ISO 9000 Norm as a Club Good: Network Effect Evidence from the French Employer Survey

Marc-Arthur DIAYE
Salah GHABRI
Nathalie GREENAN
Sanja PEKOVIC (PhD student-3rd year)
Centre d'Etudes de l'Emploi and Université PARIS-EST Marne-La-Vallée (OEP).
sanja.pekovic@mail.enpc.fr
« Le Descartes I » 29, Promenade Michel Simon
93166 Noisy -Le -Grand Cedex
Tel. 0033 (0)145926973

The objective of this article is to provide empirical evidence supporting the claim of ISO certification as a Club Good. To this purpose, we use two French cross-sectional surveys called the "Changement Organisationnel et Informatisation" (COI 1997) and the "Enquête Annuelle d'Entreprises" (EAE 1997) and we show that there is a positive relationship between the hierarchical's position inside the ISO network and the effect on the turnover per employee and the value-added per employee.

Key words: ISO certification; Club Goods; Network

JEL classification: L15, H41, D62

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1. Introduction

Club Goods are type of goods in Economics classified as a subtype of public goods that are excludable but non rivalrous. It is well-known in the literature that voluntary standards like *ISO* can be conceptualized as a Club Good (Prakash and Potoski, 2007; Kollman and Prakash, 2000). One of the reasons for this is the impossibility to price the discrete units of goodwill benefits that ISO generates, on the other side firms only have to pay an incentive as a membership fee if the excludable benefits are seen to outweigh the costs. Hence, Club's excludable benefits that stem from a membership of *ISO 9000* will provide an important signal to the market of company's engagement with a policy for quality.

Even though there is a number of studies implying ISO norms as a Club Good, there is, to the best of our knowledge, no true analysis of ISO norms in terms of a network in which firms are certified or not and in which the ties (between the firms) represent an economic relationship. From our point of view an approach in terms of network is important because as shown by Bramoullé and Kranton (2007), the

production of Public Goods fundamentally induces a network of relationships between different participants. In our case, the advantage of network analysis is that it makes the empirical analysis of ISO as a Club Good more definitive. Indeed, if from empirical analysis one can show that the payoff (for instance, the profit) of a firm varies according to its relative position in the network (network effect) then one can argue that the ISO standard is a Club Good. In this paper, we aim to provide empirical evidence of this network effect.

The rationale for our approach is that a costly process of ISO certification, as an obstacle for many firms, influence firms to choose between different positions inside the network. Hence some firms may try to be indirectly certified, through their suppliers, to gain advantage of ISO certification, but at the same time try to avoid a difficult and costly process of ISO certification. Using two French microeconomic surveys called the "Changement Organisationnel et Informatisation[1]" (COI 1997), "Enquête Annuelle d'Entreprises[2]" (EAE 1997), we distinguish four types of firms[3]. The first category of firms called Direct Complete Adopters includes companies that have ISO 9000 certification and whose suppliers are also ISO 9000 certified. The second category named Direct Non Complete Adopters, presents those firms that are certified with ISO 9000 certification although their suppliers are not. The third category called Indirect Adopters includes firms which are not ISO certified but their suppliers have ISO certification. The fourth category named Non Adopters includes firms that are not ISO certified and their suppliers also do not have ISO certification. This categorisation allows us to empirically construct a network of relationships between firms (certified/non certified)[4]. For instance, Direct Complete Adopter firms are those which are certified and deal only with certified firms.

The objective of this short paper is not to show the impact of ISO certification on firms' economic performance as this has already been shown by studies of Terlaak and King, 2006 and Corbett et al., 2005. Rather, it is to provide empirical evidence (through network analyses) that ISO certification

[1]The COI survey includes information about firms' organizational change and computerization, http://www.enquetecoi.net.
[2]The EAE is a survey covering basic firm-level variables such as employment, sales, capital stock etc…
[3]We worked with a sample of 4699 companies with more than 20 employees.
[4]Being Direct Complete Adopter, Direct Non Complete Adopter, Indirect Adopter or Non Adopter therefore represents in some sense the position of the firms inside the network.

represents a Club Good. After controlling for selection bias (through propensity score estimates), we arrived at a conclusion that the economic performance of Direct Complete Adopters is higher than that of Direct Non Complete Adopters, which is higher that that of Indirect Adopters which itself is higher than that of Non Adopters. Consequently, the network analysis shows that firms which are not certified gain more when they deal with certified companies.

The remainder of the paper is organized as follows: section 2 introduces the ISO 9000 standard; section 3 develops the main issue of the paper; section 4 presents the data sets and some descriptive statistics; section 5 introduces our econometric analysis and section 6 concludes.

2. Brief description of ISO 9000 standard

The first ISO 9000 certificates attesting that firms were adhering to standards were issued in 1987 (ISO, 1998). The ISO's goal is to facilitate worldwide trade through development of international standards that add value to the products and services in the context of globalisation.

According to ISO (1998),*"The ISO 9000 international standards are a set of written guidelines that make up a non-specific quality management system that can be applied to any organization regardless of the product or service being provided"*. ISO 9000 provides a framework without a need to change how the organization operates so as to "ensure that nothing important is left out and that everyone is clear about who is responsible for doing what, when, how, why and where". Therefore, the certification only recommends the basic elements of a proper quality assurance system, without imposing the ways to apply them (ISO, 1998).

Establishing quality standards and documenting the company's quality systems requires a considerable managerial time and effort. Nonetheless, the ISO 9000 certification is not a risk-free undertaking. The cost of certification (Anderson et al., 1999) can be very high (ranging from $10 000 to $300 000 per company). The time required for a company to become certified depends on many factors, including a firm's size and complexity, current level of work quality, extent of current documentation, and the degree of management commitment and it usually takes between six to twelve months.

Benefits of ISO certification could be distinguished on internal and external levels. Internal advantages include increased customer demand, improved company quality image and competitiveness on the market, compliance with customer requirements. On the other side external advantages include streamlined procedures and documentation, increased awareness of preventive and corrective actions, and provision of foundation for TQM (Total Quality Management). The literature suggests that the most prominent reason for implementing the ISO 9000 certification is that customers prefer to buy from firms that are ISO certified (Rao et al., 1997). In addition, it is identified that firms that have directly adopted the ISO certification often require their suppliers to obtain this kind of certification.

