The Adoption of Sustainable Technologies in Manufacturing Firms

Pressured by an institutional perspective

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Abstract

This research investigates, from an institutional perspective, the relationships between coercive-, mimetic- and normative pressure and the adoption of sustainable technologies in manufacturing firms. With sustainable development becoming more and more important, the adoption of sustainable technologies in manufacturing firms do likewise. Within manufacturing firms, sustainable development is intertwined with the adoption of new technologies. To investigate possible predictors or influencers on this adoption, coercive-, mimetic- and normative pressures will be investigated regarding their relationship with the adoption of sustainable technologies in manufacturing firms. Besides their relationship with the adoption of sustainable technologies, their mutual relationships will be further examined using a mediation model.

Using data of 149 Dutch organizations, no significant relationships between the coercive-, mimetic- and normative pressure and the adoption of sustainable technologies were found. These relationships were hypothesized, based on existing literature. The absence of significant results could indicate two things: that prior research in this area might not be applicable to any kind of organization, operating in any kind of industry, operating in any kind of geographical region. The second possibility is that the significant result were absent due to the limitations of this research.

Within this research no specific conclusions can be drawn about whether these in the past confirmed relationships between the pressures and adoption can be generalized. Nevertheless, this research confirms that there is still a lot to investigate regarding these constructs and it exposes constructs and relationships that might be fruitful for further investigation in future research.

Keywords: coercive pressure, mimetic pressure, normative pressure, adoption of sustainable technologies, manufacturing firms.

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Introduction

Sustainable development has been upcoming for the past decades, and over 95% of the firms in Europe and the United States believe that it is important (Giddings et al., 2002). Sustainability is "the development that is capable to cover today's needs for an intact environment, social justice and economic prosperity, without limiting the ability of future generations to meet their needs" (Bruntland, 1987). This makes sustainable development not only important to firms, but also to their environment and all actors in this environment. Sustainable development can be seen as a condition for shareholder value creation (Porter & Kramer, 2011) and thus as a competitive advantage. Organizations with high sustainability outperform organizations with low sustainability on (accounting) performance (Eccles et al., 2014), therefore sustainable development has a direct positive impact on organizational (financial) performance.

To accomplish sustainable development, innovations are necessary. An innovation is the commercial introduction of a new technology or combination of technologies to meet a user's or market's needs (Utterback & Abernathy, 1975). Sustainable (or eco-) innovations can be defined as: "the development of new ideas, behavior, products and processes that contribute to reduction in environmental burdens or to ecologically specified sustainability targets" (Hellström, 2007). Within these eco-innovations, distinctions can be made between technological-, organizational-, social-, and institutional innovations (Rennings, 2000). In the case of manufacturing firms, sustainable development is intertwined with new technology, and therefore with the technological side of eco-innovation. New technologies lead to cleaner production processes, and when a firm wants to improve their environmental performance, it will need new technologies to do so (Hofmann et al., 2012). Within manufacturing firms, technology is not only intertwined with sustainable development, but also considered as the most attractive solution to reduce the environmental burden (Kemp, 1994).

Regarding to Damanpour (1987) innovation occurs when an idea is implemented, instead of when it is initiated. Thus the real innovation occurs, when it is adopted. When looking at the adoption of sustainable innovations for consumers, sustainable innovations diffuse slowly into markets (Ozaki, 2011). Diffusion is the process in which an innovation is communicated among social members of a system overtime. This diffusion process develops slowly mainly because it takes five steps from gaining knowledge of the innovation through social networks to actually confirming the decision, thus adopting the innovation (Rogers, 2003). The speed of this process can differ per individual and that is why Rogers (2003) defined five categories of adopters : innovators, early adopters, early majority, late majority, and laggards. Observing adopting decisions within organizations, many organizational factors play a role in the adoption process and it is more of a group decision (Premkumar et al., 1997).

The adoption of sustainable innovations within organizations, in this case technological innovations, can be influenced by several organizational factors. Internal factors such as employee qualification (Wolf, 2013) and the individual attitude of employees (Rosen, 2013). External factors such as governmental regulation and pressure from external stakeholders (Hofmann et al., 2012). Within an institutional perspective, Dimaggio & Powell (1983) defined three types of external pressures influencing organizational behavior and leading to the isomorphism of organizations : coercive, mimetic and normative pressures. With isomorphism is aimed at the process in which organizations become more similar by adopting similar structures, strategies and processes, because they are experiencing the same coercive, mimetic and normative pressures (Dimaggio & Powell, 1983).

Sustainable development has clear benefits, but not all organizations prioritize sustainability above other organizational aspects. This prioritization may differ for organizations operating on different locations experiencing different coercive, mimetic and normative pressures. Sustainable development seems inevitable in the Western world, but for a lot of less developed countries, priorities lay somewhere else. Adoption of sustainable technologies within organizations is not just based on the individual distinction in speed of adoption, but adoption within organizations is also influenced by external pressures and/or actors. While different countries, show different levels of development (Jovane et al., 2008), different countries also show different levels of sustainable development.

The scope of this research is limited to manufacturing firms. Manufacturing firms are the backbone of industrial society and the industrialization of countries has taken place through manufacturing (Jovane et al., 2008). While in the 1960's organizations just focused on growth, this focus shifted to sustainable development in the last decades. Development must not only enable growth but also be sustainable (Jovane et al., 2008). To accomplish competitive sustainable manufacturing, to pursue sustainable development and meet key challenges within manufacturing, several requirements are necessary (Jovane et al., 2008). One of these requirements is the political willingness, within countries, to make a move towards sustainable development. Political willingness includes not only the will, but also regulations towards, grants for, and stimulation towards sustainable innovations. Grants, regulations and stimulation from a government experienced by organizations can be seen as coercive pressure (Dimaggio & Powell, 1983). Besides coercive pressure, organizations perceive other pressures (Delmas & Toffel, 2004), such as mimetic and normative pressures. Mimetic pressure motivates organizations to adopt processes, structures or technologies, because other organizations are adopting these processes, structures or technologies (Suddaby, 2010). Operating in an uncertain environment, organizations seek and mimic standardized processes, structures or technologies within the industry (Dimaggio & Powell, 1983). Normative pressure are associated with professionalism (Dimaggio & Powell, 1983) and this professionalism leads to a collective of organizations within an industry (Meyer & Rowan, 1977). Normative pressure derives from the creation of labor markets of expertise which lead to a more professional, similar and collective labor force (Slack & Hinings, 1994). This professionalism and collectivism motivates organizations to operate socially and environmentally responsible, due to a mechanism comparable with peer-pressure (Campbell, 2007).

The aim of this research is to distinguish if and how the adoption of sustainable technologies in manufacturing is influenced by the coercive, mimetic and normative pressures organizations are experiencing. The main question addressed is:

Is the adoption of sustainable technologies in manufacturing firms influenced by the coercive-, mimetic- and normative pressures these firms are experiencing and do these pressures relate?

Within institutional theory, or with an institutional approach there are no standards for definitions, variables or a research methodology (Tolbert & Zucker, 1999). This research aims to distinguish the different pressures, specify the concepts and to focus on its specific relationship with adoption of sustainable technologies, the adoption within manufacturing firms and with each other. One of the presumptions of institutional theory is that organizations will adopt similar practices to conform to coercive-, mimetic- and normative pressures (Kostova & Roth, 2002). Escobar & Vredenburg (2010) argue that sustainable development is mostly stakeholder driven and that therefore sustainable development is not influenced by normative and coercive pressure. These in institutional theory adopted similar practices may or may not include the use of sustainable technologies. This research aims to confirm whether this adoption of similar practices is likewise applicable to sustainable technologies and whether the possible influences of these pressures differ.

Using data of 149 Dutch organizations a possible distinction or relationship between the influences of the different pressures on the adoption of sustainable technologies in manufacturing firms will be made. These distinctions or relationships can support Dutch managers to comprehend the pressures they are experiencing and guide them on how to act upon these pressures.

Theory

Sustainability

With the amount of natural resources decreasing rapidly, the fundamental character of the interactions between society, nature and natural resources, and therefor sustainability science, becomes more important (Schandl et al., 2016). With the CO2- and the sea level rising, time is running out, and sustainable development seems like the only way out. Sustainability is not only focused on the environmental impact of operations, it also covers the economic impact and the impact on the social well-being of individuals (Finkbeiner et al., 2010). Sustainable development is the link between environmental- and social-economic problems and emphasizes on the fact that natural resources should be managed instead of exploited (Hopwood et al., 2005). Sustainable technology embeds an ambition to make the world cleaner, to manage natural resources more properly, and to be economically attractive doing so (Eckert et al., 2000). Organizations should not only focus on the 'greenness' of a technology they adopt, but also if it contributes to economic and social aspects of the organization and it's environment. The perceived legitimacy that an organization or individual acquires operating more sustainable influences the intention of adopting sustainable technologies or processes (Thomas & Lamm, 2012). Intention is one of the antecedents of behavior (Thomas & Lamm, 2012) and therefor an antecedent of the adoption of sustainable technologies and/or processes.

Manufacturing Firms

With the industrialization, manufacturing firms occurred. This industrialization led to: "environmental exploitation from the poles to the tropics, from the mountain tops to the ocean depths" (Mebratu, 1998, p. 495). With machines being the central mean of production, manufacturing firms led to great material productivity, but also to ecological scarcities (Mebratu, 1998). Manufacturing firms are not only the backbone of industrial society, but they also consume great amounts of resources, generate waste, and therefore need to look for sustainability (Millar & Russel, 2011). Thus it becomes more important for manufacturing firms to become aware of sustainable technologies and to adopt them. Regarding the fact that the industry sector makes up for 79.8% of the total consumption of natural resources in the world (IEA, 2016), manufacturing firms could make a big difference by adopting new technologies and operating more sustainably.

Adoption

"Adoption is a process, rather than a decision, which each user experiences individually and differently" (Hall et al., 1975). It is a process where individuals have the choice to adopt and start using an innovation (Gallivan, 2001). This individual adoption can differ from organizational adoption, because organizational adoption is not always every individuals' choice. Organizational adoption is often mandated and influenced by organizational implementation processes, structures and cultures (Gallivan, 2001). Organizational size is seen as one of the biggest determinants in the organizational adoption of IT- or technological innovations (Lee & Xia, 2006). Besides size, centralization, differentiation, specialization, and type of innovation are distinguished as determinants for organizational adoption (Moch & Morse, 1977). Despite these distinguished determinants, little is known about possible factors that influence a firm's ability to adopt environmental- or management innovations and to translate this improvements into competitive advantage (Hofmann et al., 2012). One of the factors is regulation, but organizations do not just adopt sustainable technologies because they legally have to, but there are other argumentations for the adoption as well (Teece, 2007).

There is an increasing environmental- and social pressure on organizations to focus on sustainable innovations and to operate sustainably (Hall & Vredenburg, 2003). Organizations adopt sustainable technologies because their stakeholders, including the government, impose pressures on organizations to operate sustainably (Delmas & Toffel, 2004). Thus organizations not just experience legal pressures, but all kinds of pressures. These governmental, environmental and social pressures could differ in different countries. Organizations will not just do what is mandatory, but will go beyond the mandatory to respond to these pressures. When organizations operate in uncertainty and experience external pressures, organizations tend to adopt technologies because similar situated others do so (Walden & Browne, 2009). So the way in which organizations respond to the pressures they experiencing could be (partially) based on how other organizations within the industry are responding.

