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Violation of environmental regulations as a disinvestment in social capital

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Abstract

This paper developed a simple dynamic model in order to analyse the impact of social capital on violation of environmental regulations. Two main channels of influence were identified; through informal enforcement of regulations and through effects on costs from disinvestment in social capital caused by violation. The model was tested using survey data on enforcement and violation of command and control regulations at municipalities and counties in Sweden. Four different measures on the social capital variable were used; general trust, trust in local and national governments, and organizational activity. Count data models were used for estimating the explanatory power of these variables in relation to inspection frequency and control variables of community characteristics. Statistically best results were obtained for organizational activity for all firm categories. The results showed that both the level of this social capital measure and its growth over time curb violation.

Key words: social capital, violation of environmental regulations, econometric test, count data model, Sweden.

JEL: K33, K42, Q58

1. Introduction

The concept of social capital can be traced to Hanifan (1916) but it was not until 1980s that it was defined in a way that is commonly used today; as a link between individuals (Coleman 1988). The concept emerged from the need of explaining cooperative behaviour among individuals when they have little economic incentives to do so (e.g. Boix and Posner 1998). A common component of the many existing approaches to and definitions of social capital is related to expectation of reciprocity in cooperation. If people expect others to engage in and comply with agreements beneficial for the community but not so much for the individual they will do the same. The last decades have witnessed the development of a large body of literature on the empirical evidences of the role of social capital for the enforcement of the rule of law (e.g. Glaeser et al. 1996; Lederman et al. 2002; Lazzarini et al. 2004; Yamamura 2009). However, in spite of Ostrom's seminal contribution on the role of social capital for sustainable management of common pool resources (Ostrom 1990), the literature on social capital and enforcement of environmental regulations rules is scant. Abundance of social capital may be of particular importance for compliance with environmental regulations because of the difficulty in connecting violations of ambient environmental standards to the activities of specific firms. The purpose of this study is to develop and test a model of firm violation behaviour in the presence of social capital and formal enforcement. Econometric tests are carried out for compliance with command and control regulations in Sweden.

In principle, the literature identifies two main mechanisms through which social capital can effect violation of regulations (e.g. Glaeser et al. 2002). One is through the impact on violating firms' benefits from losses of access to local transactions that build on trust. The other mechanism acts through suspected or detected violation. Social capital may facilitate the creation of lobbying activities that result in private reporting of environmental activities without permits, and it may create a damaging impact on firms' transaction by a quick and widespread reputation of the firm as 'environmental criminal'. However, these mechanisms are likely not to act in isolation from formal enforcement, i.e. enforcement by law and public bodies, of regulations. There are two main theories on the linkages between formal and informal enforcement of rules or contracts; substitution and complementarity (e.g. Lazzarini et al. 2004; Jackson 2011). According to the substitution perspective, social capital defined in terms of expectations of reciprocity creates informal enforcement mechanisms. These can be hampered by formal rules which signal the absence of mutual trust and good will with respect to compliance with rules. On the other hand, the complementarity view argues that informal agreements can not be sustained without a strong formal enforcement power.

To the best of our knowledge, there is no empirical study with the explicit aim of assessing the impact of social capital on violation of environmental regulations and its interaction with formal enforcement. However, a further investigation of the parameterization of social capital for empirical analysis shows that a few studies have included variables that can be attributed to social capital although the concept as such was not used. Two central elements in the quantification of social capital is the degree of social trust and number of social contacts in organisations (e.g. Coleman 1988; Putman et al. 1993; Rothstein 2003). A few studies addressed one of these elements by including organisational engagement as explanatory variable for non-compliance in addition to variables reflecting formal enforcement (Kagan et al. 2003; Earnhart 2004; Langpap and Shimshack 2010). Kagan et al. (2003) found that local governments, environmental activists, and company culture were important factors to explain high level of compliance. Earnhart (2004) included voter engagement as an explanatory variable for pollution by facilities in the US, but found no significant result. Langpap and Shimshak (2010) tested the relation between private groups' suits on compliance with regulations under the Clean Water Act in the US, and found that private enforcement can act as a complement to public monitoring. One study, Jones (2010), had an explicit focus on social capital but investigated its impacts on the effectiveness of voluntary waste treatment by households, and not specifically on compliance with regulations.

In contrast to social capital, the effect of formal enforcement on violation has been empirically tested in a large body of literature since the seminal contribution by Becker (1968), with a large number of studies applied to environmental regulations (see Gray and Shimshack 2011 for a review). The variables used for explaining violation are related to the detection of violation and penalty if found in violation, which are mostly expressed in terms of inspection design and/or penalty (Gray and Deily 1996; Shimshack and Ward 2005; Eckert and Eckert 2010; Earnhart and Friesen 2013; Lin 2013; Stafford 2013). Most of these studies show that violation is decreasing in inspections and/or penalties. Lin (2013) reports another result where reported pollutant emissions in China increase with more frequent inspection, which is explained by the specific two tier pollutant levy system and the low penalties.

In our view, the main contribution of this study is the theoretical and empirical investigation of the impacts of social capital on violation of environmental regulations, and its interaction with formal enforcement. A dynamic model provided the basis for the formulation of three testable hypotheses; *i*) non-compliance is decreasing in formal enforcement and social capital, *ii*) formal enforcement and social capital act either as complements or substitutes, and *iii)* violation is decreasing in the level of growth in social capital. Four different measures of social capital were defined; general trust, trust in local and national governments, and civic engagement. The results indicated that part of the first hypotheses, decreasing violation in formal enforcement, was rejected for all regression models. The other part of the first hypothesis and the other two were supported by two measures of social capital; civic engagement and trust in the national government.

The paper is organised as follows. Section 2 gives a theoretical model used for tracing channels of influence on violation of environmental regulations from social capital. The data are presented in Section 3, and regression results in Section 4. The paper ends with a summary and discussion in section 5.

2. A simple model of violation and social capital

A firm *i,* where *i=1,…m* firms, subject to environmental regulations in a community *k*, with *k=1,..,n*, is assumed to violate in period *t=1,..,T* if associated expected net benefits are positive. Benefits of violation, $B^{ik}(V_t^{ik})$ where V_t^{ik} is violation, consist of avoided costs for complying with the regulation, such as evaded charge payments or costs of pollutant cleaning devices. The identification of violation costs is more involved. A common perception in economics is that the cost consists of expected penalty of detected and convicted violation. In general, the expected penalty depends on the probability of detection and the size of the penalty for a convicted violation. It may very well be the case that the probability of detection in one period depends on violation in previous periods, see Gray and Shimshack (2011). A simplification is made in this study by assuming that the expected penalty per unit violation in a community, P^k, is time independent and given to the firm.