3. Methodology

We will use the network based analysis (Jackson, 2005). Let us recall that the network is considered as a collection of nodes (that represent the members of the network) and ties (which present relationships between members in term of diffusion of quality improvement information).

3.1. Relative position inside the network

In the ISO network, being certified is a positive signal concerning quality improvement (Terlaak and King, 2006), and dealing with (i.e. having as a supplier) a certified firm amplifies this positive signal. On the contrary, dealing with (i.e. having as a supplier) a non-certified firm when certified reduces the positive signal concerning quality improvement. However dealing with (i.e. having as a supplier) a certified firm while non-certified improves your signal concerning quality improvement.

As a consequence, the relationships between firms will determine their position inside the network. The fact that both actors in the relationship (firm and supplier) of Direct Complete Adopters[5] are members of the ISO Club creates a very strong relationship in terms of two-way diffusion of quality improvement information (presented in Figure 1 as link “a”). Moreover, even if we do not find both actors in the relationship of Direct Non Complete Adopters as members of the ISO Club, the firm’s certification

[5]Direct Complete Adopters include companies that have ISO 9000 certification and their suppliers are also ISO 9000 certified; Direct Non Complete Adopters present firms that are certified with ISO 9000 certification but their suppliers are not; Indirect Adopters include firms which are not ISO 9000 certified but their suppliers have ISO 9000 certification; and Non Adopters include firms that are not ISO certified and their suppliers do not have ISO 9000 certification

permits this group to still have a strong relationship in one-way diffusion of quality improvement information (link “b”). Although the actors of this group lost on their link’s strength, they still have a strong position inside the ISO Club. Furthermore, in the case of Indirect Adopters, although the principal beneficiary of ISO advantages (firm) does not directly belong to the ISO Club, firms in this group indirectly benefit from ISO advantages through its suppliers which are certified (indirect membership). We define this relationship as a fairly weak relationship in terms of diffusion of quality improvement information (link “c”). Finally, firms which belong to Non Adopters category are not members of the ISO Club so the signal in terms of quality information is therefore very weak as are the ties between firms in terms of diffusion of quality improvement information (link “d”).

According to the strength of the links (“a”, “b”, “c” and “d”), we can classify our four types of firms: Direct Complete Adopters are on the top of the classification followed by Direct Non Complete Adopters, then Indirect Adopters and finally Non Adopters, respectively.

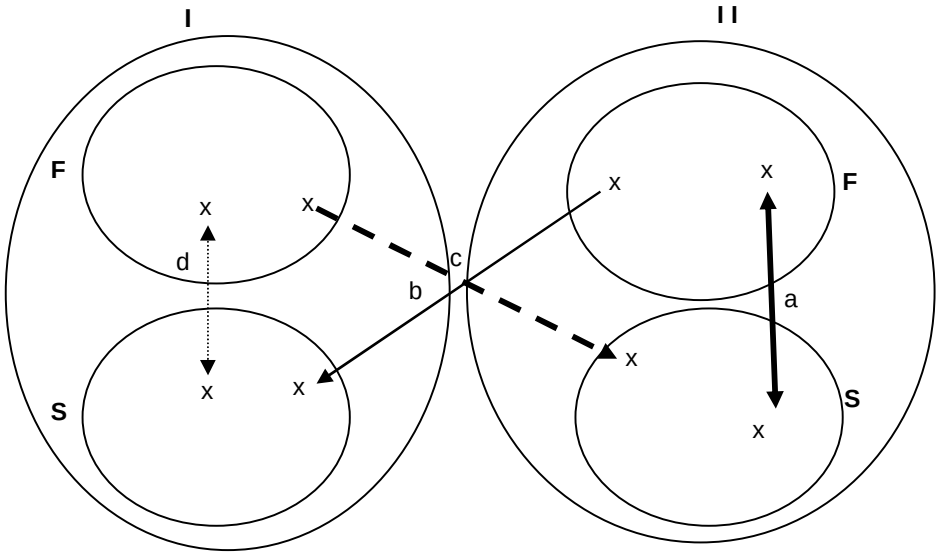

Figure 1 : Graph of Correlations inside the ISO Network.

LEGEND:

Set "I" is the Non-adopter's set of firms
Set "II" is the ISO adopter's set of firms

Subset "F" is a set of firms which do not supply any other firms
Subset "S" is the set of firms which supplies other firms

The nodes:
Node "x" = firm or supplier

The links:

- *Link "a"* represents a very strong correlation in terms of two-way diffusion of quality improvement information between ISO's adopters. It represents Direct Complete Adopter companies that have ISO certification and their supplier who are also certified.
- *Link "b"* represents a fairly strong correlation in terms of one-way diffusion of quality improvement information between ISO's adopters and non adopters (that is reflected by a firm as an adopter of ISO). It represents Direct Non Complete Adopter companies that are certified with ISO certification but their suppliers are not.
- *Link "c"* represents a not strong correlation in terms of diffusion of quality improvement information between ISO's adopters and non adopters (that is reflected by a supplier as an adopter of ISO). It represents Indirect Adopter firms which are supplied by firms that have ISO certification, but are not themselves certified.
- *Link "d"* represents a very weak correlation in terms of diffusion of quality improvement information between ISO's non adopters. It represents Non Adopters companies that are not certified in either direct or indirect way, i.e. they or their suppliers do not have ISO certification.

3.2. Hierarchical Positioning by Cost-Benefit Analysis

Does the hierarchy inside the ISO network imply a similar hierarchy in terms of monetary gains? The level of costs and benefits could help us to define the real advantages of each member inside the network. Taking into account all possible benefits and costs that are part of being a member of the ISO Club, we will try to graphically understand what correlations exist between the strength of the links and economic value inside the network.

