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The role of top-managers and their entrepreneurial strategies in the adoption of inbound open innovation: A longitudinal analysis

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1. Introduction

Open Innovation (OI), defined as the purposive use of inflows and outflows of knowledge to accelerate internal innovation, and expand markets for external use of innovation (Chesbrough, 2003); has established itself as a new paradigm and perspective on industrial innovation (see Gassmann et al, 2009; 2010; Gassmann & Enkel, 2004; Dahlander & Gann, 2010; West & Bogers, 2011; Huizingh, 2011 for review papers).

A range of prior studies has documented that open innovation are associated with better performance and increased innovativeness (e.g. Laursen & Salter, 2006; Bae & Chang, 2012; Amlik & Wei, 2011; Huang, 2011; Quintana-García & Benavides-Velasco, 2011; Enkel & Gassmann, 2008; Chiang & Hung, 2010; Sofka & Grimpe, 2010). However, an issue that in parallel has been scarcely examined is how firms have been able to conduct the journey from closed to open innovation (Mortara & Minshall, 2011; Chiaroni et al, 2010; 2011). In this paper we argue that although it is important to continue to verify (under what conditions) open innovation is a superior innovation paradigm, it is increasingly important to research how companies can adopt it, given its increasingly demonstrated superiority over closed innovation. We focus in particular on inbound open innovation (IOI) where firms actively source and acquire external knowledge. The reason is that the benefits and advantages of IOI for firms have been widely studied and demonstrated, which leads to the question of how firms can implement and maintain IOI.

Motivated by the relative lack of studies on how companies adopt open innovation (Mortara & Minshall, 2011; Chiaroni et al, 2010; 2011), this paper proposes that top-managers and to what extent they act entrepreneurially in their strategies and decision-making represent an important driving force behind the successful adoption of OI by firms. To measure top-mangers entrepreneurial strategies we draw on the literature on entrepreneurial orientation (EO). EO is a central concept with the (corporate) entrepreneurship literature (Miller, 1982; Coven & Slevin, 1989; Rauch et al, 2008) where it highlights the nature of entrepreneurial decision-making by top-managers within firms. Specifically, the EO concept focuses on the processes in which top-managers act innovatively, proactively and take risks (Miller, 1982), and thereby imprint their firm with entrepreneurial spirit.

Measuring top-managers entrepreneurial strategies with EO, the following research question is asked: What is the role of EO in the adoption of IOI by firms over time? This broad research question is developed into 2 testable hypotheses. By combining OI and EO we contribute to the scholarly literature on entrepreneurship and innovation in three important ways:

First, we formulate a model where there is a direct link between top-managers entrepreneurial strategies, as measured by EO, and adoption of open innovation over time. Thus, we make a connection between the EO concept in the Corporate Entrepreneurship (CE) literature and the OI literature. Since there has been little theorizing on adoption of OI, the OI literature lacks concepts that can help explain through which theoretical mechanisms firms can successfully implement OI. Thus, we argue in particular that the CE literature can add to the OI literature by providing the OI literature with a concept (i.e. EO) that can help explain how firms and their top-managers can succeed with the implementation of OI.

A related second contribution is that the paper studies the role of EO in firms' journey towards increased openness in the innovation process *over time*. While several studies have focused on the theoretical implications of open innovation (e.g. Chesbrough et al, 2006) or the performance implication of openness (e.g. Laursen & Salter, 2006), fewer studies have examined antecedents of open innovation. As argued by Chiaroni et al (2011): "scant attention has been dedicated so far to the process through which firms implement Open Innovation" (p. 934). By adopting a longitudinal research design, this paper contributes to the literature by analyzing the extent to which top-managers and their entrepreneurial strategies (as measured by EO) can help explain why some firms are better able to undertake the journey towards increased openness in the innovation process (over time).

A third and related contribution is that we extend the small set of mainly qualitative studies that have been undertaken on how firms have managed the open innovation journey (Mortara & Minshall, 2011; Chiaroni et al, 2010; 2011). A key finding in this literature is that top-managers and their entrepreneurial strategies matter in the organizational change process from closed to open innovation. While case studies provide a rich understanding of the phenomena that is being studied, it is also important to examine how specific variables, such as EO, influence firms' adoption of OI, controlling for possible confounding variables in a quantitative research design. Insight from qualitative studies can further not be generalized in a statistical way. Thus, the adoption of OI by firms should also been analyzed from a quantitative research angle. This is particularly important in the case of OI adoption as the available case study evidence has tended to focus on companies that have succeeded with the implementation of OI. This may give the impression that that open innovation journey is a liner process, something that we challenge in this paper which tracks 700 firms and their "success" in OI adoption over time.

The paper is organized as follows. In the next section we discuss theorizing on OI with a particular emphasis on its adoption by companies. Section 3 presents the methodology, data and method used to examine our research question and test our hypotheses. The analysis is conducted in section 4 while section 5 concludes.

2. Theory and hypotheses

Research within Innovation Studies (IS) has for several decades argued and shown that innovation within firms do not happen in isolation from other actors (Fagerberg et al, 2005). Quite on the contrary, it has been demonstrated that innovation processes within firms are influenced by the firms' external knowledge environment (Breschi et al, 2000; Winter, 1984). Firms receive valuable knowledge contributions to their technology development by actors external to the firm, such as suppliers, users, universities, consultants and research institutes (Von Hippel, 1988; Nelson, 1993; Enkel & Gassmann; 2008). Summarizing and further extending this research, the literature on open innovation has recommended firms to exploit external innovations and knowledge that actors outside the boundary of the firm have access to (Chesbrough, 2003; Chesborugh et al, 2006).