Isomorphism

Isomorphism can be defined as: "The structural and strategic resemblance of one unit in a population to other units in that population, especially those facing similar institutional- and task-environmental conditions" (Heugens & Lander, 2009, p. 68). Within social sciences and institutional theory, organizational isomorphism is described as the manner in which organizations resemblance other organizations operating in the same environment (Deephouse, 1996). This resemblance derives from the conformity to institutional norms, facilitated by coercive, mimetic and normative processes (Kondra & Hinings, 1988). Coercive, mimetic and normative pressures are the factors influencing the resemblance of organizations (Dimaggio & Powell, 1983). Competitive pressures select out the non-optimal forms of organizations, thus the ones that survive show more resemblance with each other (Slack & Hinings, 1994). This resemblance of organizations embeds the adoption of similar structures, strategies and processes (Dimaggio & Powell, 1983). Organizations conform to institutional norms, thus resemblance each other, rather to gain legitimacy and organizational survival than to accomplish efficiency (Kondra & Hinings, 1988). Therefore adopted processes do not need to be the most efficient or economical. These processes could also include the adoption of more sustainable technologies. Organizations resemblance each other considering that isomorphism leads to organizational legitimacy (Deephouse, 1996). An organization acquires legitimacy when the social values they imply with their actions, meet the acceptance norms of the environment of the organizations (Dowling & Pfeffer, 1975). Legitimacy can be seen as an organizations' externally-generated perception of viability and credibility and is crucial for organizations.

Coercive pressure

Coercive pressures can be defined as: "Conformist pressures on an organization emanating from other organizations upon which it depends for critical resources or from institutions upholding the cultural expectations of the society in which it functions" (Heugens & Lander, 2009. P. 68) Coercive pressures can exist of regulations from the government and are experienced by organizations as a force or a persuasion, thus organizations respond by changing because of government mandates (Dimaggio & Powell, 1983). "Coercive pressures regulate behavior by setting rules, monitoring compliance and sanctioning behavior" (Heugens & Lander, 2009, p. 63). Coercive pressures are created by authorities, therefore the coercive pressures that might influence the adoption of sustainable technologies in manufacturing firms are governmental regulations such as laws and sanctions. One of the greatest governmental challenges in the 21th century is sustainability (Meadowcroft et al., 2005), therefor a lot of the governmental regulations cover sustainability issues such as the adoption of sustainable technologies. Coercive pressures have a positive effect on sustainable development (Bansal, 2005) and coercive pressures drive the adoption of 'green' technologies (Chen et al., 2009; 2011). Therefore, the first hypothesis tested is:

H1: The coercive pressure that manufacturing firms are experiencing has a positive influence on the adoption of sustainable technologies in manufacturing firms.

Mimetic pressure

Mimetic pressures can be defined as : "Pressures experienced by an organization to model itself after other organizations in its organizational field when faced with uncertainty over goals, technologies, mean-ends relations, et cetera" (Heugens & Lander, 2009 : 68). Therefore mimetic processes derive from uncertainties and are caused by the behavior of other, similar organizations operating in the same organizational field. The organizations to mimic are mostly the ones achieving, the role models within the industry. When organizations operate under uncertainty, environmental, goal-specific or technological, they are more likely to model themselves on other succesful organizations (Dimaggio & Powell, 1983). This comparing, identifying and maybe even copying of other organizations' behavior can be unconscious, but results in isomorphism. When organizations operate in an uncertain environment, their actions and interest might be unclear. The corporate community of the organization influences the perception of interest and facilitates that organizations mimic each other (Davis, 1991). Regarding sustainability and the adoption of sustainable technologies, sceptics question whether organizations operate more sustainably for intrinsic motives, or whether they operate more sustainably to gain legitimacy and because other organizations do so (Thomas & Lamm, 2012). If an organization adopts sustainable technologies, other organizations in the same corporate community are likely to mimic this behavior, therefor mimetic pressures influence the adoption of sustainable technologies. Mimetic pressures drive the adoption of 'green' technologies (Chen et al., 2009). Therefore, the second hypothesis tested is:

H2: The mimetic pressure that manufacturing firms are experiencing have a positive influence on the adoption of sustainable technologies in manufacturing firms.

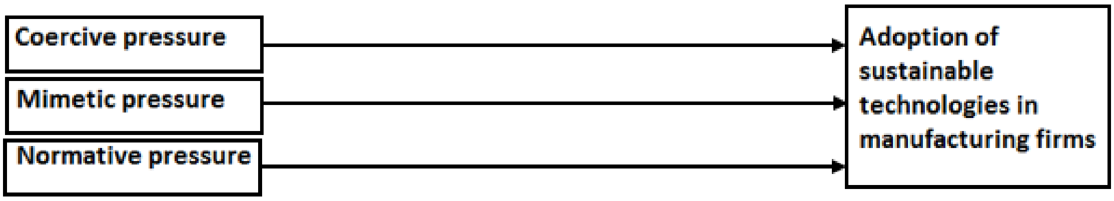
Normative pressure

Normative pressures can be defined as: "Pressures on an organizations to comply with the norms collectively issued by the other occupants of its organizational field in their struggle to define the conditions and methods of their work" (Heugens & Lander, 2009 : 68). Thus normative pressures are caused by other professionals operating in the same organizational field. Normative pressure is the third pressure that influences the operations of organizations and convergences them with other organizations. Normative pressures derive from professionalization and the similarities between professionals (Dimaggio & Powell, 1983). Due to education and the needed legitimation, a professional doing a particular job has a lot of similarities with a professional in another organization doing the same job. The pressure for organizations to professionalize leads to a certain perspective which influences whether organizations adopt or do not adopt for example sustainable technologies. Normative processes harmonize interpretations and reduce variations in policies and structures among organizations (Davis, 1991). These normative pressures influence organizational behavior, including the adoption of sustainable technologies. There are no clear outcomes on the influence or effect from normative pressures on the adoption of sustainable technologies yet.. The third hypothesis tested is:

H3: The normative pressures the manufacturing firms are experiencing influence the adoption of sustainable technologies in manufacturing firms.

Due to the lack of existing research on the influence from normative pressure on the adoption of sustainable technologies, there is no assumption whether the relationship could be positive or negative. Therefore, the presence of a relationship is hypothesized. This leads to the following conceptual model:

Figure 1.

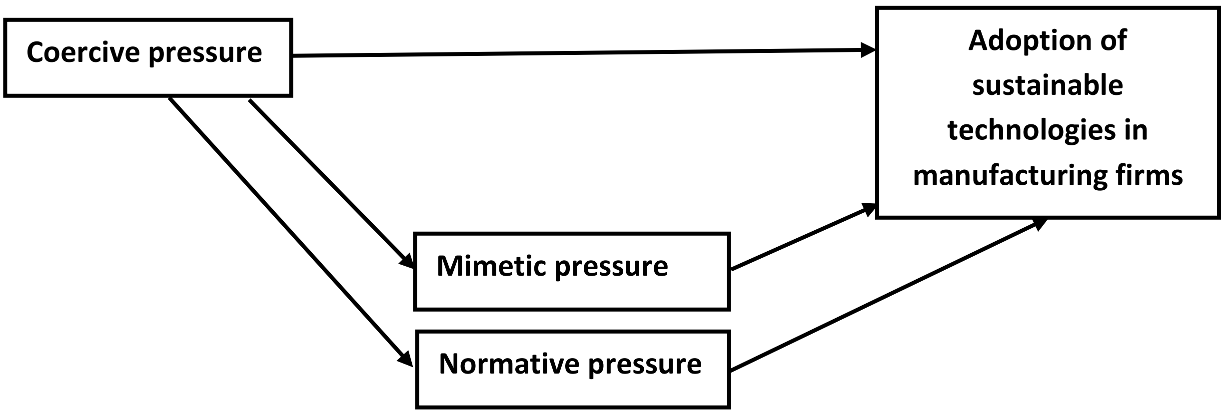


Based on the fact that the coercive, mimetic and normative pressures an organization is experiencing, lead to the resemblance of organizations. And the fact that sustainability has become more important, the expected influence from the coercive- and mimetic pressure on the adoption of sustainable technologies in manufacturing firms is positive.

Coercive pressure as precursor

Within the conceptual model (Figure 1.) the independent constructs coercive-, mimetic- and normative pressure are displayed as three concepts influencing and explaining the adoption of sustainable technologies. With coercive pressure consisting of regulations created by authorities, the government, this coercive pressure may also influence and explain the two other pressures and through the two other pressures the adoption of sustainable technologies in manufacturing firms. Regulations influence the field organizations are operating in. This influence, influences how organizations behave and therefor also the behavior other organizations possibly mimic. The coercive pressure might not change the quantity of mimetic pressure organizations experience, but it might influence the nature of this mimetic pressure. The same could occur with the normative pressure firms are experiencing. The coercive pressure regulates in which way the professionalization of organizations plays out. Therefore another conceptual model could be constructed with mimetic- and normative pressures, being mediators regarding the influence from coercive pressure on the adoption of sustainable technologies in manufacturing firms. This second conceptual model is displayed in Figure 2.

Figure 2.



For this second conceptual model to be accurate, there not only has to be a relationship between coercive pressure and mimetic- and normative pressure, but also a relationship between mimetic- and normative pressure and the adoption of sustainable technologies. For the model to fit, a relationship between coercive pressure and the adoption of sustainable technologies in manufacturing firms is necessary as well. The relationships between the pressures and the adoption of sustainable technologies in manufacturing firms are already tested constructed in hypotheses one, two and three. The fourth and fifth hypotheses are therefore as followed:

H4: The mimetic pressure manufacturing firms are experiencing are influenced by coercive pressure.

H5: The normative pressure manufacturing firms are experiencing are influenced by coercive pressure.

Methodology

Data sample

The data used within this research was already captured in the European Manufacturing Survey (EMS). The EMS survey was designed and conducted by several research institutes and universities across Europe. The aim of a survey is to collect representative data of a population (Bartlett et al., 2001). And by that to add to the general body of interest in that area by collecting information on the matter (Bertrand & Fransoo, 2002). The aim of the EMS survey is to acquire insights in the efforts industrial organizations make to modernize their operations. With this modernization comes the adoption of sustainable technologies in these manufacturing firms. There are items where the reasons for adoption are asked and a part of the reasons could be divided under the coercive, mimetic and normative pressure. The data used is from the EMS surveys that were held in 2012. The participating organizations are operating in the production (manufacturing) industry and count at least 10 employees. The survey was answered by a chief executive officer or production manager of these organizations.

The data sample counts 149 participating organizations. According to Dean & Lawless (1989) a sample size of at least 50 is appropriate to draw conclusions accurately and reasonable using negative binomial regression. Thus the sample of 149 seem sufficient.

One of the aims, but also major issues of a survey is the representativeness, which is necessary to generalize the findings to the population. The representativeness of the EMS survey has three dimensions on which it is tested : sector, firm size and region. Through cross-checking with statistics of the Central Agency of Statistics, representativeness of the Dutch EMS survey is confirmed, therefor the Dutch sample is representative for the Dutch manufacturing population. Reliability and representativeness is necessary to generalize findings.

Procedure

The organizations that participated in the survey, where approached by mail. This method was chosen because it is more facile to reach a lot of respondents, than to deduct this many surveys face-to-face. A survey is suitable when information is gathered about a lot of research units, aspects or variables (Korzilius, 2008). This applies to the EMS survey, regarding the fact that the questionnaire covered a lot of items and reached a lot of organizations. The survey was a cross-sectional investigation (Vennix, 2012), the data was collected at one moment at one organization regarding the specific items.

The relationships between the variables will be analyzed using negative binomial regression analysis. Regression analysis is a technique that tests and predicts a (possible) relationship (Field, 2010).

Operationalization

To create measures for the concepts adoption of sustainable technologies, coercive pressure, mimetic pressure and normative pressure, items from the EMS database will be composed into measurable variables. The scores on the items, indicators, will be composed using the 'compute variable' function in SPSS.

Adoption of sustainable technologies

The variable adoption of sustainable technologies contains items regarding the application of sustainable technologies within the manufacturing firms. When energy/raw materials reducing technologies or technologies that arouse sustainable energy are in use, these items are indicators for the adoption of sustainable technologies. These items in the EMS survey are: 'dry processing/minimum lubrication', 'control system for machine shutdown', 'retrieval of kinetic and process energy', 'bi/tri-generation', 'technologies to generate solar- or wind energy, hydropower, biomass or geothermal energy' and 'technologies to generate warmth by use of solar-energy, biomass or geothermal energy'. Thus the adoption of sustainable technologies in manufacturing firms consist of the technologies that are already adopted by the firms. A distinction can be made between two kinds of sustainable technologies, energy saving technologies and material saving technologies. Within this research these two kinds of sustainable technologies are captured in one, because the focus is on sustainable technologies and sustainability in general and not on the difference between different kind of sustainable technologies.