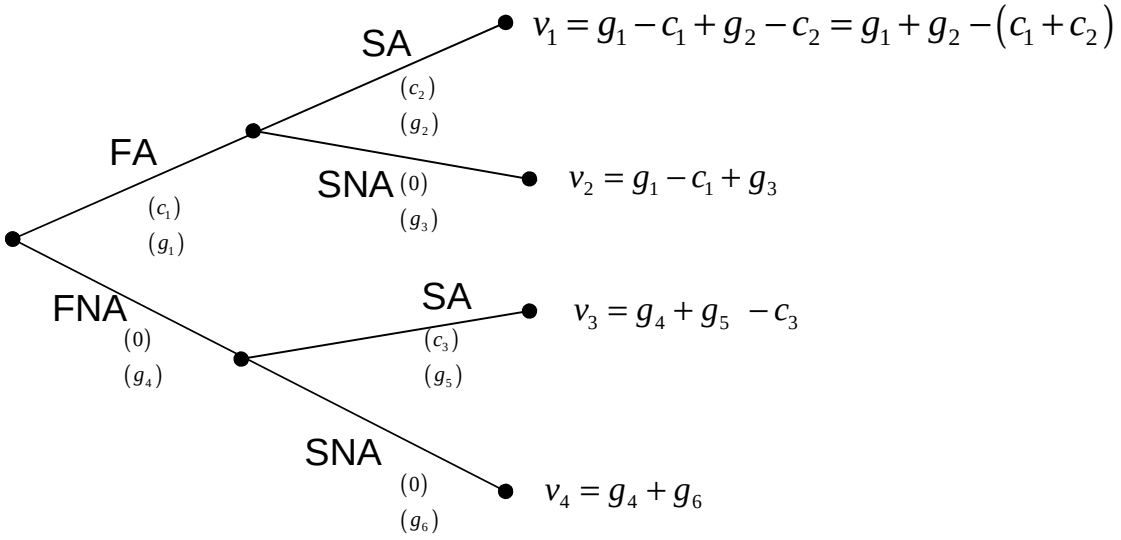

Figure 2 : Net monetary gains of the ISO adopters and Non adopters.

where:

- FA, FNA, SA and SNA respectively mean "ISO Adopter Firms", "non ISO Adopter Firms", "ISO Adopter Suppliers" and "non ISO Adopter Supplier".

- c_1, c_2, and c_3 are respectively the cost of ISO certification, the additional cost of having suppliers that are certified with ISO when the company is certified with ISO and the additional cost of having suppliers that are certified with ISO when the company is not certified ISO.

- $g_1 + g_2$ is the gain of company that is certified with ISO when its suppliers are also certified with ISO.

- $g_1 + g_3$ is the gain of company that is certified with ISO when its suppliers are not certified with ISO.

- $g_4 + g_5$ is the gain of company that is not certified with ISO when its suppliers are certified with ISO.

- $g_4 + g_6$ is the gain of company that is not certified with ISO when its suppliers are not certified with ISO[6].

- $v_j, j \in \{1, 2, 3, 4\}$, is the net monetary gain that company could receive or not from the implementation/non-implementation of ISO certification.

[6] Of course, it seems reasonable to state that $g_1 > g_4$, $g_2 > g_3 > g_5 > g_6$; and $c_1 > c_3 > c_2$.

It is easy to see[7] that v_1, v_2, v_3, v_4 are respectively the values of Direct Complete Adopter firms, Direct Non Complete Adopter firms, Indirect Adopter firms and Non Adopters firms.

It is important to mention that Indirect Adopters do not act as "free riders" in this network because they pay additional costs of having certified suppliers. Thus, it seems that for a firm to become Direct Complete Adopter, Direct Non Complete Adopter, Indirect Adopter or Non Adopter, it is a rational decision because the other alternatives lead to a weaker net monetary gain. In other words, a decision of a firm to become a Direct Complete Adopter, Direct Non Complete Adopter, Indirect Adopter or Non Adopter is always optimal.

As a consequence, the ordering inside the ISO network does not necessarily imply a similar ordering ($v_1 > v_2 > v_3 > v_4$) in terms of monetary gains. If we take four different firms which are respectively Direct Complete Adopter, Direct Non Complete Adopter, Indirect Adopter and Non Adopter, it is a *priori* impossible to say whether the net monetary gains (v_1) for the Direct Complete Adopter firm are higher than the net monetary gains (v_2) for the Direct Non Complete Adopter firm which are higher than the net monetary gains (v_3) for the Indirect Adopter firm which are higher than the net monetary gains (v_4) for the Non Adopter firm. Hence the question of the relationship between the ordering inside the ISO network and the ordering in terms of monetary gains in not trivial.

3.3 Econometric Model

We aim in this paper to show that from an empirical standpoint the net monetary gain (v_j) of a firm varies according to its relative position in the network (network effect). Therefore, we want to provide an empirical answer to the question whether the ordering inside the ISO network (the position inside the network) is positively correlated with the ordering in terms of net monetary gains (v_j).

[7] The notation could be confusing, indeed roughly speaking, we have to put an index to v_j. For instance v_j^k where $j \in \{1, 2, 3, 4\}$, and $k \in$ {Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters and Non Adopters}.

If the answer to this question is positive, it demonstrates the real existence of a network that we presented in Figure 1 and it also shows that the application of our analysis using the concept of ISO as a Club Good is pertinent.

From an empirical standpoint, we will either look at the ordering $v_1 > v_2 > v_3 > v_4$ or at the ordering $v_{1\_2} > v_3 > v_4$ where v_{1_2} is the net monetary gains of Direct Complete Adopters and Direct Non Complete Adopters considered as one category. More precisely, let "y" be the economic performance variable (turnover per employee or value-added per employee). Following Baumol et al. (1989) we choose labor productivity instead of total factor productivity (TPF) because as they argue, labor productivity, has its legitimate use for which the allegedly superior index of TFP is not a substitute.

y_i is therefore the economic performance variable of firm i. y_i writes: $y_i = Z_{1i} + Z_{2i}$, where Z_{1i} is the economic performance due to all other factors but the position inside the ISO network, and Z_{2i} is the economic performance due to the position inside the ISO network.

Let $Z_{1i} = \beta_0 + \beta_1 X_{1i} + \ldots.. + \beta_p X_{pi} + \varepsilon_{1i}$ where the $X_1 , \ldots., X_p$ are variables which explained Z_1

and, $Z_{2i} = v_1\chi_{1i} + v_2\chi_{2i} + v_3\chi_{3i} + v_4\chi_{4i} + \varepsilon_{2i}$ if we look at the ordering $v_1 > v_2 > v_3 > v_4$

or, $Z_{2i} = v_{1\_2}\chi_{1\_2i} + v_3\chi_{3i} + v_4\chi_{4i} + \varepsilon_{2i}$ if we look at the ordering $v_{1\_2} > v_3 > v_4$.

Of course, the χ_{1i}, χ_{1_2i}, χ_{2i} , χ_{3i} , χ_{4i} are the characteristic functions equal to 1 if firm i belongs to the corresponding category and 0 if otherwise; and ε_{1i} , ε_{2i} are error terms.

