost of production in the host country affects export-orientated FDI and local-market-orientated FDI differently [a distinction made in the theoretical contributions of Markusen (25) and Helpman (26)]. Tang (24) considers both a Cournot case, which assumes homogeneous goods with competition taking place in terms of output, and a Bertrand case, which assumes the foreign firm produces a differentiated good and firms compete on price. Both settings predict that export-orientated FDI is more sensitive to stricter environmental regulations than local-market-orientated FDI.

The first theoretical contribution to extend the theory that captures the endogenous nature of FDI and regulations such that it explains the lack of PHH-consistent evidence is provided by Dijkstra et al. (27), who use a Cournot duopoly three-stage model where the duopoly structure in the host country is exogenous. The argument presented is that an increase in the stringency of environmental regulations increases the production costs for all firms, including domestic firms. A key assumption is that if a foreign firm has more efficient technology and pollutes less per unit of output, then an increase in environmental regulations will give that firm a cost advantage, as it would incur lower pollution-abatement costs per unit of output than those of domestic competitors. The incentive of the foreign firm is therefore to lobby for higher environmental regulations to reduce their competition in the host country. Their approach also introduces a trade-off between exporting and FDI and shows that an increase in environmental tax can result in the foreign firm changing from exports to FDI, as long as the relocation cost is offset by a larger increase in environmental costs for the domestic firm relative to the foreign firm.

Elliott & Zhou (28) use a similar endogenous market structure and derive a similar result to Dijkstra et al.'s (27). They show that increases in regulatory stringency (through increases in lump sum permit costs) can result in greater FDI if the decision is whether to export or invest (and the home country firm has first-mover advantage). They term capital flows of this type environmental regulation–induced FDI. The main contribution is to model the decision of a foreign firm to engage in FDI as a deliberate strategy to restrict entry into the host country market by potential domestic competition.

Zeng & Zhao (29) provide a further explanation for limited empirical evidence and introduce agglomeration economies into a spatial model that takes into account cross-boundary pollution and footloose capital (FDI). In a north–south two-country model of increasing returns, significant transport costs, and imperfect competition, Zeng & Zhao (29) show that agglomeration economies can allow firms to resist the pull of lower environmental regulations. The benefits from being in a regional cluster with the attendant productivity spillovers may more than offset the reduced environmental abatement costs from relocating.

A related theoretical approach is to model environmental outsourcing for a firm who, instead of relocating overseas in reaction to stringent environmental regulations, chooses to outsource the production of the dirtiest part of its production process. In this case, a firm would not lose the potential agglomeration economies that Zeng & Zhao (29) describe, and it seemingly does not engage in FDI, although the overall mechanisms for emission reductions at home are fairly similar. An increase in the stringency of environmental regulations will encourage firms to either relocate (FDI) or to outsource the dirtier parts of the production process. This so-called pollution outsourcing hypothesis (POH) (30) has spurred the development of a small number of theoretical papers. For example, Kawata & Ouchida (31) develop a two-country model in which a final good

producer in the home country produces goods using offshored inputs and examines the impacts of the interaction between offshoring and transboundary emissions on environmental policies. Their model demonstrates that joint welfare cannot be maximized without international agreement on environmental standards. Their finding is that the quantity of intermediate inputs and the impact of international emission spillovers on aggregate pollution are ambiguous. Cole et al. (32) also develop a theoretical model of international environmental outsourcing that examines the role of firm size, transport costs, and environmental regulations in which heterogeneous firms can either pay an abatement cost and continue to produce in the home market as usual or incur a fixed and variable cost to offshore their polluting activity (related to finding and maintaining arms-length supplier relationships). The main prediction is that as regulations increase (everything else the same), offshoring becomes a more attractive proposition.

In sum, although early theoretical contributions provided a simple framework to predict that capital should flow from high-regulation to low-regulation countries, a lack of empirical support led other researchers to provide theoretical predictions that suggest that firms may prefer to remain in (or indeed relocate to) relatively higher-regulation countries or regions as part of an optimal strategy. Hence, in developed countries especially, the benefit of lower environmental costs could be more than offset by pull factors such as agglomeration economies, raw material supplies, skilled labor, availability of capital and infrastructure, etc. Given these different predictions, it is ultimately an empirical question as to whether PHH-consistent effects can be found in the data.

## 3. THE IMPACT OF ENVIRONMENTAL REGULATIONS ON FOREIGN DIRECT INVESTMENT LOCATION

This section focuses on the area of debate that has attracted the most attention, namely, whether and to what extent environmental regulations influence the location of FDI (the PHH). Levinson (33) identifies two challenges that empirical tests of the PHH must overcome. First, they must find an appropriate measure of regulatory stringency, and second, they must then utilize appropriate econometric techniques to capture unobserved differences between countries' trade and FDI flows (unobserved heterogeneity) and to allow for the possibility that FDI flows and regulations will influence each other (simultaneity). Chichilnisky (3) divides the literature into two generations. The first generation used aggregate data for the analysis, such as cross-sectional data at the country level, and made no attempt to control for unobserved heterogeneity and simultaneity. These studies failed to provide convincing support for the PHH. Studies in later years have tended to use panel data and to utilize more advanced econometric approaches to address unobserved heterogeneity and simultaneity and find some evidence that is consistent with the PHH. In this section, we summarize and discuss this literature, first examining how regulatory stringency has been measured. **Table 1** provides a summary of a selection of papers discussed in this section and includes information on the estimation method, period of analysis, and country(s) of study as well as whether PHH-consistent evidence is found.

