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On Factors explaining Organisational Innovation and its Effects

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Abstract

This paper demonstrates how various factors influence the probability of attempts at organisational innovation and the effects of such innovation. An integrated firm-level dataset obtained from two recent waves of the Norwegian Community Innovation Survey (CIS3 & 4) and firms' financial accounts is used to investigate these factors. An analysis which employed a Heckman two-step estimation to ensure against potential sample selection bias demonstrates that, between 1999 and 2004, Norwegian firms were persistent in organisational innovation, and this persistence raised the (positive) effects of organisational innovation on their performance. In addition, the results indicate that a firm's decision to pursue organisational innovation can be influenced by its past economic performance and the high costs of innovation. The results also reveal that a good share of firms in the sample undertook, and benefitted from, different types of organisational change, and such benefits could increase by means of the complementarity of organisational and technological innovation. In further explaining the rates and consequences of organisational innovation, this study argues that a firm's age and size have different impacts on its decision to undertake organisational innovation and on the effects of such innovation on its performance. The study found some evidence to suggest that older, larger firms are more inclined to make an attempt at organisational change, while, in terms of outcomes, smaller firms are more able to benefit from such an attempt.

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Introduction

Recent decades have seen a remarkable increase in scholarly attention devoted to innovation (Fagerberg, 2004; Fagerberg and Verspagen, 2009; Fagerberg and Sapprasert, 2010). Despite the great importance of organisational innovation, especially in economic 'forging ahead' and 'catching up' at different points in time (Bruland and Mowery, 2004), thus far, technological innovation, such as in the sense of new or significantly changed products and processes, has received much more research interest and been taken into account in a far larger number of (quantitative) analyses, mainly owing to the availability of statistics. Taking advantage of a unique firm-level dataset obtained from an integration of the Norwegian CIS 3 & 4 (Community Innovation Survey) and firms' financial accounts, this study attempts to quantitatively analyse how firms make a decision to undertake, and benefit from, organisational innovation, i.e. non- or less technological innovative change of how firms organise their work (see more description below). Arguably, firms' survival and competitiveness depend greatly upon innovation of this sort, as well as its cooperation with technological innovation in boosting performance (Chandler, 1962; Nelson, 1991).

Nonetheless, organisational innovation and its effects can be influenced by firm heterogeneity and other factors. For instance, a firm's past performance, together with various obstacles it faces, may determine the likelihood of organisational innovation (Cyert and March, 1963; Mohr, 1969), while the effects of such innovation may be elevated by its persistence and (complementary) technological innovation. This paper investigates the change of 'organisational routines' (Nelson and Winter, 1982) in a firm, and the consequences of this change, by taking account of these and other important determinants, such as the firm's age and size. Put simply, the paper's main objective is to analyse the factors which explain: (i) the firm's decision to attempt organisational innovation; and (ii) the effects of such innovation on its performance.

The remainder of the paper is organised as follows. Section 2 gives a note on organisational innovation. Section 3 provides the theoretical background and hypotheses. Section 4 presents the data and method used in this study. Section 5 discusses descriptive statistics and empirical findings from the econometric analysis. Section 6 makes final remarks and concludes the study.

2. A Note on Organisational Innovation

More than half a century ago, Schumpeter (1911, 1942), a famous pioneer of innovation and economic change, presented a broad concept of innovation as being the introduction of new products, new processes, new sources of supply, the exploitation of new markets and new ways of organising business.[2] This broad perspective remains valid today, even though the innovative forms of organisations differ considerably, depending on time, and industrial and institutional contexts (Lazonick, 2004). More importantly, innovation literature suggests that the complementarity of technological and non-technological change is essential. These two aspects of change are greatly interdependent (Freeman, 1995), and their co-evolution is part and parcel of real economic progress (Nelson, 1991). Any effort to implement technological innovation would meet with only limited success unless it was accompanied by organisational change (Chandler, 1962). Bruland and Mowery (2004) point out that, historically, 'organisational' innovations, together with certain key technological innovations, have helped to improve firms' performance and growth in many leading and catching-up countries (for example, the US, Germany and Japan) from the first industrialisation through different 'business cycles' (Schumpeter, 1939).[3] More recent evidence confirms that organisational innovation is also crucial in our time, since it complements a key technological driver like Information and Communication Technology (ICT) in elevating firms' performance and growth (Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000, 2003; Brynjolfsson et al., 2002; Sapprasert, 2007).

It should be noted that this paper uses the term 'organisational innovation' to refer to a new or significantly changed firm's structure and management method.[4] More specifically, unlike the works of authors such as Damanpour (1991) and Sorensen and Stuart (2000), organisational innovation is defined rather narrowly here as innovative change in a non, or rather less, technological manner to a firm's nature, structure, arrangement, practices, beliefs, rules or norms (see also Pettigrew and Fenton, 2000), which may be subsumed under one of Schumpeter's innovation categories mentioned earlier, namely, "new ways of organising business". This is worth noting because different lines of research apply this term in different

[2] For a good discussion on this notion, see Fagerberg (2003, 2004).