Benefits and expected penalty of violation can be regarded as one of several motives for compliance with regulations (e.g. Winter and May, 2001). In addition to this so-called calculated motive noncompliance can be driven by normative and social motives. The first refers to inherent moral values of what is wrong and right, and the second to the search of approval of others. We may then consider social capital, or informal enforcement, S^k, as a stimulator of these three different motives. It can affect the calculated motive through the firm's believes of earning profits, such as losses profits from being regarded as an environmental criminal. The normative motive may be stimulated if social capital affects the firm's opinion of what is right or wrong with respect to breaking rules or to degrade the environment. The social motive can be impacted if social capital contributes to the firm's appreciation by the public.

The violation cost is then determined by violation for given levels of formal enforcement, P^k, and informal enforcement, S_t^k, and is written as $C(V_t^{ik};P^k,S_t^k)$. The costs are assumed to be increasing in V_t^k, P^k, and S_t^k. Formal and informal enforcement can be independent, complements or substitutes. We define complementarity (substitution) as $C(V_t^{ik}, P^k{}', S_t^k{}') > (<) \; C(V_t^{ik}, P^k{}') + C(V_t^{ik}, S_t^k{}')$. Costs are then higher or lower under simultaneous acting of given levels of $P^k{}'$ and $S_t^k{}'$ than under separate consideration. Under complementarity, the impact on violation deterrence of a given inspection stringency increases in $S_t^k{}'$. On the other hand, when there is substitution P^k replaces, or crowds out, part of the effect of S_t^k and violation is then higher than if the enforcement parameters acted separately.

It is assumed that social capital in a community *k* shows an organic development over time, $S_{t+1}^k = (1+\theta^k)S_t^k$ where θ^k can be positive, negative or zero. When $\theta^k > (<) 0$ social capital can be regarded as a renewable (degradable) resource, and when $\theta^k = 0$ as an exhaustible resource. The growth in this resource is reduced by violation of all firms in the community, which is written as:

$$S_{t+1}^k = (1+\theta^k)S_t^k - F^k(V_t^k) \tag{1}$$

$$S_0^k = \overline{S}^k$$

where $F^k(V_t^k) = F^k(V_t^{1k},...,V_t^{mk})$, which is increasing in V_t^{ik}.

Given all assumptions, the firm is assumed to maximise total discounted net benefits over a period of time, *t=1,…,T*, according to

$$Max \quad \sum_{t=1}^{T} \rho_t \pi_t^{ik} \tag{2}$$

s.t. (1) and $S_t^k \geq 0$ for *i=1,..,n* ; *k=1,..,l* and *t=1,..,T* where $\pi_t^{ik} = B^{ik}(V_t^{ik}) - C^{ik}(V_t^{ik}, P^k, S_t^k)$, $\rho_t = \dfrac{1}{(1+r)^t}$, and r is the discount rate. The associated first-order conditions are obtained from the Hamiltonian, which is constructed as

$$H(V_t^{ik}, S_t^k, \mu_{t+1}^k) = \rho_t \pi^{ik}(V_t^{ik}, P^k, S_t^k) + \mu_{t+1}((1+\theta^k)S_t^k - F^k(V^k)) + \lambda_t^k S_t^k \qquad (3)$$

where μ_{t+1}^k are the co-state variables and λ_t^k are the Kuhn-Tucker multiplier for the restriction on non-negative stocks of social capital. The first-order conditions are

$$\frac{\partial H}{\partial V_t^{ik}} = \rho_t \pi_{V_t^{ik}}^{ik} - \mu_{t+1}^k F_{V_t^{ik}}^k = 0 \quad \text{for } i=1,..,n\text{ ; } k=1,..,l \text{ and } t=1,..,T-1 \qquad (4)$$

$$\mu_t^k = \frac{\partial H}{\partial S_t^k} = \rho_t \sum_i \pi_{S_t^k}^{ik} + (1+\theta^k)\mu_{t+1}^k + \lambda_t^k \quad \text{for } k=1,..l, \text{ and } t=1,..,T-1 \qquad (5)$$

$$\mu_T^k = \rho_T \omega_T^k \quad \text{for } k=1,..,l \qquad (6)$$

Assuming interior solutions, solving for μ_{t+1}^k in (5) and inserting the solution into (4) deliver the condition for optimal violation where marginal net benefits are zero, which is written as

$$\pi_{V_t^{ik}}^{ik} - F_{V_t}^k \sum_{\tau=t}^{T} (1+\theta^k)^{T-\tau+1} \rho^{\tau-t} \sum_i \pi_{S_\tau^k}^{ik} = 0 \qquad (7)$$

The left-hand side of (7) consists of two parts; current marginal net benefit of violation, the first term at the LHS, and discounted future streams of net benefits revealed by the second term at the LHS. Without consideration of impact on social capital, the condition includes only current net benefits, and it simply states that optimal violation occurs where marginal benefits equal marginal costs in each period of time. The additional term at the LHS of (7) extends the condition to include discounted future net benefits for all firms in the community from changes in social capital caused by the violation of firm i. This can be either positive or negative depending on the sign of $\pi^{ik}_{S^k}$. When the firm considers the impact of changes in social capital on all firms in the community, eq. (7) corresponds to the optimal violation level in a community perspective. If, as is common with many common pool resources, the firm considers only its own future net benefits, condition (7) is changed to

$$\pi^{ik}_{V^{ik}_t} - F^k_{V^{ik}_t} \sum_{\tau=t}^{T} (1+\theta^k)^{T-\tau+1} \rho^{\tau-t} \pi^{ik}_{S^k_\tau} = 0 \qquad (7')$$

According to (7'), social capital can influence optimal violation through two main mechanisms; *i)* on $\pi^{ik}_{V^{ig}_t}$ when formal and informal enforcement are dependent (substitutes or complements), and *ii)* on $\pi^{ik}_{S^k}$. In the first case, a certain level of S^k_t will give a lower optimal violation when there is complementarity in the enforcement mechanisms compared with when they are substitutes due to the reinforcement of violation deterrence by P^k.

With respect to the other mechanism, i.e. through $\pi^{ik}_{S^k}$, there are three possible cases; $\pi^{ik}_{S^k} = 0$, $\pi^{ik}_{S^k} < 0$ or $\pi^{ik}_{S^k} > 0$. In the first case, the impact on the firm's profit from a marginal change in community social capital is zero, which may occur for relatively small firms. In the second case, the optimal level of violation will be lower than without consideration of the dynamic effects of disinvestment in social capital. The additional marginal cost created by the decline in social capital in period *t*, $F^k_{V^{ik}_t}$, corresponds to the foregone net benefits from violation during the entire period from *t* to the end period *T*. This future cost of disinvestment in social capital is increasing in $F^k_{V^{ik}_t}$, *T,* and θ^k. If instead $\pi^{ik}_{S^k} > 0$ the opposite is the case where violation is higher than without the dynamic impact of social capital since the degradation of the capital reduces discounted future costs of violation.

So far it has been assumed that $F^k_{V_t}$<0. The level of $F^k_{V_t}$ is affected by the perception of compliance with environmental regulations compared with other moral duties in community. If environmental issue is of little concern and/or the detection rate of violation is almost zero, we may have that $F^k_{V_t}=0$, and the value of the disinvestment is then zero.