### 3.1. Measuring the Stringency of Environmental Regulations

A fundamental difficulty within this literature is how to measure the stringency of environmental regulations (see, e.g., 34). In this section, we discuss the three types of measures widely adopted in the environment and FDI literature, namely, an actual measure of pollution emissions, a measure of environmental legislation, and an index of environmental regulation. One study that uses emissions as a proxy for regulations is that of Xing & Kolstad (35), who use aggregate national sulfur dioxide ($SO_2$) emissions to proxy for the environmental policy of 22 countries who receive FDI from the

**Table 1 A selection of empirical studies examining the impact of environmental regulations on FDI**

| Study | Country examined | Time period | Methodology | Support of PHH |
|---|---|---|---|---|
| Tang (24) | United States | 1999–2003 | GMM | Yes |
| Xing & Kolstad (35) | United States | 1985–1990 | OLS, IV | Yes |
| Eskeland & Harrison (37) | United States | 1982–1993 | OLS | Yes |
| Javorcik & Wei (38) | 143 MNCs in 25 economies in Eastern Europe and the former Soviet Union | 1997 | Logit | No |
| Naughton (39) | 28 OECD countries | 1990–2000 | OLS | Mixed |
| Kahouli et al. (40) | 14 home countries and 39 host countries | 1990–2011 | FE, RE, Hausman–Taylor regressions, GMM | No |
| Dardati & Saygili (42) | Chile | 1995–2001 | DDD | No |
| Chung (43) | South Korea | 2000–2007 | DD | Yes for polluting industries |
| List & Co (44) | United States | 1986–1993 | Conditional logit model | Yes |
| List (45) | United States | 1983–1922 | Poisson | Yes for pollution-intensive sectors; no for nonpollution-intensive sectors |
| Keller & Levinson (46) | United States | 1977–1994 | Pooled OLS, FE, GMM, negative binomial | Yes |
| Manderson & Kneller (48) | United Kingdom | 2005 | Probit, conditional FE logit | No |
| List et al. (49) | United States | 1980–1990 | DD PSM, FE Poisson | No |
| Hanna (50) | United States | 1966–1999 | DD | Yes |
| Kheder & Zugravu (51) | France | 2002 | Conditional logit model | Yes |
| Wagner & Timmins (53) | Germany | 1996–2003 | GMM | Yes for chemical industry |
| Kalamova & Johnstone (54) | 27 OECD source countries and 99 host countries | 2001–2007 | FE | Mixed |
| Rezza (55) | Norway | 1999–2005 | FE | Yes for vertical FDI; no for horizontal FDI |
| Rivera & Oh (56) | 94 MNCs across 77 countries | 2001–2007 | Logit | No |
| Poelhekke & Ploeg (57) | The Netherlands | 1999–2005 | IV | Yes for some industries |
| Fredriksson et al. (59) | United States | 1977–1987 | OLS, IV | Mixed |
| Henderson & Millimet (60) | United States | 1977–1994 | Generalized kernel estimation | Yes |
| Di (61) | China | 1992–1995 | Nested logit, OLS, Poisson | Yes for polluting industries |
| Dean et al. (62) | China | 1993–1995 | Conditional and nested logit | Yes for FDI from Hong Kong, Taiwan, and Macau only |

(*Continued*)

**Table 1** (*Continued*)

| Study | Country examined | Time period | Methodology | Support of PHH |
|---|---|---|---|---|
| Cai et al. (63) | 175 cities and 380 prefectural cities of China | 1992–2001 | DDD | Yes |
| He (64) | 29 Chinese provinces | 1994–2001 | GMM | Yes |
| Zhang & Fu (65) | China | 1998–2003 | FE, GLS | Yes |
| Bu & Wagner (67) | MNEs invested in China | 1992–2009 | OLS, probit | No |
| Waldkirch & Gopinath (70) | Mexico | 1994–2000 | Tobit | Yes for $SO_2$; no for other pollutants |
| Raspiller & Riedinger (71) | France | 1993–1999 | Conditional logit model | No |
| Bialek & Weichenrieder (74) | Germany | 2005–2009 | Mixed-logit | Yes for greenfield investment; no for M&As |
| Millimet & Roy (75) | United States | 1977–1994, excluding 1987 | OLS, GMM | Yes |
| Dam & Scholtens (125) | 540 MNEs from various countries | 2004 | Binary location choice model | Yes for firms with poor social responsibility; no for responsible firms |
| Hoffmann et al. (126) | 112 countries | 1971–1999 | VAR | Yes |

Abbreviations: DD, difference in differences; DDD, difference-in-difference-in-differences; FDI, foreign direct investment; FE, fixed effects; GLS, generalized least squares; GMM, generalized method of moments; IV, instrumental variable; M&A, mergers and acquisitions; MNC, multinational corporation; MNE, multinational enterprise; OECD, the Organisation for Economic Co-operation and Development; OLS, ordinary least squares; PHH, pollution haven hypothesis; PSM, propensity score matching; RE, random effects model; VAR, vector autoregression.

United States. They argue that the $SO_2$ levels of a country should be positively related to the laxity of environmental policy. However, Zarsky (36) claims such emission-based proxies confuse cause and effect because higher emissions are as likely to be the effect of FDI as the cause. Rather than emission levels, other studies use measures of pollution intensity, i.e., emissions scaled by the total output (or value-added) of an industry (or a firm) (see 37–40). Other papers use energy use as a measure of pollution intensity under the assumption of a positive relationship between pollution emissions and energy use (37, 41–43).

The most popular alternative to emissions is to use pollution abatement costs to capture the regulatory pressure faced by a firm or an industry. Studies focusing on the United States tend to use data from the Pollution Abatement Costs and Expenditures Survey from the United States Bureau of the Census and, specifically, their measure of pollution abatement operating costs (PAOC).[2] PAOC, usually scaled by value-added, is used by numerous studies (37, 38, 44–47) with mixed results. Manderson & Kneller (48) also use pollution abatement costs from the UK equivalent survey [the UK Environmental Protection Expenditure Survey (EPES)]. However, as with emissions, there are several drawbacks. First, the coverage of countries is rather small and the time period is relatively short: The US Pollution Abatement Costs and Expenditures Survey was conducted annually from 1973 to 1994—excluding 1987—discontinued after 1994, and conducted again in 2005, whereas the EPES is only available from 2000. Second, data on pollution abatement costs are difficult to standardize, which makes international comparisons difficult.