The variable adoption of sustainable technologies is a count variable. Count variables are dependent variables that have nonnegative integer values (King, 1989). The value is calculated by counting the presence of the different technologies used in the manufacturing firms. Within the survey for each of the six technologies, respondents could answer with 'yes' or 'no' referring to the presence and use of these technologies in their firm. With yes, given a value of 1 and no a value of 0, the value of the calculated variable adoption of sustainable technologies could range between zero and six. Remarkable about the range of the variable adoption is that it has a maximum of three (Appendix 1), thus the maximum of technologies adoption within one firm is three. This is not very high, considering that the maximum of possible technologies adopted is six. This small range might be caused by the fact that the technologies asked for in the survey are pretty specific or due to the fact that back in 2012 not that many firms were really adopting sustainable technologies. Another declaration for the low number of technologies adopted in the Dutch firms, might be caused by the fact that the payback period of these technologies was too long. Payback period has been defined as one of the factors that executes a big impact on the adoption of sustainable technologies (Evans et al., 2008). Because of the counted data, the variance found in the data may be greater than the expected variance based on theory, this is called overdispersion (Hilbe, 2007). With a Poisson distribution, the variance and the mean of each distribution are equal. When the variance of a distribution is greater than the mean, overdispersion occurs (Hilbe, 2007). Overdispersion can cause the normal distribution of the variable to be skewed. When data is referred to as Poisson or count overdispersed, the data may be distributed as negative binomial (Hilbe, 2007). Negative binomial regression aims to model relationships between predictors and the likelihood of count outcomes and is used to model this kind of overdispersed data (Hilbe, 2007). As shown in descriptive statistics (Appendix 1), the variance and the mean of adoption of sustainable technologies in manufacturing firms (and the other variables) are not equal. In the case of the adoption of sustainable technologies the variance (.572) is greater than the mean (.409), thus the distribution is negative binomial and negative binomial regression is a suitable method to analyze this data.

Coercive pressure

The variable coercive pressure contains several items regarding the reason for adopting technologies that reduce the use of energy and/or raw materials and technologies that arouse sustainable energy. When the answer to the question why these technologies are adopted is : ‘because of political or lawful determinations’ or ‘because of available subsidy’, these items are indicators for the presence of coercive pressure manufacturing firms are experiencing. Coercive pressures are governmental or environmental and these items measure the governmental pressures experienced by organizations. The two items above, indicate a presence of two possible manners of coercive pressure. Both items are nominal, they have two categories : yes/no, ‘yes’ receiving a value of 1 and ‘no’ a value of 0. The two items will be taken along in the analysis separately to see whether, one or even two of these indicators, dimensions, of coercive pressure are present and have an influence on the adoption of sustainable technologies. Therefor the construct of coercive pressure in this case is separated in two dimensions: lawful determination and subsidy. When the nominal items are given the values of respectively 1 or 0, these items could be taken along as variables in the analysis. By giving the nominal items a value of 1 or 0, dummy variables are created. A dummy variable is created by transforming a non-metric variable, into a metric one by giving the categories a value of respectively 0 (reference category), or 1(Field, 2010).

Mimetic pressure

The variable mimetic pressure contains an item regarding the collaboration with other organizations. Besides the mimicking of the success of competitors, mimetic pressure also consist of collaboration with other actors (competitors). Mimetic pressures do not occur in for example buyer-seller relationships, but only in collaborative relationships (Ke et al., 2009). Collaborating with other organizations is an indicator of the construct of mimetic pressure. When organizations are ‘collaborating with other organizations for research and development’. This form of collaboration is focused on (sustainable) development. So this item is a collaborative item, narrowed down to sustainable development and therefore the adoption of sustainable technologies. The answer in the questionnaire to this question is yes/no. Yet again ‘yes’ will be given a value of 1 and ‘no’ will be given a value of 0, thus this item is dummyfied as well.

Normative pressure

The variable normative pressure contains items regarding some standards that are set in the industry regarding sustainability. When organizations meet the environmental- or energy ISO norms, these items are indicators for the variable normative pressure. ISO norms are set for the industry, by professionals in the industry. So if other professionals, probably with a similar educational background, set them, this is a pressure for other professionals operating in other organizations to do the same. The difference with mimetic pressure is that the norms are set, so organizations are not mimicking competitors successful actions, but they are responding to already existing norms set by professionals. The in the EMS survey used items are: ‘environmental certification according to ISO 14031’ and ‘energy audit according to ISO 50001:2011’. These two items indicate the presence of two possible manners of normative pressure. The ISO 14031 norm consists of guidelines on the use of environment performance evaluation (Jasch, 2000). The ISO 150001 norm consists of requirements for the use of an energy management system (Kulkarni & Katti, 2013). Therefor this construct is distinguished in the two dimensions: environment performance evaluation and energy management system. The two items are nominal, both having possible answers of yes/no. Yet again dummy variables for the items are made, where ‘yes’ receives a value of 1 and ‘no’ a value of 0.

Control variables

Control variables are used to see whether the relationship between the dependent and independent variable(s) are not caused by any other aspects. Thus to control for these variables and focus on the relationship of investigation. Size is seen as one of the biggest determinants of organizational adoption (Moch & Morse, 1977), so size is taken into account as a control variable. Within the EMS survey, seven different industries are distinguished: ‘Metals and Metal products’, ‘Food, Beverages and Tobacco’, ‘Textiles, Leather, Paper and Board’, ‘Construction and Furniture’, ‘Chemicals (energy and non-energy)’, ‘Machinery, Equipment and Transport’ and ‘Electrical and Optical equipment’. Further within the research these categories are shortened to: Metal, Food, Textiles, Construction, Chemicals, Machinery and Electrical. One of the conditions for regression analysis, is that all variables included need to be metric (Field, 2010). Industry is not a metric variables, so industry needs to be dummyfied. The dummy variable ‘Construction and Furniture’ is left out due to the fact that none of the organizations that filled in the industry question are scaled in the construction category. In Table 1 below, a operationalization table is displayed.

Table 1. Operationalization table

Construct	Dimension	Item(s)	Scale	EMS question	Code
Adoption		-dry processing /minimum lubricant -control system -retrieval of energy -bi/tri-generation -technologies to generate energy -technologies to generate warmth	Interval	*3. Which of the following techniques are currently applied in your organization?*	-h03o1 -h03p1 -h03q1 -h03r1 -h03s1 -h03t1

Coercive pressure	- Lawful determination - Subsidy	-political or lawful determinations -available subsidy	Nominal Nominal	*4. Which reasons are decisive for the introduction of sustainable technologies within the organization?* *5.4 When you've applied sustainable technologies, which reasons were decisive in that decision?*	-h04a5 -h05g2
Mimetic pressure	-Collaboration	-collaborating for research and development	Nominal	*7. Does your organization collaborates with other organizations in one of the following areas?*	-h07c1
Normative pressure	- Environment performance evaluation - Energy management system	-ISO 14031 -ISO 50001:2011	Nominal	*8.1Which of the following organizational concepts and methods are applied in your organization at this moment?*	-h08p1 -h08q1
Size			Ratio		-h20b1
Industry		-Line of business	Nominal	*1.2 Industry*	-NACErev2
	Industry categories; dummy variables	-Metal -Food -Textile -Construction -Chemicals -Machinery -Electronic			

Analysis

First the data will be checked. Using the rule of thumb that missing values need to be <10% (Field, 2010) the variables will be examined. Missing values should be acted upon when an item has missing values over 10% or when a respondent, in this case organizations, has not filled in over 50% of the questionnaire (Field, 2010). From all the items, one indicating coercive pressure, the subsidy dimension (CP_subsidy), has missing values of 16,8% (Appendix 1), so it should be deleted according to theory. Another general rule for the deletion of items due to missing values is based on the content of the item. In this case, it is one of the two items indicating the construct coercive pressure. Thus there is only one other item explaining the pressure and that is not as extended as it could be. That is the reason why the item is not deleted right away. To check whether the missing value of CP_subsidy was problematic, all analysis where conducted with and without the item, but there was no severe difference. That is why the item is kept, to get a more extended, so holistic, view of the construct. All the other items have missing values <10%.

Assumption testing

The variable adoption of sustainable technologies in manufacturing firms is a count variable, therefore this variable is not normally distributed, but skewed (Appendix 1). The same is the case for the other variables. A variable does not meet the assumption of normality when skewness or kurtosis values divides by their standard error are greater than |3| (Hair et al., 2014). The following assumptions defined by Hardin & Hilbe (2007) of negative binomial regression are tested:

- Negative binomial regression does not assume that the variables are normally distributed.
- There is no linear relationship between the dependent variable and the predictors, independent variables.
- There is no multicollinearity, correlation between the predictors, independent variables.

In Appendix 1, skewness and kurtosis values for all the variables are included. With the exception of two variables one indicating mimetic pressure (MP_collab) and one indicating normative pressure (NP_epe), all the items are skewed and kurtosed. These two variables have a kurtosis divided by its standard error smaller than |3|, but this does not occur for the skewness values so these items are not normally distributed. As displayed in the scatterplots (Appendix 2), there are no signs of linearity between the dependent variable and one of the independent variables. The categorical outcomes are distributed within the plot instead of forming a linear line. To distinguish whether there are problematic correlations between the predictors, so between the pressures and the control variables, collinearity statistics are requested. Multicollinearity, correlation between predictors, impairs the reliability of the independent variables predicting the dependent variable. Multicollinearity becomes problematic when VIF values are greater than 3 (Field, 2010). As shown in the coefficients tables in Appendix 3, there are some VIF values greater than 3. These VIF values occur with the dummy variables for industry: Food, Chemical, Machinery, Metal and Electronic. These dummy variables correlate with each other, implicating that they might not be reliable to predict the independent variable. Therefor the results regarding these dummy variables of industry should be interpreted with caution within the analysis.

Besides these assumptions, Hilbe (2007) also puts forth the assumptions that within negative binomial regression zero counts are possible and that these zero counts are included in the data. As shown in the descriptive frequency tables in Appendix 1, the minimum for each item is 0. Thus zero counts are possible and taken into account.

Analysis of the main model

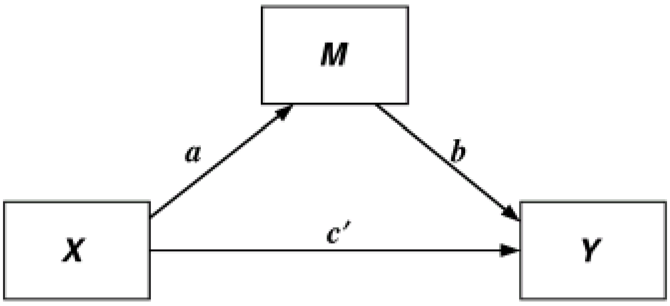
The first step of the analysis is to make a composite variable for calculating the adoption of sustainable technologies in manufacturing firms. The variable ‘adoption of sustainable technologies in manufacturing firms’ exist of six different items (h03o1, h03p1, h03q1, h03r1, h03s1, h03t1) computed into one count variable. The range for the variable adoption of sustainable technologies could be from zero to six. With the value of six meaning that the organization adopted all the six kinds of sustainable technologies asked in the survey and zero meaning that the organizations adopted none of them. In Appendix 1 the minimum and maximum of the adoption of sustainable technologies in manufacturing firms are adjunct. With a minimum of zero and a maximum of three, the range of the variable adoption of sustainable technologies in manufacturing firms is limitary.