The analytical results allow for the derivation of three main hypothesis with respect to the impacts of social capital on violation of the exogenous parameters P^k, $\overline{S}^0$, and θ^k:

1. Violation is decreasing in each of the parameters P^k and $\overline{S}^0$.
2. We have no prior expectations about whether formal and informal enforcement mechanisms are substitutes or complements, but allow for both possibilities.
3. Violation is decreasing in θ^k, which reflects consideration of the future role of social capital.

3 Data retrieval

The main difficulty with respect to data collection is to obtain information on violation and associated costs and benefits. For obvious reasons, it would be difficult to collect the data from a survey to firms. Instead, a survey was distributed to Swedish local (275 municipality) and regional (21 county board) authorities responsible for supervision of environmental regulations (Holstein 2010). This did not allow for data on benefits of violation, but an approximation of the cost was obtained from information on number of visits to regulated firms. This reflects the probability of detecting violating firms, which is a part of the expected cost. With respect to measurements of social capital, we follow the literature by using general trust and organisation activities as variables for social capital. However, before presenting the data in more detail we give a brief description of the system of supervision of environmental regulations in Sweden, since it guides the choice of several variables and associated measurements.

3.1 Brief description of formal enforcement of environmental regulations in Sweden

Environmental protection in Sweden is regulated by the Swedish Environment Protection Act, which was enacted in 1969 and was replaced by the Swedish Environmental Code on January 1, 1999 (Swedish Environmental Protection Agency 2009). The overall objective of the Code is to promote sustainable development (Chapter 1, paragraph 1) and in principle, the Code is applicable to all human activities that may harm the environment. For example, the Code states that as long as it is technically and financially feasible, the best available technology should be used and that an activity should be located so that the environmental effects are minimised. However, the Code itself is quite general, while more detailed rules are found in Government Ordinances. An appendix to the Ordinance specifies the activities (type and extent) for which notification or permission is required. Activities are then classified in relation to their "potential environmental influence", which is determined by the type and scope of the activity. Accordingly, firms are classified into four different categories, A, B, C and U, where firms in category A have the largest environmental impact and firms in category U the smallest. Firms in categories A and B require an operating licence. Examples of category A firms are nuclear power plants and firms operating in the steel, paper and pulp industries. Large farms and food producers are examples of category B firms. The category C firms, such as medium-sized farms, have to report their activities. Firms in category U, such as petrol stations and laundries, do not need a licence and do not have to report their activities, but are under observation for re-classification into any other category.

The Ordinance also prescribes the responsibility for supervision. In general, the municipal authorities are responsible for the supervision of category C and U firms, while the county administration boards, or in some cases other central government authorities, are responsible for the supervision of category A and B firms. However, municipal authorities may request and be delegated the responsibility for supervision of the activities of category A and B firms. Hence, the municipal authorities are responsible for the supervision of the activities of category C and U firms and, in some cases, category A and B firms. According to Gren and Li (2011), the total number of regulated firms in Sweden amounts to approximately 82 000, of which the vast majority, 89%, are category U and C firms, and 10% and 1%, respectively, are category B and A firms. Responsibility for these firms is divided among 21 county administration boards and 287 municipal authorities. Supervision of approximately 30% of the category A and B firms has been delegated to municipal authorities at their request.

In order to ensure compliance with the Code, the supervision authority can issue any injunctions and prohibitions necessary in individual cases. These injunctions and prohibitions may be associated with fines. The supervision authorities impose an environmental sanction charge that must be paid by business activities that violate rules pursuant to the Code, e.g. by pursuing an activity that requires permission or notification but failing to meet this requirement, or by neglecting to comply with the terms of a permit or conditions. Finally, infringements of the Code or rules issued in pursuance of the Code must be reported to the police or to the public prosecution authorities by the supervision authority.

3.2 Description of data

The operationalization of social capital is related to the distinction between cognitive and structural components (Putman 2000). The cognitive aspect refers to trust and the structural part to links such as networks and associations. Trust, in turn, has been divided into social and institutional trust, where the former refers to the perception of others acting in a similar way as one self, and the latter is connected with the expectations about institutions' ability to implement and effectively enforce policies (e.g. Jones 2010). In this paper, we use these both the structural and cognitive types of social capital by constructing an explanatory variable on organizational activity, S_{Org}, and three variables for trust. One is on trust in general, $S_{Gen,}$ and the other two on trust in politicians at the municipal, $S_{Mun,}$, and the national, $S_{Nat,}$, jurisdictional levels.

All four social capital variables are measured at the municipal and the county level, but their impact on violation may differ depending on how they stimulate firms' compliance motives. Both S_{Gen} and S_{Org} can affect the calculated motive through the effects on profits, the normative motive by influencing the perception on the ethics of compliance, and on the social motive through local society's appreciation of the firm. Trust in local public institution, S_{Mun}, may act on the perception about the ability to enforce environmental regulations. Trust in national government, S_{Nat}, may be of relevance for the opinion about the legitimacy in the environmental regulation as such. In all cases, we would expect violation to decrease in the social capital level

Data on all four social capital variables are found in a poll investigation (Holmberg et al. 2011), as cardinal measurements. Data on S_{Org} is obtained from a question where people were asked to rank their engagement in organisations on a scale where 1 indicates "not member", 2 "member but have not participated in any meeting last year", 3 "member and have participated in meeting last year", and 4 "member with some kind of commission". Measurements of S_{Mun} and S_{Nat} are obtained from questions with a 5 point Likert scale, where '1' is very little trust, and '5' is much trust. The variable S_{Gen}, is measured on a cardinal scale between 0 and 10, where 0 is no trust and 10 is full trust on 'people in general'.

Growth rates in social capital are calculated from time series data on our four social capital variables in Holmberg et al. (2011). Unfortunately, such data are available for all four social capital variables at the earliest from 2000, which does not allow for any econometric estimates of the growth rates. Average annual growth rates during the period have therefore been calculated for each of the social capital variables.

Data on violation, enforcement and inspection style are not available in official Swedish statistics and we therefore obtained these from a survey to inspection officers at 287 municipal authorities and 21 county administration boards (Holstein 2010). There is one inspection authority in each jurisdiction, and the survey was sent to all authorities. The survey contained questions on supervision duty, i.e. number of firms in each category (A, B, C and U) for which the respondent was the supervising authority, number of violations, and visits to firms. All questions covered the period 2005-2007. Thus, this survey contains data on total firms and firms in different categories, N_F, inspections, Ins_F, and violations, $Viol_F$, where $F=all,A,B,C,U$.

Of 287 municipal authorities approached, 79 (31%) answered the questionnaire after two follow-up contacts, while seven (33%) of the 21 county administration boards in Sweden responded. One reason for this relatively low response rate can be attributed to the lack of specific requirements with respect to the requested data. There is a great variety among the inspection authorities with respect to efforts needed to collect the information asked for in the survey. At the follow up contacts inspection authorities informed that they did not have necessary resources to find and collect the data. The non-responses may then not be correlated with the number of violations or inspections in a community which would bias the results. Nevertheless, we carried out test of differences in sample and populations on variables for which these means exist, which are presented below in this section.