[2]PAOC includes salaries, parts and materials, fuel and electricity, capital depreciation, contract work, equipment leasing, and other operating costs associated with a plant's abatement of air and water pollution and solid waste.

The third approach is to capture the extent of environmental legislation. One example is the US Clean Air Act Amendments (CAAA), which were originally passed in 1970. Starting in 1977, the US Environmental Protection Agency assigns each US county an attainment status according to whether its air quality meets the federal standards. Counties that receive a nonattainment designation are required to impose more stringent regulations and thus new plants considering locating in these nonattainment counties are likely to face more significant start-up compliance costs. List et al. (49) use county-level attainment status to evaluate the impact of environmental regulation on foreign and domestic plant births. Their results from both propensity score matching and a fixed effects (FE) Poisson model show that the location of foreign new plants is not influenced by local environmental stringency. Hanna (50) also uses the CAAA as a proxy for strengthened environmental policies in the United States and studies how US-based multinationals respond to regulations using difference-in-differences estimations. Results show that the CAAA caused multinationals in more highly regulated areas to increase outbound FDI.

Finally, several studies employ environmental regulation indices. Such indices are constructed by, for example, a count of participation or the signing of multilateral environmental agreements (MEAs)/treaties or the number of environmentally oriented nongovernmental organizations (NGOs). Javorcik & Wei (38) create two environmental indices based on three treaties, the Convention on Long-Range Transboundary Air Pollution, the Convention on Environmental Impact Assessment in a Transboundary Context, and the Convention on the Transboundary Effects of Industrial Accidents. The first index is created by awarding each country a particular point for signing or ratifying each treaty before or after 1996 and the second, an enforcement-adjusted treaty index, is constructed by multiplying the treaties with the number of environmental NGOs per million people of each country. Similarly, Kheder & Zugravu (51) calculate an environmental index following the Z-score technique and principal component analysis integrating three variables: MEAs, environmental international NGOs, and energy costs.

A second approach to the construction of an environmental regulation index is to use surveys. The most widely used in the literature is The Executive Opinion Survey published in the *Global Competitiveness Reports* by the World Economic Forum (WEF). WEF partner institutes in more than 100 countries have surveyed business executives on environmental issues since the mid-1990s. Given the survey questions have changed over the years, the surveys are not directly comparable. However, since 2000 two questions have remained unchanged: regarding the environmental stringency of the country and the consistent enforcement of those regulations. Executives are asked to assess the level of stringency and enforcement of the regulations on a scale ranging from 1 to 7. The advantage of using this survey is that it covers a wide range of countries with a standardized method of measurement thus, in principle, allowing for direct comparison across countries (see 24, 43, 48, 52–57 for some studies that have used this approach). Similarly, Dam & Scholtens (58) use a question from the World Business Environmental Survey (WBES) by the World Bank, which asks how problematic are the environmental regulations their businesses face for their operation and growth with a scale from 1 (no obstacle) to 4 (major obstacle).

In sum, a range of measures of regulatory stringency clearly have been used, each suffering from potential advantages and disadvantages. Unfortunately, there is no perfect measure of the stringency of environmental policy, and all are essentially proxies for something that is inherently difficult to measure.

## 3.2. Country- or Region-Level Studies

Some of the earliest studies to examine the relationship between regulatory stringency and FDI flows focus on US-inbound FDI and the extent to which it was influenced by state-level, or other, measures of regulations. List & Co (44) and Keller & Levinson (46) both find evidence that

state-level regulation costs influence inbound FDI flows, whereas Fredriksson et al. (59) extend this result to illustrate the role played by corruption in influencing regulations. However, when Henderson & Millimet (60) utilize nonparametric techniques to analyze the impact of state-level abatement costs on inbound FDI they suggest that previous results may have overstated this impact and that the results may not have been robust.

As with the United States, China is sufficiently large with subregional regulatory differences to allow for the possibility that pollution haven–consistent behavior could be detected by observing inbound FDI. As a result, several studies have examined whether such behavior can be observed within China. Di (61), for example, examines whether environmental regulatory stringency across Chinese provinces influences the inbound FDI location choice. Using effective levy rates for water and air pollution as a measure of province-level regulation, they find that FDI from firms in pollution-intensive industries is more sensitive to regulation status and hence more likely to locate in provinces with less stringent environmental regulations. Dean et al. (62) also use pollution levies together with an official water pollution–tax formula to measure province-level environmental stringency. Their approach is to estimate the determinants of location choice for foreign manufacturing equity joint ventures (EJVs) in China during the early period of overseas investment in China (1993–1996). Evidence of pollution haven–consistent behavior is found for only EJV projects in highly polluting industries from Hong Kong, Taiwan, and Macau, with no significant evidence found for projects originating from other sources, regardless of the pollution intensity of the industry. More recently, Cai et al. (63) examined whether the Chinese Two Control Zones policy, which resulted in tougher regulations in those cities that adopted the policy relative to those that did not, influenced inbound FDI. They find that tougher regulations do deter FDI, particularly when the FDI is from countries with weaker environmental stringency than China (see 64–67 for other tests of the PHH using Chinese data).

Other studies have looked for cross-country evidence of the PHH. Xing & Kolstad (35) use aggregate economy-wide $SO_2$ emissions as a proxy for the laxity of environmental regulation and find no convincing evidence that such regulations are influencing US outbound FDI. Perhaps the best known study to examine the FDI-regulation relationship is that of Eskeland & Harrison (37), who examine the extent to which inbound FDI into Côte d'Ivoire, Morocco, Mexico, and Venezuela is affected by regulatory differences. They find no compelling evidence that the stringency of environmental policy is influencing FDI inflows into such countries. More recently, Naughton (39) examines the impact of both home country and host country environmental regulation on FDI using a panel of 28 OECD (the Organisation for Economic Co-operation and Development) countries and measures the stringency of environmental regulations using emission intensities of five pollutants. She finds that host country regulation discourages FDI, whereas home regulation has a quadratic relationship such that home regulation costs initially increase FDI flows before ultimately decreasing them.