The first analysis run, will be the one including the control model. So the model including the adoption of sustainable technologies and the control variables size and the dummy variables for industry. As stated before, the adoption of sustainable technologies in manufacturing firms is a count variable, so the normal distribution of this variable will probably be skewed and distributed as Poisson or negative binomial. The assessment of the model is an iterative process which starts with estimating if the data fits the analysis by estimating whether the Pearson Chi-square divided by its degrees of freedom is greater than .05 (Fabio et al., 2012) and see whether the Pearson Chi-square is significant, for model significance. The goodness of fit of the model can be estimated by the deviance of the model (Fabio et al., 2012). After the control model, the first main model will be tested including the adoption of sustainable technologies, the control variables and the variables indicating the pressures.

Analysis of the mediation model

Mediation analysis is used to determine the mechanism that explains the relationship between an independent and dependent variable (Field, 2010). Mediation analysis is conducted to set out the process underlying this relationship between the independent and dependent variable (Preacher & Hayes, 2004). A mediating variable transmits the influence from an independent variable on a dependent variable (MacKinnon et al., 2007). Within mediation analysis not solely the effect from the independent on the dependent is tested

Figure 3.



(c'),but also the effect from the independent on the mediator (a) and the effect from the mediator on the dependent variable (b). The three different effects tested are shown in Figure 3, with X being the independent variable, Y being the dependent variable and M being the mediator variable. Mediation analysis consist of executing multiple regression analyses, in this case along with negative binomial regression analyses, sequentially.

The first analysis conducted will consist of the independents, the two variables indicating coercive pressure, and dependent variable, adoption of sustainable technologies in manufacturing firms. When there is a significant influence from the two variables indicating coercive pressure on the adoption of sustainable technologies in manufacturing firms, it is possible that there is a mediating effect. The second step op mediation analysis includes an analysis of the independent, coercive pressure, on the mediator(s) (Field, 2010), in this case the variables indicating mimetic- and normative pressure. For the presence of a mediator effect a significant relationship between coercive- and one of the other variables indicating the pressures (mediators) is needed. The third step of mediation analysis includes an analysis of the mediator(s) and the dependent variable, the adoption of sustainable technologies. Therefore, two analyses will be conducted, both with the adoption of sustainable technologies in manufacturing firms as dependent variable and the variables indicating the different pressures as independent variable. When there is a significant effect from the mediator(s), the pressure(s), on the dependent variable, the adoption of sustainable technologies in manufacturing firms, the last analyses will be conducted. The last analyses consist of an analysis examining both the independent and the mediator variables and their influence on the dependent variable (Field, 2010). So in this case two analyses, one testing the model containing the influences of the variables indicating coercive pressure and mimetic pressure on the adoption of sustainable technologies in manufacturing firms. The other one testing the model containing the influences of the variables indicating coercive pressure and normative pressure on the adoption of sustainable technologies in manufacturing firms. This last analyses will be conducted to see whether the mediation is partial or full.

The two pressure will be taken along as separated mediators, so three different mediation models will be tested. One for the variable indicating mimetic pressure. And two separated ones for the two variables indicating normative pressure. The variables are examined as separate mediators because there is the possibility that only one of the variables indicating the pressures is a mediator on the relationship between coercive pressure and the adoption of sustainable technologies in manufacturing firms, while the other variables are not.

Results

All the statistical analyses are conducted with IBM SPSS statistics 23.

Descriptive and correlation statistics

Table 2 shows the descriptive statistics and correlation coefficients. The means of all the variables indicating the three pressures are below .5, indicating that more than half of the firms do not experience these variables indicating the pressures. For the calculating the correlation coefficients, Spearman's Rho is used, due to the fact that the variables are categorical or counted and there is no linearity. The Pearson correlation assesses the linear relationship between two continuous variables, Spearman's rho assesses the monotonic relationship between two ordinal or continuous variables (Field, 2010). Monotonic relationship refers to a relationship between two variables that change each other, but not at a constant (linear) pace. The adoption of sustainable technologies in manufacturing firms correlates significantly with the two variables indicating normative pressure and with the control variable size. The correlations between the adoption of sustainable technologies and normative pressure EPE (.191, $p>.05$), normative pressure EMS (.217 $p>.05$) and size (.334 $p>.01$) are weak. The two variables indicating normative pressure correlate significantly with each other (.372, $p>.01$) but this correlation is also weak. There are significant correlations found between the dummy variables for industry. Metal correlates significantly with all the other dummy variables, except Food. Metal correlates significantly with Textile (-.241, $p>.01$), Chemical (-.327, $p>.01$), Machinery (-.258, $p>.01$) and Electronic (-.187, $p>.01$), yet again all these correlations are weak. All these correlations are negative, due to the fact that when one of the dummy variables is high, the other dummy variables get lower due to the fact that every firm only fills in 'yes', or 1 to one of the six categories or dummy variables. Significant correlations between the two variables indicating normative pressure and size are also present, size correlates moderate with normative pressure EPE (.449, $p>.01$) and weak with normative pressure EMS (.262, $p>.01$). These positive correlations may indicate that normative pressure has a bigger influence in bigger organizations. Based on the correlations, predictors for the adoption of sustainable technologies could be the two variables indicating normative pressure and size. Descriptive statistics and the correlation table are adjunct in Appendix 4.

Table 2 descriptive statistics and correlations.

Constructs	Variables	Mean	SD	1	2.1	2.2	3	4.1	4.2	5.1	5.2	5.3	5.4	5.5	5.6
The adoption of sustainable technologies in manufacturing firms	**1.** Adoption	.409	.726												
Coercive pressure	**2.1** Coercive pressure lawful	.355	.480	.009											
	2.2 Coercive pressure subsidy	.129	.337	.072	-.031										
Mimetic pressure	**3.** Mimetic pressure collaboration	.245	.432	.101	.049	-.039									
Normative pressure	**4.1**Normative pressure EPE	.205	.405	.191*	.026	-.046	.050								
	4.2 Normative pressure EMS	.062	.241	.217*	.112	-.018	.124	.372**							
Industry	**5.1** Metal			.104	-.021	.039	-.044	-.104	-.082						
	5.2 Food			.005	.052	-.004	-.154	-.072	-.070	-.155					
	5.3 Textile			.117	-.044	.026	.033	.080	.138	-.241**	-.112				
	5.4 Chemical			-.025	.173*	-.234**	-.129	.150	.122	-.327**	-.153	-.237**			
	5.5 Machinery			-.151	-.107	.169	.107	-.077	-.057	-.258**	-.133	-.206**	-.280**		
	5.6 Electronic			-.057	-.065	.062	.202*	.006	-.084	-.187**	-.087	-.135	-.183*	-.160	
Size	**6.** Size	186	797.104	.334**	.074	-.026	.023	.449**	.262**	-.057	.023	-.026	.055	.113	-.135

*=sign. at .05 (2-tailed). **=sign. at .01 (2-tailed). Spearman's Rho is used for calculating correlations. Means for the dummy variables of industry are not displayed, due to the fact that they are not usefully interpretable.

Negative binomial regression

Control Model

The first model run is the model containing the variable adoption of sustainable technologies, the variable size and the dummy variables for industry. To verify whether the data fits the model and manner of analysis, the Pearson Chi-square/df should be greater than .05. As shown in Table 3, the Pearson Chi-square/df value of the control model is .996, so the analysis fits the used data. As shown in the negative binomial regression table (Table 3), the model is not significant. The likelihood ratio Chi-square has a p value of .381 which is not significant with an estimated α.1. The likelihood Chi-square compares the overall model to a null-model, the model without predictors. With an insignificant likelihood Chi-square, the model is no improvement over a null-model for predicting the adoption of sustainable technologies in manufacturing firms. Looking at the effects of and industry, all the dummy variables have an insignificant effect on the adoption of sustainable technologies in manufacturing firms. Looking at size, this effect is significant (p.082<.1), but it does not explain any of the variance in the adoption of sustainable technologies in manufacturing firms. The Exp (B) explains the direction and the extent in which an change in the independent variable explains the dependent variable. With an Exp (B) value of 1.000, the variable size explains no variance in the adoption of sustainable technologies in manufacturing firms. SPSS output from the analysis of the control model is adjunct in Appendix 5.

Main model

The second model run is the model containing the variables indicating the pressures, the control variables size and the dummy variables for the control variable industry. As shown in Table 3, the Pearson Chi-square/df has a value greater than .05 (.896), indicating that the analysis fits the used data. The likelihood ratio Chi-square is not significant (.839) indicating that the model is no improvement over a null-model for the adoption of sustainable technologies in manufacturing firms. Due to their categorical character, the variables are split up in a 0, reference, and a 1 category (Appendix 6). As shown in table 3, the 1 category results are taken into account in the analysis and the 0 category is the reference category.

Table 3. Negative binomial regression results

	Control Model		**Main Model**	
	Control variables.		Control model + the variables indicating coercive-, mimetic and normative pressure.	
	Exp (B)	p-value.	Exp (B)	p-value.
Intercept	.277	.024	.267	.069
Predictors				
Coercive pressure lawful			.920	.832
Coercive pressure subsidy			1.687	.327
Mimetic pressure collaboration			1.281	.593
Normative pressure EPE			1.313	.553
Normative pressure EMS			2.352	.198
Covariates				
Metal	1.965	.285	1.689	.469
Food	1.177	.852	1.255	.834
Textile	1.864	.366	1.308	.739
Chemical	1.270	.715	1.188	.829
Machinery	.673	.597	1.011	.981
Electronic	1	.	1	.
Size	1.000	.082*	1.000	.988
Model information				
Deviance /df	.775		.819	
Pearson Chi-square /df	.996		.896	
Log Likelihood	-114.972		-91.171	
Likelihood ratio Chi-square /df	6.385/6		6.487/11	
p-value.	.381		.839	

*sign. at p<.1, ** sign. at p<.05, ***sign. at p<.01 The '0' or 'no' categories of the variables are used as reference and not included in the table above.

As shown in Table 3, not one of the effects of the predictors is significant. All the Exp (B) effects are positive (>1), but do not explain enough variance in the model to have an significant effect on the adoption of sustainable technologies in manufacturing firms. Based on the Deviance/df the model has a slightly better fit than the control model, but the difference between the deviances of the models is so small that it could be neglected. Therefore, the first three hypotheses, including the influences from the pressures on the adoption of sustainable technologies in manufacturing firms, could not be confirmed by these results.

Mediation model (s)

The influence from coercive pressure on the adoption of sustainable technologies in manufacturing firms, mediated by mimetic pressure.

Despite the fact that there was no significant relationship between coercive pressure and the adoption of sustainable technologies in manufacturing firms in the main model, the mediation analysis will be conducted. Although hypotheses are testes based on the full model, underlying relationships and correlations could be detected through a partial model like this. The analysis will be conducted to see whether some significant results could be found between the mediator and the independent or other results that might explain some variance in the variables or any kind of (underlying) relationship between variables, despite the fact that the variables did not have significant relationships in the main model. When there is for example an relationship between the independent and the mediator, this might be a relationship to investigate further, in future research. As explicated in the methodology chapter, the first test is the one of the effect from the independent variable, coercive pressure, and the dependent variable, adoption of sustainable technologies. For the construct coercive pressure, the two variables indicating coercive pressure are taken into account. In Table 4, significance levels from the negative binomial regression analyses and the regression analyses of the mediation analysis are displayed. The overall output of model 3 is adjunct in Appendix 7.

Table 4. Significance statistics of the mediation analyses with mimetic pressure as mediator.

	Model 3			
	The influence from coercive pressure on the adoption of sustainable technologies in manufacturing firms with mimetic pressure as mediator			
Coercive pressure -> The adoption of sustainable technologies in manufacturing firms **(c')**		Exp. (B)	p-value.	**Model sign.**
	(lawful)	.923	.817	
	(subsidy)	1.463	.424	.683
Coercive pressure -> Mimetic pressure **(a)**		Beta	p-value.	**Model sign.**
	(lawful)	.077	.422	
	(subsidy)	-.009	.924	.715
Mimetic pressure -> The adoption of sustainable technologies in manufacturing firms ***(b)***		Exp (B)	p-value.	**Model sign.**
		1.529	.225	.229

With negative binomial regression models, the models including the dependent, the significance level of the likelihood ratio Chi-square is used for the significance of the model. For the other models the significance level of the regression in Anova is used. *=sign. at p<.1 **=sign. at p<.05 ***=sign. at p<.01

As displayed in Table 4, not one of the effects, in the mediation model is significant. Based on the absence of an significant effect from the independent on the dependent, a mediating effect is not possible. But as elaborated on before, the whole mediation model was run due to the fact that maybe other significant effects or relationships could be found, which is not the case in the first mediation model (Model 3). Hypotheses four, predicting the influence from coercive pressure on mimetic pressure could not be confirmed based on these results.