Testing $v_1 > v_2 > v_3 > v_4$ in the model $y_i = \beta_0 + \beta_1 X_{1i} + \ldots.. + \beta_p X_{pi} + v_1\chi_{1i} + v_2\chi_{2i} + v_3\chi_{3i} + v_4\chi_{4i} + \varepsilon_i$ is equivalent to testing $0 > v'_2 > v'_3 > v'_4$ in the model $y_i = \gamma_0 + \beta_1 X_{1i} + \ldots.. + \beta_p X_{pi} + v'_2\chi_{2i} + v'_3\chi_{3i} + v'_4\chi_{4i} + \varepsilon_i$. Likewise, testing $v_{1\_2} > v_3 > v_4$ in the model $y_i = \beta_0 + \beta_1 X_{1i} + \ldots + \beta_p X_{pi} + v_{1\_2}\chi_{1\_2i} + v_3\chi_{3i} + v_4\chi_{4i} + \varepsilon_i$ is equivalent to testing $0 > v'_3 > v'_4$ in the model $y_i = \gamma_0 + \beta_1 X_{1i} + \ldots.. + \beta_p X_{pi} + v'_3\chi_{3i} + v'_4\chi_{4i} + \varepsilon_i$.

However the position inside the ISO certification network may not be random and may depend on the firms' individual characteristics. Hence, the results provided by the two previous models may be subject

to a selection bias. Propensity score technology (which will be used in this paper) allows for correcting the selection bias by matching firms according to their propensity score which is the estimated probability of receiving treatment (the position inside the ISO network) given the background characteristics. Moreover, the results of Rosenbaum and Rubin (1983) allow for constructing a group of treated firms and a group of non treated firms in accordance to their propensity score. We can use a *non parametric kernel matching estimator* proposed by Heckman, Ichimura, and Todd (1997, 1998) which under some regularity assumptions is convergent and asymptotically normal.

Broadly speaking, using this estimator each non treated firm takes part in construction of a counterfactual of each treated firm, that is to say of an estimate of what would be the response of the treated firm if it was in the non treated population. The importance of each non treated firm in this construction varies according to the distance between its propensity score and that of the treated firm. Moreover, since in order to estimate the treatment effect we have to construct for each treated firm a counterfactual of firms in the non treated population, we must have a set of non treated firms which have propensity scores close to the propensity scores of the treated firms.

In other words, a counterfactual can only be constructed for the firms whose propensity score belongs to the intersection between the support of propensity score distribution of the treated firms and the support of propensity score distribution of the non treated firms. Consequently, an important point in the estimation concerns a determination of the common support of propensity score distributions.

4. The database and the variables

4.1 The database

The research presented here is based on two microeconomic surveys from the French National Institute of Statistics (INSEE), the “Changement Organisationnel et Informatisation” (the Organizational Changes and Computerisation COI 1997) and “Enquête Annuelle d’Entreprises” (the Annual Survey of Industry EAE 1997). The COI survey was created by researchers and statisticians within the economic

administration. This collaboration gathered a great deal of knowledge, which made it possible to put together the surveys of different companies and the surveys concerning employees section ("labour force"). In this survey, we can find the manufacturing industry, the agro-food industry, branches of the service industry (i.e. accountancy), and branches of the commercial industry. The COI survey has been used by several researchers like Acemoglu et al. (2007), Aubert et al. (2006) and special issue of Revue Economique. The Annual Survey of Industry (EAE) is the principal source of economic data regarding companies' activities, structure and performance. The choice of companies is based on the files of companies in the Annual Survey of Industry (EAE). We restricted our empirical analysis to the manufacturing industry and we worked with a sample of 4699 companies which have at least more than 20 employees.

4.2. The variables

In order to construct our two dependent variables (the logarithmic value of the turnover per employee and the logarithmic value of the value-added per employee), we have selected from the EAE survey the turnover, the value-added, and from the COI survey, the number of employees.

Our four different categories of adopters (Direct Complete Adopters, Direct Non Complete Adopters, Indirect Adopters, and Non Adopters) are constructed using two variables from the COI survey: whether firm is ISO 9000 certified in 1997 (yes/no) and whether firm has ISO 9000 certified suppliers in 1997 (yes/no).

The variables (from the COI survey) that we use for the descriptive statistics are: whether firm is ISO certified in 1994 (yes/no), whether there is a full time quality manager in 1997 (yes/no), whether there is an outsource manager for quality in 1997 (yes/no), whether firm has another type of certification measure or total quality management in 1997 (yes/no) and the export by company's turnover.

Furthermore variables (from the COI survey) used in the first step of the PS-matching (i.e., used as determinants of choosing one of our four categories of adopters) are:

- importance (not much important/quite important/important/very important) of the feature of the companies strategy: quality improvement, cost reduction and new process,
- influence of external market constraints: competitive pressure (yes/no), uncertainty on the market (yes/no), clients conditioned (yes/no), suppliers conditioned (yes/no) and stockholders conditioned (yes/no),
- whether there is a full time quality manager in 1994 (yes/no),
- and whether there is an outsource manager for quality in 1994 (yes/no).

The control variables are the firm size and the sector of activity (46 sectors).

4.3. Descriptive Statistics

Firm distribution for each category of adopters (Direct complete Adopters, Direct non complete adopters, Indirect adopters, Non adopters) is respectively 2000 firms, 194 firms, 983 firms and 1522 firms. From the table 1 we can see that the proportion of uncertified companies that have certified suppliers is significant: 22% firms (from a total of 64% non certified companies) are part of this group, or approximately 40% of non certified companies. In comparison, only 4% companies certified with ISO (from a total of 36% certified companies) have suppliers that are not certified with ISO which suggests that ISO certified companies avoid having relationships with suppliers that are not certified with ISO. This suggests, as we expected, that being certified (i.e. inside the network) gives a positive signal concerning quality information, and having as a supplier a certified firm amplifies this positive signal. Our data suggests several important first-order differences between four types of ISO firms. In particular, we can observe that there are more companies that are certified with ISO since 1994 under category Direct Non Complete Adopters than Direct Complete Adopters. We noticed that there is a positive correlation between company's size and the position inside the network so that highest percentage of larger companies make up Direct Complete Adopters (10%) whilst the highest percentage of smaller companies belong to Non adopters (1%). Furthermore, although the full time quality manager is present

in each category of adopters, the percentage of concentration is positively related to the group position inside the network with the highest percentage being present in the category of Direct Complete Adopters (74%). Interestingly, there exist a small percentage of companies (in each category) that utilize quality service from outsource managers.