The municipalities and counties differ considerably with respect to wealth and income where the urban regions with the largest cities have the highest average income. This may reflect opportunities for firms to earn income, which may have a negative or positive effect on violation. Following Earnhaert (2004) we therefore include income per capita, *Inc,* as an explanatory variables. If it reflects firms' losses of incomes from complying with regulations, it should have a positive impact on violation. If it instead is negative, it can be interpreted as profits showing firms' affordability to comply with regulations. In addition, we controlled for environmental activity in the community, since it has been shown to affect compliance by firms in Sweden (Holstein and Gren 2013). Data on environmental interest, *Env*, were obtained from a regular poll of Swedish citizens' attitudes in which citizens are asked to state their interest on a scale ranging from 1-5, where 1 is the highest and 5 the lowest level of interest (Holmberg et al. 2011). In order to control for the relative size of the jurisdictions, we introduced a variable on population density, *Popdens*.

There might also be differences between the two jurisdictional levels, which may influence compliance by the category A and B firms. Results from Burby and Paterson (1993) indicated that local enforcement generates higher compliance rate than state enforcement in the US. Similar observations were made by Cutter and DeShazo (2007) and Chang et al. (2014) who found that enforcement stringency and environmental ambitions are higher in states granted authority in the US. We therefore introduce a dummy for inspection authority, *Dauth*, which is 1 for a county and 0 for a municipality.

The data constitute a panel of 3 years and 95 jurisdictions. We introduced dummy variables for two years, *D2005* and *D2006*. All variables, abbreviations, explanation, and data sources are presented in Table 1 followed by descriptive statistics in Table 2.

Table 1: Abbreviations, description of variables and data sources

$Viol_F$	violations of F classified firms where F=all,A,B,C,U (Holstein 2010)
N_F	number of all firms to be inspected where F=all,A.B,C,U (Holstein 2010)
$Insfr_F$	number of inspections of F classified firms where F=all,A.B,C,U (Holstein 2010)
Inc	income/capita, 1000 SEK/year (SCB 2010)
Env	environmental interest, 1 highest and 5 lowest (Holmberg et al. 2011)
S_{Mun}, S_{Nat}	trust in municipal and national politicians, 1 lowest and 5 highest (Holmberg et al. 2011)
S_{Gen}	general trust, index, 0 to 10 (Holmberg et al. 2011)
S_{Org}	organizational engagement, 1 to 5 (Holmberg et al. 2011)
$Growth_K$	average growth rate, %, during 2000-2007 in S_K where K= Mun, Nat, Gen, Org
Popdens	1000 per km^2 (SCB, 2013)
Dauth	dummy for county inspection
D2006	dummy for year 2006
D2005	dummy for year 2005

Table 2: Descriptive statistics

Variables	*Observations*	*Mean*	*Stand. dev.*	*Minimum*	*Maximum*
Dependent variables:					
$Viol_{all}$	258	32.64	68.17	0	496
$Viol_{A}$	74	1.63	4.73	0	26
$Viol_{B}$	197	6.24	16.30	0	88
$Viol_{C}$	230	16.42	34.20	0	200
$Viol_{U}$	201	14.92	34.18	0	252
Explanatory variables:					
N_{all}	258	232.52	352.26	14	2955
N_{A}	77	5.49	7.22	1	46
N_{B}	197	27.39	43.77	1	290
N_{C}	230	74.86	72.19	2	548
N_{U}	198	186.63	316.87	7	2339
$Insfr_{all}$	258	0.312	0.298	0	1.571
$Insfr_{A}$	77	1.228	1.875	0	7.000
$Insfr_{B}$	197	0.681	0.689	0	3.631
$Insfr_{C}$	230	0.339	0.338	0	1.910
$Insfr_{U}$	198	0.219	0.295	0	1.850
Inc	283	213.20	26.17	174.40	372.10
Env	285	2.20	0.15	1.91	2.64
Popdens	285	203.26	676.10	0.78	4248.63
S_{Mun}	285	3.23	0.48	1.00	4.50
S_{Nat}	285	3.09	0.53	1.00	4.50
S_{Gen}	285	6.35	0.37	5.32	7.00
S_{Org}	285	1.42	0.09	1.23	1.94
$Growth_{Mun}$	285	3.73	6.35	-5.72	32.69
$Growth_{Nat}$	285	4.68	8.73	-5.00	45.70
$Growth_{Gen}$	285	2.07	4.88	-1.49	18.42
$Growth_{Org}$	285	1.39	6.92	-1.45	41.57

The descriptive statistics show that average number of U-classified firms is approximately 34 times larger than that of A-classified firms, which is in line with the entire population measured in early 1990s (Gren and Li 2011). On the other hand, the average level of violation among U-classified firms is approximately 16 times larger than that of A firms. It can also be noted that in average, an A classified firm is inspected 1.33 times during the three year period, and a U classified firm 0.12 times. It can also be seen that the average growth is positive for all four social capital variables. Another noteworthy observation is that the standard deviations of the response variables are quite large relative to the means which may be an indication of over-dispersion.

Considering that the response rate of the survey was relatively low, even after two follow up surveys, we carried out t-tests of the characteristics of the variables S_K, *Env* and *Inc*, for which we have data on population means. The test results showed no significant difference between the sample and population means at the 1% level for any of the three years. However, we may still have a selection bias where the most interested and active inspection authorities answer the questionnaire. This may be of specific relevance for this survey since some respondents answered that much efforts were needed to provide answers. Some caution is therefore needed in generalizing the results for entire Sweden, although the test results of the variables did not reveal any difference between the sample and population.

4. Econometric models and results

In order to test the role of social capital, measured in four different ways, we carried out zero-inflated negative binomial regressions for each specification. The choice of this method is based on the relatively large number of observations with the value zero on the response variable. A zero can arise when violation is present but not detected, but also as a true non-existent violation. A count data model is therefore used which gives possibilities to test for the two interpretations of zeros using an extra component accounting for the surplus of zeros, a so called zero-inflated model. The response variable, number of violating firms, is then characterised as an event count, i.e. the realisation of a non-negative positive integer (Cameron and Trivedi 1998). Ordinary least square method then gives rise to biased and inefficient estimates, and nonlinear models that are based on Poisson or negative binomial distributions have therefore been developed (e.g. Long 1997). A Poisson distribution is a discrete probability distribution where the probability that an event occurs in a given time interval is independent from the occurrence of the last event but at a known average rate, implying that the mean equals the variance. Thus, the number of occurrences fluctuates around its mean. Since the variance in the response variable is considerably larger than the mean (see Table 2), we tested for a negative binomial regression model. The likelihood ratio test resulted in the choice of this model.