The influence from coercive pressure on the adoption of sustainable technologies in manufacturing firms, mediated by normative pressure.

Due to the absence of an significant effect from coercive pressure on the adoption of sustainable technologies in manufacturing firms, the mediation model with coercive pressure as independent, the adoption of sustainable technologies in manufacturing firms as dependent and normative pressure as mediator is not a significant model. In Table 5, significance levels of the effects, Beta or Exp (B) for the negative binomial relationships, and models are displayed. The model was run two times, with the two variables indicating normative pressure taken along as two separate mediators in two separate mediation models.

Table 5. Significance statistics of the mediation analysis with normative pressure as mediator

	Model 4a				**Model 4b**			
	The influence from coercive pressure on the adoption of sustainable technologies in manufacturing firms with normative pressure EPE as mediator				The influence from coercive pressure on the adoption of sustainable technologies in manufacturing firms with normative pressure EMS as mediator			
Coercive pressure -> The adoption of sustainable technologies in manufacturing firms ***(c')***		Exp (B)	p-value.	**Model sign.**		Exp (B)	p-value.	**Model sign.**
	(lawful)	.923	.817		(lawful)	.923	.817	
	(subsidy)	1.463	.424	.683	(subsidy)	1.463	.424	.683
Coercive pressure -> Normative pressure ***(a)***		Beta	p-value.	**Model sign.**		Beta	p-value.	**Model sign.**
	(lawful)	-.005	.958		(lawful)	.092	.329	
	(subsidy)	-.024	.802	.968	(subsidy)	-.069	.945	.616
Normative pressure -> The adoption of sustainable technologies in manufacturing firms ***(b)***		Exp (B)	p-value.	**Model sign.**		Exp (B)	p-value.	**Model sign.**
		1.878	.077*			3.275	.021**	
				.080*				.023**

With negative binomial regression models, the models including the dependent, the significance level of the likelihood ratio Chi-square is used for the significance of the model. For the other models the significance level of the regression in Anova is used. *=sign. at p<.1 **=sign. at p<.05 ***=sign. at p<.01

Despite the fact that the mediation model is not significant, some significant relationships are found in the mediation models containing the variables indicating normative pressure. The results of the two model run are displayed in Table 5. The first model contains the energy performance evaluation dimension of normative pressure, normative pressure EPE. As confirmed before, the relationship between coercive pressure and the adoption of sustainable technologies in manufacturing firms is not significant. The relationship between coercive pressure and normative pressure, in this case normative pressure EPE is not significant as well. The third relationship tested, between the mediator normative pressure EPE and the dependent, the adoption of sustainable technologies in manufacturing firms is significant ($p<.1$). The Exp (B) of 1.878 illustrates, that the adoption of sustainable technologies for normative pressure EPE is 1.878 times higher than for the reference category, so when the firms did not experience this dimension of normative pressure.

The last mediation model run is the one inclosing the energy management system dimension of normative pressure, normative pressure EMS, as mediator (Model 4b). Yet again there is no significant relationship between coercive pressure and this dimension of normative pressure. Recurrently there is a significant relationship between the mediator, normative pressure EMS and the dependent, the adoption of sustainable technologies in manufacturing firms ($p<.05$). With an Exp (B) that demonstrates that the adoption of sustainable technologies in manufacturing firms is 3.275 times higher when the firms experience this kind of normative pressure, than when they do not (reference category).

Based on these results the fifth hypotheses, predicting the influence from coercive pressure on normative pressure could not be confirmed. The significant relationships found between the variables indicating normative pressure and the adoption of sustainable technologies should be interpreted with caution, due to the fact that in a more holistic model, containing the other pressures and the control variables, these relationships are not significant. Conclusions will be drawn on the more holistic models, but the possibility of the presence of these relationship will not be ruled out.

Conclusion

Based on the analyses conducted with data from 149 Dutch manufacturing firms, the research question:

Is the adoption of sustainable technologies in manufacturing firms influenced by the coercive-, mimetic- and normative pressures these firms are experiencing and how do these pressures relate?

Could not be confirmed within this research. There were no significant results found that support the fact that the adoption of sustainable technologies in manufacturing firms is influenced by the coercive-, mimetic- and normative pressures these firms are experiencing. Despite the fact that the adoption of sustainable technologies in manufacturing firms correlates significantly with normative pressure, size and industry, no specific significant results were found in the models completed and analyzed. Therefore, the first hypothesis, indicating that coercive pressure has a positive influence on the adoption of sustainable technologies in manufacturing firms gets rejected. This does not explicitly indicates that this relationship is absent in any case, but in this case using the data of these organizations and these items, the relationship is not significant.

The same goes for the second hypothesis, indicating that the mimetic pressure has a positive influence on the adoption of sustainable technologies in manufacturing firms. Yet again this hypothesis is not supported by the founded results, so in this case it can be rejected. The third hypothesis, indicating that there is a relationship between normative pressure and the adoption of sustainable technologies in manufacturing firms gets rejected as well. No significant results regarding the confirmation of this hypothesis.

Notable for the relationship between normative pressure and the adoption of sustainable technologies in manufacturing firms is the fact that when testing this relationship in a less holistic manner, solely testing the relationship between the variables indicating the constructs of normative pressure and the adoption of sustainable technologies as done in one part of the mediation analysis, the relationship is significant. So based on the correlation between these variables and the significant relationships when the relationships are tested univariate the conclusion can be drawn that there is an influence from normative pressure on the adoption of sustainable technologies in manufacturing firms. This influence is just too weak to explain a significant part of the variance in the adoption of the sustainable technologies in manufacturing firms when other predictors are taken into account as well.

For hypothesis four and five to be confirmed, the mediating effect from mimetic- or normative pressure, a significant relationship between coercive pressure and the adoption of sustainable technologies was mandatory. So hypotheses four and five, indicating that the relationship between coercive pressure and the adoption of sustainable technologies in manufacturing firms was mediated by mimetic- or normative pressure get rejected likewise. Due to the fact that there is no significant relationship between the independent, coercive pressure, and the dependent, the adoption of sustainable technologies in manufacturing firms, a mediating variable for this non-significant relationship is absent as well.

Discussion

According to Chen et al. (2009; 2011) and Bansal (2005), coercive- and mimetic pressure drive the adoption of green technologies and have a positive effect on sustainable development. Within this research, no such significant relationships were found. This dissonance with previous research could have various explanations. Chen et al. (2009; 2011) put an emphasis on green technologies and systems in the information sector/industry. Within this research the aim was on manufacturing firms, so the production industry. This might be a possible explanation for the difference in outcomes. Despite the fact that the different industries gathered within the construct of manufacturing firms did not have a significant relationship with the adoption of sustainable technologies, other industries might have. Bansal (2005) did focus on resource intensive industries, such as the oil-, gas- and mining industries. These industries seem more relatable to the manufacturing industry. Differences in findings might be explained by the fact that data was gathered in a another country, not the Netherlands. Different countries show different levels of sustainable development (Jovane et al., 2008) and different environmental conditions in different geographic regions, such as environmental- and social pressures, lead to distinctive moral attitudes towards sustainability and thus the adoption of sustainable technologies (Thomas & Lamm, 2012). Therefor it might not be possible to compare results found in different geographic regions or countries. The coercive-, mimetic- and normative pressures within countries also differ due to the fact that homogenization, or the isomorphism, of organizational fields derives from a structuration process which is affected highly by the state and professionalism (Dimaggio & Powell, 1983).

Research limitations

The lack of significant results when expected may also be the consequence of the limitations this research has. According to the adequate sample size for negative binomial regression analysis, there are many different views. As reported by Saha & Paul (2005) a sample size of 10 can be enough although Dean & Lawless (1989) consider a sample size of at least 50 and Robinson & Smyth (2008) elaborate on cases where 100 or even a 1000 respondents are favorable. Lawless (1987) acknowledges that when the *a* in the negative binomial regression model, representing the value for the independent variable, is close to zero the model might not be compared and interpreted right unless the sample size is large. Looking at the mean of the adoption of sustainable technologies in manufacturing firms (.4085 in Appendix 1), being close to zero, you can infer based on Lawless (1987) that the sample size of this research needs to be large. Due to the fact that there is no further elaboration on what is meant by a 'large' sample size, there can only be suspicion that the Dutch sample of 149 organizations might be too small for the analyses conducted.

Besides the limited sample size, the limited number of items measuring the used constructs might also have an impact on the results. Within this research, a deductive research method was used, so test were run based on (existing) theory. Due to the fact that the used data was already captured in the EMS data base, the theoretical constructs could not be fully operationalized to the widest range of items. The items that were picked, were selected based on their content and not selected based on the adequate quantity and quality favorable for measuring these constructs. So the best available items from the EMS database were selected, but these items are not destined the best suited to measure the constructs in general. With the pressures only consisting of one or two items, this might not be the most extended view of the construct. When the data would not have been already captured, possibly more items would be used to explain the constructs in this research. This may have caused that the constructs are not as extended and holistic as necessary to get any significant or generalizable results. The variables indicating the pressures are the best fit based on the EMS data base, but are probably different from when the possibility is there to operationalize and create a measurement model from scratch based on the theory. The items are just indicating the presence of the pressures, but not representing the pressures in a holistic matter. This can be a reason that there were no significant results found when expected.

Future research

Due to the limitations of this research, there still a lot of relationships that could be distinguished and displayed in future research. Despite the fact that nothing derives from the mediation analysis conducted regarding the mutual relationships of the pressures, this might still be a subject for further research. Within the existing literature about institutional theory there are many perspectives and relationships tested with the pressures and other constructs, but not really going in on how the three pressures relate to each other. Even though there were no significant results explaining the mutual relationships of the pressures in this research, there still might be mutual relationships between the pressures.

As elaborated on in the first section of the discussion chapter, sustainable development differs in different countries and the coercive-, and possibly the mimetic- and normative pressures experienced differ in different countries. That is why the construct of national difference might be an interesting construct to add to the conceptual model containing the pressures and the adoption of sustainable technologies in manufacturing firms. National difference could have an influence on the pressures as well as on the adoption of sustainable technologies in manufacturing firms, so a mediation model occurs which could be suitable and interesting for further research. National difference is one possible construct to add to the conceptual model to get a more holistic and realistic view of the factors influencing the adoption of sustainable technologies in manufacturing firms.

Theoretical implications

Although the research question is not confirmed and all the hypotheses are rejected, this research still contributes to the general body of existing literature. With hypotheses derived from existing literature being rejected this research is a suggestion that this subject could use more insights on other factors explaining the adoption of sustainable technologies. The existing literature is not applicable on these cases tested, so there might be many other cases (other countries, industries etc.) where these theories are not applicable as well. This research confirms that and hopefully motivates other researchers to learn more about these constructs and dive into other constructs that also might relate to the constructs and relationships tested within this research.

Managerial implications

From a managerial perspective, this research is not the most advantageous guideline. The aim was to distinguish the different pressures and see how they relate, so that Dutch managers could make sense of the pressures they are experiencing and whether they should ‘obey’ to these pressures and start to adopt more sustainable technologies. With no significant relationships found, there are no specific results that indicate and further explain the pressures ,and their relationships, that the Dutch manufacturing firms are experiencing. However this research might be helpful for managers to receive some insights regarding the adoption of sustainable technologies in manufacturing firms, specifically how many (other) factors influence this adoption. Thus instead of confirming relationships and recommending how to act upon these relationships, managers get more insight in the bigger picture and all the factors influencing or not influencing the construct, adoption of sustainable technologies. This research suggest that other factors play a key-role in predicting the adoption of sustainable technologies and that supports managers to get a more expanded view of the environment they are operating in.

