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Environmental Protection of Foreign Firms in Germany: Does the country of origin matter?*

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Abstract:

Only recently have the aspects of pollution and environmental protection entered into the empirical literature about international firm activities. The present paper is the first firm-level study on the link between foreign ownership and environmental protection in Germany. We find that, *ceteris paribus*, foreign owned firms in Germany are more likely to invest in environmental protection. They also invest on a larger scale in terms of add-on measures as well as integrated measures. These results are robust against different measures, different time periods, different control groups, and selection issues arising from fractional response data. Once we control for productivity levels, the differences become less straightforward. However, the higher probability of foreign firms' making general as well as integrated environmental protection investments and the tilt of their composition towards integrated measures remain. We cannot find any support for differences among foreign firms by country of origin. This can be interpreted as support for the new institutionalist hypothesis of international convergence of management practices in the field of environmental management due to normative pressure and *de facto* standards at the global level.

JEL-classification: F21; Q52; Q55; Q56

Keywords: Environmental protection; foreign ownership; country of origin; multinational enterprises; manufacturing; Germany

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1 Introduction

The environmental consequences of economic globalization have long been debated. But only recently have pollution and environmental protection aspects been the subject of empirical firm-level investigation. By using a new and unique database, the present study provides the first evidence on the link between foreign ownership and spending on environmental protection for the German manufacturing sector.

Traditionally, the issue of cross-border firm activities and environmental pollution has been discussed in the context of developing economies and whether or not multinational enterprises shift production to countries with relatively lower environmental standards (the pollution haven hypothesis). In the context of industrialized economies, environmental regulation can also be an economic policy instrument, but rather for securing competitive advantages for domestic firms than for attracting foreign direct investment (FDI). From a macro-level perspective, there can be assumed to be a nonlinear relation between industrialization and pollution, meaning that higher levels of industrialization imply higher levels of pollution only up to the point at which incomes are high enough to enable environmental awareness and clean technologies (the environmental Kuznets curve hypothesis; for empirical evidence see Grossmann and Krueger (1995)).

Another popular strand of the literature focuses on the impact of environmental regulations on a firm's competitiveness. For example, Porter and van der Linde (1995) argue that environmental regulations and competitiveness do not necessarily pose a trade-off. Instead, an increased green performance can lead to a simultaneous improvement in the economic performance. These hypotheses generally seem to apply to Germany: German society is shaped by a pronounced environmental awareness (BMU (2013)) and German manufacturing in particular should be regarded as a technologically highly sophisticated sector in which technological innovations play an important role. This demonstrates that economic efficiency and pollution abatement are closely interrelated issues.

Foreign owned firms play an important role in the German economy, one of the world's most important FDI inflow destinations (UNCTAD (2012)). In 2008 they generated 27 % of total turnover in the non-financial sector (Nahm (2011)) and are generally much more productive than their German counterparts (e.g., Weche Gelübcke (2013)). Given the sig-

nificant economic weight and relatively larger output of foreign owned firms, do they also spend more on environmental protection? There has not yet been any study on pollution abatement and foreign ownership for Germany, and only a very few empirical studies exist for other countries. We use a new and highly representative database from German official statistics to fill this research gap. We not only account for heterogeneity on the side of the foreign owned firms by considering the country of origin, but also consider different types of environmental protection investments (EPI), namely those for end-of-pipe and integrated measures. Therefore, by considering the aspect of technological progress, we are able to answer questions such as whether technologically advanced foreign firms have to spend less on add-on measures due to their up-to-date technology.

We find foreign firms in Germany to be more likely to invest in environmental protection and to invest on a larger scale. This seems to reflect their advantageous productivity and their costs involved with complying with environmental regulations. Foreign firms also invest more in both add-on and integrated measures, and show a different composition of overall EPI, one tilting towards integrated measures, which lends support to the assumption that foreign firms have "mainstreamed" their EPI into their general investment to a greater extent (Kaiser and Schulze (2003) with reference to Low (1992)). We also find that the export activity of German firms does not explain this difference through the need to comply with higher environmental standards abroad. This underlines that Germany already has very high environmental standards. Once we control for productivity levels, the differences become less straightforward but, nevertheless, there is still a higher probability of foreign firms' making general as well as integrated environmental protection investments, and their tilt in composition towards integrated measures also remains. If we look at foreign firms by country of origin, we do not find significant differences in their investment behavior, and therefore we reject hypotheses stating that EPI echoes cultural or institutional differences.

Given an inevitable future increase in the importance of environmental protection and the virtual necessity of finding complementary solutions to combine economic and green performance, our analysis offers initial micro-evidence for Germany and also an inspiration for more empirical research on environmental protection efforts and economic globalization at the firm-level.

The paper is structured as follows: Section 2 discusses theoretical considerations on corporate ownership and environmental protection, Section 3 reviews the previous empirical evidence, and Section 4 presents our empirical results. Section 5 concludes.

2 Ownership and environmental performance

Foreign owned firms generally outperform their domestically owned counterparts in many respects. For instance, foreign firms enjoy superior productivity levels, pay higher average wages, are larger in terms of employees, and use more capital intensive production methods. For an overview of the literature, see Bellak (2004). This would be no surprise in the context of a developing economy, but this is also true for the German economy. For example, Weche Gelübcke (2013) finds foreign controlled enterprises in German manufacturing to be on average and *ceteris paribus* more productive by more than 14,000 EUR in terms of labor productivity, to spend around 900 EUR more for Research and Development (R&D), both per year and per employee, and to be almost 60% larger. Due to this general superiority, foreign owned firms generated more than 25% of the total turnover in the German non-financial sector, although they amount to only about 1% of the absolute number of firms (Nahm (2011)). Given the significant economic weight of foreign owned firms, do they also spend more for environmental protection?

Since foreign firms are generally more productive, they produce more efficiently. The two concepts, efficiency and environmental friendliness, overlap and are both strongly related to technological progress. New production technologies generally help save both costs and resources through an improved efficiency. The concept of eco-efficiency essentially builds upon this alignment of economic and ecological performance by "creating more value with fewer environmental resources resulting in less environmental impact" (Guenster and Bauer (2011)). However, this does not hold true for end-of-pipe treatment technologies, since they are unable to improve resource management (e.g., Hellweg et al. (2008)). It is therefore hard to say whether the motivation behind general EPI is to protect the environment or to save costs. However, the consequences are the same and one may argue that the motivation is irrelevant in this context, but it should be kept in mind when interpreting EPI data.

Theoretical considerations regarding the differences in EPI between foreign and domestic firms include the following:

1. *Internationalization and production standards*

Firms based in developed economies such as OECD countries generally have advanced production technologies and sophisticated environmental management systems as compared to firms based in developing countries. The reasons for this are, among others, different consumer preferences, and the stricter regulations in the area of environmental protection. If those firms now produce in developing economies, it can be argued that they keep their production standards as they export their products to serve their home country market or other markets with comparable standards (Cole et al. (2008) and Kaiser and Schulze (2003) with reference to Wheeler and Martin (1992)).

There has been a lot of discussion going on in this context. Contrary to the assumption above that foreign firms keep their standards of production, less stringent regulation could be as well (at least partially) the initial reason for these companies' FDI. Thereby, countries could start a "race to the bottom" in terms of environmental protection regulations in order to attract FDI (the "pollution haven hypothesis") (e.g., Wheeler (2001)). On the other hand, the presence of foreign companies with higher production standards could also lead to an overall improvement of environmental protection through positive spillover effects for indigenous competitors (the "pollution halo hypothesis") (e.g., Zarsky (1999)). For instance, multinationals increasingly use codes of conduct in order to make their suppliers in host countries comply with certain (international) environmental and social standards, thus helping raise the level of standards in those countries.