Investment in the quality norms can at the same time be a function of improvement of the company's competence and can also make a positive signal on the market, especially for companies that export abroad. Companies might view ISO certification as an export requirement, especially if they operate a majority of their business abroad (Terlaak and King, 2006). The international marketing aspects of ISO 9000 certification have been regarded as one of the most important reasons to seek certification. We noticed that the percentage of export is positively correlated with the position inside the network, the highest export being for the category of Direct Complete Adopters which descends in the following pattern: Direct Complete Adopters > Direct Non Complete Adopters > Indirect Adopters > Non Adopters. Finally we observed that firms which are not ISO certified do not tend to substitute ISO certification for another type of certification (QA, ISO 14000, QS …).

On the other hand, as we can see from Table 1, 35% of Direct Complete Adopters have other types of certification or total quality management. In contrast, only 13% of Non Adopters have another kind of certification. It seems therefore that there is no strategy of substitution among Non Adopter companies relating to the quality norms. Other kinds of adopters such as Direct Complete Adopters may view the ISO certification as being complementary to other kinds of certifications. Interestingly, the category Indirect Adopters has the highest percentage of firms (51%) that have other type of certification or total quality management. Possible reason for this is that Indirect Adopters firms want throughout previous experience with similar standards to lower additional costs of ISO 9000 implementation (*e.g.*, through the overlap of documentation requirements) because of learning by doing and scale economies.

Table 1. **Descriptive Statistics**

	Direct Complete Adopters	Direct Non Complete Adopters	Indirect Adopters	Non Adopters
	Year of ISO Certification			
1994	38%	47%	0%	0%
	Company's Size			
20 to 49 employees	39% (a)	54%	62%	70%
50 to 199 employees	37%	33%	29%	26%
200 to 499 employees	14%	8%	7%	3%
500 employees and more	10%	5%	2%	1%
	Quality department in 1997			
Full time quality manager	73%	56%	42%	21%
	Quality outsourcing in 1997			
Outsource quality manager	18%	22%	13%	6%
	Previous certification			
Other certification or total quality management	35%	25%	51%	13%
Total	32%	4%	22%	42%

Source: Survey COI, sample 4699 companies, weighted by the number of employees.
Field: manufacturing industries of more than 20 employees.
Lecture: (a) 39% of "direct complete adopters" are companies that have from 20 to 49 employees (category-small company).

5. Results with Propensity Score Estimates

5.1. Method

Let us remind ourselves that the economic performance variable was denoted y and that y is either the (logarithm of the) turnover per employee or the (logarithm of the) value-added per employee. To test the existence of a network effect, we will consider the positions inside the network as the treatments and evaluate the effect of each treatment on y. Let T be a dummy variable indicating whether the firm has received (T=1) or not (T=0) the treatment. y_1 will be the economic performance of the treated firms and y_0 will be the economic performance of the non-treated firms. For instance, let us consider the following model in which we compare Direct Complete Adopters to Indirect Adopters (Model 1C1). T = 1 if the firm is a Direct Complete Adopter and 0 if the firm is an Indirect Adopter. y_1 will be the (logarithm of the) value-added per employee of Direct Complete Adopter firms and y_0 will be the (logarithm of the) value-added per employee of Indirect Adopter firms.

Thus three quantities are of interest to us: $C=E\ [y_1-y_0]$ is the average treatment effect over the whole population; $C_1 = E\ [y_1-y_0 \mid T = 1]$ is the average treatment effect over treated firms and $C_0 = E\ [y_1-y_0 \mid T = 0]$ is the average treatment effect over non-treated firms.

To resume, we will consider ten models[8]:

- *In Models 1C1 and 1D1,* T = 1 if the firm is a Direct Complete Adopter and T = 0 if the firm is an Indirect Adopter.
- *In Models 1C2 and 1D2,* T = 1 if the firm is a Direct Complete Adopter and T = 0 if the firm is a Non Adopter.
- *In Models 1C3 and 1D3,* T = 1 if the firm is an Indirect Adopter and T = 0 if the firm is a Non Adopter.

[8] We do not take directly compare the Direct Non Complete Adopters with the other categories because only 194 firms are Direct Non Complete Adopters.

- *In Models 2C1 and 2D1*, T = 1 if the firm is a Direct Complete Adopter or a Direct Non Complete Adopter and T = 0 if the firm is an Indirect Adopter.
- *In Models 2C2 and 2D2*, T = 1 if the firm is a Direct Complete Adopter or a Direct Non Complete Adopter and T = 0 if the firm is a Non Adopter.

For each model, we will estimate the quantities C, C_1 and C_0. The estimation proceeds as follows:

- The propensity score is estimated from a *logistic model*. That is, treatment (position inside the ISO network) is the explained variable, background characteristics are the explanatory variables, and the estimated probability of receiving treatment given the background characteristics is the propensity score.
- The common support is computed as the intersection between the propensity score for the treated group and the propensity score for the control group.
- We will estimate the treatment causal effect using a *non parametric kernel matching estimator* proposed by Heckman, Ichimura, and Todd (1997, 1998).
- The estimate standard deviation is computed by bootstrap.

5.2. Determinants of the position inside the ISO Network

The results concerning the logistic regressions are available in Tables 2 and 3. The first groups of variables that we have utilised are company's size and sector of activity. We found the same results as in the literature relating to the effects of company's size or sector of activity on the adoption of ISO certification (Anderson et al., 1999; Terlaak and King, 2006). Generally, the firm's size mainly determines the firm's possibility (in a sense of financial resources) to choose one of the categories of ISO adopters. We noted in Tables 2 and 3 that variables concerning the company's size are positive and significant for the five logistic regressions.

We have used 46 sectors of different company's activities and as a reference the sector of textile industry. As in the literature, we found that the probability to be ISO certified is higher in certain industries such the basic metal, the construction, the machinery, the chemical and the steel industry.