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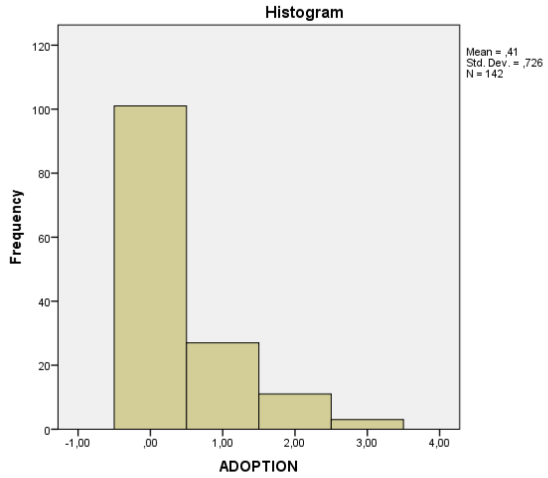
Appendix 1 : Frequencies

Histogram of the count variable ‘adoption of sustainable technologies in manufacturing firms’.



Frequency table of one of the items indicating coercive pressure, the subsidy dimension.

CP_subsidy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,0	108	72,5	87,1	87,1
	1,0	16	10,7	12,9	100,0
	Total	124	83,2	100,0	
Missing	-99,0	21	14,1		
	-98,0	3	2,0		
	-97,0	1	,7		
	Total	25	16,8		
Total		149	100,0		

Descriptive statistics of the variables adoption, size, the dummy variables indicating the pressures and the dummy variables created for the variable industry.

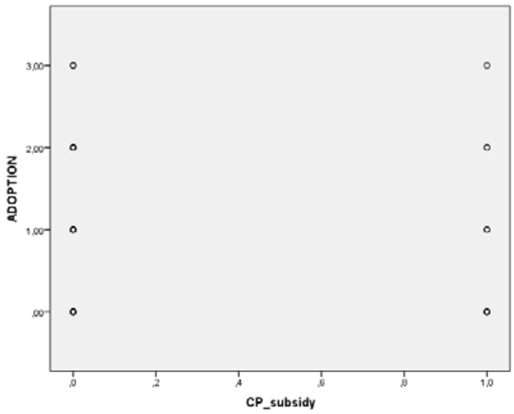
Statistics

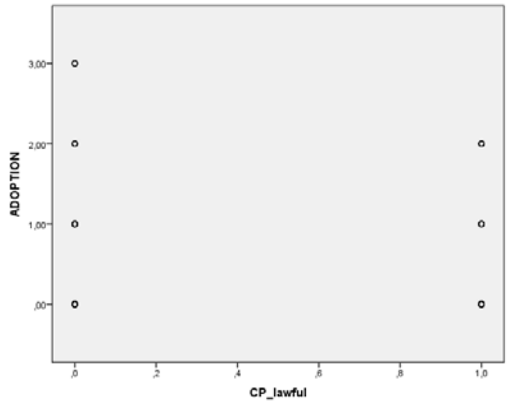
	ADOPTION	CP_lawful	CP_subsidy	MP_collab	NP_epe	NP_ems	Metal	Food	Textile	Construction	Chemical	Machinery	Electronic	Size
N Valid	142	138	124	143	146	146	148	148	148	148	148	148	148	147
Missing	7	11	25	6	3	3	1	1	1	1	1	1	1	2
Mean	,4085	,355	,129	,245	,205	,062	,2500	,0676	,1486	,0000	,2432	,1959	,0946	185,8571
Std. Deviation	,72596	,4803	,3366	,4315	,4054	,2413	,43448	,25185	,35695	,00000	,43050	,39827	,29365	797,10448
Skewness	1,791	,612	2,240	1,200	1,473	3,683	1,167	3,481	1,996		1,209	1,548	2,799	7,392
Std. Error of Skewness	,203	,206	,217	,203	,201	,201	,199	,199	,199	,199	,199	,199	,199	,200
Kurtosis	2,584	-1,649	3,068	-,568	,172	11,726	-,648	10,256	2,009		-,545	,401	5,914	57,390
Std. Error of Kurtosis	,404	,410	,431	,403	,399	,399	,396	,396	,396	,396	,396	,396	,396	,397
Minimum	,00	,0	,0	,0	,0	,0	,00	,00	,00	,00	,00	,00	,00	4,00
Maximum	3,00	1,0	1,0	1,0	1,0	1,0	1,00	1,00	1,00	,00	1,00	1,00	1,00	7184,00

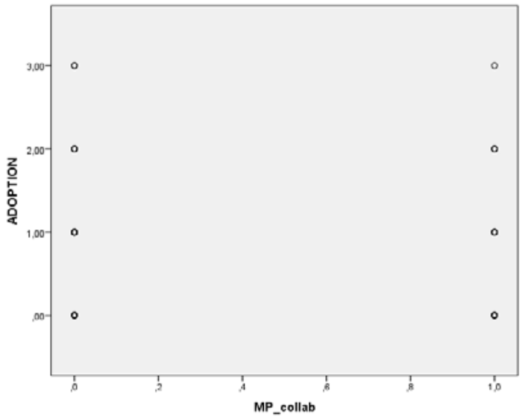
Variable labels used:
ADOPTION = the adoption of sustainable technologies in manufacturing firms
CP_lafwul / CP subsidy = the two variables indicating coercive pressure
MP_collab = the variable indicating mimetic pressure
NP_epe/NP_ems = the two variables indicating normative pressure
Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry
Size = Size

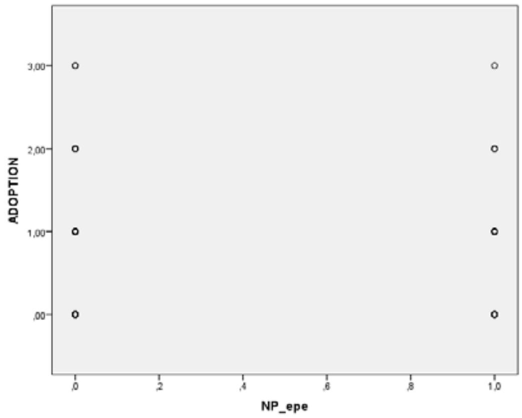
Appendix 2 : Scatterplots

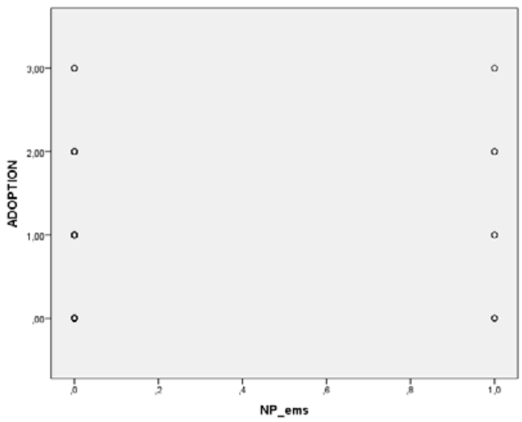
Scatterplots of all the dependent variables (the dummy variables indicating the pressures, the control variable size and the dummy variables for industry) and the adoption of sustainable technologies in manufacturing firms.

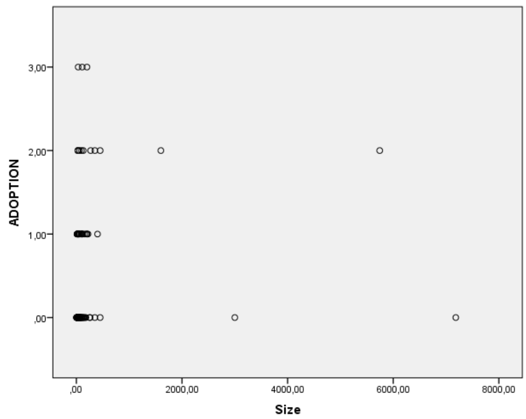


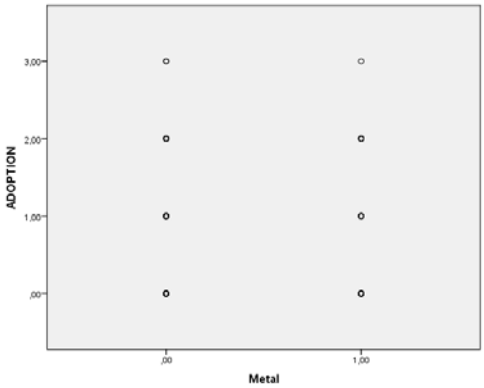


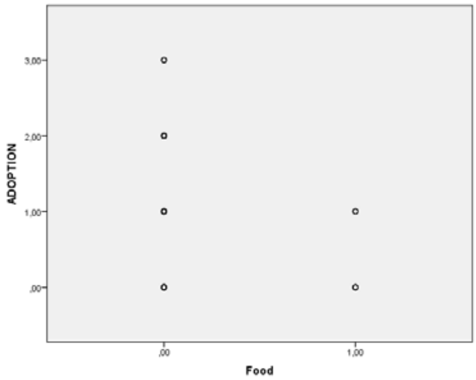


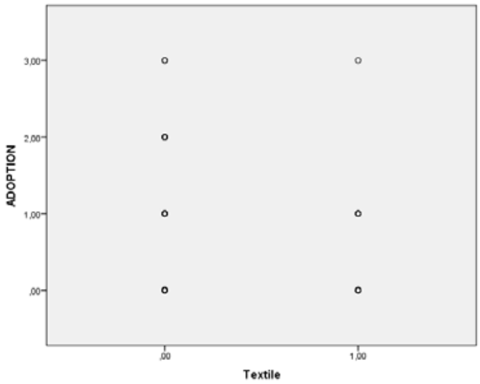


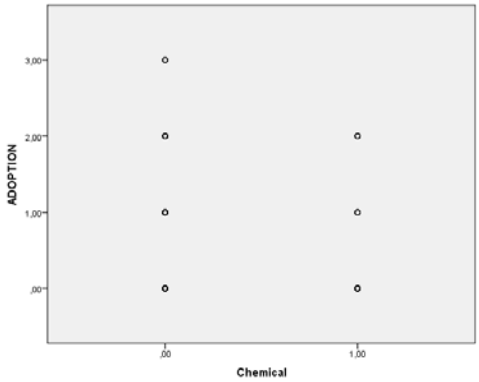


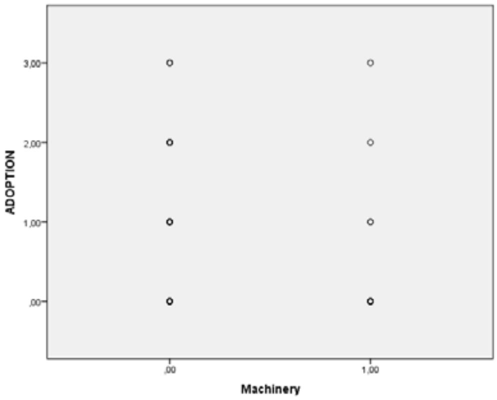


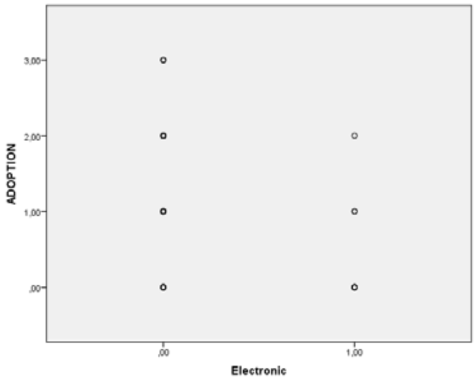












Variable labels used:

ADOPTION = the adoption of sustainable technologies in manufacturing firms

CP_lafwul / CP_subsidy = the two variables indicating coercive pressure

MP_collab = the variable indicating mimetic pressure

NP_epe/NP_ems = the two variables indicating normative pressure

Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry

Size = Size

Appendix 3 : Collinearity Statistics

Collinearity statistics of all the predictors, independent variables. Subsequently rotated with one predictor as the ‘dependent’ variable.