However, these considerations are not applicable to Germany since it is not a developing country in the usual sense. Because of its relatively heavy environmental protection regulation, it is unlikely to be the case that foreign firms in Germany are less efficient or environmentally friendly, as only those will start a business in the German market who are generally able to cope with their domestic competitors. The advantageous economic performance, outlined above, lends support to this assumption.

2. *Heterogeneous productivity levels*

It can rather be presumed that analyses of EPI differentials mirror results from internationalization and productivity, at least in the case of investments for integrated measures. Recent studies on heterogeneous firms and international trade find a clear hierarchical order of productivity levels according to the firm's internationalization stage. These levels are mainly to be traced back to the particular costs of the cross-border activities: more productive firms can bear the additional costs of exporting and serving foreign markets through this channel. The even more productive firms can bear the risk and costs of establishing affiliates abroad and engaging in FDI (Melitz (2003); Helpman et al. (2004)). The link between production technology and productivity in manufacturing should be largely straightforward: the more productive a firm is, the more advanced the technology it uses. Therefore, they also have to invest more in up-to-date technology and efficiency, which is regarded as environmental protection (see above). Consequently, the share of investments for integrated measures should be higher in more internationalized firms.

On the other hand, it is also true that these firms presumably have to invest less in add-on environmental protection in order to comply with the regulations in place, and hence arises the question of whether firms would have to spend more on EPI if they are already using up-to-date technology or if they intervene *ex post* in their production process to enhance its green performance.

3. *Reputation and "green consumerism"*

Turning to the demand side, another point is that foreign firms and multinationals may face more pressure from consumers and other stakeholders to retain a "clean" image. Reputational risk management is generally found to be the most important driving force of voluntary Corporate Social Responsibility (CSR) activities, which include environmental management efforts (Lim and Tsutsui (2005)). Kytle and Ruggie (2005) find multinationals particularly vulnerable to the reputational risks arising from criticism by actors in civil society with regard to environmental and social issues. Environmental responsibility is therefore crucial in order to maintain the societal "license-to-operate" (Bansal (2005)). This pressure may be even more pronounced for foreign multinationals, for example, through a media bias as in the case of downsizing: Friebel and Heinz (2012) find a much more intensive consideration

of downsizing in German newspapers if the owner is situated abroad. Such a media bias could foster efforts to communicate a "clean" image. Furthermore, German consumers are extraordinarily aware of environmental issues (BMU (2013)), which could create additional turnover incentives for companies to provide a green image, independent of the ownership type. This is often referred to as "green consumerism".

4. *German environmental regulation*

Germany is a relatively highly regulated country when it comes to environmental protection.[1] Therefore, it is probable that most of the EPI are spent in order to comply with the legal framework, and simply reflect the costs of such requirements. If this is the case, the essential question is who is able to meet the guidelines at minimal costs, but it seems also likely that EPI do not differ.

However, Germany's strict regulation does not exclude possible differences in EPI among firms: looking at the mix of policy instruments for environmental protection used in Germany, one can observe, in recent years, a development from a prevalence of command and control regulation towards a wider use of "new" environmental policy instruments (NEPIs), especially voluntary agreements and informational devices, such as eco-labels and eco-audits, as well as some market-based instruments, such as eco-taxes and tradable permits (Wurzel et al. (2003)). These NEPIs allow for greater flexibility in environmental efforts on the firm side, and therefore might trigger differences in EPI spending. Furthermore, more and more companies take voluntary measures (private regulation) in the context of CSR and corporate sustainability management. A recent study by AmCham and McKinsey (2011) finds that 70% of the companies surveyed have a sustainability strategy and sustainability targets, which they monitor regularly, going beyond legal compliance. Despite this shift towards NEPIs and private regulation, which follows a general international trend, traditional regulatory instruments remain important in German environmental policy and serve to level the playing field.

[1] In its *Environmental Country Reviews*, the OECD puts Germany in a strong position when compared internationally: it is considered to have "an ambitious environmental policy framework", "rigorous implementation of environmental policies", and to be a "leader in climate policy" (OECD (2012)). Klassen and Angell (1998) even described German environmental legislation as "considered to be the most stringent in the world".

5. *Country of origin effects versus international isomorphism*

Despite the fact that there surely has been a lot of convergence in international management systems, firms could still have significant imprints from their specific home country (Ferner (1997)). From a new-institutionalism perspective, the question arises whether international isomorphism is responsible for a convergence of EPI and environmental management as part of the global standardization of management practices (Tempel and Walgenbach (2007)). In our case, this view could be supported by the fact that an array of global governance standards and initiatives has emerged during the last decade, which put normative pressure on multinationals to implement environmental management systems and other corporate sustainability measures (e.g., ISO 14001 and the Global Reporting Initiative). Mimetic isomorphism, i.e., the imitation of other organizations in the field, is considered another reason for the alignment of multinationals' management systems. For example, in a KPMG survey on Corporate Sustainability Reporting (2011), it is stated that "where CR [Corporate Responsibility] reporting was once merely considered an 'optional but nice' activity, it now seems to have become virtually mandatory for most multinational companies." Foreign owned firms then would be more likely to have an environmental management system due to their higher level of internationalization.

In contrast, the national business systems approach emphasizes the persistence of national differences, highlighting "how business continues to be influenced by the national institutional frameworks in which it is embedded" (Tempel and Walgenbach (2007): 2). This approach would on the one hand support the assumption that foreign firms' spending on EPI in Germany should not differ from domestic ones, as they are both exposed to the same national institutional environment and MNCs are likely to adopt local practices and become isomorphic to the local institutional context (Kostova and Roth (2002)). On the other hand, when taking into account the influence of a multinational's home country on its corporate culture, the same approach could suggest that this firm has (institutional and cultural) characteristics of its country of origin which affect its environmental management approach (Matten and Moon (2008); Caprar and Neville (2012)). These moderating effects are also discussed in the literature on human resource management as "nationality effects" (Ferner and Quintanilla (1998)). For instance, compared to Germany as a coordinated market economy, the U.S. is considered to be a liberal market economy linked to a voluntary and

pro-active approach of companies to corporate sustainability (Matten and Moon (2008)). Its environmental policy relies heavily on command and control instruments, which would rather foster end-of-pipe solutions, and NEPIs are less used, although there has been a recent emphasis of voluntary initiatives (OECD (2006)). Another cultural factor that could influence environmental management decisions and EPI is the tendency for a short-term orientation towards shareholder value in the U.S. (Ferner and Quintanilla (1998); Christie et al. (2003); Hofstede (1980)), which would rather hinder EPI. In contrast, Scandinavian countries such as Denmark and Sweden have taken a rather progressive approach to environmental protection and corporate sustainability, for example, mandating companies by law to regularly report on their environmental and social performance (UNEP et al. (2010)). From a firm-level view, MNCs will tend to "leverage practices on a worldwide basis" (Kostova and Roth (2002)), consequently, it is worth examining whether there can be found any "nationality effects" in the context of the EPI spending of foreign firms in Germany.

