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Environmental certification of industrial establishments is accompanied by a reduction of environmental pressures

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Contents

Executive Summary

For the environmental component of corporate social responsibility, the implementation of environmental management systems (EMS) allows companies to make an appropriate response to the key environmental issues facing them. Such strategies can then help companies obtain certification, with the two main accreditations being the ISO 14001 standard and EMAS registration. Companies decide to implement an EMS and obtain certification for different reasons (to reduce their consumption of inputs, anticipate future regulations, improve their corporate image, etc.).

The aim of the study is to characterise the certified establishments and analyse whether the adoption of such a strategy is accompanied by a significant reduction in environmental pressures (consumption of energy and water, CO_2 and atmospheric pollutant emissions and waste production). Data concerning French industrial sectors over the 2004 to 2010 period were used and reveal that for the majority of environmental pressures, the greater the rise in pressure, the higher the number of certified establishments. Moreover, for a given level of pressure, the proportion of certified establishments increases according to the size of establishments (over half of establishments with more than 250 employees are certified). For major establishments, however (with over 500 employees), the propensity to obtain certification does not appear to depend solely on the level of pressure, as other factors also come into play (e.g. the public relations dimension).

An econometric assessment of the level of environmental pressure according to whether or not a company is certified (and by inspecting the specific characteristics of the company) reveals that the ISO 14001 and EMAS environmental certifications act as good indicators of an effective environmental policy being implemented by establishments: for the year of certification, water abstractions and energy consumption are 2% below the levels for the rest of the industry. There is a difference of 3% for CO_2, and 4% for waste production. The reduction of environmental pressures continues during the years following certification – at a rate of an additional 1 to 2% compared to non-certified establishments. The results are more mixed with regard to atmospheric pollution and vary according to the types of pollution in question.

Introduction

According to the terms used by the European Commission, Corporate Social Responsibility (CSR) is defined as "the responsibility of enterprises for their impacts on society" which, in order to fulfil this obligation, requires them to incorporate "social, environmental, ethical human rights and consumer concerns into their business operations and core strategy". For the environmental component of CSR, companies can make an appropriate response to the key environmental issues facing them by implementing an environmental management system (EMS). Such strategies can then help companies obtain certification, with the two main existing accreditations being the ISO 14001 standard and EMAS registration[1].

Companies may have different reasons for implementing an EMS and obtaining the associated certification, such as cutting production costs by reducing the consumption of inputs or pollutant emissions, anticipating stricter regulations, improving access to Socially Responsible Investment[2] (SRI) funds, or improving their image as perceived by their commercial partners and consumers, etc.

Although the implementation of an EMS and the associated certification form part of a voluntary process, they may also promote the application and development of environmental standards. Indeed, certification facilitates the inspection and monitoring of compliance with the standards in force by providing easier access to information, designating an identified contact person in charge of environmental issues and providing comprehensive documentation concerning procedures and organisational systems, for example. Furthermore, certification, by promoting greater awareness in certified companies of the regulations in force, may lead to the adoption of voluntary procedures with strict requirements from an environmental standpoint.

The main aim of this study is to determine whether ISO 14001 or EMAS certification goes hand-in-hand with improved environmental performance. More specifically, this involves assessing whether certification, in the companies concerned, is accompanied by reductions in carbon dioxide and pollutant emissions, the consumption of inputs (water and energy) and waste production. The study was carried out in establishments operating in French industry over the 2004-2010 period, thus updating and extending Riedinger and Thévenot (2008)[3].

Part 2 describes the context of the environmental certification, provides several theories concerning the motivations for adopting the certification and includes a short review of the literature. Next comes a description of companies that have obtained environmental certification according to their size, their business sector and their environmental impact (part 3). Finally, part 4 covers the actual assessment of the environmental impact coinciding with the certification.

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[1] Eco Management and Audit Scheme.

[2] A socially responsible investment (SRI) is an individual or group investment made according to social, environmental, ethical or corporate governance criteria, without losing sight of financial performance.

[3] Riedinger, N. and Thévenot, C. (2008), "La norme ISO 14001 est-elle efficace ? Une étude économétrique sur l'industrie française" Economie et Statistique, No. 411

1. Environmental regulations and certification: context

1.1. Corporate Social Responsibility – a widely debated and topical notion

In 1970, Milton Friedman asserted in a *New York Times Magazine*[4] article that "the social responsibility of business is to increase its profits". This implies that responsibility for the management of externalities and public property should in no way be incumbent upon companies but rather on governments or even non-governmental organisations. However, the idea that companies also have goals with social or societal implications emerged shortly after the Second World War. The concept of CSR appeared in the 1960s[5] and was then widely debated, both in theory and also in the form of practical measures implemented by governments and organisations. In its 2001 Green Paper on "promoting a European framework for corporate social responsibility", the European Commission defined the notion of CSR as "a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis[6]". This is not only a question of compliance with the regulations and legal obligations in force, but also of going further by more actively promoting the social, environmental and human considerations. The topicality and importance of the concept of CSR were strengthened by the Commission in 2011, with the presentation of its "new strategy 2011-2014 for CSR[7]".

While the implementation of socially responsible measures by companies may be a market-driven strategy (e.g. due to consumers' propensity to pay for more "responsible" products), it also a response to political issues (e.g. consumer boycotts or trade union pressures, influence of public policies and regulations), as the development of CSR practices may improve relationships with society and regulators. In this respect, CSR falls within the context of a rising awareness of the need for sustainable development at the national and international levels. Indeed, the concept of sustainable development, introduced in the Bruntland report in 1987[8], is based on three pillars – economic, social and environmental – with the report emphasising that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". In particular, in a context of climate disruption, the loss of biodiversity and recurrent debates concerning the protection of the environment, environmental performance issues take on particular importance. Ernst and Honoré-Rougé (2012) thus reveal significant differences in the environmental practices of companies which are involved in CSR and the others with no involvement, both in terms of energy efficiency (60% of companies that are aware of CSR and consider that they carry out related actions are involved in an energy improvement or greenhouse gas emission reduction strategy compared to 27% for companies that are not aware of CSR or do not claim to carry out related actions) and in terms of the development of eco-products (43% compared to 23%)[9].

For the environmental dimension of CSR, companies can implement an environmental management system (EMS), which corresponds to the "management methods of an entity seeking to take account of the environmental impact of its activities, assess this impact and reduce it"[10]. An EMS can be certified according to two standards: ISO 14001, derived from the family of ISO standards, and EMAS (*Eco-Management and Audit Scheme*), implemented by the European Union (cf. box).

ISO 14001 is one of the most commonly used standards for environmental management: in 2012, 286,000 ISO 14001 certificates were awarded in 155 countries[11]. In France, the number of ISO 14001 certificates awarded has been constantly rising since 1990, with nearly 8,000 certificates awarded in 2012. EMAS certification remains clearly in the minority in France (4,168 organisations registered at the European level in May 2013). It should be noted that a field of

[4] Friedman, M. (1970), "The Social Responsibility of Business is to Increase its Profits", *The New York Times Magazine*, September 13, 1970.

[5] Howard R. Bowen is generally considered to be the author of the seminal work on the concept of CSR, written in 1953 and entitled *Social Responsibilities of the Businessman* (New York, Harper & Brothers).

[6] Commission of the European Communities, Green Paper on "Promoting a European framework for corporate social responsibility", Brussels, 2001, COM(2001) 366, page 7.

[7] European Commission, "A renewed EU strategy 2011-14 for Corporate Social Responsibility", Brussels, COM(2011) 681.

[8] "Our Common Future", Gro Harlem Brundtland, Report of the United Nations' World Commission on the Environment and Development, 1987

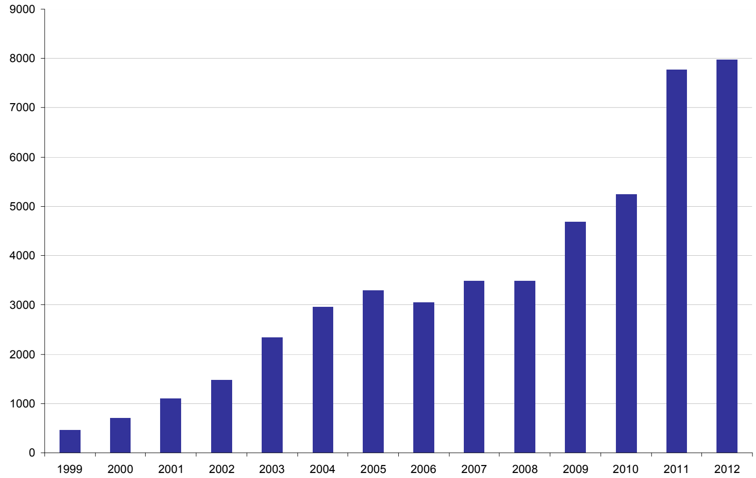
[9] Ernst, E. and Honoré-Rougé, Y. (2012), "La responsabilité sociétale des entreprises : une démarche déjà répandue" (Corporate social responsibility: an already widespread approach) (INSEE Première, No.1421) provide a definition of these three pillars of CSR.

[10] Id.

[11] ISO 2012 study:
http://www.iso.org/iso/fr/home/standards/certification/iso-survey.htm?certificate=ISO%2014001&countrycode=FR#countrypick

application is specified when a certificate is issued, which may cover one or more site(s) within a single company. In the framework of this study, we have thus considered certification at the establishment level.

Figure 1.1: Number of ISO 14001 certificates awarded in France (flows)



Source: ISO 2012 study

EMS and environmental certification

In the framework of corporate social responsibility, many companies are resorting to environmental management. An **environmental management system (EMS)** is defined by organisational practices and methods within a company that are designed to take account of the environmental issues relating to its activities. Different phases lead up to the concrete implementation of an EMS, according to the principle of the continuous improvement of environmental performance, based on the Deming wheel (*Plan*; *Do*; *Check*; *Act*).

Once implemented, an EMS can be certified by different standardisation institutions. The two main environmental certification standards are:

- the **ISO 14001 standard**[12], created in 1996 and revised in 2004, is a generic standard that can be used by any organisation, regardless of its business sector. ISO 14001 – a certificate that remains valid for three years – requires the implementation of a framework involving the identification of the company's environmental impacts and the definition of the environmental objectives to be achieved. It should be noted that ISO 14001 does not provide for a performance guarantee, although a verification system does exist in the form of certification, inspection and renewal audits, which are intended to make sure that the company is indeed taking the steps required to improve its environmental impact;

- the **EMAS (Eco-Management and Audit Scheme)** standard, established by the European Union and operating since 1995. Although the EMS-related requirements are similar (monitoring of the environmental impact of its activities by the company, continuous improvement strategy with a view to achieving environmental objectives, etc.), EMAS requires the entity concerned to conform to the environmental regulations in force and to make its environmental results public. EMAS registration is valid for a period of three years. It should be noted that an ISO 14001-certified company can obtain EMAS registration provided that it complies with the requirements.

For more information:

- ISO website: http://www.iso.org/iso/home/standards/management-standards/iso14000.htm
- EMAS website: http://ec.europa.eu/environment/emas/index_en.htm
- MEDDE website, "CSR" section: http://www.developpement-durable.gouv.fr/Qu-est-ce-que-la-responsabilite.html

[12] ISO – the International Organization for Standardization (non-governmental organisation) – founded in 1947, federates 163 national standardisation institutions and, for its fields of application, issues standards concerning the different components of sustainable development (economic, societal and environmental). The family of ISO 14000 standards, to which the ISO 14001 standard belongs, specifically concerns aspects relating to environmental management.