Open innovation theorizing argues that the role of internal R&D has declined as a direct source of innovation. Although firms can still benefit from the internal generation of knowledge through the R&D function, the volume of knowledge generated through firm

internal R&D is scarce compared to the volume of knowledge generated by actors external to the firm. Although firms still need to invest in their ability to identify and assimilate external knowledge by conducting internal R&D – generally referred to as absorptive capacity (Cohen & Levinthal, 1989) - it is argued that the relevance of internal R&D as a direct source of innovation is rapidly declining. As a consequence, many innovative firms have at the same time successfully reduced their expenditures on internal R&D *and* implemented open innovation strategies that have made them able to boost innovation (Chesbrough et al, 2006), for instance through inbound open innovation where companies source knowledge and technology from actors external to the firm (Dahlander & Gann, 2010).

Firms have thus been recommended to adopt the open model of innovation in order to be competitive and profit from open innovation (Chesbrough, 2003; Chesbrough et al, 2006). Although many studies have examined the performance implications of open innovation, inbound open innovation in particular, there is much less knowledge on how firms can adopt open innovation. Few studies have examined the journey towards open innovation and the factors that influence it. Thus, how companies can adopt and implement OI has recently been highlighted as an important avenue for further research (Mortara & Minshall, 2011; Chiaroni et al, 2010; 2011). A consequence of this is that the OI literature generally lacks theories and concepts that can account for and help explain how companies can implement OI.

The few qualitative studies that have been conducted on this topic have analyzed companies' adoption of OI through an "organizational change lens" (Chiaroni et al (2010; 2011)). Based on data from a handful firms in mature industries, Chiaroni et al (2010; 2011) extends Christensen (2006) and argue that the adoption of OI by firms represents a major organizational change on the behalf of the firm.

2.1 The adoption of OI as major organizational change

Organizational change is a vast topic and has generated much research and controversy, particular in evolutionary oriented organizational theory e.g. (Carroll & Teo, 1996; Amburgey et al, 1993; Barnett & Carroll, 1995; Singh et al, 1986). At the risk of oversimplification, two theoretical perspectives dominate the debate about the extent to which companies can successfully change (e.g. Carroll & Teo; Arnett & Caroll, 1995); the adaption and external selection perspectives.

Organizational ecology thinking is an external selection perspective which downplays the role of managerial agency as a source of (successful) change and adaption (Hannan & Freeman, 1984) simply downplays the possibility of human and managerial agency as a source of successful change. It is argued that firms are more or less unable to successfully change, an inability that increase with age and size of firm (Carroll & Hannan, 2000). Organizational ecology researchers thus argue that new practices and ways of organizing firms in the business sector, such as the adoption of OI, is driven be the emergence of new firms (i.e. open innovators) replacing incumbents (i.e. closed innovators).

In contrast to the selection perspective, the "adaption" perspective has a much more positive view of the role of managerial agency in producing successful organizational transformation. A "weak" variant of the adaption perspective can be found in the

evolutionary economics traditions stemming from Nelson & Winter (1982) and the behavioral theory of the firm (Cyert & March, 1963). Both suggest that firms are somewhat adaptable and capable of transformation in response to environmental change, especially when confronted with important problems and performance shortfalls (either relative to past performance or to the performance of competitors). Applying this theorizing to the adoption of OI, the evolutionary economics perspective suggests that managers and their firms will start the journey towards open innovation when the productivity of closed innovation projects decline, measured either relative to the firms past performance or to the performance of competitors. Arguably, the start of this industry change is what Chesbrough may have documented in his seminal book (Chesbrough 2003)as the OI model now has received widespread attention among current managers and firms as an alternative and arguably superior way to organize the innovation process (Mortara & Minshall, 2011).

Evolutionary economics theorizing suggest in this case that most firms will be interested and willing to adopt the open model of innovation which other companies (and competitors) have had success with in order to adapt to a new innovation environment and to increase the productivity of their innovative efforts. Thus, this theoretical perspective has a more positive view on the role of managerial agency as a driver of successful organizational change compared to the ecology perspective (Hannen & Freeman, 1984; Caroll & Hannan, 2000).

What may be called internal selection theory (Henderson, 2004) is a "strong version" of the adaption perspective. Internal selection theorists (e.g. Burgelman; 1996) see the firm as an internally diverse organizational being, with a portfolio of projects and technologies that arise through bottom-up initiatives by workers and frontline managers (Henderson, 2004). Managers are seen as the prime evolutionary agent because they anticipate changes in the external environment and "tune" firm internal work practices and organizational routines in accordance with external transformation processes. Frontline managers and workers are an important source of technological variation as they propose new initiatives and compete for corporate resources. By shifting resources from old projects to new ones, managers are in the position to (radically) change their firm (Burgelman, 1991; 1996; Minor, 1996). Thus, internal selection theory argues that top-managers can have a strong influence on whether or not their firms adopt open innovation by shifting funding and managerial attention from "closed innovation projects" to "open innovation projects" within the firm over time.

2.1.1 Prior research on the open innovation journey

Qualitative research has shown that top-managers have an important role in the adoption of OI by firms. Indeed, case study evidence shows that "the enabeling role of top-management […] is a key prerequisite for the implementation of open innovation" (Chiaroni et al, 2011. p. 40). Case studies further demonstrate that firms which successfully undergo the open innovation journey have top-managers that are able to "unfreeze" the firm in the sense that they have been able to overcome inertial forces resisting change within the firm (Chiaroni et al, 2011; 2012; Mortara & Minshall, 2011). Thus, qualitative studies suggest that the first adoption of OI by firms is driven to a large extent by committed top-mangers. Case study evidence on how firms adopt OI thus appears to be in line with internal selection theory and evolutionary economics theorizing which stresses managerial agency and the role of the (top) management as an evolutionary agent of change within firms. Inspired by these qualitative findings we argue that top-managers can act more or less entrepreneurially and

that the variation among them in their ability to act innovatively, to take risks, and to be proactive, will have a direct influence on to what extent companies adopt open innovation, as discussed in greater detail below.