3 Previous empirical evidence

Microeconometric studies of environmental performance and international firm activities are rare (see Table 1). This is especially true for the link between nationality of ownership and environmental performance. In the context of a developing economy, Cole et al. (2008) find no overall effect of foreign ownership on the energy use of Ghanaian manufacturing firms (1991–1997), only the electricity consumption increases. They also look at the impact of Chief Executive Officer (CEO) training and experience abroad and find a positive relation with overall energy use. They conclude that "foreign ownership and foreign training have clear environmental implications" (ibid: 540) as the authors regard electricity to be the most environmentally friendly energy form available. Eskeland and Harrison (2003) also find foreign ownership associated with lower levels of energy use in Côte d'Ivoire (1977–1987), Mexico (1984–1990), and Venezuela (1983–1988). Albornoz et al. (2009) consider the implementation of environmental management systems in manufacturing firms in Argentina (1998) and find foreign firms to be more likely to implement such systems and to implement a greater range of system types. Chudnovsky and Pupato (2005) also find that foreign owned manufacturing firms in Argentina (1998–2001) are more prone to undertake environmental

management activities but that foreign ownership decreases the quality of such management activities. Kaiser and Schulze (2003) analyze Indonesian data (1994–1996) in which only about 15% of the firms reported environmental expenses at all. Specifically their main variable of interest is total environmental expenses, excluding technology investments. As for their result, foreign firms in Indonesia do not appear to spend more or less than domestic firms, but once they decided to do so, they spend significantly more. Earnhart and Lízal (2006) find no effect of foreign ownership in the Czech Republic (1993–1998) and Aden et al. (1999) even find foreign ownership associated with lower levels of pollution abatement spending than domestically owned firms in Korea.

For European countries there is evidence for the UK and Ireland. Collins and Harris (2002 and 2005) use data for the UK metal manufacturing and chemical plants (both 1991–1994). For the metal manufacturing they find a higher probability of pollution abatement spending for firms from Australia, New Zealand, South Africa, and Canada. EU firms spend a higher amount if they spend, but only in terms of post-production measures and "payments to others," in terms of integrated measures they spend less. U.S. firms are more likely to spend for post-production reduction but less likely in all other categories. In the case of chemical plants, U.S. and Asian firms are not more likely to have post-production pollution abatement expenditures but the former spend more often in all other categories and the latter do so in the category "payments to others." EU plants do so as well but do not show a very different pattern than UK plants otherwise. Moreover, Collins and Harris (2005) find more efficient firms to generally spend less on pollution abatement.

Haller and Murphy (2012) as well as Batrakova and Davies (2012) are two recent studies that both use Irish data. While the former explicitly focus on foreign ownership, the latter emphasize environmental links with export activity, foreign ownership just poses an exogenous variable in their estimated model (1991–2007). However, foreign ownership is negatively related to firms' energy consumption in lower quantiles but positively when energy intensity rises. Haller and Murphy (2012) look at non-capital environmental expenditures and capital investment for pollution control (2006 and 2007). In their sample, 25% have current environmental expenditures and only 5% report capital investments in pollution control. Results show that foreign firms, once they have environmental expenditures, do that on a greater

scale. Overall the authors conclude that "firms for whom environmental concerns are most costly in terms of production do most to address them" (ibid: 279).

There exists only one microeconometric study by Heinbach and Krumm (2009) dealing with environmental spending for Germany and it is restricted to data only for the federal state of *Baden-Württemberg* and there is no information about international firm activities or corporate ownership patterns used in this study. The authors find no employment effects due to environmental protection investments and no crowding-out of other investment activities.

All in all, it is apparent that the existing studies use very different variables to measure environmental performance, which makes a comparison rather difficult. Furthermore, not one single study exists for Germany, and there are only very few for industrialized countries although this group is the major polluter.

[Table 1 about here]

4 Data and variables

The database used involves three data sources. The first source is the monthly and annual reports administered by the German statistical offices from establishments from the manufacturing, mining, and quarrying sectors. The information is aggregated at the enterprise level and is available in the form of annual results for all German firms which employ at least 20 persons and operate in the sectors mentioned. For more information, see Konold (2007). This data is of particularly high quality because firms in Germany are legally required to respond to these surveys.

A second source of information is the enterprise group database created by the German Federal Statistical Office to comply with EU regulation (EC) 716/2007. Since 2007, the European Union legislation has demanded harmonized statistics on foreign controlled enterprises in each member state (e.g., Vergina and Grell (2009)). A foreign controlled enterprise[2] is there defined as an enterprise of which more than 50% is owned by a legal or natural person situated abroad. Considered are capital shares as well as voting rights and other forms

[2] The terms *foreign controlled*, *foreign owned*, and *foreign* are used interchangeably in this text.

of control, such as indirect or effective minority control (Eurostat (2012)).[3] Furthermore, detailed information about the ultimate owner is provided, such as the type and country. In order to be able to provide the Foreign Affiliates Statistics (FATS) for Germany, the institutions in charge had to purchase information on ownership structures from the commercial data vendor Bureau van Dijk and to integrate this into the national business register (*Unternehmensregister*). Therefore, industry and topic specific surveys have recently become available for analyses related to foreign ownership. For a detailed description of this new database, see Weche Gelübcke (2011).

A third source is the survey of environmental protection investments which is also conducted by the German Federal Statistical Office and the statistical offices of the German federal states. This survey covers all firms which reported environmental protection investments (EPI) in the general investment survey (Statistisches Bundesamt (2012)), and therefore covers all German manufacturing firms with a threshold of 20 employees. EPI include those investments which aim exclusively or predominantly at protecting the environment from a harmful impact of production. This includes *production related measures* such as the purchase of fixed assets to reduce pollution during the production process, as well as *product related measures* for the production of goods whose application or consumption reduces pollution.

Within the category of production related EPI, end-of-pipe or add-on measures can be differentiated from integrated measures. End-of-pipe measures are normally equipment which is physically separate from the other production facilities and can therefore be identified relatively easily. Add-on technologies are, for example, facilities for waste incineration or exhaust air filtration, sewage treatment plants, and noise barriers (Statistisches Bundesamt (2011a)). Integrated measures are more difficult to identify since they do not necessarily have to be technological elements. Integrated measures make the process of production generally more efficient in terms of a lower level of pollution. They can therefore be technological elements (heat exchanger, absorbing filter, recirculation of cooling water), or it may be impossible to distinguish a specific component (changes to the use of environmental friendly raw and

[3] Indirect control refers to the fact that enterprise A is controlled by enterprise B and both are domestic companies but enterprise B is, in turn, controlled by an entity abroad. Then, enterprise A will also be foreign controlled. Effective minority control is when several minority owners with shares adding up to more than 50% act in concert.

auxiliary materials, changes in the forming process, changes in the structure of the combustion chambers). In the latter case, firms are only obliged to report the environmentally relevant part of the costs, i.e., the difference between the actual investment and a comparable investment without this environmentally relevant factor (Statistisches Bundesamt (2011a)).

Although the institutions in charge make an effort to facilitate the classification of add-on and integrated investments, for example by providing the firm a graphically appealing checklist for the classification of investments (ibid.: 87), the separation is not always straightforward and in some cases firms are allowed to report estimates of their investments (ibid.: 79). In the area of climate protection, for example, there does not even exist any such differentiation. Nevertheless, integrated measures play an important role in today's environmental protection, and their importance is increasing due to political support for a change from command and control policy instruments towards a wider use of NEPIs and overall technological change (Grundmann and Becker (2004)).[4]

The interpretation of EPI as a measure of green performance is not without shortcomings. First of all, cross-sectional data on investments may generally be highly period-specific and should not be confused with running expenses.[5] Moreover, it is unclear whether a firm with high EPI has had much catching up to do, or already has high environmental standards which make additional improvements extraordinarily expensive (Statistisches Bundesamt (2011b)).

In our data, information on EPI is available for seven areas of environmental protection[6] and was merged within the AFiD-Project (Official Firm Data for Germany; Malchin and Voshage (2009)) for the years 2007 and 2008.[7] For this analysis, observations were restricted to enterprises from the manufacturing sector in accordance with the NACE classification. The final analytical samples cover 38,314 (2007) and 38,867 (2008) enterprises of which, in both years, almost 11% reported EPI but only around 3% invested in integrated measures

[4] The (re)inclusion of integrated investments in the survey questionnaire in 2003 was also supported by the Association of German Engineers (Grundmann and Becker (2004)).