1.2. Environmental management and certification: for what reasons?

Before analysing the effectiveness – both economic and environmental – of procedures for implementing an EMS and its certification, it is worth examining the reasons for doing so, in the more general context of the development of CSR practices.

Empirical studies (Kitzmueller and Shimshack, 2012) reveal that the implementation of CSR measures by companies conforms to strategic practices whose motivations remain directly or indirectly related to the company's profits, due to its competitiveness, image, relationships with the regulator and stakeholders... Crifo and Forget (2013), who examine the economic justifications behind CSR approaches, thus associate them with market failures (externalities, imperfect competition and incomplete contracts). In the presence of negative externalities generated by certain companies – especially environmental externalities – CSR practices provide a response to regulatory issues (anticipation of strict future regulations in order to reduce their transaction costs or requirements) and social issues (response to pressures exerted by civil society, via non-governmental organisations, for example). CSR also offers a way of implementing product differentiation strategies (e.g. in response to public and consumers' demands for more environmentally friendly products). Finally, CSR practices may embody the responsibilities entrusted to the company director by parties such as shareholders (via socially responsible investment) or employees (via corporate culture). These situations can be compared to the conditions of incomplete contracts in which, as it is impossible for the parties to envisage all possible contractual conditions, particularly with regard to social and environmental issues, one party delegates the responsibility for managing these issues to the other.

There are varied economic justifications for the development of CSR practices on the environmental level.

In line with the Porter hypothesis (cf. box), Ambec and Lanoie (2009) identify the mechanisms through which the implementation of an EMS can combine both environmental and economic performance. An initial reason for this is the differentiation of products, as mentioned above, which responds to a specific consumer demand and constitutes an advantage in relation to competitors' offerings. Technology also comes into consideration: the company may have recourse to new processes which, although they may prove costly in the short term, may lead to higher long-term earnings, e.g. by reducing the consumption of inputs or providing a first-mover advantage (Ambec and Lanoie, 2008). For this reason, companies may be prompted to voluntarily anticipate future standards, or even to demand stricter standards in order to maintain the competitive advantage of their technology, or to sell it to their competitors. It should also be noted that tax provisions may provide an incentive for environmental certification. For example, ISO 14001-certified or EMAS-registered storage and incineration installations may benefit from lower tax rates of the specific tax on waste treatment (*Taxe générale sur les activités polluantes*-TGAP). Finally, the existence of an EMS may indicated a lower financing risk for potential investors in the company and thus facilitate access to capital.

Finally, an additional motivation in favour of environmental certification is signalling. Through the information it provides about the company's environmental performance, its management system and the quality of its products, it allows for the correction of any irregularities in the information transmitted between the company and the other stakeholders (State, consumers and suppliers, etc.). In the case of ISO 14001 certification and EMAS registration, the information is all the more pertinent given the existence of a monitoring process (independent audits). Potoski and Prakash (2005) thus categorise ISO 14001 as one of the standards with relatively few constraints (involving a monitoring system but no public reports or sanctions), which can lead to an improvement in environmental performance. The certification may thus have a signalling effect, allowing companies with the best *ex ante* performance to stand out from the competition while also offering a first mover advantage (Toffel, 2006). The costs associated with adopting the standard could be prohibitive for the least efficient companies but not for those that already have management systems with a more advanced environmental policy.

The Porter hypothesis – links between environmental and economic performance

A long-established and widespread view held by companies – that environmental protection is necessarily associated with higher costs – was challenged by Porter and Van Der Linde (1995). According to what can be referred to as the "Porter hypothesis", the authors assert that improving environmental performance can go hand-in-hand with better economic performance, by boosting innovation and improving competitiveness. Well-defined environmental regulations can thus lead to Pareto-optimal improvements (reduction of costs and protection of the environment without any drop in profits – indeed, they may even rise), whereby the environment and companies are in a "win-win" situation.

A. Jaffe and K. Palmer (1997) identify three "versions" of the Porter hypothesis. In the "minimalist" version, the environmental regulations encourage the implementation of environmental innovations. This "light" version emphasises the fact that sufficiently flexible environmental regulations give companies more of an incentive to innovate than strict regulations (e.g. technology standards, which restrict the choice of technologies and inputs that can be used in the production process). The "strong" version of the Porter hypothesis postulates that correctly specified regulations generate innovations that lead to a reduction in costs which exceeds the expenditure required for upgrading in order to comply with the regulations, resulting in a net profit for companies.

The Porter hypothesis has nevertheless been criticised. One of the limitations put forward resides in the fact that the hypothesis, based on empirical facts, is not sufficiently aligned with the theoretical framework of traditional economics (maximisation of profits by companies). While it cannot necessarily be extended to the entire economy, the Porter hypothesis can nevertheless be used to identify situations that conform to the "win-win" principle, and the innovations generated by environmental research may, at least partially, offset the expenditure associated with upgrading to ensure the company's compliance with the environmental regulations (S. Ambec *et al.*, 2013).References: Jaffe and Palmer (1997), Porter and Van Der Linde (1995), S. Ambec et al. (2013)

1.3. Contrasting results presented by the empirical literature and the potential contributions of this study

Although the environmental certification procedures followed by companies conform to the aforementioned motivations, the empirical literature presents mixed results in terms of the effectiveness of these procedures.

With regard to the validity of Porter hypothesis, Ambec and Lanoie (2008) provide an overview of the empirical literature on the subject, which in many cases mentions that environmental certification or the implementation of an EMS have no significant impact on economic performance. Lanoie et al. (2007) test different versions of Porter hypothesis in seven OECD countries. The "strong" version of the hypothesis is not confirmed: although the environmental regulations give rise to innovations, the economic earnings generated do not compensate for the costs incurred.

Conversely, Ambec and Lanoie (2008) identify certain "win-win" situations and also emphasise that the majority of studies tend to show that improved environmental performance is associated with better financial performance and a lower cost of capital. Furthermore, according to a survey conducted in the Provence-Alpes-Côte d'Azur (PACA) region in 2004[13] (which at the time was home to 5% of the ISO 14001-certified companies in France), 50% of certified companies have a "quite positive" view of the cost-benefit ratio of the EMS on savings of inputs and waste.

Improved corporate performance may also be a result of greater productivity by employees. Delmas and Pekovic (2012) identify a direct relationship between compliance with environmental standards by a company and the productivity of labour, based on an econometric study of French data. By adopting environmental standards, the company sends out a signal that influences its employees' attitude and makes it more attractive. The productivity of labour is further improved as the adoption of environmental standards goes hand-in-hand with the implementation of a specific organisational structure (training of workers, relationships within the company, etc.).

In terms of the impact of certification on the environmental performance of companies, the studies reveal contrasting results. Some of them find that their environmental performance is not improved by ISO 14001 certification (King, Lenox and Terlaak, 2005; Barla, 2007). The evolution of environmental performance also varies according to the sites, with

[13] Survey carried out by the PACA region Chamber of Commerce and Industry (*Chambre de Commerce et d'Industrie*) (2004), "Norme ISO 14001 – État des lieux du management environnemental en région PACA, l'expérience des entreprises" (ISO 14001 standard – Review of the current state of environmental management in the PACA region: review of the experience of companies).

some of them reducing their emissions while others see their emissions rising following certification (Barla, 2007, in a study concerning 37 pulp and paper manufacturing sites in Quebec between 1997 and 2003). Given this absence of a favourable environmental impact, certification could be compared to a "rational myth", according to the concept presented by Meyer and Rowan (1977): companies dissociate the superficial adoption of a certification and environmental standards from the actual implementation of such practices (Boiral, 2007). ISO 14001 could thus appear to be a rational structure that allows certified establishments to increase their institutional legitimacy, while being dissociated from the internal performance-improving practices of the industrial organisation. However, the monitoring and inspection system for the certification could make a significant contribution to improving the environmental performance of the companies concerned[14] (Potoski and Prakash, 2005).

In line with what has already been mentioned with regard to CSR practices, the fact of obtaining certification can provide an opportunity to announce good environmental performance, in the spirit of the Spence model (1973). Companies that obtain certification could find it beneficial to announce information concerning their good environmental results that would otherwise go unnoticed. However, the empirical results do not always confirm this hypothesis, and certain studies reveal that companies with quite poor environmental performance may actually be more likely to obtain certification (King, Lenox and Terlaak, 2005).

In his study of American companies between 1991 and 2003, Toffel (2006) shows that ISO 14001 certification is a good indicator of the environmental performance of companies, while distinguishing between a "selection effect" and a "treatment effect". The former corresponds to the fact that certification has a greater impact on companies with less intense pollution in terms of toxic emissions and the latter reflects the fact that holders of the standard make greater improvements to their environmental performance (whether it be the volume of toxic emissions, the level of health risk on the industrial site or the intensity of these two dimensions in relation to production). This distinction between the selection and treatment effects has an impact on the choices made by the regulator, the consumer and partners of the company. For a selection effect, there is no need to allow a particularly long period for a certified establishment to achieve a good standard of environmental performance. For a treatment effect, it would seem more appropriate to allow more time for learning and adaptation, which means that the environmental improvement may take a little longer to occur. ISO 14001 certification may also create a knock-on effect and contribute to the implementation of "greener" production lines, with certified companies tending to be more likely to monitor the environmental performance of their suppliers and require them to implement specific environmental practices (Arimura *et al*, 2011).

The effectiveness of ISO 14001 or EMAS certification within French industry is also highlighted by Riedinger and Thévenot (2008) in an econometric study of French industry over the 2001-2005 period. The aim was to assess whether ISO 14001 or EMAS certification can be used to identify companies with management practices that effectively take account of environmental issues. The authors concluded that certified establishments tend to reduce their environmental impacts and production costs (e.g. reduction in water abstractions and carbon dioxide emissions).

In some respects, this study follows Riedinger and Thévenot (2008). It sets out to examine – still for French industry but over a longer and more recent period (2004-2010) – the extent to which ISO 14001 or EMAS certifications can provide information about the effectiveness of the environmental policies of the companies concerned and the evolution of their environmental pressures. It should be noted that it is not a question of directly attributing the observed reduction of environmental pressures to the certification, insofar as such a change could be the result of a broader environmental policy, for example.

In this context, the study initially characterises French industrial establishments that obtained certification between 2004 and 2010 under the ISO 14001 or EMAS standard. It then identifies whether or not, concurrently with obtaining certification, the companies actually reduce their environmental pressures. Having access to panel data over a sufficiently long period makes it possible to test the hypothesis of an immediate and long-term reduction of environmental pressures within certified establishments. The data used finally allows for the testing of hypotheses of disparity in terms of environmental pressures, by making distinctions in terms of time or according to the size of establishments, for example.

[14] Conversely, self-regulation programmes that are intended to promote a continuous improvement in the fields of health, safety and the environment but are not accompanied by any sanctions, are not necessarily able to avoid problems of opportunism and do not lead to better performance in companies. This applies to the "*Responsible Care*" programme concerning the American chemical industries, which does not lead to an improvement in the environmental performance of companies (King and Lenox, 2000).

2. ISO 14001 and EMAS certifications: how have they evolved? Which establishments hold certification?

The study focuses on French industrial establishments (more specifically: companies with over 20 employees in sectors 07 to 35 of NAF ver. 2 – the standard French industrial classification in force in France since 1 January 2008), between 2004 and 2010[15].