Finally, Tole & Koop (68) examine the location decisions of multinational gold mining firms and identify the extent to which they are influenced by host region characteristics. They construct regional (groups of countries) proxies for environmental regulations based on indicators of pollution and find these to have no statistically significant relationship with a mining firm's decision to invest in a particular region. Instead, location decisions were based on proximity to the head office, low levels of corruption, and a risk-free business environment.

### 3.3. Firm- or Industry-Level Studies

As the availability of firm- and industry-level data on pollution control costs has improved, there has been a resultant increase in the number of tests of the FDI-regulation relationship using such disaggregated data. One of the first studies to utilize firm-level data is that of Javorcik & Wei (38),

who focus on investment flows into Eastern Europe and the former Soviet Union. Their dataset enables them to avoid biases related to aggregation and unobserved heterogeneity by computing pollution intensity and abatement costs at the 4-digit SIC industry level and incorporating firm-specific FE into their estimations. Despite these advances, Javorcik & Wei (38) find no evidence that FDI from dirtier industries is more likely to be attracted to countries with weak environmental regulations. Kahouli et al. (40) provide an early study that uses industry-level data and examines industry-level FDI flows from the United States into Mexico and Brazil. This study emphasizes the fact that pollution haven pressures may be counteracted by factor endowment effects given the most pollution-intensive industries tend to be the most capital intensive; however, countries with lax regulations are often some of the least capital intensive. Cole & Elliott (47) find compelling evidence of a positive relationship between US PAOC at the industry level and FDI flows into both Mexico and Brazil. Similarly, Kellenberg (52) finds that regulatory differences do influence US outbound FDI, particularly in relatively "footloose" industries, i.e., those that are typically less capital intensive and for whom relocation is more feasible.[3]

Other recent industry-level studies of the FDI-regulation relationship (e.g., 43, 53, 57, 70) examine Mexico, Germany, South Korea, and the Netherlands, respectively. Each of these studies finds evidence of pollution haven–consistent behavior for the most pollution-intensive industries in their sample.

Turning to recent firm-level studies, Raspiller & Riedinger (71) focus on France and examine whether the location decisions of French firms are influenced by environmental compliance costs. They find no statistical evidence of any such influence. Kheder & Zugravu (51) also examine French firms and estimate the relationship between their foreign investment and a country-level index of environmental regulations. Perhaps counterintuitively, but consistent with the more recent theories described in Section 2, they find that FDI into developing countries is attracted to higher regulations, whereas the opposite is true of FDI into developed countries. Kheder & Zugravu (51) interpret this finding as indicating that French firms prefer to locate in countries with less stringent environmental regulations, as long as those regulations are not too lax and as long as there is a developed business environment. Hanna (50) focuses on US-based multinationals and examines whether their investment decisions are partly determined by firm-level regulation emanating from the CAAA. She (50) finds evidence of pollution haven–consistent behavior, more specifically, that the CAAA caused regulated multinational firms to increase their foreign assets by 5.3% and their foreign output by 9%. Finally, turning to the United Kingdom, Manderson & Kneller (48) test whether industry-level environmental compliance costs have influenced firms' foreign investment decisions. They conclude that UK firms that find it costly to comply with environmental regulation are no more likely to establish foreign subsidiaries than firms with low environmental compliance costs.

### 3.4. Types of Foreign Direct Investment

So far we have implicitly assumed that FDI is a homogeneous entity, taking the same form the world over, irrespective of the motives of the investor or the characteristics of the host country. In reality, FDI can take several different forms, and there is no reason to assume that regulatory stringency will have the same impact on each type of FDI. FDI can be categorized as horizontal FDI, vertical FDI, export-platform FDI, and complex FDI (see 26, 72, among others). The main objective of horizontal FDI is market seeking, whereas for vertical FDI it is efficiency seeking. For

[3] Ederington et al. (69) also emphasize the importance of footloose firms in the context of US trade flows.

export-platform FDI, multinational corporations (MNCs) aim to serve regional export markets using a host country for production and sales as a platform. Complex FDI is associated with exports of intermediate goods from affiliates to a third country for further processing and then export to a final destination. Given these different motivations, different types of FDI may respond differently to environmental regulations. Kukenova & Monteiro (73) examine whether environmental stringency in a host country has an influence on inflows of FDI and summarize the responsiveness to environmental stringency of different types of FDI. They argue that complex FDI is particularly sensitive to environmental stringency in a given host and its neighboring countries, as the most polluting stages of production are more likely to be located in a host country possessing relatively lax environmental regulations. The authors also find evidence of a negative relationship between FDI and environmental stringency using information on OECD investment to less developed countries for the period 1981–2005.

Using Norwegian manufacturing firm-level data, Rezza (55) categorizes multinational affiliates into horizontal and vertical FDI and finds that horizontal FDI is not affected by the environmental stringency of the host countries but that vertical FDI is deterred from locating in more environmentally regulated countries. Similarly, Tang (24) tests whether evidence of the PHH may depend on the type of FDI being examined and uses US outward FDI data for 50 host countries between 1999 and 2003. Tang finds that host country environmental stringency has a negative impact on both export-oriented and local-market-oriented types of FDI and that the impact is greater for the former.

Bialek & Weichenrieder (74) take a similar approach and test the effects of environmental policies on FDI, making the distinction between greenfield FDI and mergers and acquisitions (M&A). The argument is that M&A activity differs from greenfield investment as the former involves local firms, which should make compliance with environmental regulations easier than it would be for firms starting a new enterprise in a foreign country. Using firm-level data for outbound FDI from Germany and controlling for the mode of entry, they find that environmental stringency deters greenfield investment in dirty industries, whereas stricter environment regulation seems to attract M&A investments in low-polluting industries.