[5] A survey of the running expenses for environmental protection exists for Germany but the micro-data is not available to researchers.

[6] In particular, these are waste management, water protection, noise abatement, prevention of air pollution, nature protection and landscape preservation, soil rehabilitation, and climate protection.

[7] As already mentioned, information on ownership patterns have only been available since 2007. In 2008, the industry classification was changed and the two years are therefore not perfectly comparable. Instead of using data for only one year, we analyze both periods separately for the sake of robustness. All computations were programmed in Stata 12 and carried out within the Research Data Center of the statistical office Berlin-Brandenburg for confidentiality reasons.

(see Table 2 for descriptive statistics). On average, firms invested only 12 EUR (16 EUR) per capita in environmental protection in 2007 (2008) which is a tiny share of less than 2% in overall investments.

[Table 2 about here]

5 Results

5.1 Unconditional evidence

Theoretical considerations, discussed in Section 2, lead to a set of assumptions regarding firm investment behavior for environmental protection. These hypotheses can now be tested with the data at hand. Since we are interested in differences between foreign and German firms, we compare the mean values of the EPI for the group of foreign controlled firms with those of the domestically owned control groups. The first reference group consists of enterprises which are dependent affiliates, owned by a group head just as the group of foreign owned enterprises. Therefore, both types of firms gain from company network effects such as technology and know-how transfers and are comparable in this respect. The second comparison group is restricted to only those domestically owned affiliates that generate a share of their turnover abroad and are hence exporters. The underlying idea is that differences in EPI spending, and in particular differences in EPI for add-on and integrated measures, may be due to access to foreign markets. If a firm has spread its activities across national borders, the assumption that this firm enjoys easier and faster access to up-to-date and cleaner technologies is a probable one. If foreign firms hence report higher EPI figures than their domestically owned counterparts, this could be due to the fact that these firms are organized internationally and have different sourcing patterns (Kaiser and Schulze (2003)). If those firms are now compared to only domestically owned firms that can be also labelled international, differences could decline or even disappear.[8]

Table 3 shows EPI means by enterprise group. Within the group of foreign enterprises in Germany, around 22% invested in environmental protection, which is twice as much as

[8] Unfortunately, there is no information on the multinational status in the data. Therefore we are not able to look at differences between domestic multinationals and foreign multinationals or domestic non-multinationals.

within the group of domestically owned firms and also clearly more than among German exporters (13%). The same picture emerges when looking at EPI for integrated measures: there are only 4% of indigenous affiliates, 4% and 5% of indigenous exporters, and 9% of foreign owned firms reporting integrated EPI. Also, the share of integrated EPI within overall EPI is the highest for foreign firms (5%). This first impression of the data shows exactly the hierarchical order suggested by the literature on heterogeneous firms and internationalization discussed in Section 2: foreign firms are the most productive, which means that they have more output and apply more up-to-date technology and hence spend more on overall and integrated EPI. German exporters are less productive but still more productive than non-exporting firms, and hence have a place in the middle also in terms of EPI. However, the group of only exporters does not differ much from the first comparison group of German affiliates here, as the former is part of the latter.

We get a similar picture when we look at the magnitude of EPI. Foreign owned firms spent on average 26 EUR per capita in 2007 and 35 EUR per capita in 2008, and both groups of domestically owned firms about one-half. A similar order is prevalent in terms of the EPI share in general investment and end-of-pipe EPI. When looking at the amount of EPI spent, the reported figures differ much more across the two samples for 2007 and 2008 what seems plausible for investment data.

In order to assess whether the differences are not only of economic relevance in terms of magnitude but also statistically significant, we applied the t-test for each of the two groups with unequal variances. The results in Table 4 show that almost all the differences are highly statistically significant at common significance levels.

So far, we have considered only mean values, but differences in mean values do not necessarily imply differences along the entire distribution of firms. To account for differences along the distribution, the non-parametric Kolmogorov–Smirnov test evaluates whether all moments of the two cumulative distribution functions of a variable are statistically different from each other and whether one distribution dominates the other according to the concept of first-order stochastic dominance (see Conover (1999): 456ff.). None of the results in Table 4 gives rise to concerns about the validity of differences along distributions.

[Table 3 about here]

[Table 4 about here]

The population of foreign firms should not be treated as a homogeneous group. Foreign owned firms differ from each other in many respects. An important characteristic is where a certain affiliate is controlled from, in other words, the nationality of the firm. A separate analysis of EPI by country of origin can offer interesting insights, for example, because environmental protection in general is closely related to concepts of corporate culture and institutional backgrounds which, in turn, are likely to differ across countries (cf. Section 2). Studies of foreign owned firms very often neglect to consider this group's heterogeneity, due to the limited size of the datasets. We are able to build several subcategories of foreign firms: two for firms whose group head is located in an extra-European country, namely *U.S.* and *Other*, and three inner-European, namely *South Europe*, *Scandinavia*, and *Rest of Europe*.[9]

Table 5 shows that 24% of U.S. firms invested in environmental protection, compared to 20%–22% and 21%–22% of Scandinavian and other European firms. These numbers are fairly stable across the two samples for 2007 and 2008 and fit the picture created by the comparison of all foreign firms with domestically owned firms in the sense that EPI levels seem to mirror productivity and pollution levels: U.S. firms show relatively much general and integrated EPI activity (11%) and also push the productivity premium among foreign firms in Germany (Weche Gelübcke (2013)). However, the differences are not large and in the group of other extra-European firms, there were 26% investing in environmental protection in 2007. Among firms from Southern Europe, only 14%–16% reported overall EPI. Together with other extra-European firms, they spent only 3/4 EUR per capita on integrated measures.

All in all, there appear to be no other clear-cut differences in Table 5 and the reported numbers can differ greatly between the 2007 and 2008 samples. For example, Scandinavian firms invested on average 15 EUR per capita in environmental protection in 2007 and 44 EUR per capita in 2008, an increase by almost 200%. This reflects the limitation of the investment data in which expenses are not incurred steadily over time, and the smaller the sample, the larger the fluctuation. The statistical significance of the differences can be seen in Table 6. It becomes obvious that almost no difference is statistically significant at the conventional levels, not even the overall EPI of the U.S. firms.

[9] For a list of the particular countries covered by these categories, see Table 5. We had to consider both theoretical considerations as well as the availability of data for these categories since the confidentiality of our micro-data does not allow investigating EPI by every single country due to the small numbers of observations.

[Table 5 about here]

[Table 6 about here]

5.2 Conditional evidence

Although an unconditional perspective is interesting in itself and may be crucial for policy decisions, the conditional perspective is more interesting from a researcher's point of view. What if the higher EPI figures of foreign firms, found in the unconditional mean comparison, can be exclusively traced back to the fact that those firms operate in particular industries where EPI are generally above average due to higher pollution levels? Foreign owned firms would still invest more on average but their foreignness would not be the reason for this. In the following step, we run regression analyses and control for industry effects via 2-digit industry dummies (Model 1) and firm size, measured as the number of employees and the number of employees squared to account for non-linearity (Model 2). Larger firms are on average more productive due to the realization of scale effects and because they operate with more modern technology since they can afford to make larger investments. Hence, we expect the link between firm size and EPI to be positive. The correlation with add-on EPI is less clear since, on the one hand, smaller firms have to compensate for older technology through add-on investments (positive link), but, on the other hand, are also expected to have a disproportionately lower productivity which may translate into a disproportionately lower per capita pollution (negative link).[10] In the theory section, we have demonstrated, in addition to our unconditional results, that differences in EPI can probably be traced back to differences in productivity levels. Consequently, we include each firm's labor productivity in our model (Model 3) and expect it to be positively correlated with EPI and particularly with overall and integrated EPI.