Presentation of databases
The data used relate to establishments: according to the INSEE (National Institute of Statistics and Economic Studies) definition, an establishment corresponds to a "production unit that is geographically individualised but legally dependent on the company". This is a relevant unit of observation because investments are made at this level. For information concerning agri-food industries, the majority of the data originate from surveys carried out by INSEE in conjunction with French Ministry of Agriculture's Statistics and Forward Planning Department (*Service de la statistique et de la prospective*). These surveys concern establishments in the manufacturing sector, i.e. sectors 07 to 35 of NAF ver. 2 codes. As NAF standards were revised in 2008, this change of standard may make it difficult to conduct a sector-specific study of the impact of certification. Certification-related data were obtained from the survey of environmental protection investments in the industry ("**Antipol**" survey)[16], conducted between 2004 and 2010. This survey concerns approximately 12,000 industrial establishments. It should be noted that a modification was made to the survey in 2005, with regard to the methodology and scope of the survey: until 2005, establishments with more than 100 employees were questioned exhaustively (with a lower threshold for certain activities - particularly the most polluting). For establishments with fewer than 100 employees, only those producing the most pollution were questioned. From 2006, the survey was extended to establishments of 20 employees or more. While small establishments are now covered, the threshold of comprehensiveness is higher. Whereas establishments with over 250 employees (lower threshold for highly polluting sectors) are comprehensively surveyed, the others are surveyed by sampling (over 80% of the establishments questioned responded). Before 2005, for example, it was impossible to obtain a good representation of the proportion of certified establishments for establishments with fewer than 100 employees throughout all of the sectors covered (regardless of the size). The data relating to energy consumption and CO_2 emissions were obtained by investigating the energy consumption in the industry ("**EACEI**" survey) between 2005 and 2010. The survey includes all industrial establishments with at least 20 employees in the most energy-intensive sectors, or 10 employees in the industrial gas production sector. Establishments with more than 250 employees are comprehensively surveyed, while the others are surveyed by sampling in the least energy-intensive sectors. Data concerning the production of waste by establishments originate from the ***Enquête sur la production de déchets non dangereux par les établissements industriels* (Survey of the production of non-hazardous waste by industrial establishments)** for 2006 and 2008. The waste in question (all considered to be "non-hazardous" in this survey) includes sludge waste and organic waste of animal or other origin, mixed waste (unsorted or residual) and non-mixed waste (food waste, waste equipment, etc.). The survey is comprehensive for establishments with over 100 employees (it is carried out by sampling for establishments with 20 to 99 employees) and covers approximately 10,500 establishments in total. The size of the establishment in terms of the workforce, used in order to estimate its economic activity, was obtained from the **CLAP** (*Connaissance Locale de l'Appareil Productif* [Local knowledge of production facilities]) source, determined by INSEE, which is drawn from a variety of administrative sources. The data concerning the workforce cover the 2004 to 2010 period. They correspond to the workforce on 31 December (the workforce in terms of work stations would have been more accurate but this data was not available in the CLAP database before 2007). With regard to water abstractions and emissions of pollutants into the air, water and soil, the data originate from the **annual declaration of pollutant emissions and waste (*déclaration annuelle des émissions polluantes et des déchets* (GEREP)**. The French Order of 31 January 2008[1] sets the thresholds beyond which a declaration is mandatory, according to the pressures in question (threshold of 10,000 tonnes per year for CO_2, and 50,000 m^3 per year for abstractions of water, etc.). The data for this study which extends to 2010, are concerned by this Order (levels of pressure below the threshold are not entered into the database). It should be noted that this Order was amended by the Order of 26 December 2012, leading to the modification of certain declaration thresholds and the introduction of new substances to be declared. The data are gathered by the French Ministry for Ecology, Sustainable Development and Energy and concern classified installations ("industrial facility or agricultural holding likely to create risks or cause pollution or environmental nuisances"[2]). As practically all industrial facilities are "classified" this does not pose any problems in the framework of our study. [1] http://www.legifrance.gouv.fr/affichTexte.do;jsessionid=59E99F51E94AF26A51A833234FAD20C6.tpdjo14v_2?cidTexte=JORFTEXT000018276495&categorieLien=id [2] http://www.installationsclassees.developpement-durable.gouv.fr/-Installation-classee-.html

[15] The entry "n.d" is used in tables when there is insufficient confidence in the result due to a lack of data (fewer than 15 data items).

[16] The variable used is 1 if the establishment surveyed is ISO 14001 or EMAS-certified. With regard to the time of certification, the variable is zero for the first year of certification, followed by 1 for the second year and so on (after three years of certification, the time since certification is equal to 2).

Variables used

Water abstractions: the variable used is derived from the GEREP database and concerns volumes abstracted from groundwater, surface water, distribution networks and the sea/ocean. The threshold for the declaration of water abstractions is 50,000 m^3 per year.

Energy consumption: this refers to consumption for energy purposes, calculated on the basis of the EACEI survey. The energy consumed originates from gas, oil or coal. The consumption of energy originating from wood, electricity generation, black liquor (paper production), steam and special fuels is not included in the variable. The energies used for calculating the variable are given in Appendix 1.

CO_2 emissions: the variable was calculated on the basis of the energy consumption data derived from the EACEI survey. It does not take account of the emissions associated with chemical reactions from industrial processes. The calculation takes account of a conversion factor for energy into CO_2, attributed to each type of energy consumed (cf. appendix 1). The variable takes account of energy from oil, gas and coal. Black liquor, electricity, wood and special fuels are excluded from the variable, due to measurement difficulties or because these types of energy do not improve the explanatory quality of the variable. An alternative solution would have involved using data from the GEREP database, based on the companies' declarations of emissions. However, errors in the measurement and estimation of emissions are likely to be found (e.g. depending on whether or not the establishment making the declaration of emissions possesses an appropriate measurement device). Moreover, the variable calculated on the basis of data derived from the GEREP database seemed to contain a significant number of atypical data. Finally, data from the EACEI survey offer the advantage of being more numerous.

Waste production: the variable used only includes data for the years 2006 and 2008. Recovered waste consists of waste that is sent to centres for the recovery of materials or energy, or to sorting centres. All types of waste are considered, except for sludge and organic waste.

Atmospheric pollution: a global atmospheric pollution variable is calculated by aggregating the total amounts of the General Tax on Polluting Activities (*Taxe générale sur les activités polluantes* - TGAP) for atmospheric pollutants (known as "TGAP air") calculated on the basis of the applicable rates in 2013 and for the following substances: SOx (sulphur oxides), NOx (nitrogen oxides), NMVOC (non-methane volatile organic compounds) and TSP (total suspended particulate). This variable thus represents the cost of pollution for companies, as imposed by society:

$$\text{"atmospheric pollution"} = (136.02 \times SOx + 160.8 \times NOx + 136.02 \times NMVOC + 259.86 \times TSP)$$

where SOx, NOx, NMVOC and TSP designate the quantities of emissions of the pollutants in question (GEREP database) and where the numerical values correspond to the TGAP rates for 2013 applied to each pollutant. The variable thus corresponds to the costs expressed in euros. It should be noted that the emission thresholds to which the TGAP air tax applies differ from the declaration thresholds for the GEREP database. Furthermore, atmospheric pollution includes other components that have not been considered in this study as they are less numerous and for which there is a limited number of data. Although the variable does not exactly correspond to the TGAP, it does, however, allow for the aggregation of a sufficient number of data to investigate the effect of certification on atmospheric pollution. Table below shows the composition of the aggregated variable for the study of atmospheric pollution.

Table: Composition of the variable relating to atmospheric pollution, for the year 2010

	Total quantity, in kt	Percentage of the "atmospheric pollution" variable
Sulphur oxides (SOx)	122	32.2%
Nitrogen oxides (NOx)	129	40.2%
Total suspended particulate (TSP)	12	6.1%
Non-methane volatile organic compounds (NMVOC)	81	21.4%

Interpretation: in 2010, the total quantity of SOx produced by approximately 950 establishments was 122 kilotonnes, which represents 32% of the "air" variable aggregating the different types of atmospheric pollution.

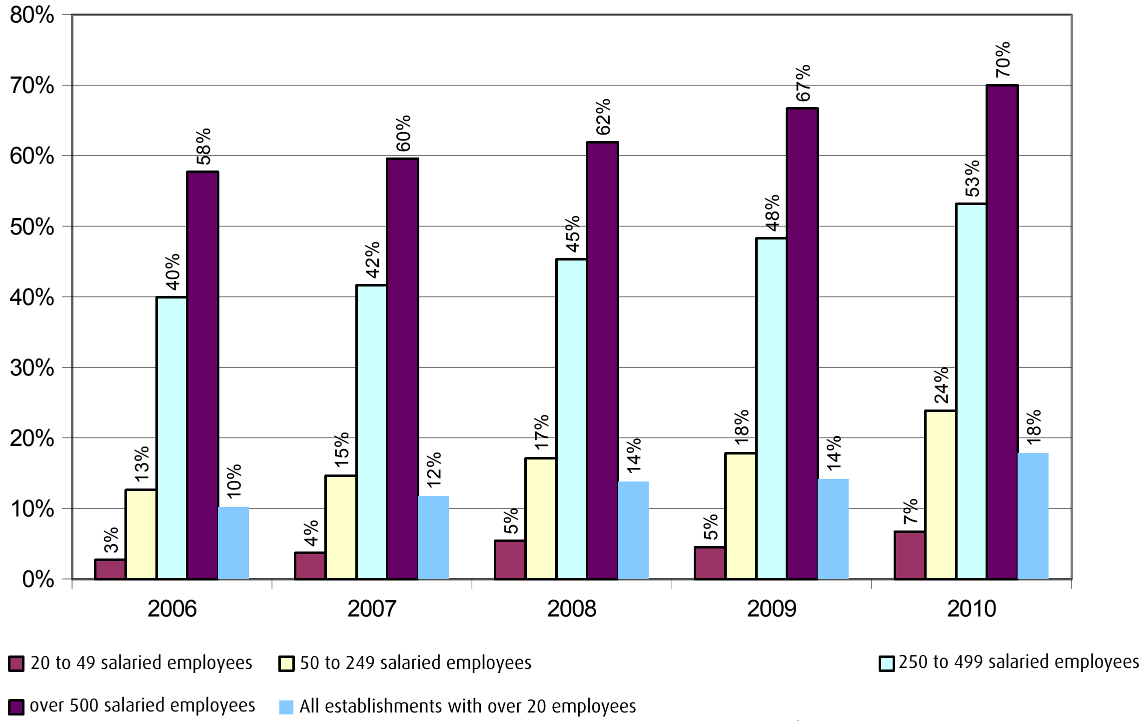
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.

Sources: Antipol, CLAP, EACEI and the authors' calculations.

2.1 An increasing number of French industrial establishments are being certified

Between 2006 and 2010, the proportion of certified establishments within the observed sample increased: by 10% in 2006 to 18% in 2010 (figure 3.1). Primarily, establishments of 250 employees and more are obtaining certification, but there is also a sharp rise in establishments with 50 to 249 employees (for which the proportion of certified establishments doubled between 2006 and 2010, increasing from 13 to 24%), in addition to establishments with 20 to 49 employees (from 3% to 7%). The interpretations of this phenomenon echo the economic justifications mentioned previously in relation to the development of CSR practices: growing awareness of environmental issues, increasing pressure from public authorities and society in general, the desire to project an environmentally friendly image in response to a demand for greener products, and the aim of developing an economic advantage in terms of the consumption of inputs or the management of waste and pollution in a context of increasingly expensive resources.

Figure 2.1: Proportion of ISO 14001 or EMAS-certified establishments between 2006 and 2010



Interpretation: In 2006, 10 % of establishments with 20 employees or more was ISO 14001 or EMAS certified.
Scope: French industrial establishments.
Sources: Antipol, CLAP and authors' calculations.

2.2 The highest proportion of certified establishments is found in the energy sector, while the agri-food industries are at the opposite end of the spectrum.