2.2 The role of EO in the open innovation journey

The literature on corporate entrepreneurship suggests that top-managers and their strategies are an important source of change within firms with performance implications. A substantial research stream within the corporate entrepreneurship literature has examined the role of top-managers and their entrepreneurial strategies, generally referred to as Entrepreneurial Orientation (EO). With its origins in the strategy-making literature the EO concept focuses on the processes in which top-managers and their firms act innovatively, proactively and take risks. Illustrated by the words of Miller (1983), a seminal contribution to EO research, an entrepreneurial firm is "one that engages in product-market innovation, undertakes somewhat risky ventures, and it *first* to come up with "proactive" innovations, beating competitors to the punch" (p.771). Subsequent research has measured EO as concept consisting of 3 (highly correlated) dimensions: risk-taking, innovativeness and proactiveness (see Rauch et al, 2008 for a review of the EO literature)

In this paper we argue that to overcome internal resistance, to change their firm and to put their firm on the path towards increased openness in the innovation process, top-managers and their firms need to "act innovatively, proactively and take risks". This is in line with qualitative studies of the adoption of OI which have demonstrated that top-managers must "unfreeze" their firm and combat and champion inertial forces resisting the adoption of OI. A recent case study of the company Italcementi supports this argument: "The journey of Italcementi towards Open Innovation undoubtedly starts with the firm's top management makes clear its commitment to innovation" (p. 40). The following hypothesis reflects this:

H1. There is a positive relationship between EO at T1 and adoption of inbound open innovation at T2.

If OI resembles other innovation processes, then Kline & Rosenbergs (1986) chain-linked model of innovation suggest that the OI journey may have feedback loops and even setbacks. Thus, the adoption of OI may not be a linear process. Further, not all companies that try to adopt OI may succeed. Some may also fail in the open innovation journey and revert back to closed innovation practices and routines within the firm which have been the norm for decades in many industries and companies. Inertial forces and general resistance to change may deter successful organizational change as predicted by ecology research. Ecology research therefore also stress that although firms can change, very few firms are able to change *successfully* (Caroll & Hannan, 2000). The reason is that managers and their firms are in general believed to be unable to change as fast as environmental changes - an issue generally referred to as structural inertia (Hannan & Freeman, 1984).

Case study evidence on the adoption of OI has not really examined to what extent companies succeed or fail in the adoption of OI. Do most companies that adopt OI at one time period persist in their adoption of OI at a later time period? Or do some revert back to closed innovation? There has been little research on this issue. Arguably, the reason is that companies included as cases in longitudinal qualitative research on OI adoption have all

been successful in the adoption of OI (e.g. Mortara & Minshall, 2011; Chiaroni et al, 2010; 2011).

If the adoption of OI is a process, and we accept that must processes do not unfold in a linear way, then the adoption of OI may not be a "once and for all" decision by the firm and its management. Rather, top-managers may have to maintain their commitment to the major organizational transformation that the adoption of OI is (Christensen, 2006). Managerial attention is a scarce resource within firms (Ocasio, 1998), suggesting that (top) managers may differ in the extent they allocate time and effort to persistently pursue adoption of OI *over time*, with strong implications for whether or not the firm will maintain, increase, or even decrease its adoption of OI.

Theorizing on major organizational change, as reflected in internal selection theory, as well as qualitative research on the adoption of OI, suggest in combination that firms and their top-managers need to be committed to undertaking the open innovation journey if it is going to be successful.

Managers may therefore need to be prepared to continuously combat inertial forces within their firm that almost always emerge in the face of large scale organizational transformation processes (Hannan & Freeman, 1984). Increases and decreases in top-managers willingness to act entrepreneurially, to proactively drive the change in their firm and to take the risks that almost always are associated with major organizational change may thus have an important "unfreezing" influence on to what extent firms will succeed in the journey towards increased openness in the innovation process. The following hypothesis reflects this:

H2. The increase (decrease) in EO between T1 and T2 is positively (negatively) related to adoption of inbound open innovation at T2.

3. Method

3.1 Research design and sample

In order to examine the role of EO in the adoption of open innovation we have collected survey data from R&D active firms in Norway at two points in time. The population was all businesses registered to a scheme for tax deduction of R&D costs (called SkatteFUNN). As all enterprises which are eligible for taxation could register their R&D activities to receive a tax refund, the registered enterprises include close to all enterprises which are involved in such activities at the time of our study. Although the firms in our sample have R&D activity and innovation as a goal in common, the sample varies in terms of industry membership (spans over 40 industries) as well as firm size and age.

All enterprises which registered R&D activities during May to December 2005 were approached, in all 1721 enterprises. A web-based questionnaire was developed containing the measures of EO as well as measures of firms' environment and questions about their network etc. A link to the questionnaire was e-mailed to the enterprises within a month after they registered R&D activities. The initial mailing was followed by two e-mail reminders. Of the enterprises approached, 1199 (70 %) returned filled-in questionnaires. The

1199 companies that filled out the questionnaire were contacted again 1.5 - 2 years later. The majority of enterprises were contacted in spring/summer 2007. All received a web-based questionnaire containing the measures of EO, IOI, etc. 754 of the enterprises returned filled-in questionnaire.