Table 7 gives the regression estimates for all models and both comparison groups. All coefficients are slightly smaller in the Model 2 estimates than for Model 1, which suggests an overall positive correlation of firm size with EPI.[11]

[10] Our models do not claim to be explanatory models since they offer a fairly tentative modeling of EPI decisions. The so-called premium regressions are rather supposed to uncover statistically significant differences between enterprise groups, accounting for major determinants.

[11] The coefficients for the firm size covariates are indeed positive and statistically significant.

To start with the Model 2 Probit estimates of the probability of reporting any EPI, in 2007 and 2008, foreign firms were more likely to invest, on average and *ceteris paribus*, by five and six percentage points (Model 2).[12] This is a large difference if we consider that the overall EPI rate is only 11% (Table 2). Moreover, the restriction of the comparison group to only exporters does not seem to change this result. The probability of investing in integrated measures is also higher for foreign affiliates, by about three percentage points on average. These results are highly statistically significant at the 1% level. Considering the amount spent for environmental protection, a similar pattern appears in the Model 2 estimates: foreign owned firms invest significantly more (by 18 EUR per capita in 2008), irrespective of the export behavior of German affiliates. Only the share of EPI in general investments is not significantly different from German exporters in 2008. Foreign owned firms also invest more in end-of-pipe (by 4 EUR in 2007 and 9 EUR in 2008) as well as integrated EPI (by between 2 and 3 EUR). Again it has to be noted that these differences, although small in absolute terms, are large from a relative point of view.

Summing up the results for the Model 2 estimates, foreign firms spend on average more for environmental protection, regardless of industry and size effects. Furthermore, export activity seem not to have an important impact on the investment behavior, which underlines the fact that the German market has relatively high environmental standards and firms producing in Germany do not need to comply with even higher standards in export markets abroad.

If we consider the productivity levels in Model 3, we can observe the expected positive link with EPI. The coefficients and marginal effects for the productivity covariates from Model 3 estimates are given in Table 8. As expected, most coefficients have a positive sign and are statistically significant. The only independent variable for which this is not the case is end-of-pipe EPI, thereby confirming that a higher productivity goes hand in hand with a shift towards integrated EPI.

Turning to Model 3 results for the foreign ownership dummy in Table 7, there is still a higher probability for foreign firms to invest in EPI, but the difference in terms of the amount spent decreases and becomes even insignificant in the 2007 sample. This pattern

[12] The reported numbers are marginal effects at the sample mean. Since different samples have different means, the comparability of the two values is limited.

can probably be observed for EPI shares in overall investment although it is less clear-cut. Regarding integrated EPI, the probability also does not seem to change markedly, and the differences shrink and turn insignificant in 2008 when domestically owned exporters serve as the reference group. Interestingly, in the 2007 sample, foreign firms invest less in integrated measures by almost 3 EUR per capita once we hold productivity levels constant. However, the share of integrated EPI in overall EPI remains higher for foreign owned affiliates.

The results from Model 3 estimates show that, once firms' productivity levels have been controlled for, the superior EPI of foreign owned firms appears to be much less straightforward and depend highly on the period under consideration. Nevertheless, the fact that foreign firms are more likely to spend on overall and integrated EPI and have a composition tilted towards integrated measures does not seem to be affected by heterogeneous productivity levels.[13] This confirms Bansal's (2005) findings that the level of a firm's international experience is positively linked to corporate sustainability performance.

[Table 7 about here]

[Table 8 about here]

Regression estimates of EPI by country of origin are given in Table 9. All coefficients and marginal effects are relative to the category *Rest of Europe*. What is apparent at first sight is that the statistical significance levels are much lower than in the former regressions and most coefficients are not statistically significant at any common level. Those coefficients which are statistically significant seem to represent special cases since they arise only in one of the two periods considered. For example, Scandinavian firms invested significantly less in overall environmental protection, by 12 EUR per capita in 2007, than the rest of Europe (Southern Europe excluded). In 2008, the coefficient is positive and statistically highly insignificant. The same applies to Southern European firms but in a reversed order. The estimates therefore correspond to results from the unconditional mean comparisons and highlight that there do not seem to be any structural differences within the group of foreign controlled firms according to their country of origin. The only exception is found for the

[13] Unfortunately we are not able to appropriately control for total factor productivity (TFP). Instead, our productivity measure is labor productivity, and we therefore do not consider capital intensities, which are certainly of great interest in the context of technology investments.

EPI probability of Southern European firms, which is significantly lower, by seven and six percentage points in both years, than the rest of Europe (Scandinavia excluded).

These results reject the assumption that foreign controlled firms would show the effects of a "national business systems" influence of their home countries on their approach to EPI. Scandinavian companies, for instance, who, according to that hypothesis, would have been likely to invest more, in fact show adverse behavior. It is not clear, though, whether the potential effects are curbed due to the limited period of our data, and may show up in a longitudinal study. However, the findings can be interpreted in a way that supports the new institutionalist hypothesis of an international convergence of management practices in the field of environmental management due to normative pressure and *de facto* standards at the global level.

[Table 9 about here]

5.3 Robustness: Selection issues

We have seen in Table 2 that only 11% of all firms in our sample carried out EPI. This is a relatively small proportion, and the vast majority in our sample reported zero investments. This is even more desperate in the case of integrated EPI, where more than 96% of our observations reported zero investment. If now the amount spent is estimated, as we did for example in Table 7, the results may suffer a selection problem because we do not consider the initial likelihood of each firm to invest (Heckman (1979)).

Samples with a disproportionate number of observations with zero values are often treated as censored data, because, for example in our case, the potential magnitude of investments of non-investing firms if they would invest, is unknown. Many studies account for this feature by using appropriate methodologies such as the Heckman selection model and estimate both the probability of investing and the amount spent jointly in a two-step procedure. Although the consideration of this special data feature would be suitable, these procedures necessarily assume an independence of the decision to invest from the decision on how much to invest and this seems most unlikely in the context at hand: EPI do not necessarily reflect cases of voluntary expenses in which, for instance, one department brings up the idea to spend money on environmental protection and another department decides on how much it should

be. Rather, EPI mostly represents the costs of environmental regulations and so should be regarded as highly output-dependent. The major decision seems to be whether a firm wants to comply with a specific regulation or not, and once this decision is made, the amount to spend is basically determined by the firm's output-level.

Therefore, we apply a generalized linear model (GLM) with a logit-link function to account for the fractional response of our independent variables without assuming the independence of the two decisions as discussed above – see Ramalho et al. (2011) and Wagner (2001) for a similar case. The estimated model demands the values of the independent variable to be bounded between zero and one and uses a maximum likelihood estimator. The results for the two variables with appropriate features, namely the share of EPI in general investments and the share of integrated EPI, are given in Table 10.

The results support our results from Table 7 in terms of sign and statistical significance. The coefficients of the GLM estimations cannot be interpreted straightforwardly, and therefore we also provide simulations of hypothetical enterprises in Table 10. For these simulations, all variables, except the foreign ownership dummy (fo), are fixed at their means. This allows predicting specific EPI intensities for hypothetical individual cases (in percentages) and shows the difference between hypothetical average foreign and domestically owned firms. These differences are comparable to those estimated in Table 7, although slightly smaller.

[Table 10 about here]

6 Conclusion

The environmental consequences of economic globalization and global trade have long been debated. But only recently have the aspects of pollution and environmental protection been the subject of empirical investigation of the international activities of firms. The present study is the first firm-level investigation of a link between foreign ownership and environmental protection in Germany.