Establishments in the energy sector (sector 35) have a greater propensity to obtain certification, regardless of their size (table 2.1). Next come the automotive industry, the chemical and pharmaceutical industry followed by the electrical and electronic component sector. Conversely, certain sectors have a significantly lower proportion of certified establishments (e.g. agri-food industries). These sectoral distinctions reflect the fact that belonging to a particular sector may be a determining factor in whether or not an establishment is certified, beyond the environmental performance of the establishments concerned.

Regardless of the sector, the proportion of certified establishments within the sector increases with the size of the establishments. More than half of all establishments with 250 employees or more are certified in the vast majority of business sectors (100% in the energy sector).

Table 2.1: Percentage of certified establishments, according to the business sector and size of the establishment, for the year 2010

Sector	Number of observations	20 to 49 salaried employees	50 to 249 salaried employees	250 to 499 salaried employees	Over 500 salaried employees	All establishments with over 20 employees
35 Water, electricity and gas	213	44%	85%	89%	100%	73%
29-30 Automotive industry and other transport equipment	395	1%	32%	77%	89%	36%
19-21 Chemical industry, pharmaceuticals, coking and refining	885	16%	33%	53%	50%	30%
26-28 Information technology, electrical and electronic products	789	4%	29%	68%	79%	23%
22 Rubber and plastic	718	6%	24%	58%	92%	19%
23 Manufacture of mineral non-metal products	621	7%	30%	60%	43%	19%
13-15 Textiles, clothing, leather	262	19%	15%	14%	12%	17%
24-25 Metallurgy and metal products	1,583	6%	27%	61%	86%	16%
16-18 Wood and paper, printing	926	6%	14%	52%	49%	11%
10-11 Agri-food industries	1,708	4%	13%	26%	33%	10%
31-33 Manufacture, repair/installation of machines and equipment	370	1%	15%	47%	50%	7%

Interpretation: in 2010, 4% of agri-food industrial establishments with 20 to 49 employees were certified. Scope: French industrial establishments. Source: Antipol, CLAP and authors' calculations. Sectors defined on the basis of the NAF ver. 2 classification in force in France since 2008.

2.3 The biggest consumers of inputs are increasingly obtaining certification

For a given number of employees, the trend is for major consumers of inputs (water and energy) to increasingly obtain certification, which suggests that they are taking greater responsibility for environmental issues when they are significant. It should also be noted that for a given level of consumption of inputs, the propensity to obtain certification increases with the size of the establishment: this point seems to show that the size of the establishment is a key factor in obtaining certification, which concurs with the observations made above.

Table 2.2: Percentage of certified establishments, according to the volume of water abstracted and the size of the establishment, for the year 2010

Abstractions of water (m^3/year)	number of observations	20 to 49 salaried employees	50 to 249 salaried employees	250 to 499 salaried employees	Over 500 salaried employees
Less than 50,000 m^3	8,049	6%	22%	52%	71%
50,000 to 150,000 m^3	497	23%	32%	48%	74%
150,000 to 500,000 m^3	428	47%	30%	49%	56%
Over 500,000 m^3	411	n.d	48%	66%	76%

Interpretation: in 2010, 23% of all establishments with 20 to 249 employees, that consume between 50,000 and 150,000 m³ of water per year, were certified to ISO 14001 or EMAS standard.
NB. The "less than 50,000 m³ per year" category includes establishments that did consume water but in a volume of less than 50,000 m³, in addition to establishments that declared no consumption.
Source: Antipol, CLAP, GEREP and authors' calculations.

Table 2.3: Proportion of certified establishments, according to the amount of energy consumed (estimated in tonnes of oil equivalent, for gas, oil and coal) for the year 2010

Energy consumption (toe/year)	number of observations	20 to 49 salaried employees	50 to 249 salaried employees	250 to 499 salaried employees	Over 500 salaried employees
Less than 80 toe	2,455	5%	15%	44%	69%
Between 90 and 200 toe	1,226	10%	26%	62%	60%
Between 200 and 400 toe	1,031	23%	32%	60%	80%
Over 450 toe	1,280	21%	43%	63%	75%

Interpretation: in 2010, 10% of all establishments with 20 to 249 employees, that consumed between 90 and 200 toe per year, were certified.
Source: Antipol, CLAP, GEREP and authors' calculations.

2.4 An increasing proportion of establishments are certified in line with their level of pollution

We shall now consider the environmental pressures exerted by CO_2 emissions, waste production and atmospheric pollutant emissions[17].

2.4.1 CO_2 emissions

As a reminder, the manufacturing industry accounted for 23% of total CO_2 emissions in metropolitan France in 2010, compared to 32% for the road transport sector, 24% for the residential/tertiary sector and 16% for energy conversion

[17] The term "pollution" is misused in this case, as CO2 constitutes a pressure in terms of climate change.

(SECTEN Report by CITEPA[18]). As observed for the consumption of inputs, the proportion of certified establishments increases with the volumes of CO_2 emitted, including for establishments of comparable size.

Table 2.4: Percentage of certified establishments, according to the CO2 emissions associated with energy consumption (in tonnes of CO2/year) and the size of the establishment, for the year 2010

CO2 emissions (tCO2/an)	number of observations	20 to 49 salaried employees	50 to 249 salaried employees	250 to 499 salaried employees	Over 500 salaried employees
Less than 90 t	1,948	5%	13%	44%	69%
Between 90 and 300 t	1,202	8%	24%	56%	74%
Between 300 and 1000 t	1,215	20%	32%	61%	72%
Over 1000 t	1,627	20%	39%	62%	76%

Interpretation: In 2010, 8% of all establishments with 20 to 49 employees, which emit between 90 and 300 tonnes of CO_2 due to energy consumption, were certified. Source: Antipol, CLAP, GEREP and authors' calculations.

2.4.2 Waste production

For a given salaried workforce, the proportion of certified establishments does not increase in line with the volume of waste produced (table 2.5) or recovered, i.e. that is used as an alternative to other products (2.6). However, at this stage of the analysis, this information is not sufficient to conclude that there is no link between certification and a reduction of waste products.

Table 2.5: Percentage of certified establishments, according to the quantity of waste produced and the size of the establishment, for the year 2008

Waste production (tonnes per year)	number of observations	20 to 49 salaried employees	50 to 249 salaried employees	250 to 499 salaried employees	Over 500 salaried employees
Less than 100 t	1,611	5%	16%	51%	86%
Between 100 and 250 t	1,311	3%	17%	42%	69%
Between 250 and 500 t	1,139	7%	22%	50%	59%

Interpretation: Interpretation: in 2010, 3% of all establishments with 20 to 49 employees, that produced between 100 and 250 tonnes of waste per year, were certified.
Source: Antipol, CLAP, GEREP and authors' calculations.

[18]CITEPA, Inventory of atmospheric pollutants and greenhouse gas emissions in France, SECTEN Report, April 2012: http://www.citepa.org/images/III-1_Rapports_Inventaires/secten_avril2012-indb_sec.pdf

Table 2.6: Percentage of certified establishments, according to the quantity of waste recovered and the size of the establishment, for the year 2008

Recovered waste production (tonnes per year)	number of observations	20 to 49 salaried employees	50 to 249 salaried employees	250 to 499 salaried employees	Over 500 salaried employees
Less than 50 t	1,203	5%	13%	39%	25%
Between 50 and 180 t	1,680	4%	22%	39%	65%
Between 180 and 600 t	1,715	7%	21%	51%	61%
Over 600 t	1,807	4%	22%	45%	65%

Interpretation: Interpretation: in 2010, 4% of all establishments with 20 to 49 employees, that produced between 50 and 180 tonnes of recovered waste per year, were certified.
Source: Antipol, CLAP, Survey of the production of non-hazardous waste by industrial establishments and authors' calculations.

2.4.3 Certification and atmospheric pollution

According to the SECTEN Report by CITEPA, the energy conversion sector is the biggest contributor to SOx emissions (51% of emissions in metropolitan France in 2010, while emitting 8% of total NOx emissions during the same year and 5% of NMVOC emissions). The rest of the emissions originate from the manufacturing industry, the residential/tertiary sector, agriculture and transport. An analysis of the sample reveals that within industry, the proportion of certified establishments increases in line with the level of atmospheric pollution (table 2.7).

Table 2.7: Percentage of certified establishments, according to the global atmospheric pollution and the size of the establishment, for the year 2010

Global atmospheric pollution	number of observations	20 to 49 salaried employees	50 to 249 salaried employees	250 to 499 salaried employees	Over 500 salaried employees
1. Under €4,000	8,854	7%	23%	51%	67%
2. Between €4,000 and €15,000	223	18%	37%	55%	86%
3. Between €15,000 and €50,000	153	n.d	37%	59%	82%
4. Over €50,000	155	n.d	72%	83%	67%

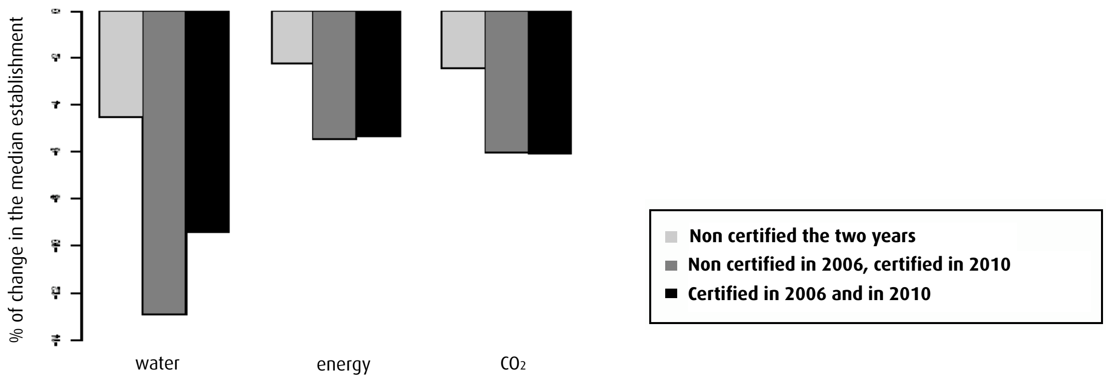
Interpretation: Interpretation: in 2010, 18% of all establishments with 20 to 49 employees, whose global atmospheric pollution amounted to between €4,000 and €15,000 of TGAP (General Tax on Polluting Activities) per year, were certified. The definition of global atmospheric pollution is given in the "Variables used" box.
Source: Antipol, CLAP, EACEI and authors' calculations.

In summary, it is apparent that for the majority of environmental pressures, the greater the rise in pressure, the higher the number of certified French industrial establishments. Furthermore, at a given level of pressure, the proportion of certified establishments increases with the size of the establishments. Consequently, more than half of establishments with 250 salaried employees and more are certified. With regard to major establishments, around 70% or more of them hold at least one of the ISO 14001 or EMAS standards, regardless of their levels of consumption/pollution. Furthermore, for major companies with over 500 employees, the propensity to obtain certification does not appear to depend solely on the level of pressure and may be determined by other factors (e.g. their desire to use as a public relations tool).

3. Establishments that hold an ISO 14001 or EMAS certification improve their environmental performance

Before presenting the economic analysis, it is worth observing the evolution of the environmental pressures exerted by the establishments according to whether or not they are certified (graphs 3.1 and 3.2). In this preliminary analysis, we present the median rather than the mean rate of change, in order to obtain more reliable results at the extreme values.