### 3.5. The Endogeneity of Environmental Regulations

An ongoing concern in the empirical literature is how to deal with the problem of endogeneity that was discussed in the theoretical section. In the context of FDI and the environment, endogeneity concerns come from the observation that, for example, environmental policies may be correlated with unobserved determinants of the FDI decision. In addition, it is also possible that FDI itself may affect the stringency of environmental policy. For example, an increase in FDI may result in newly strengthened industrial lobby groups pressuring local bureaucrats to change environmental regulations. Similarly, if a country or region observes a fall in FDI inflows it may decide to reduce the stringency of regulations to help reverse this trend. To address these concerns, studies have tended to use panel data for country-, industry-, or firm-level measures of regulatory stringency, which allows the researcher to use FE to control for unobserved heterogeneity that might be correlated with both regulatory stringency and FDI. However, FE can only control the unobserved heterogeneity that is fixed over time. One alternative is to use instrumental variables (IV) where environmental stringency is instrumented with some observable variable that is closely correlated with environmental regulation but uncorrelated with the determinants of FDI. The difficulty is finding valid instrument(s) [see Millimet & Roy's (75) review of the three categories of instruments used in the literature]. Another approach to deal with endogeneity is to find a natural experiment under which firms or countries are exposed to

some particular environmental regulation determined by an external force. A good example is the US CAAA mentioned earlier. Unfortunately, such natural experiments are relatively scarce.

Fredriksson et al. (59) provide the first study to address the endogeneity issue in the context of FDI and the environment. They develop a theoretical model endogenizing environmental policy such that government corruption influences capital flows only via its effects on environmental policy and on the amount of public goods. Using US state-level panel data from 1977 to 1987 and instrumenting for environmental policy and public goods using measures of corruption, nonmilitary government employment and the share of legal services, they find that environmental policy stringency and state-level bureaucratic corruption play a significant role in determining the location of US FDI inflows. They also confirm that treating environmental policy as exogenous biases the estimates of the impact of environmental policy on FDI. In a test of whether FDI influences environmental regulations, Cole et al. (15) also treat environmental policy as endogenous and show that if the degree of corruptibility is sufficiently high, FDI leads to less stringent environmental policy, and FDI contributes to the creation of a pollution haven. However, Kheder & Zugravu (51) show that investors favor countries with relatively weak environmental regulations regardless of the corruption level of the host countries.

Other studies have attempted to address the endogeneity issue (see, e.g., 57, 62, 73, 75). Kukenova & Monteiro (73) test the PHH in an intercountry bilateral FDI panel setting and apply a system generalized method of moments (GMM) estimator to correct for endogeneity bias. Results for an OECD sample over the period 1981–2003 show a significant negative relationship between environmental stringency and inflows of FDI once endogeneity and spatial dependence are taken into account. Poelhekke & Ploeg (57) address the potential endogeneity of environmental regulations by instrumenting the environmental policy index with the predetermined demand for environmental protection proxied by the net present value of protected areas per capita. Rather than seeking traditional instruments, Millimet & Roy (75) apply two novel identification strategies by utilizing higher moments of the data to address the endogeneity concerns. By examining the distribution of US manufacturing FDI inflows for the period 1977–1994, they consistently find evidence that environmental regulation is endogenous and a large and significant effect of environmental regulation on FDI distribution is found once endogeneity is controlled.

A final methodological approach to the impact of regulations on FDI is to include agglomeration externalities and spatial spillovers [motivated in part by the theoretical contribution of Zeng & Zhao (29)]. Theoretical models and empirical studies on location choice have shown that agglomeration externalities are an important determinant (76–78). The literature on environmental regulations and trade has also presented evidence that environmental regulations are spatially correlated and that environmental policies tend to be similar between countries with close trade relations (79). However, early studies on environmental regulations and FDI have ignored the importance of agglomeration effects or spatial spillovers. Wagner & Timmins (53) test the PHH using German outbound FDI and include inward FDI stock to capture agglomeration effects. They also control for endogenous time-varying determinants of FDI using the GMM and find strong support for the PHH in the most pollution-intensive industries. Wagner & Timmins (53) argue that ignoring the externalities associated with FDI agglomeration can bias estimates away from finding a pollution haven effect. Millimet & Roy (75) also point out that failure to account for geographic spillovers may lead to biased estimates. In their empirical tests of the PHH using information on inbound US FDI across the 48 states over 1977–1994, geographic spillovers are incorporated in an unrestricted form by including a spatially lagged counterpart for each state-level attribute. Results show that although neighboring environmental regulation is not an important determinant of FDI, spillovers from other attributes are present, indicating the importance of the incorporation of spatial effects in modeling the determinants of FDI.

## 4. THE IMPACT OF FOREIGN DIRECT INVESTMENT ON THE ENVIRONMENT

Although several studies examine the extent to which environmental regulations influence FDI location, a smaller body of literature has examined the environmental implications of FDI itself. These studies generally ask one of three questions. First, do foreign-owned firms in developing countries tend to be greener than domestically owned firms? Second, is there any evidence that the environmental performance of domestically owned firms improves due to the presence of foreign firms? Third, in general, does the presence of FDI result in environmental improvements within the host country? This section reviews these three groups of studies.

### 4.1. Are Foreign Firms in Developing Countries Cleaner than Domestically Owned Firms?

Several studies have considered the possibility that foreign-owned firms may be less pollution intensive than domestically owned firms within a developing country. There are several reasons why this might be the case. First, firms from the OECD will typically utilize newer, more energy-efficient technology than their domestic counterparts which, on average, may generate fewer emissions per unit of output. Second, foreign-owned firms are typically larger than domestic firms, which means that they are likely to have better access to the resources needed to undertake a greater degree of research and development and staff training. They are also more likely to adopt environmental management practices and accreditation schemes such as ISO 14001. Third, foreign firms' production systems are likely to be compliant with stringent OECD environmental regulations, and as such these firms may continue to operate these systems, once they become established in a developing country, particularly if they wish to continue to export to OECD markets.