Since ecology researchers stress that exit of old firms and entry of new firms drive the adoption of new practices, such as OI, in the population of firms, we need to control for survivor and non-response among our firms over time. The main source of selection bias that we need to handle is non-response at T2 or attrition between T1 and T2 (e.g. exit, bankruptcy, etc). We will control for such non-response bias by using Heckman regression in the analysis. Applied to the context of this paper, Heckman regression is a method that in the first step analyses the probability that a firm at T1 will answer the survey at T2 depending on observables at T1. This is modeled as a probit regression. Based on the probit regression in T1, the inverse mills ration (sometimes called lambda) is added to the analysis in the second step where the goal is to analyze the relationship between EO and OI adoption (using OLS regression). The inverse Mills ratio is a control factor which controls for unobserved heterogeneity. More concretely, the inverse Mills ratio will control for unobserved factors that are related to both firms' probability of answering the survey at T2. In order for this method to work properly one variable needs to be significant correlated with firms' probability of answering the survey and assumed to be uncorrelated to OI adoption. Results from the first stage in the Heckman regression (that is used to calculate lambda) is available in the appendix.

3.2 Variables and measures

3.2.1 Dependent variable - adoption of inbound open innovation

In line with prior qualitative studies we focus on the adoption of inbound open innovation. To properly measure the *adoption* aspect of inbound open innovation we a set of questions where respondents were asked about to what extent the firm uses the networks of actors at different organizational level with the firm, such as the employees, the CEO and the board. In order to measure to what extent the firm *use* inbound open innovation we asked as set of question about to what extent the firm exploit its networks, seek to influence its external knowledge environment and to what extent the firm actively search for new external collaboration partners. The following set of items were used to measure "inbound open innovation adoption": "The networks of our employees are an important source of information for the firm", "the network of the CEO has been important for the firm", "Members of the board provides the firm with access to networks", "the firm uses its network to influence its environment", "the firms network is used as a knowledge resource" and "the firms is continuously searching for potentially new external collaboration partners".

The same set of questions was measured in the survey at T1 and T2. Cronbachs alpha is 0.8 (T1) and .82 (T2).We adopted a one-sided seven point Likert scale where: 1 = strongly disagree and 7 = strongly agree.

3.2.2 Key explanatory variable -entrepreneurial orientation.

In order to measure EO (the dimensions innovativeness, proactiveness and risk taking) we use items from Covin and Slevin's (1989) strategic posture scale. We use the one-sided version of the scale where respondents are asked to indicate their agreement with 9 statements on a 7 point scale (1 = completely disagree, 7 = completely agree). Innovativeness was measured using the following three statements: "Top-managers emphasize R&D, technological development and innovation," "The firm has launched many new products and services during the last 5 years" and "New products/services have been very different from existing products/services on the market."

The following three items capture proactiveness: "Relative to the competitors my firm initiates actions to which competitors then respond to," "Relative to the competitors my firm will be the first to introduce new products/services/technologies" and "Relative to other firms my firm typically adopts a very competitive "undo-the competitors" posture".

Risk taking was assessed by the following three items: "Top-managers has a strong proclivity for high risk projects with chances of high returns," "Top-managers thinks it is necessary with bold and wide ranging acts are necessary to achieve the firms objectives" and "Our firm adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities." . In line with prior research we will use EO as a summated scale (see Rauch et al, 2008).

Questions measuring EO were included in the survey at T1 and T2. Exploiting this, we will also add the increase/decrease in EO between T1 and T2 to our regression analysis. This variable is called "EO_change" (defined as EO at T2 – EO at T1). EO has a cronbach alpha of 0.78 (at t1) and 0.85 (at T2).

3.2.3 Independent variables – controlling for competing explanations

This paper has posed managerial agency, as reflected in top-managers entrepreneurial strategies, as a positive antecedent to IOI adoption. We need to control for competing explanations to ensure that our estimates of the relationship between EO and IOI adoption is trustworthy. There are at least two sources of such competing explanations. First, evolutionary theorizing forcefully argue that firms are shaped by their external environment (Aldrich 1999; Nelson and Winter 1982). The importance of the environment has been reinforced by qualitative OI adoption research where it is argued that firms in more turbulent environments will e more likely to adopt OI faster. In order to account for this we adopt a scale from (Khandwalla 1977) that measures the extent to which the firms external environment are predictable or almost unpredictable, e.g., the degree of turbulence of the firms external environment. 3 items measuring environmental turbulence were adopted in the survey based upon Khandwalla (1977). Items are: "The rate at which products/services are becoming obsolete in the industry is very high", "actions of competitors are almost unpredictable" and "demand and consumer tastes are almost unpredictable". Cronbach's alpha is 0.64. Environmental turbulence is measured at T1.

Ecology researchers further argue that structural inertia and the inability to (successfully) change increases with firm size and age (Carroll & Hannan, 2000; Hannan & Freeman, 1984).

We will therefore control for firm size (log of the number of employees" and firm age (years since the firm was formally established in the Norwegian business register).

A powerful way to control for competing explanations, for instance historical and stable factors that cause current differences in the dependent variable, is to add a lagged dependent variable as a control variable in the regression analysis (Wooldridge, 2006). This is especially the case when one or more independent variables in the regression could be correlated to one or more omitted variables and the omitted variable has an influence on the dependent variable. Inclusion of a lagged dependent variable in the analysis is thus a "way to use two years of data for estimating a causal effect" (Wooldridge, 2006, p. 461). To exploit this method of obtaining strong effect estimates of the explanatory variables, we will add a lagged "inbound open innovation adoption" variable at T1 as an explanatory variable in one the estimated regressions.

Descriptive statistics and correlations between variables are documented in table 1 and 2 below.