A function quadratic in inspections frequency is specified for capturing possible non-linearity, and an interaction term between inspection and social capital is introduced for investigating complementarity or substitution between the enforcement parameters. The regression equation with respect to the logarithm of the mean for all firms and each firm category is then written as:

$$\log \mu_{it}^{FK} = \alpha_0^{FK} + \alpha_1^{FK} Insfr_{it}^{F} + \alpha_2^{FK}\left(Insfr_{it}^{F}\right)^2 + \alpha_3^{FK} S_i^{K} + \alpha_4^{FK} Insfr_{it}^{F} S_i^{K} + \alpha_5^{FK} Growth_i^{K} + \alpha_6^{FK} Inc_{it} + \alpha_7^{FK} Env_{it} + \alpha_8^{FK} \log N_{it}^{F} + \alpha_9^{FK} Popdens_{it} + \alpha_{10}^{FK} Dauth + \alpha_{11}^{FK} D2005 + \alpha_{12}^{FK} D2006$$

where *i=1,..,n* inspection jurisdictions, *F=all, A, B, C, U* firm categories and *K= Gen, Org, Mun, Nat* as presented in Table 1, Dauth=1 for a county board and 0 for municipalities, D2005 and D2006 year is 1 for year 2005 and 2006 respectively. The term $\log N_{it}^{F}$ was included to stabilize the ratio μ_{it}^{FK}/N_{it}^{F}, i.e. the fraction of violations with respect to the number of firms to be inspected. For a constant ratio, the hypothesis $\alpha_8^{FK} = 1$ should hold, which is supported by the results in Table 3.

The three different hypotheses derived in Section 2 are tested by the signs of the estimated coefficient of relevant variable. According to the first hypothesis we then expect $\alpha_1^{FK} < 0$, $\alpha_2^{FK} < 0$, and $\alpha_3^{FK} < 0$. The second hypothesis is more explorative and requires $\alpha_4^{FK} \neq 0$ for complementarity or substitution in inspections and social capital. The third and last hypothesis is not rejected for a statistically significant $\alpha_5^{FK} < 0$.

The specification of the regression equation may contain statistical problems; endogeneity, and heteroscedasticity. Endogeneity can be expected in inspections where the choice of inspection can be a result of compliance behaviour (e.g Gray and Shimshack 2011). If so, the estimators will not give consistent estimates. We therefore used the instrumental variable (IV) method and tested for endogeneity (e.g Davidson and McKinnon 1993). Admittedly, it is difficult to find instruments which are correlated with visit frequency but not with the response variable. Different instruments were tested, and costs of inspection authorities and area of the jurisdiction turned out to be the most valid instruments as revealed from test of over-identification (Table A1). However, test results did not show any evidence for inspection frequency to be endogenous (Table A1). One reason could be that inspectors follow guidelines provided by the Swedish Environmental Protection Agency (Bengtsson 2004). Tests were also carried out for heteroscedasticy, which turned out to be present. Therefore, estimates with robust standard errors were made for all models.

Estimations of the regression equation without the social capital variables were carried out for five different models; ordinary least squares, instrumental variable, random effect model, and the Poisson and negative binominal count data models (Table A1). The results were very similar among the models with respect to significance and sign of estimated coefficients of the independent variables. Test results indicated that the count data models gave the best statistical fit, and that the zero-inflated negative binominal model is preferred to the Poisson model (Table A1). We therefore used this model to estimate the impacts of social capital variables, Table 3.

Table 3: Results from zero inflated negative binomial regression models with robust standard errors and different social capital, S_K, variables, p-values in parentheses.

Variables	*No social capital*	S_{Org}	*Trust variables:* S_{Mun}	S_{Nat}	S_{Gen}
Intercept	-7.69 (0.00)	-2.31 (0.39)	-8.77 (0.00)	-7.36 (0.01)	-12.47(0.00)
$Insfr_{all}$	4.09(0.00)	0.04 (0.99)	7.04 (0.00)	4.24 (0.02)	8.88(0.17)
$Insfr_{all}^2$	-2.03(0.00)	-1.59 (0.01)	-1.85 (0.00)	-2.42 (0.00)	-2.60(0.00)
S_K		-3.57 (0.00)	0.46 (0.11)	-0.50 (0.08)	0.63(0.19)
$InsfrS_{Kall}$		2.75 (0.46)	-1.02 (0.18)	0.06 (0.91)	-0.63(0.53)
$Growth_K$		-3.80 (0.00)	0.11 (0.94)	-1.86 (0.00)	-0.54(0.70)
Log N_{All}	0.88 (0.00)	0.97 (0.00)	0.88 (0.00)	0.85 (0.00)	0.90(0.00)
Inc	0.01(0.00)	0.01 (0.01)	0.01 (0.01)	0.01 (0.00)	0.01(0.01)
Env	1.41(0.04)	1.05 (0.14)	1.34 (0.07)	1.94 (0.02)	1.64(0.05)
Popdens	-0.2-3(0.03)	-0.16-3(0.11)	-0.27-3(0.01)	-0.12-3 (0.30)	-0.17-3(0.12)
Dauth	-1.44(0.00)	-1.72 (0.00)	-1.50 (0.00)	-1.50 (0.00)	-1.68(0.00)
D2005	0.19(0.34)	0.22 (0.30)	0.20 (0.35)	0.18 (0.33)	0.19(0.34)
D2006	0.17(0.34)	0.20 (0.27)	0.17 (0.36)	0.20 (0.25)	0.19(0.32)
Logit:					
Intercept	-0.35(0.16)	7.22(0.17)	-1.93 (0.05)	-1.42 (0.12)	-6.49(0.09)
Insall	-0.01(0.05)	-0.04(0.10)	-0.01 (0.06)	-0.01 (0.06)	-0.01(0.19)
S_K		-5.52(0.15)	0.48 (0.11)	0.34 (0.24)	0.93((0.12)
Dauth	0.55(0.35)	2.05 (0.30)	0.63 (0.29)	0.66 (0.25)	0.31(0.72)
Log pseudo Likelihood	-881.92	-837.40	-879.66	-876.47	-842.30
Wald	231.51	228.77	240.60	219.54	231.19
AIC	1791.85	1710.80	1795.33	1788.95	1720.60
BIC	1841.48	1773.23	1859.14	1852.76	1783.03

The variable *Insall* in the logistic equation is number of inspections. When comparing the regression models with and without a social capital variable, we can notice that two of the cognitive type social capital variables, the institutional trust variables S_{Mun} and S_{Nat}, do not contribute to the explanatory power as measured by the AIC and BIC tests. We can also note that the sign and significance of the coefficients of most variables in the model without social capital are not much affected by the introduction of any social capital variable. Such results are the positive and negative sign of the linear and quadratic component of $Insfr_{all}$, the positive sign of $LogN_{All}$, and *Env*, and the negative of *Dauth*. We would expect violation to increase in number of regulated firms, and decrease in the level of environmental interest (recall that a larger *Env* means less environmental interest). The negative sign of *Dauth* indicates higher violation deterrence from inspections by county administrative boards than municipalities. However, the positive sign in the logistic equations instead shows that the country administrative board increases the probability of a zero to be a non-detected violation. These results can be compared with the findings obtained by Burby and Paterson (1993) and Cutter and DeShazo (2007) who showed that local enforcement improve compliance. On the other hand, our results on the impact of *Dauth* in the logistic equation are never significant.