Although the above arguments might sound compelling, the evidence of whether foreign firms are greener than domestic firms has, to date, been rather mixed. Early studies of Bangladesh, India, Indonesia, and Thailand by Hartman et al. (80) and Pargal & Wheeler (81) find that foreign ownership has no statistically significant impact on manufacturing plants' emissions. Dasgupta et al.'s (82) study of Mexican plants draws a similar conclusion. In contrast, Eskeland & Harrison (37) examine the energy intensity of manufacturing plants in Côte d'Ivoire, Mexico, and Venezuela and in each case find foreign ownership to be a negative and statistically significant determinant. Cole et al. (83) consider the energy intensity of Ghanaian plants and find that foreign-owned plants are more likely to utilize electricity, as opposed to solid or liquid fuels, which is arguably a cleaner source of energy. Perhaps more notably, Cole et al. (83) also consider the characteristics of the CEO of each plant and, specifically, whether the CEO is foreign trained. Interestingly, plants with a foreign-trained CEO had lower levels of energy intensity, and this difference was statistically significant. The effect of foreign training was particularly pronounced among foreign-owned plants, suggesting that both access to new technology, which is likely to be greater for foreign-owned plants, and the ability and know-how to use this technology are necessary to reduce energy intensity. Albornoz et al. (84) examine the factors that influence the adoption of a wide range of environmental management practices by Argentinean manufacturing plants. They find that foreign ownership is a statistically significant determinant of the adoption of six (out of eight) forms of environmental management. In keeping with this result, Zhu et al. (85) find that foreign-owned plants in China are more likely than domestic plants to adopt ISO 14001 environmental management certification.

Moving away from econometric studies, Zarsky (86) reviews several case studies that shed some light on whether foreign firms are cleaner than domestically owned firms and whether they are likely to transfer more advanced technologies to developing countries. Lagos & Velasco (87), for

instance, examine FDI in Chile's mining sector in the 1970s and 1980s and find that foreign-owned firms adopted environmentally responsible practices, as directed by their parent companies, at a time when domestically owned firms did not. Turning to Mexico, Mercado (88) provides evidence that foreign firms in the steel sector were more likely than domestically owned firms to comply with environmental regulations, and K.P. Gallagher (89) finds that the pollution intensity of steel production by foreign-owned plants in Mexico is lower than in the United States due to the use of newer, more energy-efficient technology. However, K.S. Gallagher (90) claims that US automotive industries transferred outdated pollution control technologies to Chinese affiliates, which limited any potential environmental benefits. Finally, Leighton et al. (91) find evidence to suggest that foreign-owned plants in the petroleum industry in Nigeria, Ecuador, Azerbaijan, and Kazakhstan did not transfer the same processes used at home and in fact adopted environmental practices that would have resulted in prosecution in their home countries.

The majority of the above studies implicitly or explicitly assume that the FDI in question originates from high-regulation OECD economies. However, a characteristic of FDI trends in recent years has been the significant growth in FDI from developing regions and in particular the growth in FDI from one developing region to another, an example of which would be the rapid expansion of Chinese FDI in Africa. If the source of FDI is a relatively low-regulation economy then it begs the question of whether we can expect firms from such economies to operate more stringent environmental practices than domestically owned firms in the host country. Studies examining the environmental effects of FDI from developing regions are relatively scarce but Zeng & Eastin (92) econometrically examine the effect of FDI from developing countries on the adoption of ISO 14001 environmental certification in the host country. Perhaps surprisingly, they find that developing country FDI does indeed increase ISO 14001 adoption rates in host countries, and they argue that foreign firms have reputational and financial reasons to operate in an environmentally responsible manner irrespective of where the investment originates from. Kolstad & Wiig (93) and Cheung et al. (94) specifically examine Chinese FDI into Africa. They find evidence to suggest that Chinese FDI is attracted to countries rich in natural resources with weak institutional capacity. Although this raises the possibility that China is exploiting Africa and its natural environment, Kolstad & Wiig (93) do point out that in this regard China is no different from any other foreign investor in Africa. However, as Shinn (95) notes, a key difference between China and other more traditional, western investors is that there is no strong domestic environmental lobby in China to keep Chinese investors in check.

## 4.2. Do Domestically Owned Firms Become Greener in the Presence of Foreign Firms?

A large body of literature has examined the extent to which FDI improves the economic performance of firms, typically by testing the impact of foreign firms' knowledge, management skills, and technology on productivity (see, for example, 96, 97). Although the results have been mixed, some evidence of productivity spillovers has been found (98). If channels exist through which foreign presence may influence the productivity of firms, it is obviously possible that foreign presence may also influence firms' environmental performance. The possibility of this happening in a positive manner has become known as the pollution halo effect.

There are several reasons why environmental spillovers might occur. First, firms might deliberately choose to disseminate environmental knowledge and technologies to domestic firms. For instance, a foreign firm may choose to purchase intermediate goods only from suppliers who adopt particular environmental management practices, perhaps under pressure from the host government or other stakeholders. Alternatively, foreign suppliers may only be prepared to sell their goods to firms that adhere to a given set of environmental rules or practices if, for example,

shareholders were nervous of reputational effects from associating with firms that were perceived to be acting in an environmentally irresponsible manner. Second, there may be an indirect route through which knowledge transfer can take place, for example, through the movement of workers from foreign to domestic firms (83, 99). Finally, domestic firms may imitate the good practice of foreign firms if it was felt to be in their interests to do so. As Albornoz et al. (100) therefore point out, firms can absorb environmental knowledge and experience, directly or indirectly, through forward links with suppliers, backward links with customers, or horizontal links with competitors.