Graph 3.1: Changes in water abstractions, energy consumption and CO_2 emissions between 2006 and 2010

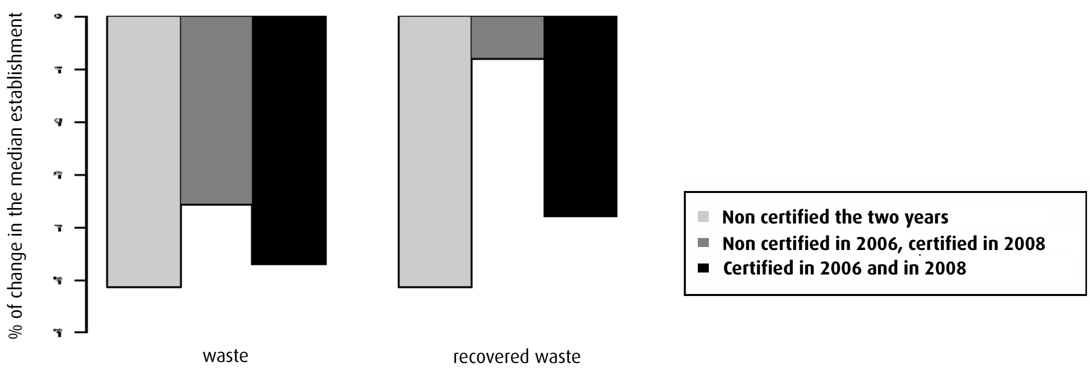


Interpretation: Between 2006 and 2010, abstractions of water decreased by approximately 4% in the median non-certified establishment, compared to a drop of nearly 13% for the median establishment that was not certified in 2006 but certified in 2010.
Sources: Antipol, CLAP, EACEI, GEREP and authors' calculations.

Water abstractions, energy consumption and CO_2 emissions drop more sharply for establishments that are certified or obtain certification during the period in question than for non-certified establishments (graph 3.1). Such results support the notion that establishments make an effort to reduce their environmental pressures both when they obtain certification and after obtaining it.

The opposite applies to waste production (graph 3.2): the median establishment that obtains certification achieves a smaller reduction than the median non-certified establishment. However, the proportion of recovered waste becomes greater in establishments that obtain certification over the period.

Graph 3.2: Changes in the production and recovery of waste between 2006 and 2008



Interpretation: Between 2006 and 2008, waste production decreased by over 5% in the median non-certified establishment, compared to a drop of nearly 3.5% for the median establishment that was not certified in 2006 but certified in 2008.
Sources: Antipol, CLAP, EACEI, GEREP and authors' calculations.

The results of these comparisons need to be put into perspective insofar as there is no monitoring of establishments according to the level of activity over this period. However, economic activity is potentially linked to both environmental pressures and certification. For example, due its cost, certification may coincide with periods of good economic health and strong growth in business. In this case, the small reduction in waste observed in the year of certification could be due to additional business. In fact, amongst establishments for which waste-related data is available in 2006 and 2008, bigger reductions in the workforce are recorded for non-certified establishments than for companies that obtain certification over this period (difference of 1 point between the median rates of increase).

While this quick comparison gives the impression of a reduction of certain environmental pressures coinciding with the acquisition of certification, the use of an econometric model can give a deeper insight into such a hypothesis by taking account of factors such as the evolution of the production level (along with changes in the workforce).

3.1 A drop in the different environmental pressures coinciding with certification

3.1.1 Method of assessing the evolution of environmental pressures

The use of panel data allows for the measurement of the evolution of environmental pressures according to ISO 14001 or EMAS certification, with all other factors remaining equal. Each establishment exerts its own specific environmental pressure and it is not possible to observe all of the characteristics that explain the differences. The availability of panel data allows for the monitoring of the disparities between companies via an individual effect[19].

A temporal effect can also be observed: indeed, a drop in the consumption of water and energy can be observed during the period in question, along with a decrease in pollution. Whether they are a consequence of the economic crisis, the rising costs of inputs or other factors, some of these reductions are not directly linked to the environmental certification. The panel econometrics also help to take account of this temporal effect, via the presence of temporal indicator variables.

Finally, the economic activity of the establishments is examined in relation to their workforce, to take account of its influence on the consumption of inputs and the pollution emitted by the establishments.

The following estimated model is thus used:

$$\log(P_{it}) = \gamma \log(workforce_{it}) + \beta\ certif_{it} + \eta\ tps.certif_{it} + \alpha_i + \delta_t + u_{it},$$

where: $\log(P_{it})$ corresponds to the logarithm[20] of the environmental pressure in question; $\log(workforce)_{it}$ represents the workforce employed on 31 December.

$certif_{it}$ is an indicator of the fact of being ISO 14001 or EMAS-certified (if the data is not entered in the survey, the company is considered to be non-certified).

$tps.certif_{it}$ corresponds to the number of years during which the establishment has been certified after the year of certification. For example, for an establishment certified in 2005: certif=1 and tps.certif=0 in 2005, certif=1 and tps_certif=1 in 2006, certif=1 and tps.certif=2 in 2007;

α_i shows the individual effect relating to each establishment;

δ_t represents the temporal effect;

u_{it} corresponds to the error term.

γ is the elasticity for the workforce employed (if the workforce increases by 1%, the level of environmental pressure in question varies by γ%). A snapshot of the pressures in the year of certification is given by the parameter β (e.g. "the fact of obtaining certification is accompanied by a drop of β% in water consumption", with a negative β and P_{it} corresponding to the abstractions of water). η shows the continuous evolution of pressures in the years following certification (additional reduction of η% per year). It is initially supposed that the changes in environmental pressures are

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19 Tests were carried out to identify the presence of individual effects. In particular, Fisher's tests were carried out on the data used for the study.

20 The use of the logarithm function allows for the interpretation of coefficients as percentages.

homogeneous between establishments. The disparities between them will then be explored by applying the model to sub-populations or by allowing the β parameter to vary between sub-populations.

The estimation of such a panel model is usually carried out by a "within"-type estimator (the transformation centres the data on zero for each company and thus eliminates the individual effect). Nevertheless, this indicator is sensitive to singular values. Whereas the majority of observations follow a given distribution, singular points behave differently and pose problems for estimating the β coefficient (instability of the results and loss of accuracy). For our panel of data, different hypotheses may explain the presence of singularities:

- industrial reasons: e.g. the establishments may be driven to carry out reorganisations (sudden change in the workforce without a significant change in industrial production). According to the economic situation, establishments may wish to retain a larger workforce than required and reduce their production (and as a consequence, the environmental pressures exerted) without a significant variation in the workforce;
- measurement errors: the companies do not necessarily possess very accurate devices for measuring their environmental pressures.

The chosen estimation method must therefore limit the influence of these singular points. To this end, we used an estimator that is resistant to singular values (see box), known as the "WMS" (Within MS Estimator), as described by Bramati and Croux (2007).

Robust version of a within estimator: "WMS Estimator", Bramati and Croux (2007)

The estimator used for this study corresponds to the "WMS" type of estimator, as described by Bramati and Croux (2007). This is a robust version of the "within" estimator used in fixed-effect models. It combines two robust estimation principles: the M-estimator for fixed effects and the S-estimator for the other parameters.

The method applies to models of the type $y_{it} = \alpha_i + x_{it}\beta + r_{it}$ where α_i represents a fixed effect to be estimated. The residual is noted as $r_{it}(\alpha,\beta) = y_{it} - \alpha_i - x_{it}\beta$ according to α and β.

A robust regression by M-estimation is based on minimising the sum of the residuals transformed in the following form:

$$\left(\hat{\alpha}_M, \hat{\beta}_M\right) = argmin_{\alpha,\beta} \sum \rho\left(\frac{r_{it}(\alpha,\beta)}{\sigma}\right)$$

where ρ is a symmetrical, positive and nil function at 0 and σ is a scale factor. When $\rho(r) = r^2$ and $\sigma = 1$, the ordinary least squares estimation method is used (non-robust). When ρ is the absolute value function and $\sigma = 2$, the estimation is a quantile regression at the median value. In general, to obtain a robust estimation at the extreme values, we retain a function ρ which increases slowly when the residuals become large, in order to limit the influence of extreme values.

For fixed β, we can estimate α by M-estimation. The choice of the absolute value for the ρ function leads directly to the following formula:

$$\hat{\alpha}_{iM}(\beta) = med_i(y_{it} - x_{it}\beta) \qquad (1)$$

This formula is similar to that used to eliminate fixed effects in the traditional within procedure, except that the mean is replaced by the median.

M-estimation is not very robust at the extreme values of the explanatory variables ("leverage" points). That is why Maronna and Yohai (2000) recommend limiting its use to categorical dependent variables. Instead, for estimating parameters associated with continuous variables, they recommend a robust S-estimation method.

In S-estimation, the sum of the transformed residuals is constrained in the following form:

$$\sum \rho\left(\frac{r_{it}(\alpha,\beta)}{\sigma}\right) = E(\rho(\varepsilon)) \text{ where } \varepsilon \sim N(0,1)$$

In other terms, the dispersion of the transformed residuals is equal to that of a normal distribution. It is the scaling factor that balances the constraint, which defines a function $S\,(r_{it}\,(\alpha\,,\beta))$. The S-estimator for the parameters is obtained by minimising the scaling factor, which allows us to obtain the constraint:

$$\left(\hat{\alpha}_S\,,\hat{\beta}_S\right)= argmin_{\alpha,\beta} S\left(r_{\mathrm{it}}\left(\alpha,\beta\right)\right)$$

This estimator is much more complex to implement than the M-estimator, which is why fixed effects are not estimated in this manner. The WMS estimator is finally characterised by the following formula:

$$\hat{\beta}_{WMS} = argmin_{\beta} S\left(r_{\mathrm{it}}\left(\alpha_M\,(\beta),\beta\right)\right) \qquad (2)$$

Bramati and Croux use the results obtained by Maronna and Yohai (2000) to show that this estimator is asymptotically normal and give the formula its asymptotic variance. The ρ function adopted for the S-estimation is a Tukey's "biweight" function, which we shall configure in order to authorise a 20% proportion of outliers.

Bramati and Croux propose an estimation algorithm inspired by the Maronna and Yohai method. The β parameter is initialised on the basis of several sub-samples of data, and then the algorithm uses the complete sample to re-estimate α and β in an alternative manner.

For the initialisation phase, Bramati and Croux suggest the random generation of 500 sub-samples, indexed by I, and each comprising as many data as there are parameters to estimate. As no approximate value for β is available, we cannot use the formula (1) to estimate the fixed effects α. In each of these sub-samples, the data are recentred in relation to the median ($\tilde{y}_{it} = y_{it} - median_i\,(y_{it})$ and and the same formula for x_{it}), and a parameter β_I is estimated by the ordinary least squares method for these transformed data. The β_0 value retained for the initialisation of the iterative algorithm is the β_I estimation which minimises the scaling factor over the entire sample.

For the iteration phase, the individual effects are estimated by the formula (1) using the last estimate of β, and then the β parameter is re-estimated with this new α value. 20 iterations are performed. The final estimator is that which corresponds to the lowest value for the scaling factor.

For this study, we needed to adapt the algorithm initialisation phase in order to integrate qualitative explanatory variables (temporal indicators δ_t). The number of observations recommended by Bramati and Croux for the sub-samples led to numerous cases in which β_I could not be identified. That is why the number of observations in the sub-samples was increased to 20% of the data. However, to maintain sufficient variability of the β_I, the number of samples drawn was increased from 500 to 1000. In practice, our results have proven to be relatively insensitive to the size and number of sub-samples.

Bramati and Croux show that the WMS estimator possesses good breaking point properties (the fraction of singular points that the estimator can tolerate without significantly deviating from the true value of the parameters). Using it allows us to resolve the problem of singular points while retaining individual and temporal fixed effects in the model. In practice, for our data, the WMS estimator gives results that are similar to those produced by a traditional within estimation, but the accuracy is improved.