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	CP_subsidy	,884	1,132
	MP_collab	,821	1,217
	NP_epe	,820	1,219
	NP_ems	,754	1,327
	Food	,832	1,202
	Textile	,721	1,386
	Chemical	,614	1,628
	Machinery	,684	1,462
	Electronic	,797	1,255
	Size	,775	1,291

a. Dependent Variable: CP_lawful

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	MP_collab	,826	1,210
	NP_epe	,818	1,223
	NP_ems	,751	1,332
	Food	,847	1,181
	Textile	,722	1,385
	Chemical	,634	1,577
	Machinery	,679	1,473
	Electronic	,797	1,255
	Size	,795	1,258
	CP_lawful	,941	1,063

a. Dependent Variable: CP_subsidy

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	NP_epe	,819	1,221
	NP_ems	,759	1,317
	Food	,851	1,175
	Textile	,722	1,385
	Chemical	,635	1,575
	Machinery	,687	1,456
	Electronic	,807	1,240
	Size	,792	1,262
	CP_lawful	,951	1,051
	CP_subsidy	,899	1,113

a. Dependent Variable: MP_collab

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	NP_ems	,839	1,193
	Metal	,606	1,651
	Food	,848	1,179
	Textile	,698	1,432
	Machinery	,595	1,681
	Electronic	,719	1,391
	Size	,775	1,291
	CP_lawful	,944	1,059
	CP_subsidy	,884	1,132
	MP_collab	,814	1,229

a. Dependent Variable: NP_epe

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Food	,831	1,204
	Textile	,731	1,367
	Chemical	,609	1,641
	Machinery	,683	1,465
	Electronic	,802	1,246
	Size	,822	1,217
	CP_lawful	,945	1,058
	CP_subsidy	,884	1,132
	MP_collab	,822	1,217
	NP_epe	,913	1,095

a. Dependent Variable: NP_ems

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Food	,830	1,205
	Textile	,721	1,386
	Chemical	,605	1,653
	Machinery	,677	1,476
	Electronic	,796	1,257
	Size	,773	1,294
	CP_lawful	,941	1,063
	CP_subsidy	,884	1,132
	MP_collab	,813	1,231
	NP_epe	,818	1,223
	NP_ems	,751	1,332

a. Dependent Variable: Metal

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Textile	,335	2,987
	Chemical	,261	3,831
	Machinery	,318	3,145
	Electronic	,422	2,368
	Size	,773	1,294
	CP_lawful	,941	1,063
	CP_subsidy	,884	1,132
	MP_collab	,813	1,231
	NP_epe	,818	1,223
	NP_ems	,751	1,332
	Metal	,251	3,987

a. Dependent Variable: Food

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Chemical	,448	2,230
	Machinery	,515	1,941
	Electronic	,650	1,538
	Size	,773	1,294
	CP_lawful	,941	1,063
	CP_subsidy	,884	1,132
	MP_collab	,813	1,231
	NP_epe	,818	1,223
	NP_ems	,751	1,332
	Metal	,454	2,204
	Food	,697	1,435

a. Dependent Variable: Textile

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Machinery	,593	1,685
	Electronic	,718	1,392
	Size	,773	1,294
	CP_lawful	,941	1,063
	CP_subsidy	,884	1,132
	MP_collab	,813	1,231
	NP_epe	,818	1,223
	NP_ems	,751	1,332
	Metal	,592	1,688
	Food	,846	1,182
	Textile	,698	1,433

a. Dependent Variable: Chemical

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Electronic	,642	1,556
	Size	,773	1,294
	CP_lawful	,941	1,063
	CP_subsidy	,884	1,132
	MP_collab	,813	1,231
	NP_epe	,818	1,223
	NP_ems	,751	1,332
	Metal	,426	2,347
	Food	,662	1,511
	Textile	,515	1,941
	Chemical	,381	2,623

a. Dependent Variable: Machinery

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	Size	,773	1,294
	CP_lawful	,941	1,063
	CP_subsidy	,884	1,132
	MP_collab	,813	1,231
	NP_epe	,818	1,223
	NP_ems	,751	1,332
	Metal	,333	3,002
	Food	,585	1,708
	Textile	,433	2,310
	Chemical	,307	3,254
	Machinery	,428	2,338

a. Dependent Variable: Electronic

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	CP_lawful	,943	1,060
	CP_subsidy	,909	1,100
	MP_collab	,833	1,200
	NP_epe	,820	1,220
	NP_ems	,798	1,253
	Food	,833	1,201
	Textile	,724	1,381
	Chemical	,607	1,647
	Machinery	,726	1,377
	Electronic	,796	1,257

a. Dependent Variable: Size

Variable labels used:
ADOPTION = the adoption of sustainable technologies in manufacturing firms
CP_lafwul / CP_subsidy = the two variables indicating coercive pressure
MP_collab = the variable indicating mimetic pressure
NP_epe/NP_ems = the two variables indicating normative pressure
Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry
Size = Size

Appendix 4 : Descriptives & Correlations

Descriptive statistics and correlations of the variables.

Statistics

		ADOPTION	CP_lawful	CP_subsidy	MP_collab	NP_epe	NP_ems	Metal	Food	Textile	Construction	Chemical	Machinery	Electronic	Size
N	Valid	142	138	124	143	146	146	148	148	148	148	148	148	148	147
	Missing	7	11	25	6	3	3	1	1	1	1	1	1	1	2
Mean		,4085	,355	,129	,245	,205	,062	,2500	,0676	,1486	,0000	,2432	,1959	,0946	185,8571
Std. Deviation		,72596	,4803	,3366	,4315	,4054	,2413	,43448	,25185	,35695	,00000	,43050	,39827	,29365	797,10448
Skewness		1,791	,612	2,240	1,200	1,473	3,683	1,167	3,481	1,996		1,209	1,548	2,799	7,392
Std. Error of Skewness		,203	,206	,217	,203	,201	,201	,199	,199	,199	,199	,199	,199	,199	,200
Kurtosis		2,584	-1,649	3,068	-,568	,172	11,726	-,648	10,256	2,009		-,545	,401	5,914	57,390
Std. Error of Kurtosis		,404	,410	,431	,403	,399	,399	,396	,396	,396	,396	,396	,396	,396	,397
Minimum		,00	,0	,0	,0	,0	,0	,00	,00	,00	,00	,00	,00	,00	4,00
Maximum		3,00	1,0	1,0	1,0	1,0	1,0	1,00	1,00	1,00	,00	1,00	1,00	1,00	7184,00

Correlations

			ADOPTION	CP_lawful	CP_subsidy	MP_collab	NP_epe	NP_ems	Metal	Food	Textile	Chemical	Machinery	Electronic	Size
Spearman's rho	ADOPTION	Correlation Coefficient	1,000	,009	,072	,101	,191*	,217*	,104	,005	,117	-,025	-,151	-,057	,334**
		Sig. (2-tailed)	.	,920	,436	,238	,024	,010	,218	,950	,165	,766	,075	,505	,000
		N	142	132	118	138	139	139	141	141	141	141	141	141	140
	CP_lawful	Correlation Coefficient	,009	1,000	-,031	,049	,026	,112	-,021	,052	-,044	,173*	-,107	-,065	,074
		Sig. (2-tailed)	,920	.	,740	,577	,765	,197	,805	,544	,613	,043	,215	,449	,395
		N	132	138	118	133	135	135	137	137	137	137	137	137	136
	CP_subsidy	Correlation Coefficient	,072	-,031	1,000	-,039	-,046	-,018	,039	-,004	,026	-,234**	,169	,062	-,026
		Sig. (2-tailed)	,436	,740	.	,676	,616	,847	,672	,965	,775	,009	,062	,497	,774
		N	118	118	124	119	122	121	123	123	123	123	123	123	122
	MP_collab	Correlation Coefficient	,101	,049	-,039	1,000	,050	,124	-,044	-,154	,033	-,129	,107	,202*	,023

	Sig. (2-tailed)	,238	,577	,676	.	,558	,143	,602	,066	,693	,125	,207	,016	,785
	N	138	133	119	143	140	141	142	142	142	142	142	142	141
NP_epe	Correlation Coefficient	,191*	,026	-,046	,050	1,000	,372**	-,104	-,072	,080	,150	-,077	,006	,449**
	Sig. (2-tailed)	,024	,765	,616	,558	.	,000	,215	,391	,338	,073	,355	,943	,000
	N	139	135	122	140	146	145	145	145	145	145	145	145	144
NP_ems	Correlation Coefficient	,217*	,112	-,018	,124	,372**	1,000	-,082	-,070	,138	,122	-,057	-,084	,262**
	Sig. (2-tailed)	,010	,197	,847	,143	,000	.	,329	,403	,098	,144	,495	,315	,001
	N	139	135	121	141	145	146	145	145	145	145	145	145	144
Metal	Correlation Coefficient	,104	-,021	,039	-,044	-,104	-,082	1,000	-,155	-,241**	-,327**	-,285**	-,187*	-,057
	Sig. (2-tailed)	,218	,805	,672	,602	,215	,329	.	,059	,003	,000	,000	,023	,497
	N	141	137	123	142	145	145	148	148	148	148	148	148	146
Food	Correlation Coefficient	,005	,052	-,004	-,154	-,072	-,070	-,155	1,000	-,112	-,153	-,133	-,087	,023
	Sig. (2-tailed)	,950	,544	,965	,066	,391	,403	,059	.	,173	,064	,107	,293	,784

	N	141	137	123	142	145	145	148	148	148	148	148	148	146
Textile	Correlation Coefficient	,117	-,044	,026	,033	,080	,138	-,241**	-,112	1,000	-,237**	-,206*	-,135	-,026
	Sig. (2-tailed)	,165	,613	,775	,693	,338	,098	,003	,173	.	,004	,012	,102	,752
	N	141	137	123	142	145	145	148	148	148	148	148	148	146
Chemical	Correlation Coefficient	-,025	,173*	-,234**	-,129	,150	,122	-,327**	-,153	-,237**	1,000	-,280**	-,183*	,055
	Sig. (2-tailed)	,766	,043	,009	,125	,073	,144	,000	,064	,004	.	,001	,026	,512
	N	141	137	123	142	145	145	148	148	148	148	148	148	146
Machinery	Correlation Coefficient	-,151	-,107	,169	,107	-,077	-,057	-,285**	-,133	-,206*	-,280**	1,000	-,160	,113
	Sig. (2-tailed)	,075	,215	,062	,207	,355	,495	,000	,107	,012	,001	.	,053	,176
	N	141	137	123	142	145	145	148	148	148	148	148	148	146
Electronic	Correlation Coefficient	-,057	-,065	,062	,202*	,006	-,084	-,187*	-,087	-,135	-,183*	-,160	1,000	-,135
	Sig. (2-tailed)	,505	,449	,497	,016	,943	,315	,023	,293	,102	,026	,053	.	,104
	N	141	137	123	142	145	145	148	148	148	148	148	148	146

	Size	Correlation Coefficient	,334**	,074	-,026	,023	,449**	,262**	-,057	,023	-,026	,055	,113	-,135	1,000
		Sig. (2-tailed)	,000	,395	,774	,785	,000	,001	,497	,784	,752	,512	,176	,104	.
		N	140	136	122	141	144	144	146	146	146	146	146	146	147

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Variable labels used:
ADOPTION = the adoption of sustainable technologies in manufacturing firms
CP_lafwul / CP_subsidy = the two variables indicating coercive pressure
MP_collab = the variable indicating mimetic pressure
NP_epe/NP_ems = the two variables indicating normative pressure
Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry
Size = Size

Appendix 5 : Analysis of the Control Model

SPSS output from the control model containing the dependent variable adoption of sustainable technologies and the covariates size and the dummy variables for industry.