We investigated not only different types of environmental protection investment (end-of-pipe and integrated), we were also able to split the sample of foreign owned firms into subcategories by country of origin and could therefore test hypotheses related to technology sophistication, voluntary expenses, and differences in management culture. We were also able

to consider the ownership and exporter status in the control group of domestically owned firms and to draw conclusions about the role of export activity in Germany for environmental protection investments.

We used a highly representative new micro-level database that covers all enterprises in the German manufacturing sector with at least twenty employees. We found that foreign owned firms in Germany are, *ceteris paribus*, generally more likely to invest in environmental protection. They also invest on a larger scale in terms of add-on as well as integrated measures. These results are robust across different measures of EPI, different time periods, and against different control groups of German firms and selection issues arising from the fractional response data. The results mirror the productivity advantages of foreign firms in Germany and simultaneously demonstrate that export activities do not seem to play a major role in superior environmental protection investments. This latter underlines the fact that Germany has relatively high environmental standards and exporting firms do not need to comply with even higher standards in foreign markets. Once we control for individual productivity levels, the differences in investment intensity become less straightforward, and depend on the period considered. In fact, foreign firms can also spend significantly less than German firms on EPI. However, foreign firms' higher probability of making general as well as integrated EPI, and their composition's tilting towards integrated measures, appear to be independent of any heterogeneity in productivity levels. This supports Bansal's (2005) findings that the level of a firm's international experience is positively linked to corporate sustainability performance.

Temporary differences between different subgroups of foreign firms by country of origin seem to be prevalent only due to the character of the investment data used, and are not persistent. Hence, we cannot find any support for differences in environmental protection by country of origin. Their expenses seem to reflect merely the minimal costs of complying with the environmental regulations. These findings can also be interpreted in a way that supports the new institutionalist hypothesis of an international convergence of management practices in the field of environmental management due to normative pressure and *de facto* standards at the global level.

Despite the shortcomings that the investment data may be period specific and the running expenses for environmental protection are not included in our data, our study offers

some initial insights into the link between environmental protection and international firm activities in Germany, a topic that is attracting increasingly attention both in the public debate and in academia.

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Table 1: Microeconometric studies on foreign ownership and environmental protection

Author(s)(year)	*Country*	*Data*	*Y*	*Method*	*Findings*
Aden, Kyu-hong, and Rock (1999)	Korea	manufacturing, cross-section	Pollution abatement expenditure	Two stage least squares	Foreign owned firms spend less on pollution abatement than domestically owned firms.
Albornoz et al. (2009)	Argentina	1998, manufacturing	Implemented environmental management systems (EMS)	Binary model	Foreign owned firms are more likely to implement EMS and to implement a greater range of EMS types as well as to benefit from environmental spillovers.
Batrakova and Davies (2012)	Ireland	1991–2007, manufacturing	Energy use	Quantile regressions	Foreign ownership reduces energy intensity in lower quantiles and the reverse is true for higher quantiles.
Chudnovsky and Pupato (2005)	Argentina	1998–2001, manufacturing	Environmental management activities (EMA)	Panel regressions	Foreign ownership decreases quality of EMA but enhances likelihood to undertake EMA.
Cole et al. (2008)	Ghana	1991–1997, manufacturing	Energy use	*Ad hoc* and trans log prod. function estimation	Foreign ownership does not increase total energy use but electricity use. The foreign training of a CEO reduces fuel use, particularly in foreign firms.
Collins and Harris (2005)	UK	1991–1994 chemicals industry	Pollution abatement expenditure (PAE)	Heckman selection	PAE differences turn out to be heterogeneous according to country of origin and type of PAE.

(Continued)

(Table 1 continued)

Collins and Harris (2002)	UK	1991–1994, metal manufacturing	Pollution abatement expenditure (PAE)	Heckman selection	Only some foreign owned firms spend more on PA than domestically owned firms and only regarding some types of PAE.
Earnhart and Lízal (2006)	Czech Republic	1993–1998	Air pollution	Panel regressions	Foreign ownership and other ownership types have no effect, only public ownership reduces polution.
Eskeland and Harrison (2003)	Côte d'Ivoire, Mexico, Venezuela	1977–1987, 1984–1990, 1983–1988	Energy use	Pooled regressions	Foreign ownership is associated with less energy use in all countries.
Haller and Murphy (2012)	Ireland	2006 and 2007, manufacturing	Environmental protection expenditure	Heckman selection	foreign firms, once they have environmental expenditures, do that on a greater scale.
Kaiser and Schulze (2003)	Indonesia	1994–1996, manufacturing	Environmental expenses (no investments)	Heckman selection	Foreign owned firms are not more likely to report environmental expenditures but if they do their expenditures are higher.

Table 2: Summary statistics

Continuous variables

Variable	*Sample*	*Mean*	*Sd*	*P75*	*P90*	*P99*
Overall EPI per capita (EUR)	2007	12	152	0	2	257
	2008	16	257	0	2	295
Share of EPI in general investment[a] (%)	2007	1.84	9.84	0	0.47	58.32
	2008	1.99	10.53	0	0.38	66.21
End-of-pipe EPI per capita[b] (EUR)	2007	5	112	0	0	94
	2008	7	200	0	0	104
Integrated EPI per capita[b] (EUR)	2007	3	46	0	0	41
	2008	3	103	0	0	41
Share of integrated EPI (%)	2007	2.40	14.10	0	0	100
	2008	2.16	13.45	0	0	100

Binary variables

Variable	*Sample*	*Number of firms*	*Share (%)*
EPI (yes=1; no=0)	2007	4,186	10.93
	2008	4,224	10.87
Integrated EPI (yes=1; no=0)	2007	1,418	3.70
	2008	1,294	3.33

Note: The full 2007 and 2008 samples cover 38,314 and 38,867 enterprises from the German manufacturing sector; The abbreviation EPI stands for environmental protection investment; [a]For this variable there are slightly fewer observations available in the 2007 sample because of missing information in the total investment variable. N is 38,304 in 2007; [b]Measures do not include investments in the area of climate protection, renewables, and energy efficiency.

Table 3: Environmental protection investment (EPI) by enterprise groups

		Indigenous affiliates (N=15,358(2007); 15,544(2008))		*Indigenous exporters (N=11,240(2007); 11,400(2008))*		*Foreign affiliates (N=3,599(2007); 3,612(2008))*	
Variable (continuous)	*Sample*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*
Overall EPI per capita (EUR)	2007	12	115	12	107	26	193
	2008	17	330	14	204	35	293
Share of EPI in general investment[a] (%)	2007	1.81	9.53	1.86	9.37	2.41	9.59
	2008	1.94	10.36	2.04	10.52	2.51	9.78
End-of-pipe EPI per capita[b] (EUR)	2007	5	87	5	84	12	96
	2008	9	280	5	56	17	180
Integrated EPI per capita[b] (EUR)	2007	3	42	3	38	6	71
	2008	4	157	4	182	7	64
Share of integrated EPI (%)	2007	2.53	14.45	2.91	15.33	5.15	19.78
	2008	2.42	14.36	2.72	15.10	5.41	20.35

Variable (binary)	*Sample*	*No. of firms*	*Share (%)*	*No. of firms*	*Share (%)*	*No. of firms*	*Share (%)*
EPI (yes=1)	2007	1,765	11.49	1,469	13.07	777	21.59
	2008	1,711	11.01	1,429	12.54	796	22.04
Integrated EPI (yes=1)	2007	609	3.97	523	4.65	331	9.20
	2008	559	3.60	476	4.18	327	9.05

Note: [a]For this variable there are slightly fewer observations available in the 2007 sample because of missing information in the total investment variable. N is 15,354 for indigenous affiliates, 11,237 for indigenous exporters, and 3,596 for foreign affiliates; [b]Measures do not include investments in the area of climate protection, renewables, and energy efficiency.