Concerning the features of the company's strategy, we can see from Tables 2 and 3 that for our five logistic regressions and for the three variables (quality improvement, cost reduction, new procedure), the coefficients, when significant, are positive. When quality improvement, cost reduction and new procedure are important or very important for the company's strategy, they will increase the company's probability of being ISO certified and to become a Direct Complete Adopter (as compared to being a Non Adopter). It is interesting to note that when comparing Direct Complete Adopters to Indirect Adopters, only the new procedure variable plays a role in a decision to be a Direct Complete Adopter, but only at a 5% level of significance.

Concerning the external market's constraints, one can remark that the variable "uncertainty on the market" seems to play negative role in determining the firm's probability to be ISO certified or the firm's position inside the ISO network. If we look at the other variables (competitive pressure, clients-conditioned, suppliers-conditioned and stockholders-conditioned), the coefficients, when significant, are positive most of the time. For instance, the variable clients-conditioned is significant (at a 1% level) for all three logistic regressions (out of five). This tells us that when clients' condition is an important external constraint, firms will adopt ISO certification either directly or indirectly through their suppliers. The same explanation can be used in the case of stockholders whereby companies are more driven to become ISO certified by stockholders' conditions. Another interesting result is that only those firms in the category of Indirect Adopters vs Non Adopters are more cautious about the conditions imposed by suppliers. The possible explanation for this is that companies in other categories have already chosen suppliers that have similar attitudes to business as they do. Finally, it is quite surprising that the variable "competitive pressure" is significant (at a 1% level) only when comparing Indirect Adopters with Non

Adopters. This result implies that the competitive pressures increase both the probability that a non-certified firm wants to have a certified firm as supplier and the probability that a certified firm wants be a supplier of a non-certified firm.

Finally having full time quality manager or outsource quality manager has positive impact on ISO 9000 adoption. Indeed as we can see, two variables are positive and significant for five regressions.

Table 2: Determinants of choosing one of the ISO categories

	Direct Complete Adopters vs Indirect Adopters (ref)	Direct Complete Adopters vs Non Adopters (ref)	Indirect Adopters vs Non Adopters (ref)
Intercept	-0.06	-1.70***	-1.75***
	Size of the company *Ref = 20 to 49 employees*		
50 to 199 employees	0.17*	0.28***	0.16*
200 employees and more	1.24***	1.95***	0.85***
	Features of the company's strategy *Ref = Less Important and Not Important*		
Quality improvement	0.01	0.36***	0.34***
Cost reduction	0.12	0.36**	0.25*
New process	0.19**	0.29***	0.10
	External market's constraints		
Competitive pressure-yes	0.05	0.23**	0.29**
Uncertainty on the market-yes	-0.28***	-0.23**	0.00
Clients conditioned- yes	0.10	0.46***	0.37***
Suppliers conditioned-yes	-0.16	0.08	0.16
Stockholders conditioned-yes	0.22**	0.63***	0.31***
	Quality department and outsourcing in 1994		
Full time quality manager	0.85***	1.50***	0.57***
Outsource quality manager	0.47***	0.70***	0.33*
	Sector of Activity *Ref = textile industry*		
Agro-Food Manufacture	-0.68***	-0.45*	0.28
Industry of leather and shoes	-1.70***	-3.03***	-1.24***
Manufacture of wearing	-2.24***	-3.37***	-1.42***
Pharmaceutical industry	-0.66**	-1.67***	-0.91***
Manufacture of soap, perfumes and care products	-2.05***	0.00	1.89
Manufacture of furniture	-0.76*	-0.50	0.03
Manufacture of jewellery, musical instruments/ sport products and games	-0.61*	-1.32***	-0.50
Manufacture of household equipments	-1.67***	-1.76***	-0.28
Manufacture of equipment for reproduction and record (sound and image)/ optical materials, camera, watch	-0.55	0.85**	1.26*
Manufacture of automobiles	-0.23	-0.28	0.08
Manufacture of automobiles equipment	0.08	0.10	0.02
Naval construction / railroad materials	2.13***	1.74***	-0.28
Aeronautical and spatial construction	0.10**	0.32	0.42
Manufacture of, vehicles, motor vehicles, transport equipment/ metal elements for construction	-0.37	1.86***	2.16***
Boilers, manufacture of metallic tank	-1.00***	-0.67	0.46
Manufacture of mechanical equipment	0.11	0.28	0.40
Manufacture machines for general utilisation	1.45***	1.90***	0.59
Manufacture of machines for agro-culture/ machines-tools	0.22	0.33	0.13
Manufacture of others specific machines / weapon and munitions	-0.38	-0.59	-0.05
Manufacture of machines for office and informatics equipment	-0.53	-0.05	0.56
Manufacture of motors, generator and equipment for electrical transformation	0.81	0.31	-0.32

	Direct Complete Adopters vs Indirect Adopters (ref)	Direct Complete Adopters vs Non Adopters (ref)	Indirect Adopters vs Non Adopters (ref)
	Sector of Activity *Ref = textile industry*		
Manufacture of equipment for emission and transmission	0.70	0.62	0.15
Manufacture of medic surgery and orthopaedic equipment	1.45	0.70	-0.39
Manufacture of equipment for the measurement and the control	0.62	1.05**	0.51
Other extractives industries	0.41	1.29***	0.94**
Manufacture of glass and other product glass	-1.17*	-2.03***	-0.44
Manufacture of ceramic products and construction equipments	0.73	-0.06	-1.12**
Cotton and weaving mills	-0.09	-0.59*	-0.36
Manufacture of chain	-0.09	-1.03***	-1.08***
Manufacture wood articles	-1.98***	-2.91***	-0.84*
Manufacture of wood filler	0.72	-1.57***	-0.78**
Manufacture of paper and carton	0.35	0.59	0.31
Industry of mineral products	0.28	0.67*	0.40
Industry of organic products	1.65**	-0.33	-1.82**
Industry of parchemical , artificial fiber and synthetic products	0.60	1.96***	1.60**
Transformation of plastic materials	1.00**	1.36***	0.43
Steel industry	0.57**	0.61**	0.20
Manufacture of non-ferrous metals	0.72**	2.07***	1.73**
Industry of melting	1.73***	1.07**	-0.68
Manufacture of metal products	1.56***	1.60**	0.33
Manufacture of electric products	0.20	0.05	-0.02
Manufacture of electric corposants	0.74**	0..97***	0.49
Industrial service for metals works	1.07**	1.41***	0.54
Extraction of coal/hydrocarbon/nuclear/petrol	0.86***	1.31***	0.55*
Electricity, gas and water supply	1.23**	1.14**	0.08
Max-rescaled R-Square	0.28	0.52	0.21

Source: Survey COI merges to the EAE, sample of 2983, 3522 and 2505 companies, respectively.
Field: manufacturing industries of more than 20 employees.
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.