Table 1. Descriptive statistics

	Minimum	Max	Mean	Std. Deviation
IOI adoption (t2)	1.17	7.00	4.96	1.1
Env. Turbulence	1.29	7.00	4.36	.89
EO (t1)	1.67	7.00	4.6	.92
EO change	-4.78	4.44	.01	.91
Firm size	.00	9.23	2.3	1.62
Age	.00	184.00	11.8	14.7
IOI adoption (t1)	1.17	7.00	5.04	1.1

Table 2. Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) IOI adoption (t2)	1						
(2) Environmental turbulence	.24	1					
(3) EO (t1)	.29	.33	1				
(4) EO change	.25	-0.3	-.33	1			
(5) Firm size	-.24	-.13	-.07	-.02	1		
(6) Age	-.14	-.|1	-.12	.04	.41	1	
(7) IOI adoption (t1)	.56	-.34	.37	-.07	-.27	-.17	1

3.4 Common method bias and discriminant validity

Survey data on dependent and independent variables supplied by a single respondent can be a source of methodological problems related to common method bias. To shed some empirical light over this we have conducted the Harmon single factor test for common method variance. We entered all items measuring EO, inbound open innovation adoption, environmental turbulence (at T1) into the same factor analysis (exploratory, varimax rotation). If a substantial amount of common method variance is present, either (a) a single factor will emerge from the factor analysis, or (b) one general factor will account for the majority of the covariance among the variables. The factor analysis extracted 4 factors and the factor where the largest eigenvalue explained 26 % of the variance. In sum, this suggests that the common method variance does not constitute a major problem in our analysis.

The same factor analysis used to examine common method bias sheds further empirical light over discriminant validity of the latent concepts used in the paper. The results from the factor analysis, reported in table 3, shows that items proposed to measure "IOI adoption", "EO" and "environmental turbulence" load high on their respective factor and do not have high cross-loadings on other factors. Items measuring EO load high on two factors, which is common. EO research nevertheless treats EO as a single scale (see Rauch et al, 2009).

Table 3: Factor analysis

	Factor 1	Factor 2	Factor 3	Factor 4
The rate at which products/services are becoming obsolete in the industry is very high	-.029	.125	.167	.666
Actions of competitors are almost unpredictable	.078	.060	-.010	.782
demand and consumer tastes are almost unpredictable	.088	.062	-.054	.727
The firms is continuously searching for potentially new external collaboration partners	.431	.336	.102	.153
The networks of our employees are an important information source of information for the firm	.597	.110	.159	.149
The network of the CEO has been important for the firm	.760	.078	.038	.008
The firm uses its network to influence its environment	.821	.127	.069	.010
The firms network is used as a knowledge resource	.827	.095	.134	.007
Members of the board provides the firm with access to networks	.657	.028	.094	-.023
Relative to other firms my firm typically adopts a very competitive "undo-the competitors" posture	.027	.386	.200	.137
Our firm adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities	.172	.765	.211	.009
Top-managers has a strong proclivity for high risk projects with chances of high returns	.074	.809	.093	.130
Top-managers thinks it is necessary with bold and wide ranging acts are necessary to achieve the firms objectives	.120	.818	.150	.051
Top-managers emphasize R&D, technological development and innovation	.206	.391	.375	-.014
The firm has launched many new products and services during the last 5 years	-.015	.036	.771	.097
New products/services have been very different from existing products/services on the market.	.182	.136	.570	.160
Relative to the competitors my firm initiates actions to which competitors then respond to	.152	.294	.645	-.079
Relative to the competitors my firm will be the first to introduce new products/services/technologies	.168	.296	.698	-.083
Explained variance	26 %	11 %	9 %	6 %
Cumulative explained variance	53 %			

4. Analysis

4.1Descriptive analysis

In this section we give a simple overview of to what extent the firms in our sample have adopted inbound open innovation our time. Table 2 above shows that there is a strong positive correlation of 0.56 between adoption of inbound open innovation at t1 and adoption of inbound open innovation at t2. Thus, there is a general trend in the direction of more openness in the innovation process over time in the innovation process among the firms in our sample. But there are important deviations from this trend. Table 4 documents this in greater detail.

In table 4, IOI adoption at t1 and IOI adoption at t2 have been recoded. Both variables are a mean index that ranges from 1 to 7. Firms with values on IOI adoption within the range 1.0-3.0 are considered to have low IOI adoption, firms with values in the range 3.1 to 5.0 are considered to be "medium IOI adaptors" and firms with values larger than 5.0 are considered to be high IOI adopters. Table 4 subsequently tracks the adoption of IOI by firms from t1 to t2.

Table 4 reveals that there is a general trend towards higher adoption of IOI in our sample, reflecting the general trend among firms towards open innovation already documented in the literature and in the reported correlation in table 2. For instance, 26 % of the firms at t1 that one may consider to be low IOI adopters" have moved into the category "medium IOI adopters" at T2. 9 % have even reached "high IOI adoption". However, 26 % are still low IOI adopters at t2. Further, 64 % of medium IOI adopters at T1 have stayed within the same category at t2. 28 % medium IOI adopters at T1 have increased their IOI adoption as they are included in the "high" category at t2, while 8 % have reverted back to low IOI adoption at t2. 69 % of the high IOI adopters at t1 are still high IOI adopters at t2. However, 31 % have decreased their IOI adoption over time, to medium or even low IOI adoption.

Table 4 thus reveals a pattern of considerable dynamics in the adoption of IOI over time. And although there is a clear trend from low to higher IOI adoption in our sample of firms, there are also a considerable number of companies that either "only" maintain or even decrease their IOI adoption over time. Some firms also stay low in IOI adoption throughout the observed time period. So what can help explain this pattern? In this paper we have proposed that top-managers and firms with higher EO at T1 can set the path of their firm towards increased openness and that top-managers need to maintain or even increase their EO over time in order for their firm to succeed in the open innovation journey. This is analyzed in the next section.