Albornoz et al. (100) provide the most direct test of the existence of environmental spillovers using Argentinean firm-level data capturing a wide range of environmental management practices. They measure forward, backward, and horizontal linkages together with a firm-specific measure of how closely a firm is connected to the firms that it supplies, buys from, and directly competes with. Albornoz et al.'s (100) key finding is that those firms that supply a sector with a large foreign presence and who have formal and informal links with their customers are more likely to adopt environmental management practices. Gallagher & Zarsky (101) also emphasize the role played by local supply chains but point out that where multinationals predominantly import intermediate goods, the scope for environmental spillovers will be limited. Extending Albornoz et al.'s (100) 2009 study, Albornoz et al.'s (102) 2014 study emphasizes the role of absorptive capacity (the ability of a firm to absorb and assimilate external knowledge) within the diffusion process, with firms possessing such capacity more likely to benefit from environmental spillovers.

Perkins & Neumayer (103, 104) examine the extent to which transnational linkages in the form of FDI can improve the pollution efficiency of host countries. Using a panel of 114 countries over the period 1980–2000, they found in 2008 (103) that inward FDI can improve carbon dioxide ($CO_2$) efficiency; however, they found in 2009 (104) no evidence that FDI improves pollution efficiency. The difference between the two papers relates to the manner in which FDI is measured. The earlier paper included country-level measures of aggregate FDI flows as a means of proxying interconnectedness between countries. However, the authors' 2009 paper instead weights FDI by pollution efficiency on the assumption that inward FDI from pollution-efficient countries might have a greater influence on domestic pollution efficiency than FDI from pollution-inefficient countries. Given the differing results of these two papers it is difficult to draw firm conclusions on the role of FDI in pollution efficiency.

Moving away from econometric studies, Garcia-Johnson (105) examines the role of multinationals in the chemical industry in Latin America and finds that US companies played a key role in diffusing the Responsible Care Program, aimed at raising levels of self-regulation within the chemical industry, to domestic firms in Mexico and Brazil. Similarly, Gentry (106) also focuses on Latin America and finds that FDI played a key role in the diffusion of environmental management practices and often through supply chains. However, in contrast, Ruud (107) in a study of India finds no evidence of such diffusion and emphasizes the role played by local norms and institutions that may inhibit spillovers of any kind. As a result, Ruud claims that environmental diffusion is far from automatic, and multinationals are often "islands of environmental excellence in a sea of dirt" (86).

### 4.3. More General Effects of Foreign Direct Investment on the Environment

The remaining studies investigating the relationship between FDI and the environment tend to examine the broad relationship between FDI and pollution, often at the country or city level, or they examine the impact of FDI on the stringency of environmental regulations.

Zugravu-Soilita (108) examines the impact of FDI from France, Germany, Sweden, and the United Kingdom on national emissions of a range of pollutants. This study finds that the environmental impact of FDI depends on the host country's environmental regulations, capital endowments, technology gap between foreign and domestic firms, and domestic labor productivity.

More specifically, Zugravu-Soilita (108) finds that FDI is associated with a reduction in pollution in countries with relatively low capital-labor ratios and relatively stringent regulations. In contrast, FDI is associated with an increase in pollution in relatively capital-abundant countries with lax regulations. These findings are consistent with the factor endowment hypothesis and the PHH (see 47, 109), which suggest that capital-intensive and hence pollution-intensive FDI will flow to capital-abundant countries with relatively lax regulations, whereas cleaner, more labor-intensive investment will be attracted to relatively labor-intensive, high-regulation economies. The problem, as Cole & Elliott (47) point out, is that capital-intensive countries tend to have more stringent regulations, whereas labor-intensive countries tend to have relatively lax regulations. Kim & Adilov (110) also undertake a country-level study of the effects of FDI, this time on $CO_2$ emissions. They find that FDI into developing countries has the effect of reducing per capita $CO_2$ emissions, which they interpret as evidence that FDI into developing regions brings with it advanced, cleaner technologies. In contrast, Shahbaz et al. (111) find that inward FDI has the effect of increasing $CO_2$ emissions in developing countries, indicating that such results appear to be sensitive to the econometric specification and to the choice of countries and time periods within the sample.

Moving away from cross-country studies, Elliott et al. (112) investigate the influence of FDI on the energy intensity of Chinese cities. They find that FDI has a negative impact on energy intensity, although this effect varies by region. Elliott et al. (112) argue that these regional differences reflect differences in the ability of regions to absorb and benefit from environmental spillovers. Wang & Chen (66) also examine FDI in Chinese cities and consider the role played by institutions. They find that FDI tends to increase emissions of $SO_2$ but these increases can be mitigated by strong legal and environmental institutions. Bao et al. (113) utilize a simultaneous equations model to identify the effect of inward FDI in China on pollution levels. They find that FDI does reduce pollution and that this occurs through changing techniques of production, which reduce the pollution intensity of output. A final study of China by Lan et al. (114) argues that the effect of FDI on the environment depends on the technological capabilities of a region, which they capture using measures of human capital. They find that FDI reduces pollution emissions in provinces with higher levels of human capital but increases emissions when human capital is low.

## 5. OUTSOURCING/OFFSHORING AND THE ENVIRONMENT

In this final section, we review the small but related strand of the literature on FDI and the environment that considers the interaction between offshore assembly or outsourcing and the environment. One possible explanation for the lack of strong evidence of a PHH-consistent effect is that firms chose to outsource/offshore the production of the dirtiest part(s) of their production abroad, thus lowering firm-level emission intensities.

Empirical tests of the so-called POH have focused on developed countries, and conclusive evidence has yet to be attained. Clark et al. (115) was the first to study the extent to which the decision to engage in offshore assembly of dirty industries is driven by the stringency of environmental regulation. Using four-digit industry information for the United States, the study shows that pollution-intensive industries are less likely to offshore their production, and relatively clean stages of the production process are being transferred to developing countries with lax environmental regulations. Levinson (116) asks whether the United States is increasingly offshoring pollution-intensive production. Taking into account the polluting intermediate inputs and using industry-specific measures of pollution intensity, they find that between 1972 and 2001 the United States imported more clean goods and fewer polluting goods; i.e., the United States has not been offshoring pollution. Clark et al. (115) and Levinson (116) test the POH by looking at highly

aggregate data with no attention given to the destinations of the offshored production. Li & Zhou (117) investigate the relationship between US firms' imports from low-wage countries (LWCs) and toxic emissions from their domestic plants using firm-level data. They find that plants release fewer toxic emissions in the United States when their parent firm imports more from LWCs. They also show that a greater share of goods imported from LWCs are in pollution-intensive industries compared to those imported from other countries. Brunel (118) also analyzes the link between pollution offshoring and emission reduction in US manufacturing. By grouping US trading partners according to their income levels into high, higher-middle, lower-middle, and low-income countries, they show that the United States has been importing more green goods from high, higher-middle, and low-income countries and more polluting goods from lower-middle countries. However, the same effect is not found for the European Union, suggesting that pollution offshoring may vary by country and region.