Table 4: T-test and Kolmogorov-Smirnov test statistics (p-values)

		H_0	*foreign affiliates vs. indigenous affiliates*		*foreign affiliates vs. indigenous exporters*	
			2007	2008	2007	2008
Overall EPI per capita	t-test	equal means	0.0001	0.0015	0.0001	0.0001
	K-S test	equal distr.	0.000	0.000	0.000	0.000
		foreign firms <	0.000	0.000	0.000	0.000
		foreign firms >	1.000	1.000	1.000	1.000
Share of EPI in general investment	t-test	equal means	0.0008	0.0021	0.0031	0.0166
	K-S test	equal distr.	0.000	0.000	0.000	0.000
		foreign firms <	0.000	0.000	0.000	0.000
		foreign firms >	0.983	0.878	0.995	0.872
End-of-pipe EPI per capita	t-test	equal means	0.0001	0.0224	0.0002	0.0001
	K-S test	equal distr.	0.000	0.000	0.000	0.000
		foreign firms <	0.000	0.000	0.000	0.000
		foreign firms >	1.000	1.000	1.000	1.000
Integrated EPI per capita	t-test	equal means	0.0044	0.0569	0.0056	0.2321
	K-S test	equal distr.	0.000	0.000	0.000	0.000
		foreign firms <	0.000	0.000	0.000	0.000
		foreign firms >	1.000	1.000	1.000	1.000
Share of integrated EPI	t-test	equal means	0.0000	0.0000	0.0000	0.0000
	K-S test	equal distr.	0.000	0.000	0.000	0.000
		foreign firms <	0.000	0.000	0.000	0.000
		foreign firms >	1.000	1.000	1.000	1.000

Table 5: EPI of foreign enterprises by country of origin

		Scandinavia		*South Europe*		*Rest of Europe*		*U.S.*		*Other*	
		N=300(2007); 271(2008)		*N=163(2007); 156(2008)*		*N=1,981(2007); 1,958(2008)*		*N=717(2007); 726(2008)*		*N=261(2007); 285(2008)*	
Variable (continuous)	*Sample*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*
Overall EPI p.c.[a] (EUR)	2007	15	56	30	223	28	209	27	227	21	82
	2008	44	234	11	49	39	349	27	221	30	200
Share of EPI in	2007	2.16	8.58	2.81	12.41	2.49	9.83	2.19	8.75	3.19	11.21
general investment[b] (%)	2008	2.66	8.83	1.84	9.23	2.65	10.37	2.25	8.62	2.47	9.29
End-of-pipe EPI p.c.[a] (EUR)	2007	8	43	22	220	14	104	8	45	13	76
	2008	14	99	4	24	21	222	11	80	23	194
Integrated EPI p.c.[a] (EUR)	2007	3	25	3	19	7	75	8	96	4	15
	2008	8	48	4	37	7	61	6	37	3	31
Share of integrated EPI (%)	2007	4	18	3	14	5	20	5	19	6	22
	2008	5	18	5	21	5	20	7	23	4	17

Variable (binary)	*Sample*	*Number*	*Share (%)*	*Number*	*Share (%)*	*Number*	*Share (%)*	*Number*	*Share (%)*	*Number*	*Share (%)*
EPI (yes=1)	2007	61	20.33	22	13.50	424	21.40	175	24.41	69	26.44
	2008	60	22.14	25	16.03	437	22.32	174	23.97	54	18.95
Integrated EPI (yes=1)	2007	24	8.00	11	6.75	172	8.68	77	10.74	31	11.88
	2008	29	10.70	12	7.69	170	8.68	80	11.02	15	5.26

Note: [a]Measures do not include investments in the area of climate protection, renewables, and energy efficiency; [b]For this variable there are slightly fewer observations available in the 2007 sample because of missing information in the total investment variable. N is 1,980 for the category Rest of Europe, 299 for the category Scandinavia, and 260 for the category Other; The category *Scandinavia* covers group heads in Denmark, Finland, Norway, and Sweden. *South Europe* covers Spain, Italy, and Portugal. *Rest of Europe* covers Austria, Belgium, Switzerland, Great Britain, France, Ireland, Luxembourg, Netherlands, Cyprus, Czech Republic, and Slovenia as well as Netherlands Antilles, Gibraltar, Cayman Islands, Liechtenstein, British Virgin Islands.

Table 6: T-test statistics (p-values)

Variable	Year	*Scan vs. SE*	*Scan vs. RoE*	*Scan vs. U.S.*	*Scan vs. Other*	*SE vs. RoE*
Overall EPI per capita	2007	0.3987	0.0169	0.1654	0.3141	0.9386
	2008	0.0265	0.7483	0.3149	0.4606	0.0017
Share of EPI in general investment	2007	0.5601	0.5416	0.9562	0.2292	0.7601
	2008	0.3685	0.9878	0.5110	0.8039	0.2954
End-of-pipe EPI per capita	2007	0.4199	0.1242	0.9981	0.3658	0.6119
	2008	0.1121	0.4185	0.5838	0.5057	0.0022
Integrated EPI per capita	2007	0.8805	0.0640	0.2636	0.7363	0.0486
	2008	0.4540	0.7801	0.5250	0.2130	0.4999
Share of integrated EPI	2007	0.2676	0.3898	0.5146	0.2920	0.0293
	2008	0.7186	0.6334	0.1475	0.5065	0.9282

		SE vs. U.S.	*SE vs. Other*	*RoE vs. U.S.*	*RoE vs. Other*	*U.S. vs. Other*
Overall EPI per capita	2007	0.8998	0.6215	0.9136	0.2711	0.5069
	2008	0.0715	0.1243	0.3212	0.5533	0.8435
Share of EPI in general investment	2007	0.5564	0.7432	0.4483	0.3404	0.1957
	2008	0.6098	0.4936	0.3111	0.7611	0.7299
End-of-pipe EPI per capita	2007	0.4176	0.6042	0.0695	0.9341	0.3367
	2008	0.0699	0.1090	0.0851	0.8549	0.2997
Integrated EPI per capita	2007	0.2323	0.6109	0.9582	0.0678	0.3129
	2008	0.7423	0.7372	0.5561	0.1427	0.3275
Share of integrated EPI	2007	0.0611	0.0470	0.8616	0.5686	0.5298
	2008	0.4953	0.3832	0.1359	0.1602	0.0231