Table 4. Transition between different levels of IOI adoption over time

	IOI adoption (t1)		
IOI adoption (t2)	Low	Medium	High
Low	26 %	8 %	1 %
Medium	65 %	64 %	30 %
High	9 %	28 %	69 %
Total	100 %	100 %	100 %
N	34	334	372

4.2 Econometric results

In table 5 we have documented the results from the regression where the relationship between EO and IOI adoption has been documented. Model 1 presents results where the lagged dependent variable has been excluded from the analysis, whereas model 2 presents results where it has been included.

Table 5. Adoption of inbound open innovation – unstandardized coefficients

	Model 1	Model 2
	IOI adoption (t2)	IOI adoption (t2)
Environmental turbulence	.026	-.017
EO (t1)	.401***	.205***
Change in EO (t2-t1)	.416***	.397***
Firm size (log)	-.135***	-.051**
Age	-.004	-.002
IOI adoption (t1)		.502***
Mills ratio	-.777	-.570
Constant	3.810***	2.019***
R2	25 %	47 %
N	695	694
	Heckman regression	Heckman regression

*Sig at the 0,1 level ** sig at the 0,05 level ***Sigh at the 0,01 level

Results in table 5 - model 1 - show that EO at t1 is a positive and significant predictor of adoption of inbound open innovation at t2. This relationship is still positive and significant when including a lagged dependent variable, as shown in model 2. Interestingly, the coefficient of EO on adoption of inbound open innovation is reduced in model 2 compared to model 1, suggesting that omitted variable bias drive some of the positive relationship between EO and IOI adoption in model 1. Still, EO has a positive and significant relationship with IOI adoption in both model 1 and model 2. Thus, hypothesis 1 receives empirical support.

Table 5 further shows that the change in EO between t1 and t2 has a significant and positive relationship with adoption of inbound open innovation at t2. This result hold in both model 1 and model 2 and the estimate of the regression coefficient is almost identical, suggesting that the change in EO in model 1 do not pick up omitted variable bias. Thus, hypothesis 2 receives empirical support.

When it comes to the other explanatory variables in table 5 we can see that firm size has a negative and significant relationship with IOI adoption at T2. Neither environmental turbulence nor firm age is significant.

Both regressions reported in model 1 and model 2 has good explanatory power as they explain 25 and 47 % of the variance in the dependent variable. Naturally, the explained variance in model 2 is much higher since we also include a lagged dependent variable as an explanatory variable and thereby pick up the effect of stable and historical factors (not measured) and which influence the adoption of inbound open innovation by firms.

4.3 Discussion of the results

While the benefits of open innovation are widely discussed and demonstrated in the OI literature, there has been scarce research on how firms can implement it. This is surprising since OI has its origin in practice oriented research as Chesbrough's (2003) open innovation model was formulated by observing and analyzing innovation practices within large firms (Vanhaverbeke et al, 2008)

Further, the open innovation paradigm has become widely popular among managers. And the parading has always had a clear orientation towards how firms can improve their innovative and economic performance by making the shift from closed to open innovation (Chesbrough, 2003). Thus, it is surprising that prior research and theorizing on open innovation has dedicated scarce attention to how companies can implement OI.

A few recent qualitative studies have examined how firms implement open innovation. These studies have drawn on theorizing on general organizational change in order to illuminate how companies implement IOI. A conclusion is that managerial agency appears to be vital in IOI adoption. However, to what extent companies can successfully change is a much debated issue within the social and management sciences (O'Reiley & Tushman, 2008). While some perspectives, like organizational ecology argues for a selection perspective where established firms (i.e. closed innovators) will eventually be replaced by new and more productive firms (i.e. open innovators), other perspectives argue that firms can successfully adapt and change through purposeful managerial action and strategies (e.g. Burgelman, 1996; Nelson & Winter, 1982). Qualitative research on OI adoption can say less about this issue as this research has focused on companies which have undertaken the open innovation journey successfully. Although descriptive results in this paper have shown that there is a general trend towards increased levels of IOI adoption, we also found considerable deviation from this trend. Thus, many companies do not increase their level of IOI adoption over time, and some even decrease their emphasis on open innovation. Allowing for both "success and failure" in IOI adoption over time, what is the importance of top-managers and their entrepreneurial strategies?

Results in this paper show that managerial agency, as reflected in top-mangers entrepreneurial strategies, are significantly and positively related to implementation of IOI over time. Thus, our results can confirm qualitative studies on OI adoption which has highlighted the important role of top-managers in companies' journey towards open innovation (Mortara & Minshall, 2011; Chiaroni et al, 2010; 2011).

Further, we have extended these qualitative findings by illuminating the mechanisms through which top-managers influence the implementation of OI within their firms. Drawing on the Corporate Entrepreneurship literature and the EO concept we have shown that companies with top-managers who act innovatively, take risk and are proactive – over time – have been able to adopt IOI to a significantly higher extent. Thus, top-managers committed to innovation, who take risks and are proactive appear to be better able to "unfreeze" their firm and overcome inertial resistance that is often accompanied by large scale organizational change, such as IOI adoption.