Michel (119) investigates the role of offshoring on the reduction in air emissions in Belgian manufacturing. Results from a decomposition analysis show that offshoring has contributed to 17% of the reduction in greenhouse gas emissions between 1995 and 2007. Leoncini et al. (120) study the link between $CO_2$-reducing innovations and outsourcing of Italian manufacturing firms in two green industries. They find that outsourcing tangible assets increases the number of $CO_2$-reducing innovations, whereas the opposite holds for intangibles outsourcing. Antonietti et al. (121) also examine the relationship between FDI, offshoring, and environmental regulation for Italian manufacturing firms. Using a survey of 684 manufacturing firms in 2011, they find that environmental policy stringency does not have a significant impact on firms' FDI decision. However, a higher probability of outsourcing to less developed countries is found. Finally, Cole et al. (32) find some evidence of an environmental outsourcing effect using Japanese firm-level data and show that with pollution-intensive and high-regulation costs, firms are more likely to outsource.

Given offshoring involves the transportation between countries of intermediate inputs in different stages of the production process, Cadarso et al. (122) propose a new methodology to quantify $CO_2$ emissions linked to international transport involved in offshoring. Using Spanish economic and emissions data, they find that the total $CO_2$ emissions stemming from international freight transportation increased by 4.16% between 1995 and 2000.

Offshoring is closely related to processing trade in which a proportion of the raw materials, parts and components, accessories, and packaging materials are exported to a country free of duty and re-exported after they have been processed or assembled. China is a good test case of the POH, given that a large proportion of its exports are processing oriented. Dietzenbacher et al. (123) examine the environmental impact of China's processing exports by estimating the greenhouse gas emissions generated by both ordinary and processing exports. By constructing a unique tripartite input-output table in 2002, they find that processing exports, which account for 55.3% of total exports, contributed to only 16.6% of $CO_2$ emissions from all exports. This indicates that processing exports by China are cleaner than ordinary exports that use domestic inputs only. Finally, Lyu (124) also examines the link between different offshoring tasks in China and $CO_2$ emissions for 12 industry sectors in 2010. The results show that offshoring makes a significant contribution to Chinese $CO_2$ emissions, particularly within polluting industries, such as iron and steel, nonferrous metals, and chemicals.

## 6. CONCLUSIONS

This review article has provided a summary of several different aspects of the FDI-environment relationship. Theoretically, there are several models where regulations are endogenously determined (through lobbying) or exogenously determined, that predict that FDI should flow from

high-regulation to low-regulation countries. More recent theoretical developments, however, show that under certain circumstances FDI may be attracted to higher-regulation countries. The range of theoretical predictions may go some way to explain the limited empirical evidence, at least in the early cross-country studies.

Our review of the empirical literature tells a similar tale. Early studies that tended to be cross-country using rather aggregated data and simple estimation techniques failed to find convincing evidence that FDI flowed from high-regulation to low-regulation countries. This led to several papers that provided different parts of the FDI-regulation jigsaw puzzle, for example, controlling for, among other things, how footloose firms in certain sectors are (capital intensity), agglomeration economics, and transport costs. Similarly, POH, a recent hypothesis, argues that in response to higher regulations firms simply outsource the dirtier parts of their production process overseas using arms-length partners instead of relocating the firm. It is also shown that the type of FDI matters, particularly, whether it is to serve local markets or is aimed at re-exporting goods back to the home country. Hence, although studies have shown why a PHH-consistent effect may be hard to find, when researchers study the relationship between certain countries and in certain pollution-intensive sectors a story emerges of compelling evidence for a PHH-consistent effect. We can conclude from our review that environmental regulations can affect the location of firms at the margin but that environmental regulation costs are just one of many costs that firms have to consider when deciding to relocate. Ultimately, firms in polluting sectors tend not to be footloose due to capital intensity and the need for raw materials that may be located nearby. In addition, agglomeration economies and higher transport costs may also be a pull factor for firms to remain in their current location despite rising environmental regulation costs. Evidence of international environmental outsourcing may be a further mitigating factor that has prevented researchers from finding a strong PPH-consistent effect of regulations of FDI flows.

Section 4 considered the environmental impact of FDI. The forces of globalization have resulted in huge flows of capital across borders. Although much FDI is between developed countries, there have also been enormous flows of FDI from developed to developing and newly industrializing countries. Although, as discussed, these FDI flows may not have been driven by environmental regulation differences, one must ascertain whether these flows have led to positive or negative environmental outcomes. Again, the results tend to be rather mixed. On balance, the more recent papers find that there are significant positive environmental spillovers from foreign to local firms and that on average FDI may have the effect of increasing energy efficiency (hence lower pollution levels), although this is offset by increased production as demand for consumer goods continues to grow.

Although there is now an expansive body of work on FDI and the environment, there are several directions in which future research should develop. First, researchers need to take issues of reverse causality more seriously, perhaps by using dynamic matching methods to estimate the reaction of firms to a given policy change in a given country or region. Given the spatial nature of local and global pollutants, one must also take into account spatial correlations between firms and regions that allow for spatial spillovers between foreign and domestic firms within geographical areas. Finally, the potential for firms to outsource pollution-intensive parts of their production process either overseas or domestically needs to be better understood, as do the advantages and disadvantages of utilizing specialist producers and environmental service companies for improving overall emission intensities.

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