Table 7: Regression estimates

Variable	*Year*	*Reference group of indigenous affiliates*					
		All affiliates			*Exporters*		
		$N = 18,957(2007); 19,156(2008)$			$N = 14,839(2007); 15,012(2008)$		
		(1)	(2)	(3)	(1)	(2)	(3)
Overall EPI p.c.[a]	2007	9.02***	8.59***	1.79	8.82***	8.46***	2.23
		(2.83)	(2.68)	(0.54)	(2.90)	(2.75)	(0.68)
	2008	18.31***	17.68***	13.70***	17.44***	16.94***	13.62***
		(3.75)	(3.59)	(4.88)	(3.73)	(3.59)	(2.91)
Share of EPI[a]	2007	0.46***	0.42**	0.34*	0.38**	0.35*	0.28
		(2.65)	(2.40)	(1.95)	(2.10)	(1.94)	(1.56)
	2008	0.43**	0.38**	0.33*	0.28	0.25	0.23
		(2.35)	(2.09)	(1.81)	(1.48)	(1.33)	(1.18)
End-of-pipe EPI p.c.[a]	2007	4.51**	4.26**	2.89	4.66**	4.47**	3.18
		(2.31)	(2.19)	(1.26)	(2.47)	(2.37)	(1.41)
	2008	9.69***	9.37***	7.92**	10.55***	10.27***	9.11***
		(3.15)	(3.02)	(2.56)	(3.55)	(3.41)	(3.05)
Integrated EPI p.c.[a]	2007	2.11**	1.95*	-2.71**	1.90**	1.77*	-2.55**
		(2.12)	(1.95)	(2.17)	(2.07)	(1.91)	(2.22)
	2008	3.29***	3.05***	2.08*	2.51*	2.33*	1.52
		(2.83)	(2.59)	(1.80)	(1.86)	(1.71)	(1.17)
Share of integrated EPI[a]	2007	2.05***	1.52***	1.28***	1.74***	1.32***	1.11***
		(5.99)	(4.44)	(3.70)	(4.95)	(3.74)	(3.13)
	2008	2.38***	1.83***	1.68***	2.15***	1.69***	1.56***
		(6.90)	(5.26)	(4.83)	(6.06)	(4.76)	(4.39)
Overall EPI indicator[b]	2007	0.08***	0.05***	0.05***	0.07***	0.05***	0.04***
		(12.05)	(8.51)	(7.61)	(9.52)	(6.74)	(5.97)
	2008	0.09***	0.06***	0.06***	0.08***	0.05***	0.05***
		(14.06)	(9.26)	(8.86)	(11.23)	(7.48)	(7.26)
Integrated EPI indicator[b]	2007	0.04***	0.03***	0.02***	0.03***	0.02***	0.02***
		(0.000)	(0.000)	(6.46)	(0.000)	(0.000)	(5.24)
	2008	0.04***	0.03***	0.03***	0.03***	0.03***	0.02***
		(10.28)	(8.21)	(7.69)	(8.46)	(6.91)	(6.49)

Note: Reported are coefficients for OLS estimates and marginal effects at the sample mean for probit estimates with |t-/z-values| in brackets; Model 1 includes 2-digit industry dummies, Model 2 controls for size additionally, and Model 3 further includes individual productivity levels; The number of observations in 2007 is slightly lower for "share of EPI" estimates according to Table 3 notes; [a]OLS estimator; [b]Probit estimation; Significance at the 10% (*), 5% (**) and 1% (***) level.

Table 8: Productivity coefficients for Model 3 estimates from Table 7

Variable	*Reference group of indigenous affiliates*			
	All affiliates		*Exporters*	
	$N = 18,957(2007); 19,156(2008)$		$N = 14,839(2007); 15,012(2008)$	
	2007	2008	2007	2008
Overall EPI p.c.[a]	0.74***	0.46**	0.78***	0.44**
	(3.95)	(2.53)	(3.88)	(2.30)
Share of EPI[a]	0.01***	0.01**	0.01***	0.004
	(4.38)	(1.97)	(4.17)	(1.39)
End-of-pipe EPI p.c.[a]	0.15	0.17*	0.16	0.16
	(1.37)	(1.68)	(1.36)	(1.51)
Integrated EPI p.c.[a]	0.51***	0.11***	0.54***	0.11***
	(3.45)	(3.16)	(3.79)	(2.69)
Share of integrated EPI[a]	0.03***	0.02***	0.03***	0.02***
	(5.88)	(3.11)	(5.47)	(2.90)
Overall EPI indicator[b]	0.001***	0.0003***	0.001***	0.0002***
	(5.66)	(4.10)	(4.39)	(3.51)
Integrated EPI indicator[b]	0.0003***	0.0002***	0.0003***	0.0002***
	(5.93)	(4.34)	(5.19)	(4.06)

Note: Reported are coefficients for OLS estimates and marginal effects at the sample mean for probit estimates with |t-/z-values| in brackets; Productivity is measured as labor productivity in 1,000 EUR; [a]OLS estimator; [b]Probit estimation; Significance at the 10% (*), 5% (**) and 1% (***) level.

Table 9: Regression estimates (Model 2)

Variable	*Year*	*Scandinavia*	*South Europe*	*U.S.*	*Others*
Overall EPI p.c.[a]	2007	-11.89**	4.72	1.91	-6.16
		(2.24)	(0.27)	(0.20)	(0.87)
	2008	8.42	-22.66**	-6.87	-5.79
		(0.50)	(2.35)	(0.73)	(0.41)
Share of EPI[a]	2007	-0.61	0.37	0.10	0.87
		(1.19)	(0.37)	(0.24)	(1.22)
	2008	0.07	-0.70	-0.05	0.02
		(0.13)	(0.85)	(0.11)	(0.03)
End-of-pipe EPI p.c.[a]	2007	-5.14	8.90	-3.12	-0.01
		(1.48)	(0.53)	(1.07)	(0.00)
	2008	-8.73	-16.67**	-7.32	3.76
		(0.91)	(2.12)	(1.47)	(0.32)
Integrated EPI p.c.[a]	2007	-3.54*	-2.38	0.06	-3.10
		(1.76)	(1.22)	(0.02)	(1.37)
	2008	2.81	-1.51	-1.50	-3.73
		(0.90)	(0.43)	(0.86)	(1.45)
Share of integrated EPI[a]	2007	-1.17	-2.18*	-0.32	0.85
		(1.13)	(1.88)	(0.38)	(0.62)
	2008	-0.11	0.15	1.01	-1.58
		(0.10)	(0.09)	(1.10)	(1.44)
Overall EPI indicator[b]	2007	-0.01	-0.07**	0.02	0.06**
		(0.43)	(2.04)	(1.24)	(2.13)
	2008	0.01	-0.06**	-0.001	-0.04
		(0.36)	(1.72)	(0.05)	(1.38)

Note: Reported are coefficients for OLS estimates and marginal effects at the sample mean for probit estimates with |t-/z-values| in brackets; N = 3,422 for the 2007 sample and 3,396 for the 2008 sample; The model includes 2-digit industry dummies and controls for firm size; The category Rest of Europe is the reference group; [a]OLS estimator; [b]Probit estimation; Significance at the 10% (*), 5% (**) and 1% (***) level.

Table 10: GLM estimates and simulation of coefficients

Variable	*Year*	*Reference group of indigenous affiliates* *All affiliates*		*Exporters*	
		$N = 18,957(2007)$; $19,156(2008)$		$N = 14,839(2007)$; $15,012(2008)$	
		(1)	(2)	(1)	(2)
Share of EPI[b]	2007	0.23***	0.20**	0.18**	0.17**
		(2.79)	(2.48)	(2.17)	(1.98)
	Simulation fo=1	0.014	0.013	0.013	0.012
	Simulation fo=0	0.011	0.010	0.011	0.010
	2008	0.20**	0.18**	0.13	0.11
		(2.45)	(2.19)	(1.51)	(1.35)
	Simulation fo=1	0.021	0.019	0.022	0.021
	Simulation fo=0	0.017	0.016	0.021	0.019
Share of integrated EPI	2007	0.57***	0.51***	0.46***	0.41***
		(6.74)	(5.78)	(5.37)	(4.64)
	Simulation fo=1	0.054	0.051	0.058	0.053
	Simulation fo=0	0.032	0.031	0.037	0.036
	2008	0.66***	0.59	0.57***	0.52***
		(7.86)	(-)	(6.66)	(5.96)
	Simulation fo=1	0.032	0.029	0.041	0.036
	Simulation fo=0	0.017	0.016	0.023	0.022

Note: Reported are coefficients for GLM estimates with |z-values| in brackets; Model 1 includes 2-digit industry dummies, Model 2 controls for size additionally; Significance at the 10% (*), 5% (**) and 1% (***) level; [b]For this variable there are slightly fewer observations available in the 2007 sample because of missing information in the total investment variable. N is 18,950 for estimations vs. indigenous affiliates and 14,833 for estimations vs. indigenous exporters.

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