3.1.2 A significant decrease in water abstractions, energy consumption and CO_2 emissions in the year of certification and during the following years

Environmental certification promotes a principle of "continuous improvement" of the environmental impact of companies. We thus expect to observe a reduction of environmental pressures, not only at the moment of certification.

In our model, while the β parameter shows the instantaneous evolution of environmental pressures in the year of certification, η shows the continuous effect in terms of the evolution of environmental pressures during the years following the certification.

The model is estimated for the 2004 to 2010 period for water, and 2005 to 2010 for CO_2 emissions and energy consumption. The results show that the fact of being ISO 14001 or EMAS-certified is accompanied by a significant drop of

2% in water abstractions in the year of certification, and a reduction of approximately 4% [21] in CO_2 emissions and energy consumption (table 3.1).

A continuous decrease in pressures can also be observed: the certified establishments continue to reduce their water abstractions during the years following certification, at a rate of approximately 1.2% per year (compared to a non-certified establishment). There is a reduction of nearly 2% per year in carbon dioxide emissions and energy consumption in the years following certification.

These results support the principle of the "continuous improvement" of the environmental impact of companies promoted by the certification. Moreover, the ISO 14001 and EMAS standards seem to be good indicators for identifying companies that actually manage to reduce their environmental pressures, compared to the rest of industry.

These results are in line with the general underlying trend of diminishing water and energy consumptions between 2005 and 2009 (on aggregate, -6.5% and -0.2% respectively over this period), although there was a sudden rise in energy consumption in 2008. There was another strong rise in energy consumption in 2010 (+10%), with water consumption also rising but to a lesser extent (+2%).

Table 3.1: Evolution of environmental pressures according to certification

	Water abstractions	CO_2 emissions associated with energy consumption	Energy consumption
log(workforce): γ	+0.322*** (0.00085)	+0.1825*** (0.0005)	+0.1776*** (0.00050)
Evolution of pressures following ISO 14001 or EMAS certification: β	-0.023*** (0.00406)	-0.0416*** (0.0030)	-0.0379*** (0.00294)
Continuous evolution of pressures in the years following certification: η	-0.012*** (0.00102)	-0.0190*** (0.0007)	-0.0186*** (0.00069)
2005: δ_{2005}	-0.011° (0.00604)	-	-
2006: δ_{2006}	-0.013*** (0.00546)	-0.0196*** (0.0031)	-0.0191*** (0.00311)
2007: δ_{2007}	-0.027*** (0.00525)	-0.0596*** (0.0031)	-0.0587*** (0.00307)
2008: δ_{2008}	-0.040*** (0.00540)	-0.0330*** (0.0030)	-0.0321*** (0.00299)
2009: δ_{2009}	-0.076*** (0.00579)	-0.1046*** (0.0034)	-0.1024*** (0.00338)
2010: δ_{2010}	-0.056*** (0.00604)	-0.0032 (0.0037)	-0.0011 (0.00365)
Number of observations	7,836	25,291	25,276

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method.
Estimation of coefficients: (°) significant at the 10% threshold; (*) 5%; (**) 1 %; (***) 0.1%
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.

3.1.3 A drop of approximately 3% in waste production with the fact of being ISO 14001 or EMAS certified

To evaluate the evolution in waste quantities at the time of the certification of the establishment, we estimate the same model as that described in section 3.1.1, while eliminating the "number of years following certification" variable (tps.certif, corresponding to the η parameter) as there are only two years of observation for waste (2006 and 2008). In addition, we exclude the establishments certified for these two years from the database, so that the β coefficient accurately reflects the evolution of environmental pressures coinciding with the year of certification (in relation to establishments remaining non-certified).

The quantity of waste produced decreases significantly by over 3% with certification (table 3.2). With regard to "recovered" wastes in particular (involving the recovery of materials, energy or waste sent to a sorting centre), the

[21] When the estimation is carried out by excluding from the sample companies which were already certified in the first year in which they are surveyed, there is little overall difference in the results (a slightly smaller instantaneous decrease in pressures in the year of certification).

evolution is estimated with significant uncertainty, at between -14% and +2.5%, which does not allow us to identify a general trend among establishments holding ISO 14001 or EMAS certification.

Table 3.2: Evolution of waste production according to certification

Estimated model: $\log(P_{it}) = \gamma \log(workforce_{it}) + \beta\ certif_{ti} + \alpha_i + \delta_t + u_{it}$

	Waste production (non-hazardous waste)	Production of "recovered" waste that can be reused (to produce energy, etc.) or sent to a sorting centre
log(workforce): γ	+0.294*** (0.0011)	+0.246*** (0.0017)
Evolution of waste production following ISO 14001 or EMAS certification: β	-0.033*** (0.0069)	-0.056 (0.0417)
2008: δ_{2008}	-0.052*** (0.0088)	-0.038*** (0.0130)
Number of observations	6,797	5,356

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method.
Estimation of coefficients: (°) significant at the 10 % threshold; (*) 5 %; (**) 1 %; (***) 0.1 %
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.

3.2 Evolution of atmospheric pollution and certification: fragile results

Over the 2006-2010 period, according to the national inventory report in SECTEN (Economic Sector and Energy) format, carried out by the French Inter-professional Technical Centre for Research into Atmospheric Pollution (*Centre Interprofessionnel Technique d'Étude de la Pollution Atmosphérique* – CITEPA), French industry significantly reduced its atmospheric pollutant emissions (by between 20 and 40% according to the pollutants: SO_2, NOx and NMVOC). Our data confirm that there were very significant reductions in emissions over the 2006-2010 period, both for establishments certified in 2010 (-50% for the median establishment) and for non-certified establishments in 2010 (-38%). There are a variety of determining factors for this decrease: technical progress made by manufacturers, regulations (desulphurisation of petroleum products) and – in addition to the regulatory obligations – a wide range of incentives that may prompt companies to embark on a policy of reducing atmospheric pollutant emissions (TGAP and Regional Air Quality Plans (*[Plans régionaux pour la qualité de l'air]*). In this context, certification would appear to be a very marginal factor in reducing emissions, which could explain the mixed results.

3.2.1 A potentially heterogeneous effect of certification, which appears to lead to a drop in NMVOC but a rise in NOx.

The previous model is simplified by removing the cumulative effects after certification. The β parameter thus measures the mean evolution of pollutant emissions between the certified period and the non-certified period, corrected to take account of changes in the workforce and the general downward trend.

With certification, establishments reduce their emissions of non-methane volatile organic compounds and sulphur oxide (table 3.3), but nitrogen oxide emissions tend to increase. However, the results of table 4.3 are fragile in view of the years used for the estimation, and change both quantitatively and qualitatively when the year 2005 is incorporated. There are several possible reasons for this year being atypical. The effects of certain regulations may be felt beyond this date (e.g. desulphurisation of energy sources). 2005 also saw the launch of the emission quota market in Europe with the aim of reducing greenhouse gas emissions. At the start, this market only covered carbon dioxide and a very limited number of sectors emitting very large quantities of CO_2. It thus allowed establishments to make very significant efforts with a view to reducing their CO_2 emissions, possibly to the detriment of other atmospheric pollutants.

Table 3.3: Evolution of atmospheric pollution according to certification

Estimated model: $\log(P_{it}) = \gamma \log(workforce_{it}) + \beta\ certif_{ti} + \alpha_i + \delta_t + u_{it}$

	Atmospheric pollution (aggregated variable)	Sulphur oxide (SOx) emissions	Non-methane volatile organic compound (NMVOC) emissions	Nitrogen oxide (NOx) emissions	Total suspended particulate (TSP)
log(workforce): γ	+0.4268*** (0.0015)	+0.3645*** (0.0031)	+0.236*** (0.0018)	+0.301*** (0.0023)	+0.473*** (0.0061)
ISO 14001 or EMAS certification: β	+0.0048 (0.0075)	-0.1907*** (0.0157)	-0.035*** (0.0092)	+0.092*** (0.0107)	+0.051 (0.0331)
2007	-0.0307*** (0.0101)	+0.0024 (0.0201)	-0.046*** (0.0122)	-0.039*** (0.0142)	+0.014 (0.0395)
2008	-0.1463*** (0.0102)	-0.0600*** (0.0193)	-0.166*** (0.0124)	-0.106*** (0.0144)	-0.056 (0.0406)
2009	-0.2836*** (0.0118)	-0.2356*** (0.0278)	-0.293*** (0.0142)	-0.224*** (0.0142)	-0.190*** (0.0365)
2010	-0.2717*** (0.0123)	-0.1915*** (0.0247)	-0.297*** (0.0153)	-0.199*** (0.0164)	-0.205*** (0.0387)
Number of observations	2,502	525	1,851	774	140

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method.

Estimation of coefficients: (°) significant at the 10% threshold; (*) 5%; (**) 1 %; (***) 0.1%

Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.

3.2.2 A potential trade-off to the detriment of air quality

The surprising result of a rise in nitrogen oxide emissions associated with certification, and more generally, the fragile nature of the results relating to the link between certification and air pollution, could be the consequence of trade-offs among the different forms of environmental pressure.

Firstly, an establishment may reduce its energy consumption or CO_2 emissions to the detriment of air quality. For example, fuel preheating processes may allow an establishment to reduce its energy consumption, potentially to the detriment of NOx emissions. Improving air quality is certainly ranked below energy savings among motivations for the implementation of an Environmental Management System: it generates smaller savings for the company[22] and is less widely used than CO_2 as a public relations claim. Air quality could therefore be easily sacrificed in trade-offs,

Different types of trade-offs may also occur with regard to the different sorts of airborne pollutants. Volatile organic compounds form part of the clearly identified substances in the framework of an Environmental Management System, which is not necessarily the case for SOx and NOx. This may influence the behaviours of establishments. For example, to reduce its volatile organic compound emissions, a company may reduce its consumption of solvents by resorting to thermal oxidisation during the manufacturing process (conversion of volatile organic compounds into inorganic compounds). In the event of improperly controlled combustion, the process may lead to an increase in sulphur and nitrogen oxide emissions.

Furthermore, the techniques used to reduce airborne pollutant emissions have their limitations. There is also a problem of cost, particularly with regard to the reduction of sulphur oxide emissions, especially for the smallest establishments. While it is possible to modify inputs in order to reduce the quantity of volatile organic compounds emitted (by using inputs with a lower NMVOC content), such a technique is difficult to adapt to NOx (modifying the inputs does not necessarily reduce NOx emissions at the end of the process).

[22] even though a reduction in pollutant emissions leads to savings in the General Tax on Polluting Activities for air (TGAP air).

3.2.3 Fragile results, calling for the performance of additional investigations concerning the relationship between environmental certification and the evolution of atmospheric pollution

In addition to the arguments that have already been put forward, the counter-intuitive result of our estimations may be due to a lack of reliability in the data used, as atmospheric pollutant emissions are harder to measure than the consumption of energy or water. Indeed, the quality of the declarations collected in the GEREP database strongly depends on the measuring instruments used by the establishments. If these types of instruments are not available, pollutant emissions are likely to be crude approximations.

In this context, the use of efficient measuring instruments may lead to an upward adjustment of emissions that had previously been underestimated (a phenomenon generally observed for estimations of quantities of waste, for example). With regard to nitrogen oxides, certification may cause establishments to improve their measurement of emissions *through* better management of industrial processes such as the use of catalysts and controlling the amounts of ammonia used.

Finally, it should be noted that certain NOx reduction techniques may lead to a significant drop in these emissions, with reductions of up to 80% being observed for certain establishments. However, such data are considered to be singular for the chosen estimation method and are thus excluded by the use of a robust estimator.