With respect to our first hypothesis, i.e. that violation is decreasing in inspection frequency and social capital, the results differ between the social capital variables. When considering only inspection frequency, the two opposite signs of *Insfr* and $Insfr^2$ imply a turning point, the level of which is affected by the sign of the interaction term. In the absence of social capital variable, the turning point occurs at *Insfr*=1.01 which is well above the average of 0.31 (Table 2). Except for S_{Org} there are only small changes when adding the social capital variables and evaluating the turning at their mean values. On the other hand, the logistic estimates show that inspections reduce the probability of a zero reported violation to be a non-detected violation. More inspections may then increase the number of detected violations and not necessarily the number of violating firms. The first part of our first hypothesis could thus not be supported.

The significant results are more unambiguous for the other part of the first hypothesis, i.e. a negative impact of social capital. The coefficients are significant and negative for S_{Org} and S_{Nat}, but non-significant and positive for the other two social capital variables. The social capital variables are never significant in the logistic equations, which indicate that they have no impact on whether a non-detected violation is a true compliance or not. A further investigation of the effect of a marginal change in S_K shows that it is negative for realistic levels of *Insfr* for S_{Org} (*Insfr<1.30*) and S_{Nat} (*Insfr<8.33*) We can thus conclude that the results seem to support the second part of the first hypothesis, i.e. a negative impact on violation from two social capital constructs, S_{Org} and S_{Nat}.

The second hypothesis on interaction between *Insfr* and S_K cannot be supported for any social capital variable, the interaction term is not significant in any model. On the other hand, significant estimates are obtained for two capital growth variables. The negative sign of $Growth_{Org}$ and $Growth_{Nat}$, give support to our third and last hypothesis. This is also in line with the findings obtained by Langpap and Shimshak (2010).

The different results of the social capital variables and the interaction term can be explained by different effects of measures of social capital as such, but also on the existence of multicollinearity among $Insfr_{All}$ and $Insfr_{All}S_K$, which was revealed by a VIF test. This does not affect the predictive properties of the entire model but can influence the estimated coefficients of the independent variables and their standard errors. We therefore estimated the regression models presented in Table 3 without the interaction term, but the signs of the remaining variables were not affected (Table A2).

When estimating the regression equations for the four categories of firms, other potential statistical problems arose. Since the dependent variables, one for each firm category, were regressed on several common independent variables, there was a risk of contemporaneous correlation, creating inefficient estimates of separate regressions. This requires methods accounting for such correlations, such as the seemingly unrelated regressions estimate (SURE). However, this method does not allow for tests of the zero reports as true non-violations or non-detected violations. We therefore applied a count data regression model to each firm category, but we merged category A and B firms because of the relatively low number of observations in these classes.

For each firm category regressions are made in the same way as for all firms, i.e. with and without a social capital variable. The results of these regressions are shown in Tables A3-A5. The results for each firm category without any social capital variable were very similar to that of all firms. The estimates improved when adding a social capital variable in almost all cases, but to different degrees. In Table 4 we present results for S_{Org} which turned out to give the best statistical results as measured by AIC and BIC for all three firm categories.

Table 4: Regression results with S_{Org} for different firm categories with zero inflated negative binominal model, p-values in parentheses.

Variables	*A+B firms*	*C firms*	*U firms*
Intercept	-19.71(0.11)	-6.80(0.03)	1.85(0.71)
$Insfr_F$	-3.72(0.65)	23.12(0.00)	-3.04(0.70)
$Insfr_F^2$	-1.17 (0.00)	-1.01(0.01)	-0.52(0.28)
S_{Org}	2.92 (0.76)	0.85(0.59)	-3.37(0.02)
$Insfr_F S_{Org}$	5.36 (0.39)	-14.38(0.00)	3.77(0.51)
$Growth_{Org}$	-4.58 (0.02)	-1.38(0.34)	-4.61(0.00)
Log N_F	1.20 (0.00)	1.21(0.00)	0.50(0.00)
Inc	-0.01 0.59)	10.7-3(0.04)	0.01(0.03)
Env	6.11 (0.05)	0.11(0.88)	0.16(0.89)
Popdens	3.5-3(0.06)	-0.03-3(0.71)	-0.7-(0.00)
Dauth	-2.10 (0.00)		
D2005	-0.16 (0.72)	0.04(0.85)	0.62(0.04)
D2006	-0.18 (0.70)	0.18(0.30)	0.14(0.54)
Logit:			
Intercept	-46.97(0.01)	1.70(0.82)	5.23(0.08)
Ins_F	-0.1-3 0.05)	-7.5-3(0.25)	-0.04(0.01)
S_{Org}	11.63 (0.01)	-1.32(0.36)	-3.26(0.11)
Dauth	2.52 (0.15)		
Log pseudo likelihood	-205.06	-601.30	-491.32
Wald	161.34	268.72	155.14
AIC	446.12	1234.59	1014.65
BIC	495.84	1288.59	1066.43

Source: Tables A3-A5

The regression results for different firm categories reveal some differences and similarities with respect to our variables of main interest. One difference is that both the linear and quadratic components of inspection frequency are negative for the large and small firm categories, but not for category C firms.

The social capital variable measured as civic engagement seems to act as complementary to formal enforcement for category C firms and as substitute for the other categories. However, the relatively large coefficient values of $Insfr_C$ and the interaction terms reveal that this could be a result from existence of multicollinearity in the equation. When estimating the regression equation without the interaction term, we obtain significant and negative estimate of S_{Org}. Another difference is that S_{Org} is significant and negative only for category U firms. A common result for all firm categories is the negative sign of $GrowthS_{Org}$, which is significant for category A+B and U firm. This is true also for Ins_F in the logistic equations, which indicate that both formal and informal enforcement reduce the probability of a zero reported violation to be a non-detected violation.

5. Summary and conclusions

This paper analysed, theoretically and empirically, the impact of social capital on violation of environmental regulations. A simple dynamic model with violation as disinvestment in social capital was constructed to identify mechanisms of impact and to derive testable hypotheses. Two main channels of social capital influence were identified; through interdependence between formal and informal enforcement which could be either complementary or substitutes, and through future decreases in profits from degradation of social capital.

Four different social capital variables were constructed in the empirical test on data from a survey to inspection authorities at the municipal and county board levels in Sweden; general trust, institutional trust in politicians at the municipal and national levels, and organisational activities. Count data regression models were used, and robust results were that violation is decreasing in growth of all social capital variables. In general, the statistically best results were obtained for organizational activity. A small difference appeared between firm categories where relatively small firms responded by reducing violation for social capital measured by civic engagement, but such results were not significant the other firm categories. One reason could be that small firms are more dependent on local civic engagement.

With respect to the relation between formal and informal enforcement as measured by the interaction between inspection frequency and any of the social capital variables, significant results were obtained only for specific firm categories where civic engagement tended to act as complement for the middle sized firms. This result is in line with Yamamura (2009) who found complementarity between formal enforcement and different social capital constructs in terms of civic engagement for reductions in crime rates in Japan.