Our findings have implications for the debate in the management/social sciences about the scope for purposeful managerial action and strategies in (successful) firm evolution. Results are clearly in line with an adaption perspective where (top) managers are an important driving force behind successful organizational change, such as the implementation of OI. However, a finding is that larger firms are significantly less able to implement IOI, as organizational ecology research would predict (Hannan & Freeman, 1984). Thus, while our results have shown that committed top managers may be a fundamental prerequisite for success in the organizational change process towards increased IOI adoption, there is at the same time a tendency that this change process is confronted with higher levels of inertia within larger firms. Both the adaption and selection perspective thus seems to shed

theoretical light over how firms implement OI, although the adaption perspective seems to be the more important.

5. Concluding remarks

Several authors have argued and empirically demonstrated that open innovation is a new innovation paradigm superior to the closed model of innovation (Chesbrough, 2003; Chesbrough et al, 2006; Laursen & Salter, 2006). Far fewer studies have studied how firms can implement open innovation. This represents a gap in our knowledge as managers and scholars need to understand how firms can undertake the journey from closed to open innovation in order to reap the advantages of open innovation. In line with a few prior qualitative studies, this paper has argued that it is now important to study and generate knowledge on how firms can implement open innovation. The research reported in this paper has been motivated by this gap in our knowledge.

Extending prior qualitative research on the adoption of inbound open innovation (IOI), this paper has examined the role of top-managers and their entrepreneurial strategies in firms' ability to implement IOI over time. Measuring top-managers entrepreneurial strategies with the entrepreneurial orientation (EO) construct, the following research question was asked: What is the role of EO in the adoption of IOI by firms over time?

Preceding a regression analysis of the relationship between EO and IOI adoption, we exploited the longitudinal nature of our data to examine the dynamics of IOI adoption. Using a survey design where over 700 firms were administered a survey at two points in time we examined the dynamics of IOI adoption from a quantitative research angle. While prior qualitative research on IOI adoption has focused on firms that have been successful in the open innovation journey, our survey design which follow a cohort of R&D active firms over time shows that IOI adoption is not a linear process: Although there is a general trend towards increased openness in the innovation process, there are also considerable "deviations" from this trend. Many firms are not able to increase their adoption of IOI over time, and some firms even revert back from higher to lower IOI adoption over time.

Both general theorizing on the role of managerial agency in the evolution of firms and qualitative studies of IOI adoption suggest that top-managers and their strategies can explain this pattern of IOI adoption. In absence of prior quantitative research insights to guide our empirical analysis of this issue we tested to what extent top-managers and their entrepreneurial strategies, as measured by EO, could explain the variation in IOI adoption among the firms in our sample of R&D active firms.

The regression analysis showed that EO at time period 1, as well as the increase in EO between time period 1 and time period 2, is a significant and positive predictor of higher IOI adoption at time period 2. These results lead us to conclude that the open innovation journey is, at least in part, driven by top-managers who act innovatively, proactively and take risks, and that top-managers need to continue to do so over time in order for their firm to succeed with the implementation of IOI.

Our empirical results lend empirical support to an adaption perspective within evolutionary theory which argues that (top) managers represent an important evolutionary change agent

that can be crucial for successful firm evolution and an important driving force needed to overcome inertial resistance to organizational change within firms.

Like most papers this paper has shortcomings. One shortcoming is the relatively short-time lag between time period 1 and time period 2. Although longitudinal quantitative research is entirely lacking on IOI adoption, the analysis in the paper would have benefitted from an analysis where the implementation of IOI could have been observed for a longer time-period. Following firms and to what extent they succeed with the implementation of IOI and testing factors that can explain their variation in success in this, represents a promising avenue for further research that can add to the scholarly literature on Open Innovation. Another shortcoming is that our dataset only consists of R&D active firms. Although R&D is considered to be an inherently integral part of firms absorptive capacity (Cohen & Levinthal, 1990), and thus a prerequisite for being able to inn source external knowledge (Clausen, 2013; Vanhaverbeke et al, 2008), the relationship between EO and IOI found in this paper could be different within non-R&D active firms. Examining this issue represents an important avenue for further research.

Another shortcoming is geographical. Strictly speaking, our results have only external validity within the Norwegian setting and for the time period 2005-2007. However, our empirical results are in line with qualitative insights on IOI implementation. Thus we believe that entrepreneurial top-managers are an important driving force behind IOI implementation within companies also in other countries, time periods and within also non-R&D active firms. This needs to be tested however.

6. Selected referrences

Amburgey, T.L., Kelly., D., Barnett, W. (1993). "Resetting the clock: The dynamics of organizational change and failure". *Administrative Science Quarterly*, vol. 38, 51-73.

Barnett, W.P., Carroll, G.R. (1995). "Modeling Internal Organizational Change". *Annual Review of Sociology*, vol.21, 217- 236.

Burgelman, R.A. (1996). "A Process Model of Strategic Business Exit: Implications for an Evolutionary Perspective on Strategy". *Strategic Management Journal*, vol.17, 193-214.

Bae, Y., Chang, H (2012). Efficiency and effectiveness between open and closed innovation: empirical evidence in South Korean manufacturers, Technology Analysis & Strategic Management, 24:10, 967-980

Becheikh, N., Landry, R., Amara, N. (2006). Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993-2003. Technovation, vol. 26 5-6, pp. 644-664.

Carroll, G.R., Hannan, M.T. (2000). *The demography of corporations and industries*. Princeton University Press.

Carroll, G. R., Teo., A.C. (1996). "Creative self-destruction among organizations: An empirical study of technical innovation and organizational failure in the American Automobile Industry". *Industrial and Corporate Change*, vol.5, 619-644.

Cyert, R.M., and March, J. (1963). *A behavioural theory of the firm*, Englewood Cliffs, NJ:Prentice Hall.

Chiang, Y- H, Hung, K-P.(2010). Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flows. R&D Management, vol. 40 3, p. 292-299.