	Direct Complete and Direct Non Complete Adopters vs Indirect Adopters (ref)	Direct Complete and Direct Non Complete Adopters vs Non Adopters (ref)
Intercept	0.29	-1.35***
	Size of the company *Ref = 20 to 49 employees*	
50 to 199 employees	0.16*	0.27***
200 employees and more	1.19***	1.87***
	Features of the company's strategy *Ref = Important and Very Important*	
Quality improvement	-0.05	0.32***
Cost reduction	0.10	0.30**
New process	0.17*	0.27***
	External market's constraints	
Competitive pressure-yes	0.05	0.26**
Uncertainty on the market-yes	-0.29***	-0.24***
Clients conditioned- yes	0.01	0.37***
Suppliers conditioned-yes	-0.18*	0.03
Stockholders conditioned-yes	0.23**	0.64***
	Quality department and outsourcing in 1994	
Full time quality manager	0.80***	1.46***
Outsource quality manager	0.46***	0.74***
	Sector of Activity *Ref = textile industry*	
Agro-Food Manufacture	-0.64***	-0.39*
Industry of leather and shoes	-1.61***	-2.94***
Manufacture of wearing	-1.31**	-2.65***
Pharmaceutical industry	-0.57*	-1.57***
Manufacture of soap, perfumes and care products	-2.11***	-0.02
Manufacture of furniture	-0.75*	-0.53
Manufacture of jewellery, musical instruments/ sport products and games	-0.61*	-1.29***
Manufacture of household equipments	-1.52***	-1.63***
Manufacture of equipment for reproduction and record (sound and image)/ optical materials, camera, watch	-0.35	1.03*
Manufacture of automobiles	-0.31	-0.35
Manufacture of automobiles equipment	-0.06	-0.07
Naval construction / railroad materials	2.09***	1.75***
Aeronautical and spatial construction	-0.06	0.17
Manufacture of, vehicles, motor vehicles, transport equipment/ metal elements for construction	-0.47	1.74**
Boilers, manufacture of metal tank	-0.90***	-0.55
Manufacture of mechanical equipment	0.06	0.23
Manufacture machines for general utilisation	1.34***	1.78***
Manufacture of machines for agro-culture/ machines-tools	0.12	0.22
Manufacture of others specific machines / weapon and munitions	-0.42	-0.63
Manufacture of machines for office and informatics equipment	-0.50	-0.08
Manufacture of motors, generator and equipment for electrical transformation	0.64	0.15
Manufacture of equipment for emission and transmission	0.54	0.45

Table 3: Determinants of choosing one of the ISO categories

	Direct Complete and Direct Non Complete Adopters vs Indirect Adopters (ref)	**Direct Complete and Direct Non Complete Adopters vs Non Adopters (ref)**
	Sector of Activity *Ref = textile industry*	
Manufacture of medico-surgery and orthopaedic equipment	1.32*	0.57
Manufacture of equipment for the measurement and the control	0.56	0.93**
Other extractives industries	0.26	1.11***
Manufacture of glass and other product glass	-0.99*	-1.78***
Manufacture of ceramic products and construction equipments	0.59	-0.22
Cotton and weaving mills	-0.20	-0.69**
Manufacture of chain	0.03	-1.09***
Manufacture wood articles	-2.13***	-3.04***
Manufacture of wood filler	-0.70	-1.54***
Manufacture of paper and carton	0.31	0.52
Industry of mineral products	0.17	0.57*
Industry of organic products	1.56**	-0.42
Industry of parchemical , artificial fiber and synthetic products	0.44	1.78***
Transformation of plastic materials	0.87**	1.21***
Steel industry	0.58*	0.62***
Manufacture of non-ferrous metals	0.56	1.91***
Industry of melting	1.65**	0.98**
Manufacture of metal products	1.48***	1.50***
Manufacture of electric products	0.18	0.02
Manufacture of electric corposants	0.61**	0.86***
Industrial service for metals works	0.93**	1.26***
Extraction of coal/hydrocarbon/nuclear/petrol	0.78***	1.24***
Electricity, gas and water supply	1.10*	0.96***
Max-rescaled R-Square	0.25	0.49

Source: Survey COI merges to the EAE, sample of 3177 and 3716 companies, respectively.
Field: manufacturing industries of more than 20 employees.
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.

5.3. Naïve results and PS-matching results

We will first introduce the PS-matching results and then compare these results with the naïve ones (tables 4a and 4b), revealing some selection effects. The comparison between Direct Complete Adopters and Indirect Adopters shows positive results concerning the effects on the Turnover per employee (table 5). This result confirms the prediction given by the graphic in Figure 1: Indirect Adopters have a link that permits them to enter into the ISO Club and thus differentiate themselves from Non Adopters. We find similar results for the ISO categories and the effects on the Value-Added per employee. One can also remark that the coefficient of significance in Models 2C1, 2C2, 2D1 and 2D2 are similar to those in Models 1C1, 1C2, 1D1 and 1D2 despite the fact that Direct Complete Adopters and Direct Non Complete Adopters have been merged.

This leads us to conclude that Direct Non Complete Adopters are in a more advantageous position inside the network as compared to Indirect Adopters or Non Adopters. Moreover, since both actors (firm and suppliers) within Direct Complete Adopters are certified, it permits this group to have the highest impact on the economic performance. Furthermore, although the suppliers of Direct Non Complete Adopters are not certified, the firms' certification still gives them a possibility to have a high impact as evidenced by their second position inside the network hierarchy.

The case of Indirect Adopters proves that firms can also indirectly profit form the ISO certification (via suppliers) and that firms inside this group differ from Non Adopters. Indeed, Indirect Adopters take up the third position in regards to the strength of impact effects, while Non Adopters occupy the lowest position. We also observed that the highest difference for two dependent variables, Turnover per employee and Value-Added per employee, is between those firms belonging to Direct Complete Adopters and Non Adopters. Similarly, differences exist between firms within Indirect Adopters and Non Adopters which shows us that Indirect Adopter firms gain from ISO certification via their certified suppliers. In Models 2C1, 2C2, 2D1 and 2D2, merging Direct Complete Adopters with Direct Non Complete Adopters decreased the value of the estimated coefficients (starting from Models 1C1, 1C2, 1D1 and 1D2). This

could mean that the ISO certified firms dealing with the non ISO certified suppliers have some negative signal on the market. Finally, a comparison of the results from naïve estimates with the PS-matching results provides an empirical evidence of some selection effects. In general, the figures obtained from naïve estimates are different (and often higher) than those obtained from the PS-matching results.