The insignificant result of the interaction between inspections and social capital was in contrast to the robust results of inspection frequency, inspection authority, and community characteristics in terms of income/capita and environmental interest. All models showed a negative impact on violation at higher inspection level, which support the results of most other studies (Gray and Shimchack 2011). Another robust result was that reported violations are lower when the inspection is carried out by county boards, but this can be a result of non-detected violation rather than violation deterrence. This result partly supports the findings by Burby and Paterson (1993) and Cutter and DeShazo (2007). However, our data set only included seven county administration boards which may not be sufficient for an evaluation of the devolution policy.

We can thus conclude that our results support earlier findings of the impacts of inspections and social capital on violation deterrence, but also add some new findings. The most robust results were the negative impact of growth in social capital on violation, which indicate that firms consider future effects on profits from disinvestment in social capital. With respect to the interaction between abundance of social capital and formal inspections, we obtained significant results only for the middle sized firms. However, the introduction of the interaction term did create statistical problems with multicollinearity, which put some doubts on the results of the coefficient estimate of this term. Further, different social capital variables may act in combination as suggested by Jackson (2011), which has not been considered in this study.

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Appendix: Tables

Table A1: Results from alternative regression models for all firm categories and without social capital, robust standard error, n=256.

Variables	*OLS*	*IV [a] (n=119)*	*Random effect model[b]*	*Poisson, zero-inflated[c]*
Intercept	-139.31(0.01)	-236.82(0.06)	-126.14(0.10)	-10.01 (0.00)
$Insfr_{All}$	139.52(0.00)	286.78(0.26)	83.12 (0.00)	4.60 (0.01)
$Insfr_{All}^2$	-99.90(0.00)	-210.54(0.30)	-47.32 (0.00)	-2.65 (0.00)
N_{All} (Log N_{All} for count model)	0.05(0.00)	0.06(0.00)	0.05(0.03)	0.91 (0.00)
Inc	0.17(0.06)	0.36 (0.06)	0.20(0.17)	0.02 (0.00)
Env	44.08 (0.04)	57.66 (0.08)	40.12 (0.20)	2.07(0.00)
Popdens	-0.02 (0.01)	-0.02 (0.00)	-0.02 (0.05)	-0.1-30.23)
Dauth	-19.68(0.00)	-45.54(0.06)	-20.12 (0.01)	-1.23 (0.00)
D2005	4.01 (0.61)	7.46 (0.48)	2.14(0.66)	0.29 (0.16)
D2006	2.45 (0.75)	6.12 (0.54)	0.88(0.85)	0.17(0.35)
Logit:				
Intercept				-0.14(0.47)
Ins_{All}				-0.01(0.01)
Dauth				0.69(0.15)
Wald			27.12	182.62
Adj. R^2	0.20	0.05	0.18	
LL	-1356.56	-627.21		-3061.92
AIC	2733.12	1274.41		6149.85
BIC	2768.57	1302.20		6195.93

[a] Hansen J statistic of over identification resulted in p=0.777, and Wu-Hausman test of endogeneity gave p=0.570.

[b] Breusch-Pagan Lagrange multiplier test for random effects gives p=0.000.

[c] Voung test of zero inflated variable p=0.000.

Table A2: Results from zero inflated negative binomial regression models with robust standard errors and different social capital, S_K, variables without the interaction term.

Variables	S_{Org}	*Trust variables:* S_{Mun}	S_{Nat}	S_{Gen}
Intercept	-1.44 (0.62)	-8.14(0.00)	-7.45(0.00)	-11.47(0.00)
$Insfr_{All}$	3.75 (0.00)	3.99 (0.00)	4.41 (0.00)	4.51(0.00)
$Insfr_{All}^2$	-1.88 (0.01)	-1.94 (0.00)	-2.42 (0.00)	-2.61(0.00)
S_K	-3.47(0.00)	0.18 (0.36)	-0.47 (0.01)	0.47(0.15)
$Growth_K$	-3.42(0.00)	0.49 (0.74)	-1.86 (0.00)	-0.45(0.75)
Log N_{All}	0.92 (0.00)	0.89 (0.00)	0.85 (0.00)	0.84(0.00)
Inc	0.01 (0.03)	0.01 (0.01)	0.01 (0.00)	0.01(0.01)
Env	0.82 (0.23)	1.33 (0.08)	1.96 (0.01)	1.81(0.02)
Popdens	-0.20-3(0.08)	-0.24-3(0.02)	-0.12-3 (0.27)	-0.17-3(0.11)
Dauth	-1.36 (0.00)	-1.38 (0.00)	-1.49 (0.00)	-1.47(0.00)
D2005	0.21(0.36)	0.20(0.35)	0.19 (0.33)	0.18(0.41)
D2006	0.19(0.27)	0.17(0.36)	0.20 (0.26)	0.21(0.27)
Logit:				
Intercept	17.51(0.07)	-1.94 (0.05)	-1.45 (0.11)	-11.37(0.06)
Insall	-0.05(0.14)	-0.01(0.06)	-0.01 (0.05)	-0.05(0.06)
S_K	-12.60(0.07)	0.48 (0.10)	0.35 (0.22)	1.75(0.06)
N_{All}				
Dauth	2.09 (0.26)	0.67 (0.27)	0.69 (0.11)	1.60(0.22)
Log pseudo Likelihood	-838.36	-880.49	-876.41	-843.12
Wald	197.19	234.08	221.11	205.88
AIC	1710.67	1794.98	1786.82	1720.23
BIC	1769.67	1855.25	1847.09	1779.19

Table A3: Results from zero inflated Negative binominal model with robust standard errors and different social capital variables for category A+B firms, (n=130 and non-zero 43)