3.3 Disparities in the evolution of environmental pressures coinciding with certification

In this section, we examine whether the link between certification and the evolution of environmental pressures may vary according to the size of establishments, business sectors or the certification date[23].

3.3.1 A smaller decrease in environmental pressures for the smallest establishments

To analyse whether the evolution of environmental pressures associated with certification varies according to the size of the establishments, the sample was divided into four workforce classes:

Class 1	Between 20 and 49 salaried employees
Class 2	Between 50 and 249 salaried employees
Class 3	Between 250 and 499 salaried employees
Class 4	Over 500 salaried employees

The results presented in the preceding sections are confirmed, except for establishments with fewer than 50 employees, for which certification is not accompanied by a significant decrease in environmental pressures (table 3.4). This observation must still be put into perspective, however, insofar as the estimations are lacking in accuracy for these companies. The evolution in levels of consumption and pollution may be harder to measure for small organisations: the differences in quantities consumed or levels of pollution among these companies are smaller than for large establishments, and measurement errors are likely to have a greater impact on the econometric estimation.

[23] This link was also tested by taking account of the levels of activity in the different sectors (Appendix 3).

Table 3.4: Disparities in the evolution of pressures following certification: distinctions according to workforce classes

Estimated model: $\log(P_{it}) = \gamma \log(workforce_{it}) \times C_i + \beta\ certif_{ti} \times C_i + \eta\ tps.certif_{it} \times C_i + \alpha_i + \delta_t + u_{it}$
where C_i is the variable of inclusion in the class of workforce

	Water abstractions	CO_2 emissions associated with energy consumption	Energy consumption	Waste production (non-hazardous waste)
Instantaneous change in pressures in the year of ISO 14001 or EMAS certification: β				
Between 20 and 49 salaried employees	+0.0670 (0.04692)	-0.0069 (0.01100)	-0.006514 (0.01115)	
Between 50 and 249 salaried employees	-0.0228*** (0.00576)	-0.0402*** (0.00392)	-0.029896*** (0.00390)	-0.052*** (0.0112)
Between 250 and 499 salaried employees	-0.0175*** (0.00701)	-0.0323*** (0.00602)	-0.026951*** (0.00595)	-0.088*** (0.0136)
Over 500 salaried employees	-0.0329*** (0.00920)	-0.0359*** (0.00842)	-0.039880*** (0.00827)	-0.084*** (0.0172)
Continuous evolution of pressures in the years following ISO 14001 or EMAS certification: η				
Between 20 and 49 salaried employees	+0.0220° (0.01139)	+0.0116*** (0.00407)	+0.009916*** (0.00411)	Data available for 2006 and 2008 only
Between 50 and 249 salaried employees	-0.0016 (0.00157)	-0.0146*** (0.00098)	-0.012038*** (0.00098)	
Between 250 and 499 salaried employees	-0.0114*** (0.00168)	-0.0198*** (0.00131)	-0.018965*** (0.00128)	
Over 500 salaried employees	-0.0179*** (0.00213)	-0.0265*** (0.00165)	-0.024949*** (0.00163)	
log(workforce): γ				
Between 20 and 49 salaried employees	+0.3284*** (0.00247)	+0.2164*** (0.00109)	+0.260632*** (0.00108)	
Between 50 and 249 salaried employees	+0.3424*** (0.00108)	+0.2182*** (0.00061)	+0.257073*** (0.00060)	+0.511*** (0.0013)
Between 250 and 499 salaried employees	+0.3517*** (0.00102)	+0.2210*** (0.00065)	+0.261295*** (0.00064)	+0.509*** (0.0017)
Over 500 salaried employees	+0.3506*** (0.00097)	+0.2269*** (0.00079)	+0.267841*** (0.00076)	+0.504*** (0.0021)
Time indicators (per year): YES				
Number of observations	7,831	25,049	25,024	7,630

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method.
Estimation of coefficients: (°) significant at the 10% threshold; (*) 5%; (**) 1%; (***) 0.1%
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.
Sources: Antipol, CLAP, EACEI, GEREP and the authors' calculations.

The lack of an improvement in environmental performance for small organisations may also be due to the fact that in certain cases, certification is imposed by an ordering party and is thus more of an external pressure than an intrinsic motivation. In fact, certification requires the presence of a specific framework with a view to reducing the environmental impact, without the publication of results. A small organisation that obtains certification to satisfy the requirements of a company on which it depends cannot seek to effectively reduce its environmental impacts if this entails investments that put it under financial strain. According to AFNOR (French Association for Standardisation), the establishment will then be engaged in a "ritual" type of approach with significant external pressures and minor internal issues.

In establishments with more than 50 employees, the size of the establishment makes no significant difference in terms of achieving an instantaneous reduction of environmental pressures in the year of certification. There are greater differences in the continuous improvement of pressures in the years following certification between workforce classes: the biggest establishments reduce their pressures to a greater extent after obtaining an ISO 14001 standard or EMAS registration. This may be explained by the fact that the biggest establishments have greater financial and logistical resources that allow them to invest in reducing their environmental pressures.

3.3.2 A smaller decrease in environmental pressures for sectors with a big footprint

It is interesting to observe how the evolution of environmental pressures depends on the level of environmental pressures exerted by the establishment. Indeed, it is considered that the environmental benefit of reducing pressures is greater when the initial level of pressure is high.

As partitioning the sample on the basis of the pressures exerted could introduce a selection bias into the estimations, we settled for one partition at the level of the business sectors. For each sector, we calculated an intensity of water and energy consumption (or the emission or production of waste) as being the sum of the consumptions (or of the emission or production of waste) divided by the sum of the workforce in the sector. For each environmental pressure, the sectors are divided into two groups according to the intensity of the pressure, with a comparable number of establishments in both groups (Appendix 2). The model is then estimated while authorising differentiated parameters for both groups.

In each group, certification is accompanied by a significant improvement in environmental pressures, both instantaneously and continuously (table 3.5). However, the drop in environmental pressures in the year of certification is smaller within sectors with the highest intensities of consumption and pollution. In fact, the most intensive sectors with regard to their environmental pressures are likely to have already been obliged to adapt to standards and may consequently find it harder to continue to reduce their environmental impacts (even though certification is still accompanied by an additional decrease in the pressures they exert, compared to non-certified establishments). Conversely, the least intensive sectors may have more room for manoeuvre in terms of reducing their consumption of inputs or pollutant emissions. This hypothesis may need to be verified in greater detail, however.

Table 3.5: Evolution of environmental pressures according to certification: distinctions between sectors according to the intensity of consumption or pollution.

	Water abstractions	CO_2 emissions associated with energy consumption	Energy consumption	Waste production (non-hazardous waste)
Instantaneous change in pressures in the year of ISO 14001 or EMAS certification: β				
Group 1: Sectors with the lowest consumption/pollution intensities	-0.0200*** (0.0062)	-0.0627*** (0.00442)	-0.0503*** (0.00482)	-0.054*** (0.0133)
Group 2: Sectors with the highest consumption/pollution intensities	-0.0151*** (0.0056)	-0.0228*** (0.00390)	-0.0251*** (0.00363)	-0.052*** (0.0100)
Continuous evolution of pressures in the years following ISO 14001 or EMAS certification: η				
Group 1: Sectors with the lowest consumption/pollution intensities	-0.0185*** (0.0019)	-0.0283*** (0.00101)	-0.0219*** (0.00110)	
Group 2: Sectors with the highest consumption/pollution intensities	-0.0026*** (0.0013)	-0.0110*** (0.00094)	-0.0154*** (0.00087)	
log(workforce): γ				
Group 1: Sectors with the lowest consumption/pollution intensities	+0.3404*** (0.0012)	+0.1819*** (0.00072)	+0.1890*** (0.00078)	+0.298*** (0.0019)
Group 2: Sectors with the highest consumption/pollution intensities	+0.3076*** (0.0013)	+0.1599*** (0.00071)	+0.1891*** (0.00065)	+0.289*** (0.0013)
Temporal indicators (per year): YES				
Number of observations:	7,831	25,294	25,254	7,934

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method. For the distinction between the two groups in the sector: for each pressure, intensity is calculated on the basis of the total volume of consumption or pollution for the sector in relation to the sum of the workforce for the sector.
Estimation of coefficients: (°) significant at the 10% threshold; (*) 5%; (**) 1%; (***) 0.1%
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.

3.3.3 The decrease in environmental pressures is greater in establishments that obtain certification at the start of the period compared to those certified at a later date.

The date of certification may also be a factor of disparity in the link between the evolution of environmental pressures and the fact of obtaining certification. In this respect, Toffel (2006) empirically shows that the first holders of the ISO 14001 standard make bigger improvements to their environmental performance than those that obtain certification later. The suggested interpretation, which applies to managerial certification programmes in general, may be that the first holders of the ISO 14001 standard are engaged in a process of genuinely improving their environmental performance, whereas those certified at a later date do so on a more symbolic level, to improve their image, for example.

To test Toffel's (2006) result on our sample, it included companies certified at the start of the observation period, i.e. before 2008, and those certified after 2008. The results show that the reduction of environmental pressures in the year of certification is greater for establishments certified after 2008 with regard to CO_2 emissions and energy consumption, whereas the difference between the two groups is not significant for water abstractions (table 3.6).

At first glance, these results tend to contradict Toffel's empirical result (2006). They pose the same question in relation to the first mover advantage hypothesis, proposed in particular by Porter and Van der Linde (1995) and bestowing an economic advantage on the first companies to commit to environmental performance improvement strategies: such an economic advantage should be reflected by a more significant decrease in environmental pressures than for companies that obtain certification afterwards and do not benefit from such an advantage… However, it should be noted that the post-2008 estimation period coincides with a period of economic crisis in which the establishments that obtain certification are likely to be in better economic health and consequently more able to optimise their production processes with a view to reducing their economic pressures.

Table 3.6: Evolution of environmental pressures according to certification temporal distinction before 2008 / from 2008

	Water abstractions	CO_2 emissions associated with energy consumption	Energy consumption
Instantaneous change in pressures in the year of ISO 14001 or EMAS certification: β			
Group 1: establishments certified before 2008	-0.0182*** (0.0046)	-0.0115*** (0.00332)	-0.0109*** (0.00330)
Group 2: establishments certified from 2008	-0.0131*** (0.0056)	-0.0336*** (0.00396)	-0.0329*** (0.00395)
Continuous evolution of pressures in the years following ISO 14001 or EMAS certification: η			
All certified establishments	-0.0090*** (0.0010)	-0.0083*** (0.00072)	-0.0078*** (0.00071)
log(workforce): γ			
Group 1: establishments certified before 2008	+0.4202*** (0.0009)	+0.1624*** (0.00054)	+0.1705*** (0.00054)
Group 2: establishments certified from 2008	+0.4160*** (0.0026)	+0.1608*** (0.00148)	+0.1694*** (0.00148)
Time indicators: YES			
Number of observations	7,836	25,291	25,271

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method.
Estimation of coefficients: (°) significant at the 10% threshold; (*) 5%; (**) 1%; (***) 0.1%
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.

3.4 No decrease in environmental pressures one year before certification

The econometric results establish the existence of a correlation between environmental certification and the improvement of environmental pressures but do not necessarily imply any causality. Certification could merely be a form of recognition for companies that had already embarked on procedures to reduce their environmental pressures. In this respect, it is interesting to check whether or not the improvement in pressures precedes the certification.