Goodness of Fit[a]

	Value	df	Value/df
Deviance	102,351	132	,775
Scaled Deviance	102,351	132	
Pearson Chi-Square	131,452	132	,996
Scaled Pearson Chi-Square	131,452	132	
Log Likelihood[b]	-114,972		
Akaike's Information Criterion (AIC)	243,944		
Finite Sample Corrected AIC (AICC)	244,799		
Bayesian Information Criterion (BIC)	264,486		
Consistent AIC (CAIC)	271,486		

Dependent Variable: ADOPTION
Model: (Intercept), Metal, Food, Textile, Chemical, Machinery, Electronic, Size
a. Information criteria are in smaller-is-better form.
b. The full log likelihood function is displayed and used in computing information criteria.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
6,385	6	,381

Dependent Variable: ADOPTION
Model: (Intercept), Metal, Food, Textile, Chemical, Machinery, Electronic, Size
a. Compares the fitted model against the intercept-only model.

Variable labels used:
ADOPTION = the adoption of sustainable technologies in manufacturing firms
CP_lafwul / CP_subsidy = the two variables indicating coercive pressure
MP_collab = the variable indicating mimetic pressure
NP_epe/NP_ems = the two variables indicating normative pressure
Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry
Size = Size

Tests of Model Effects

Source	Type I		
	Wald Chi-Square	df	Sig.
(Intercept)	25,853	1	,000
Metal	1,099	1	,295
Food	,059	1	,808
Textile	,811	1	,368
Chemical	,263	1	,608
Machinery	,009	1	,924
Electronic	.[a]	.	.
Size	3,034	1	,082

Dependent Variable: ADOPTION

Model: (Intercept), Metal, Food, Textile, Chemical, Machinery, Electronic, Size

a. Unable to compute due to numerical problems

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-1,285	,5673	-2,397	-,173	5,131	1	,024	,277	,091	,841
Metal	,675	,6319	-,563	1,914	1,142	1	,285	1,965	,569	6,779
Food	,163	,8752	-1,552	1,878	,035	1	,852	1,177	,212	6,543
Textile	,623	,6886	-,727	1,973	,818	1	,366	1,864	,483	7,190
Chemical	,239	,6555	-1,045	1,524	,133	1	,715	1,270	,352	4,590
Machinery	-,397	,7495	-1,866	1,072	,280	1	,597	,673	,155	2,922
Electronic	0[a]	.	.	.	.	.	.	1	.	.
Size	,000	,0002	-3,829E-5	,001	3,034	1	,082	1,000	1,000	1,001
(Scale)	1[b]									
(Negative binomial)	1[b]									

Dependent Variable: ADOPTION

Model: (Intercept), Metal, Food, Textile, Chemical, Machinery, Electronic, Size

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

Appendix 6 : Analysis of the Main Model

SPSS output of the main model, the control model + the variables indicating coercive-, mimetic- and normative pressure.

Goodness of Fit[a]

	Value	df	Value/df
Deviance	74,523	91	,819
Scaled Deviance	74,523	91	
Pearson Chi-Square	81,565	91	,896
Scaled Pearson Chi-Square	81,565	91	
Log Likelihood[b]	-91,171		
Akaike's Information Criterion (AIC)	206,342		
Finite Sample Corrected AIC (AICC)	209,808		
Bayesian Information Criterion (BIC)	237,958		
Consistent AIC (CAIC)	249,958		

Dependent Variable: ADOPTION

Model: (Intercept), CP_lawful, CP_subsidy, MP_collab, NP_epe, NP_ems, Metal, Food, Textile, Chemical, Machinery, Electronic, Size

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
6,487	11	,839

Dependent Variable: ADOPTION

Model: (Intercept), CP_lawful, CP_subsidy, MP_collab, NP_epe, NP_ems, Metal, Food, Textile, Chemical, Machinery, Electronic, Size

a. Compares the fitted model against the intercept-only model.

Tests of Model Effects

Source	Type I		
	Wald Chi-Square	df	Sig.
(Intercept)	14,476	1	,000
CP_lawful	,121	1	,728
CP_subsidy	,998	1	,318
MP_collab	1,313	1	,252
NP_epe	1,095	1	,295
NP_ems	2,191	1	,139
Metal	,898	1	,343
Food	,006	1	,937
Textile	,091	1	,763
Chemical	,070	1	,791
Machinery	,000	1	,984
Electronic	.[a]	.	.
Size	,000	1	,988

Dependent Variable: ADOPTION

Model: (Intercept), CP_lawful, CP_subsidy, MP_collab, NP_epe, NP_ems, Metal, Food, Textile, Chemical, Machinery, Electronic, Size

a. Unable to compute due to numerical problems

Variable labels used:
ADOPTION = the adoption of sustainable technologies in manufacturing firms
CP_lafwul / CP_subsidy = the two variables indicating coercive pressure
MP_collab = the variable indicating mimetic pressure
NP_epe/NP_ems = the two variables indicating normative pressure
Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry
Size = Size

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-1,322	,7257	-2,744	,101	3,317	1	,069	,267	,064	1,106
[CP_lawful=1,0]	-,083	,3920	-,851	,685	,045	1	,832	,920	,427	1,984
[CP_lawful=,0]	0[a]	.	.	.	.	.	.	1	.	.
[CP_subsidy=1,0]	,523	,5327	-,521	1,567	,963	1	,327	1,687	,594	4,792
[CP_subsidy=,0]	0[a]	.	.	.	.	.	.	1	.	.
[MP_collab=1,0]	,247	,4632	-,661	1,155	,285	1	,593	1,281	,517	3,175
[MP_collab=,0]	0[a]	.	.	.	.	.	.	1	.	.
[NP_epe=1,0]	,272	,4580	-,626	1,170	,353	1	,553	1,313	,535	3,221
[NP_epe=,0]	0[a]	.	.	.	.	.	.	1	.	.
[NP_ems=1,0]	,855	,6650	-,448	2,159	1,654	1	,198	2,352	,639	8,660
[NP_ems=,0]	0[a]	.	.	.	.	.	.	1	.	.
Metal	,524	,7246	-,896	1,944	,523	1	,469	1,689	,408	6,989
Food	,227	1,0845	-1,899	2,353	,044	1	,834	1,255	,150	10,513
Textile	,269	,8073	-1,313	1,851	,111	1	,739	1,308	,269	6,366
Chemical	,172	,7967	-1,390	1,733	,047	1	,829	1,188	,249	5,659
Machinery	,011	,8097	-1,576	1,598	,000	1	,989	1,011	,207	4,944
Electronic	0[a]	.	.	.	.	.	.	1	.	.
Size	3,189E-6	,0002	,000	,000	,000	1	,988	1,000	1,000	1,000
(Scale)	1[b]									
(Negative binomial)	1[b]									

Dependent Variable: ADOPTION

Model: (Intercept), CP_lawful, CP_subsidy, MP_collab, NP_epe, NP_ems, Metal, Food, Textile, Chemical, Machinery, Electronic, Size

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

Appendix 7 : Mediation Analysis, Mimetic Pressure

SPSS output from the results of the mediation analysis with mimetic pressure as mediator, coercive pressure as independent and the adoption of sustainable technologies in manufacturing firms as dependent variable.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
,762	2	,683

Dependent Variable: ADOPTION
Model: (Intercept), CP_lawful, CP_subsidy[a]
a. Compares the fitted model against the intercept-only model.

Parameter Estimates

			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-,734	,2272	-1,179	-,288	10,424	1	,001	,480	,308	,750
[CP_lawful=1,0]	-,080	,3459	-,758	,598	,054	1	,817	,923	,469	1,818
[CP_lawful=,0]	0[a]	.	.	.	.	.	.	1	.	.
[CP_subsidy=1,0]	,380	,4755	-,552	1,312	,640	1	,424	1,463	,576	3,715
[CP_subsidy=,0]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	1[b]									
(Negative binomial)	1[b]									

Dependent Variable: ADOPTION
Model: (Intercept), CP_lawful, CP_subsidy
a. Set to zero because this parameter is redundant.
b. Fixed at the displayed value.

Variable labels used:
ADOPTION = the adoption of sustainable technologies in manufacturing firms
CP_lafwul / CP_subsidy = the two variables indicating coercive pressure
MP_collab = the variable indicating mimetic pressure
NP_epe/NP_ems = the two variables indicating normative pressure
Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry
Size = Size

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,128	2	,064	,336	,715[b]
	Residual	20,934	110	,190		
	Total	21,062	112			

a. Dependent Variable: MP_collab

b. Predictors: (Constant), CP_subsidy, CP_lawful

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,222	,056		3,998	,000
	CP_lawful	,068	,084	,077	,807	,422
	CP_subsidy	-,012	,129	-,009	-,095	,924

a. Dependent Variable: MP_collab

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
1,449	1	,229

Dependent Variable: ADOPTION

Model: (Intercept), MP_collab[a]

a. Compares the fitted model against the intercept-only model.

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-1,061	,1934	-1,440	-,682	30,098	1	,000	,346	,237	,506
[MP_collab=1,0]	,425	,3498	-,261	1,110	1,475	1	,225	1,529	,771	3,036
[MP_collab=,0]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	1[b]									
(Negative binomial)	1[b]									

Dependent Variable: ADOPTION

Model: (Intercept), MP_collab

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

Appendix 8 : Mediation Analysis, Normative Pressure

SPSS output from the results of the mediation analysis with normative pressure as mediator, coercive pressure as independent and the adoption of sustainable technologies in manufacturing firms as dependent variable.

First the results from the mediation analysis with the environment performance evaluation dimension of normative pressure (NP_epe).

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,012	2	,006	,032	,968[b]
	Residual	21,229	113	,188		
	Total	21,241	115			

a. Dependent Variable: NP_epe

b. Predictors: (Constant), CP_subsidy, CP_lawful

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,247	,054		4,555	,000
	CP_lawful	-,004	,082	-,005	-,053	,958
	CP_subsidy	-,031	,124	-,024	-,251	,802

a. Dependent Variable: NP_epe

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
3,065	1	,080

Dependent Variable: ADOPTION

Model: (Intercept), NP_epe[a]

a. Compares the fitted model against the intercept-only model.

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	95% Wald Confidence Interval Upper	Hypothesis Test Wald Chi-Square	Hypothesis Test df	Hypothesis Test Sig.	Exp(B)	95% Wald Confidence Interval for Exp(B) Lower	95% Wald Confidence Interval for Exp(B) Upper
(Intercept)	-1,072	,1879	-1,440	-,704	32,529	1	,000	,342	,237	,495
[NP_epe=1,0]	,630	,3558	-,067	1,327	3,136	1	,077	1,878	,935	3,771
[NP_epe=,0]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	1[b]									
(Negative binomial)	1[b]									

Dependent Variable: ADOPTION

Model: (Intercept), NP_epe

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

The results from the mediation analysis with the energy management system dimension of normative pressure (NP_ems).

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,071	2	,036	,486	,616[b]
	Residual	8,224	112	,073		
	Total	8,296	114			

a. Dependent Variable: NP_ems

b. Predictors: (Constant), CP_subsidy, CP_lawful

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	,059	,034		1,718	,089
	CP_lawful	,051	,052	,092	,981	,329
	CP_subsidy	-,005	,077	-,006	-,069	,945

a. Dependent Variable: NP_ems

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
5,187	1	,023

Dependent Variable: ADOPTION

Model: (Intercept), NP_ems[a]

a. Compares the fitted model against the intercept-only model.

Parameter Estimates

			95% Wald Confidence Interval		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Std. Error	Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-1,069	,1728	-1,407	-,730	38,243	1	,000	,344	,245	,482
[NP_ems=1,0]	1,186	,5157	,176	2,197	5,291	1	,021	3,275	1,192	8,999
[NP_ems=,0]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	1[b]									
(Negative binomial)	1[b]									

Dependent Variable: ADOPTION

Model: (Intercept), NP_ems

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.

Variable labels used:
ADOPTION = the adoption of sustainable technologies in manufacturing firms
CP_lafwul / CP_subsidy = the two variables indicating coercive pressure
MP_collab = the variable indicating mimetic pressure
NP_epe/NP_ems = the two variables indicating normative pressure
Metal/Food/Textile/Construction/Chemical/Machinery/ Electronic = the dummy variables for industry
Size = Size