Variables	*No social capital*[a]	S_{Org}	*Trust variables:* S_{Mun}	S_{Nat}	S_{Gen}
Intercept	-18.49(0.17)	-19.71(0.11)	-15.25 (0.03)	-14.35 (0.04)	23.74(0.48)
Insfr$_{A+B}$	4.13 (0.00)	-3.72(0.65)	5.90 (0.13)	5.82 (0.00)	-27.75 (0.20)
Insfr$_{A+B}^{2}$	-1.19 (0.00)	-1.17 (0.00)	-1.31 (0.00)	-1.70 (0.00)	-0.81 (0.08)
S$_{K}$		2.92 (0.76)	-2.17 (0.26)	-1.58 (0.11)	-5.99 (0.10)
InsfrS$_{KA+B}$		5.36 (0.39)	-0.42 (0.70)	-0.04 (0.93)	4.86 (0.14)
Growth$_{K}$		-4.58 (0.02)	-17.13 (0.02)	-12.58 (0.08)	-3.19 (0.44)
Log N$_{A+B}$	1.31 (0.00)	1.20 (0.00)	1.36 (0.00)	1.38 (0.00)	1.20 (0.00)
Inc	-0.02 (0.24)	-0.01 0.59)	-0.03 (0.00)	-0.04 (0.01)	-0.03 (0.14)
Env	8.02 (0.13)	6.11 (0.05)	11.32 (0.00)	10.49 (0.00)	8.31 (0.01)
Popdens	2.18-3 0.29)	3.5-3(0.06)	-1.97-3(0.21)	-1.1-3 (0.40)	-3.2-3 (0.21)
Dauth	-1.98 (0.02)	-2.10 (0.00)	-3.15 (0.00)	-2.82 (0.00)	-1.86 (0.02)
D2005	-0.10 (0.81)	-0.16 (0.72)	-0.43 (0.24)	-0.28 (0.45)	-0.61 (0.31)
D2006	-0.04 (0.89)	-0.18 (0.70)	-0.26 (0.46)	-0.28 (0.40)	-0.32 (0.50)
Logit:					
Intercept	-0.9-3 (0.00)	-46.97(0.01)	6.93 (0.06)	-4.19 (0.19)	10.21 (0.17)
Ins$_{A+B}$	-0.08-(0.04)	-0.1-3 0.05)	-0.08-3(0.00)	-0.08-3(0.04)	-0.07-3(0.04)
S$_{K}$		11.63 (0.01)	-2.25 (0.06)	1.41 (0.21)	-1.66(0.17)
Dauth	2.07 (0.21)	2.52 (0.15)	2.06 (0.26)	2.42 (0.15)	1.82 (0.25)
Log pseudo likelihood	-228.47	-205.06	-222.71	-220.90	-212.35
Wald	129.24	161.34	207.79	151.34	134.75
AIC	473.73	446.12	481.42	477.80	460.71
BIC	507.76	495.84	532.48	528.86	510.43

[a] Voung test gives p=0.005, and a LR test of Poisson versus negative binominal distribution gives p=0.000

Table A4: Results from zero inflated negative binominal regression models with robust standard errors and different social capital variables for category C firms, n=229 (109)

Variables	*No social capital*[a]	S_{Org}	*Trust variables:*		
			S_{Mun}	S_{Nat}	S_{Gen}
Intercept	-7.30(0.00)	-6.80(0.03)	-7.33(0.00)	-5.790(0.00)	-9.54(0.00)
$Insfr_C$	2.54(0.00)	23.12(0.00)	1.33(0.42)	-0.42(0.82)	10.90(0.02)
$Insfr_C^2$	-0.47(0.30)	-1.01(0.01)	-0.56(0.22)	-0.62(0.08)	-0.75(0.07)
S_K		0.85(0.59)	-0.03(0.91)	-0.68(0.03)	0.47(0.26)
$InsfrS_{KC}$		-14.38(0.00)	0.41(0.44)	1.02(0.09)	-1.25(0.08)
$Growth_K$		-1.38(0.34)	-0.62(0.65)	-1.07(0.01)	0.34(0.82)
Log N_C	1.08(0.00)	1.21(0.00)	1.10(0.00)	0.98(0.00)	1.07(0.00)
Inc	7.5-3(0.18)	10.7-3(0.04)	-6.2-3(0.29)	7.8-3(0.18)	9.12-3(0.14)
Env	1.50(0.03)	0.11(0.88)	1.63(0.03)	1.91(0.01)	0.98(0.24)
Popdens	-0.01-3(0.89)	-0.03-3(0.71)	-0.03-3(0.77)	0.13-3(0.32)	-0.02-3(0.84)
D2005	-0.01(0.96)	0.04(0.85)	-0.01(0.95)	-0.03(0.89)	-0.05(0.82)
D2006	0.13(0.47)	0.18(0.30)	0.13(0.47)	0.14(0.42)	0.14(0.46)
Logit:					
Intercept	-0.06(0.76)	1.70(0.82)	-1.75(0.06)	-1.46(0.09)	-5.25(0.05)
Ins_C	-7.2-3(0.18)	-7.5-3(0.25)	-6.2-3(0.29)	-0.01(0.31)	-6.4-3(0.32)
S_K		-1.32(0.36)	0.52(0.06)	0.45(0.10)	0.79(0.06)
Log pseudo likelihood	-629.33	-601.30	-627.27	-6224.15	-606.12
Wald	179.63	268.72	216.22	259.22	165.37
AIC	1282.67	1234.59	1286.53	1280.31	1244.25
BIC	1323.87	1288.59	1341.47	1335.25	1298.05

[a] Voung test gives p=0.000 and LR test of Poisson versus negative binominal p=0.000

Table A5: Results from zero inflated negative binominal regression models with robust standard errors and different social capital variables for category U firms, n=197 (102) Voung p=0.00 LR p=0.00

Variables	*No social capital*	S_{Org}	*Trust variables:* S_{Mun}	S_{Nat}	S_{Trust}
Intercept	-4.40(0.05)	1.85(0.71)	-6.60(0.04)	-4.34(0.09)	-1.02(0.85)
$Insfr_{alU}$	2.58(0.00)	-3.04(0.70)	5.34(0.00)	3.42(0.00)	-4.25(0.47)
$Insfr_{aU}^2$	-0.82(0.03)	-0.52(0.28)	-0.52(0.16)	-0.85(0.01)	-0.89(0.01)
S_K		-3.37(0.02)	0.50(0.08)	-0.23(0.42)	-0.49(0.43)
$InsfrS_{KU}$		3.77(0.51)	-0.97(0.03)	-0.28(0.26)	1.09(0.23)
$Growth_K$		-4.61(0.00)	0.26(0.89)	-2.12(0.00)	-4.25(0.17)
Log N_U	0.49(0.00)	0.50(0.00)	0.53(0.00)	0.53(0.00)	0.46(0.00)
Inc	0.02(0.01)	0.01(0.03)	0.02(0.02)	0.02(0.01)	0.01(0.01)
Env	0.60(0.49)	0.16(0.89)	0.47(0.64)	0.87(0.40)	0.73(0.52)
Popdens	-0.7-(0.00)	-0.7-(0.00)	-0.8-(0.00)	-0.7-3(0.00)	-0.8-3(0.00)
D2005	0.70(0.02)	0.62(0.04)	0.73(0.02)	0.70(0.01)	0.72(0.02)
D2006	0.18(0.44)	0.14(0.54)	0.19(0.41)	0.20(0.37)	0.18(0.43)
Logit:					
Intercept	0.62(0.01)	5.23(0.08)	0.01(0.99)	-1.57(0.13)	6.49(0.08)
Ins_A	-0.03(0.00)	-0.04(0.01)	-0.03(0.01)	-0.03(0.01)	-0.04(0.00)
S_K		-3.26(0.11)	0.19(0.61)	0.70(0.03)	-0.92(0.11)
Log pseudo likelihood	-506.85	-491.32	-505.06	-500.63	-492.76
Wald	160.62	155.14	160.60	231.04	164.53
AIC	1037.73	1014.65	1042.13	1033.26	1017.52
BIC	1077.13	1066.43	1094.66	1085.79	1069.31

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