Chen, J., Chen, Y., Vanhaverbeke, W. (2011). The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. Technovation, vol. 31 8, pp. 362-373.

Cohen, W.M., Levinthal, D.A. (1989). Innovation and learning: The two faces of R&D. The Economic Journal, vol.99, 569-596.

Cohen, W.M., Levinthal, D.A. (1990). Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly, vol. 35, 128-152.

Chesbrough, H. (2003). Open innovation. The new imperative for creating and profiting from technology. Harvard Business School Press.

Chesbrough, H., Vanhaverbeke, W., West, Joel. (2006). Open innovation. Researching a new innovation paradigm. Harvard Business School Press.

Chesbrough, H.W. and Prencipe, A. (2008) Networks of innovation and modularity: a dynamic perspective. International Journal of Technology Management., **42**, 4, 414–425.

Chiaroni, D., Chiesa, V., Frattini, F. (2011). Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. R&D Management, vol.40 (3), pp. 222-245.

Chiaroni, D., Chiesa, V., Frattini, F. (2011). The Open Innovation Journey. How firms dynamically implement the emerging innovation management paradigm. Technovation, vol. 31, pp. 34-43.

Dahlander, L., Gann, D.M. (2010). How open is innovation? Research Policy, vol.396, p. 699-709.

Damanpour, F., Walker, R.M., Avellaneda, C.N. 2009, Combinative Effects of Innovation Types and Organizational Performance: A Longitudinal Study of Service Organizations", Journal of Management Studies, 464, 650-675.

Dittrich, K. and Duysters, G. (2007). Networking as a means to strategy change: the case of open innovation in mobile telephony. Journal of Product Innovation Management, vol.**24**6,p. 510–521.

Drejer, I. (2004). Identifying innovation in surveys of services: a Schumpeterian perspective. Research Policy, vol. 333, p. 551-562.

Enkel, E., Gassmann, O., Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. R&D Management, vol. 39 4, 311-316.

Enkel, E. (2010) Attributes required for profiting from open innovation in networks. International Journal of Technology Management vol.52 3.

Fagerberg, J. (2005), 'Innovation: A guide to the literature', in Fagerberg, J., Mowery, D., Nelson, R. eds., The Oxford Handbook of Innovation. Oxford University Press: Oxford.

Fagerberg, J. and Verspagen, B. (2009), 'Innovation studies – The emerging structure of a new scientific field', Research Policy, 382, 218-233.

Gassmann, O., Enkel, E., Chesbrough, H. (2010). The future of open innovation. R&D Management, vol. 40 3, 213-222.

Huang, H-C (2011). Technological innovation capability creation potential of open innovation: a cross-level analysis in the biotechnology industry, Technology Analysis & Strategic Management, 23:1, 49-63

Hannan, M.T., Freeman, J. (1984). "Structural Inertia and Organizational Change". *American Sociological Review*, vol. 49, 149-164.

Henderson, A.D. (2004). "Selection-based learning: The coevolution of internal and external selection in high-velocity environments". *Administrative Science Quarterly*, vol.49, 39-75.

Huizingh, E.K.R.E. Open innovation: State of the art and future perspectives. Technovation, Vol.31 1, pp.2-9.

Katila, R. (2002). New product search over time: Past ideas in their prime?, Academy of Management Journal, vol. 45, 995-1010.

Katila, R., Ahuja, G. (2002). Something old, something new: A longitudinal study of search behaviour and new product introductions. Academy of Management Journal, vol. 45, 1183-1194.

Laursen, K., Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. Strategic Management Journal, vol. 27, 131-150.

Lam, A. (2004), 'Organisational Innovation', in Fagerberg, J., Mowery, D., Nelson, R. eds., The Oxford Handbook of Innovation. Oxford University Press: Oxford. See also working paper version: http://mpra.ub.uni-muenchen.de/11539/1/MPRA_paper_11539.pdf

Malik, K, Wei, J (2011). How external partnering enhances innovation: evidence from Chinese technology-based SMEs, Technology Analysis & Strategic Management, 23:4, 401-413

Mortara, L., Minshall, T. (2011). How do large multinational companies implement open innovation? Technovation, vol. 31, pp. 596-597.

Minor, A.S. (1996). "Seeking Adaptive Advantage: Evolutionary Theory and Managerial Action", in J.A.C.Baum., J.V.Singh (EDS). *Evolutionary Dynamics of Organizations*. Oxford, Oxford University Press.

Nelson, R. R., & Winter, S. G. (1982). An evolutionary theory of economic change Belknap press Belknap Press.

Schumpeter, J. (1934), The Theory of Economic Development. Harvard University Press: Massachusetts.

Paananen, M. (2009). Exploring the relationships between knowledge sources in the innovation process: evidence from Finnish innovators. Technology Analysis & Strategic Management, vol.21 6,p. 711 — 725

Quintana-García, C., Benavides-Velasco, C.A (2011). Knowledge organisation in R&D alliances: its impact on product innovation, Technology Analysis & Strategic Management, 23:10, 1047-1061

Sofka, W., Grimpe, C. (2010). Specialized search and innovation performance – evidence across Europe. R&D Management, vol. 40 3, p. 310-323.

Tether, B., Tajar, A. (2008). Beyond industry-university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base, Research Policy, vol. 37, 1079-1095.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 187, 509-533.

Von Hippel, E. (1988). The sources of innovation. Research Policy, **18**5, 297–297.

West, J., Bogers, M. (2011). Profiting from external innovation: A review of research on open innovation. Working paper: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1949520

Winter, S.G.(1984). "Schumpeterian competition in alternative technological environments". *Journal of Economic Behaviour and Organization*, vol.5, 287-320.