There is a positive correlation between the hierarchy in the network and the impact on the turnover per employee and the value-added per employee. The turnover per employee and the value-added per employee of Direct Complete Adopter firms are higher than those of Direct Non Complete Adopter firms which are higher than those of Indirect Adopter firms which are higher than those of Non Adopter firms. These findings suggest that being a certified firm amplifies a positive effect on the economic performance of firms. In addition, owing to the network effect, a non-certified firm dealing with certified suppliers (Indirect Adopters) can also improve their economic performance.

Table 4a. The Mean of the logarithm of the Turnover per employee and the logarithm of the Value-Added per employee

	The Mean of logarithm of the Turnover per employee	The Mean of logarithm of the Value-Added per employee
Direct Complete Adopters	6.91	5.79
Direct Non Complete Adopters	6.84	5.69
Indirect Adopters	6.79	5.64
Non Adopters	6.51	5.51
	Difference of the Mean (Naïve estimates)	
Direct Complete Adopters vs Indirect Adopters	0.12***	0.15*** (a)
Direct Complete Adopters vs Non Adopters	0.40***	0.28***
Indirect Adopters vs Non Adopters	0.28***	0.13***

Source: Survey COI merges to the EAE, sample 4699 companies.
Field: manufacturing industries of more than 20 employees.
The regression integrates 46 indexes of industries that correspond to NAF 114 (reference: textile industry).
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.
(a): The value-added per employee of the Direct Complete Adopters = exp(0.15)×The value-added per employee of the Indirect Adopters

Table 4b. The Mean of the logarithm of the Turnover per employee and the logarithm of the Value-Added per employee

	The Mean of logarithm of the Turnover per employee	**The Mean of logarithm of the Value-Added per employee**
Direct Complete Adopters and Direct Non Complete Adopters (a)	6.90	5.78
Indirect Adopters	6.79	5.64
Non Adopters	6.51	5.51
	Difference of The Mean (Naïve estimates)	
Direct Complete and Direct Non Complete Adopters (a) vs Indirect Adopters	0.11***	0.14***
Direct Complete and Direct Non Complete Adopters (a) vs Non Adopters	0.39***	0.27***

Source: Survey COI merges to the EAE, sample 4699 companies.
Field: manufacturing industries of more than 20 employees.
The regression integrates 46 indexes of industries that correspond to NAF 114 (reference: textile industry).
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.
(a) The categories Direct Complete Adopters and Direct Non Complete Adopters are merged.

Table 5. PS-matching estimates (a)

	Global	Treated	Non-treated
	Effect on the logarithm of Company's Turnover per employee		
MODEL 1C1 : Direct Complete Adopters *vs* Indirect Adopters	0.10***	0.08**	0.14***
MODEL 1C2 : Direct Complete Adopters *vs* Non Adopters	0.22***	0.20***	0.25***
MODEL 1C3 : Indirect Adopters vs Non Adopters	0.13***	0.13***	0.13***
	Effect on the logarithm of Company's Value-Added per employee		
MODEL 1D1 : Direct Complete Adopters *vs* Indirect Adopters	0.10***	0.09***	0.13***
MODEL 1D2 : Direct Complete Adopters *vs* Non Adopters	0.18***	0.18***	0.18***
MODEL 1D3 : Indirect Adopters vs Non Adopters	0.06**	0.06*	0.06*
	Effect on the logarithm of Company's Turnover per employee		
MODEL 2C1 : Direct Complete and Direct Non Complete Adopters *vs* Indirect Adopters	0.08**	0.06*	0.11***
MODEL 2C2 : Direct Complete Adopters and Direct Non Complete *vs* Non Adopters	0.23***	0.22***	0.24***
	Effect on the logarithm of Company's Value-Added per employee		
MODEL 2D1 : Direct Complete and Direct Non Complete Adopters *vs* Indirect Adopters	0.09***	0.08***	0.11***
MODEL 2D2 : Direct Complete Adopters and Direct Non Complete *vs* Non Adopters	0.16***	0.15***	0.17***

Source: Survey COI merges to the EAE, sample 4699 companies.
Field: manufacturing industries of more than 20 employees.
The regression integrates 46 indexes of industries that correspond to NAF 114 (reference: textile industry).
Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level respectively.
(a) The standard deviation of the treatment effect is computed using bootstrap with 150 simulations.
The characteristics of support over 150 simulations are: *Model 1C1*: min=3601; max=4219; mean=3882.45.
Model 1C2: min=3127; max=3794; mean=3491.54. *Model 1C3*: min=3695; max=4322; mean=3996.50.
Model 1D1: min=3530; max=4109; mean=3865.95. *Model 1D2*: min=3195; max=4272; mean=3982.43.
Model 1D3: min=3673; max=4203; mean=3962.61. *Model 2C1*: min=3755; max=4166; mean= 3966.95.
Model 2C2: min=3386; max=3943; mean=3664.61. *Model 2D1*: min=3700; max=4207; mean=3963.17.
Model 2D2: min=3425; max=3870; mean=3660.59.

6. Conclusions

The main contribution of this article is the provision, through a network analysis, of empirical evidence demonstrating the ISO norms as Club Goods. We show that companies which are not ISO certified will, if they have ISO certified firms as suppliers, profit from this network generating the positive signal on the market through their certified suppliers.

Moreover, our *empirical paper* poses the important *theoretical question* as to whether the number of firms which are ISO certified is equal to the Pareto optimal number of ISO certified firms. This question is not trivial. At the first glance, due to the existence of external factors, the answer could be a negative one (i.e. the number of firms which are ISO certified is lower than the Pareto optimal number of ISO certified firms). However, since there is no 'poaching effect' (i.e. the companies which are not ISO certified also have to pay an additional cost in order to have ISO certified suppliers), the firms which are not ISO certified directly have in some sense internalised the external effects in their behaviour. Hence, it may be the case that a number of firms which are ISO certified is equal to the Pareto optimal number of ISO certified firms.

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