For this purpose, we add a "one year before certification" indicator to the model, which amounts to 1 for the year before ISO 14001 or EMAS certification is obtained, and 0 otherwise. The model is thus expressed in the following manner:

$$\log(P_{it}) = \gamma \log(workforce_{it}) + \beta\, certif_{it} + \eta\, (certif_{i(t+1)} - certif_{it}) + \alpha_i + \delta_t + u_{it}.$$

The results of the robust regression do not show a significant reduction in pressures prior to certification (table 3.7).

Therefore, this supports the idea of a causal effect of certification on the reduction of pressures: if certification is accompanied by a simultaneous reduction in environmental pressures, it is doubtless because the reduction was carried out with a view to obtaining the certification or thanks to its implementation.

Table 3.7: test of robustness, with the "certif.m1" variable (one year before certification)

Estimated model: $\log(P_{it}) = \gamma \log(workforce_{it}) + \beta\, certif_{it} + \eta\, certif_{i(t+1)} + \alpha_i + \delta_t + u_{it}$

	Water abstractions	CO_2 emissions associated with energy consumption	Energy consumption	Waste production (non-hazardous waste)
log(workforce): γ	+0.313*** (0.00086)	+0.1397*** (0.00051)	+0.1489*** (0.00051)	+0.230*** (0.0011)
Instantaneous change in pressures in the year of certification: β	-0.026*** (0.00291)	-0.0299*** (0.00207)	-0.0277*** (0.00205)	-0.057*** (0.0080)
Evolution of pressures one year before certification: η	-0.013 (0.00792)	+0.0004 (0.00608)	+0.0035 (0.00601)	-0.015 (0.0228)
Time indicators (per year): YES				
Number of observations	7,835	25,290	25,274	7,934

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method.
Estimation of coefficients: (°) significant at the threshold of 10%; (*) 5%; (**) 1%; (***) 0.1%
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.
Sources: Antipol, CLAP, EACEI, GEREP and the authors' calculations.

Conclusion

For industrial establishments with similar workforces, those which are most commonly certified to ISO 14001 or EMAS standard belong to business sectors that emit the highest levels of pollutants or consume the most inputs, i.e. those for which reducing environmental pressures is a key issue. Certification is accompanied by a significant reduction in water abstractions, energy consumption, CO_2 emissions associated with energy consumption and waste production. In the year of certification, a 2% decrease in water abstractions is observed in relation to the rest of the industry. This decrease amounts to 4% for energy consumption and associated CO_2 emissions. In the years following certification, the drop in environmental pressures is also greater than in the rest of the industry by one to two points per year. This continuous decrease in environmental pressures during the years following certification is greater within the biggest establishments. However, the results concerning the impact of certification on the evolution of atmospheric emissions are more fragile and difficult to interpret.

These results show that environmental certification allows for the identification of establishments that reduce their environmental pressures in the short to medium term, at least with regard to their consumption of water and energy, as well as their waste production. While the *ex ante* environmental performance of establishments holding ISO 14001 or EMAS certification does not appear to be better, the fact of obtaining certification causes them to reduce their environmental impacts, within a process of continuous improvement.

Nevertheless, the impact of certifications on environmental pressures as a whole remains difficult to quantify. In particular, the simultaneous occurrence of environmental improvements and certifications is not sufficient to prove any causal link, even though this seems probable. Moreover, the use of an estimator that is robust vis-à-vis singular values was required in order to take account of the fact that the strongest environmental pressures are often exerted by a small number of establishments, whose behaviours may deviate significantly from the average behaviours.

In addition, it could be interesting to analyse the economic aspects associated with the certification process. In addition to observing the improvement in the environmental performance of companies that hold ISO 14001 or EMAS certifications, a parallel analysis, using panel data, of the potential economic savings made by establishments during the certification process would allow for the testing of Porter's hypothesis of a joint improvement in both environmental and economic performance. Certification may indeed lead to reorganisations and have an impact on employment or even on the productivity of employees.

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Appendices

Appendix 1: Calculation of the CO_2 emissions and energy consumption variables

Type of energy	Emission factor: in kg CO_2/GJ
Mains natural gas	57
Mains gas (other than natural)	57
Coal	95
Lignite (brown coal)	100
Coal coke	107
Petroleum coke	96
Butane-propane	64
Commercial heavy fuel oil	78
Domestic fuel oil other than diesel	75
Other petroleum products	73

Energy sources not considered for CO_2 emissions and energy consumption:
Wood
Black liquor
Special renewable fuels
Steam

Energy sources not considered in the calculation of energy consumption:
Special non-renewable fuels
Electricity?

Appendix 2: Distribution of sectors in the two groups, for regressions according to the consumption or pollution intensity

	Water abstractions	CO_2 emissions associated with energy consumption	Energy consumption	Waste production (non-hazardous waste)
Group 1: Sectors with the lowest consumption/pollution intensities	29-30 Automotive industry and other transport equipment 22 Rubber and plastic 31-33 Manufacture, repair/installation of machines and equipment 26-28 Information technology, electrical and electronic products 13-15 Textiles, clothing, leather 10-11 IAA	31-33 Manufacture, repair/installation of machines and equipment 26-28 Information technology, electrical and electronic products 29-30 Automotive industry and other transport equipment 22 Rubber and plastic 13-15 Textiles, clothing, leather 16-18 Wood and paper, printing	31-33 Manufacture, repair/installation of machines and equipment 26-28 Information technology, electrical and electronic products 29-30 Automotive industry and other transport equipment 22 Rubber and plastic 13-15 Textiles, clothing, leather	13-15 Textiles, clothing, leather 26-28 Information technology, electrical and electronic products 19-21 Chemical industry, pharmaceuticals, coking and refining 31-33 Manufacture, repair/installation of machines and equipment
Group 2: Sectors with the highest consumption/pollution intensities	23 Manufacture of mineral non-metal products 24-25 Metallurgy and metal products 16-18 Wood and paper, printing 19-21 Chemical industry, pharmaceuticals, coking and refining 07-08 Extractive industries 35 Water, electricity and gas	24-25 Metallurgy and metal products 07-08 Extractive industries 19-21 Chemical industry, pharmaceuticals, coking and refining 23 Manufacture of mineral non-metal products	24-25 Metallurgy and metal products 16-18 Wood and paper, printing 07-08 Extractive industries 19-21 Chemical industry, pharmaceuticals, coking and refining 23 Manufacture of mineral non-metal products	10-11 IAA 22 Rubber and plastic 29-30 Automotive industry and other transport equipment 23 Manufacture of mineral non-metal products 24-25 Metallurgy and metal products 16-18 Wood and paper, printing 07-08 Extractive industries

Appendix 3: Results still evident even taking account of different levels of activity according to the sectors

The workforce variable only partially demonstrates the evolutions of industrial activity. Differences in the economic situation from one sector to another may influence the results of the model being studied. To verify their robustness, we have thus added a temporal trend for each business sector. More specifically, in each sector, a coefficient demonstrates the mean evolution of pressures between 2004 and 2010, in addition to the temporal indicators. Therefore, while there is a different increase in each sector, which is inaccurately reflected by the workforce, the sectoral parameter does reflect its impact on environmental pressures. This enrichment of the model does not change the results.

The environmental pressures decrease in the year of certification, in relation to the rest of the industry (cf. table below). The results remain similar to those obtained previously. Except for water abstractions, a continuous trend is still apparent, with a greater improvement in environmental performance than for non-certified establishments in the years following certification to ISO 14001 or EMAS standard.

Evolution of environmental pressures according to certification: instantaneous effect and continuous effect with trends for each sector

	Water abstractions	CO_2 emissions (co2 emission variable) associated with energy consumption	Energy consumption
ISO 14001 or EMAS certification: instantaneous effect:	-0.02295*** (0.0040901)	-0.03571857*** (0.0029724)	-0.0287037*** (0.0029549)
log(workforce):	0.28021*** (0.0017273)	0.16086376*** (0.0011654)	0.1773342*** (0.0011749)
ISO 14001 or EMAS certification: continuous improvement:	-0.00060 (0.0010512)	-0.01737232*** (0.0007091)	-0.0155759*** (0.0007033)
Trends in the different sectors			
Automotive and transport	-0.02559*** (0.0000079)	-0.00000119 (0.0000041)	-0.0000589*** (0.0000041)
Wood and Paper	-0.00838*** (0.0000054)	-0.00003361*** (0.0000034)	-0.0000761*** (0.0000034)
Rubber and plastic	-0.02561*** (0.0000072)	+0.00001392*** (0.0000036)	-0.0000656*** (0.0000036)
Chemicals, pharmaceuticals and coking	-0.02561*** (0.0000056)	+0.00002276*** (0.0000034)	+0.0000240*** (0.0000034)
Water, electricity and gas	-0.05553*** (0.0000143)		
Information technology and electrical equipment	-0.02563*** (0.0000075)	+0.00000066 (0.0000038)	-0.0000625*** (0.0000038)
Agri-food industries	0.00006*** (0.0000055)		
Extractive industries	-0.02563*** (0.0000093)	+0.00013116*** (0.0000036)	+0.0000605*** (0.0000036)
Manufacture of machines and equipment	-0.02559*** (0.0000106)	+0.00000940*** (0.0000038)	-0.0000539*** (0.0000038)
Metallurgy	-0.02559*** (0.0000061)	-0.00001313*** (0.0000034)	-0.0000607*** (0.0000035)
Non-metal minerals	-0.02560*** (0.0000058)	+0.00003958*** (0.0000033)	-0.0000029 (0.0000033)
Textiles, clothing and leather	-0.02561*** (0.0000059)	+0.00000656 (0.0000038)	-0.0000405*** (0.0000038)
Year indicator: YES			
Number of data	8,152	26,979	26,968

Interpretation: the standard deviations are shown in brackets. Robust estimations, "WMS" method.
Estimation of coefficients: (°) significant at the 10% threshold; (*) 5%; (**) 1%; (***) 0.1%
Scope: French industrial establishments, sectors 07 to 35 of the NAF ver.2 classification.
Sources: Antipol, CLAP, EACEI, GEREP and the authors' calculations.

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Environmental certification of industrial establishments is accompanied by a reduction of environmental pressures

For the environmental component of corporate social responsibility, the implementation of environmental management systems (EMS) allows companies to make an appropriate response to the key environmental issues facing them. Such strategies can then help companies obtain certification, with the two main accreditations being the ISO 14001 standard and EMAS registration. Companies decide to implement an EMS and obtain certification for different reasons (to reduce their consumption of inputs, anticipate future regulations, improve their corporate image, etc.).

The aim of the study is to characterise the certified establishments and analyse whether the adoption of such a strategy is accompanied by a significant reduction in environmental pressures (consumption of energy and water, CO_2 and atmospheric pollutant emissions and waste production). Data concerning French industrial sectors over the 2004 to 2010 period were used and reveal that for the majority of environmental pressures, the greater the rise in pressure, the higher the number of certified establishments. Moreover, for a given level of pressure, the proportion of certified establishments increases according to the size of establishments (over half of establishments with more than 250 employees are certified). For major establishments, however (with over 500 employees), the propensity to obtain certification does not appear to depend solely on the level of pressure, as other factors also come into play (e.g. the public relations dimension).

An econometric assessment of the level of environmental pressure according to whether or not a company is certified (and by inspecting the specific characteristics of the company) reveals that the ISO 14001 and EMAS environmental certifications act as good indicators of an effective environmental policy being implemented by establishments: for the year of certification, water abstractions and energy consumption are 2% below the levels for the rest of the industry. There is a difference of 3% for CO_2, and 4% for waste production. The reduction of environmental pressures continues during the years following certification – at a rate of an additional 1 to 2% compared to non-certified establishments. The results are more mixed with regard to atmospheric pollution and vary according to the types of pollution in question.

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