[3] These business cycles are also referred to as 'techno-economic paradigms', such as by Freeman and Perez (1988) and Freeman and Louca (2002).

[4] This largely corresponds with the CIS4's definition of organisational innovation. See below.

ways.[5] For example, organisational innovation is often more broadly defined in management/organisation studies as an adoption of "any" novelty in an organisation (see, for example, Evan, 1966; Daft, 1978; Damanpour, 1987, 1991; Kimberly and Evanisko, 1981; Teece, 1980),[6] while Edquist et al. (2001), leaving aside product innovation, make a distinction between "technical" and "organisational" process innovation.

As argued above, organisational innovation has received much less attention than the technological aspect of innovation. When looking at the scholarly contributions within the area of innovation studies (see Fagerberg, 2004; Martin, 2008; Fagerberg and Sapprasert, 2010), it may be observed that the majority of prominent works, especially those with an empirical focus, have failed to take into consideration the importance of organisational innovation. This is due, in large part, to the availability of statistics. While technological innovation is, for instance, widely examined by reliance on patent and R&D data, how is it possible to measure organisational innovation, which is less tangible in character? Fortunately, a very recent attempt by the CIS has yielded data which may be used to quantitatively analyse this long-neglected aspect of innovation (see below).

3. Theoretical Background and Hypotheses

A central tenet of evolutionary economics highlights 'organisational routines' as being fundamental ways of doing things in a firm (Nelson and Winter, 1982). As time passes, some of the best practices or prevailing routines in the firm may become less effective or may even be no longer acceptable, especially in comparison with those of competitors (Dosi and Nelson, 1994). Organisational transformation is thus crucial (Romanelli and Tushman, 1994), i.e. old routines need to be replaced by new ones if the firm is not to be driven out of business. Following the adaptation perspective, in order to survive, remain competitive, or co-evolve with industrial dynamics, the firm has to search for better solutions and make changes (Nelson and Winter, 1982; Teece and Pisano, 1998), particularly if its performance falls below its 'aspiration level' or a new window of opportunity opens up (Cyert and March, 1963; Greve, 2003; March and Simon, 1958). Although such routine change is clearly important to all firms, considerable heterogeneity exists among them (Nelson and Winter, 1982), i.e. firms have a variety of characteristics which make them different in how they decide to attempt a

[5] See also a discussion on 'organisational innovation' studies in, for example, Lam (2004) and Sapprasert (2009).

[6] The term "administrative innovation" is used as opposed to "technical innovation" in this line of research.

routine change and benefit from such an attempt. In line with Becker et al. (2005), the concept of 'organisational routine' is applied in the present study to investigate the influence of firm heterogeneity and other factors on the rates and consequences of organisational innovation.

3.1 Performance Feedback and Obstacles

As outlined above, understanding why firms do or do not innovate is an important item on the evolutionary economics research agenda (Nelson and Winter, 1982; Fagerberg, 2003). Just as sunglasses are worn when sunlight is noticed, firms change in response to managers' recognition of problems and of various other changes (Cyert and March, 1963). In particular, variation in performance is one obvious factor which typically induces change in a firm, especially when the manager's or shareholder's aspiration level of performance cannot be achieved (March and Shapira, 1992; Greve, 2003). On the one hand, an unsatisfactory situation, such as low profit, may hinder the firm's decision to engage in an innovation project,[7] which is naturally costly and risky.[8] On the other hand, adaptive learning perspectives suggest that innovation in a firm is more likely when the firm's performance appears to have under-achieved, i.e. past failures drive a firm to change in pursuit of better performance (Cyert and March, 1963; Greve, 1998; Levinthal and March, 1981; Tushman and Romanelli, 1985). Thus, it is argued that a performance shortfall may be an important motive for organisational innovation.

H1: *A decline in growth increases the probability of attempts at organisational innovation*

Moreover, Mohr (1969) points out that the propensity to innovate is determined, not only by managers' or shareholders' motivations, but also by the strength of the obstacles to innovation and the resources available to overcome such obstacles.[9] Clausen (2008) argues that some obstacles or problems perceived by a firm may trigger organisational change. For example, a firm may remedy its lack of funds or skilled workers by changing its structure or business

[7] This also implies that a firm which has made high profits is possibly more inclined to innovate, which corresponds to the idea that "success breeds success". This idea suggests that past commercial success, i.e. profit from successful innovation, may be conducive to financing current and future innovation projects/activities. See Flaig and Stadler (1994), Nelson and Winter (1982) and Clausen et al. (2010).

[8] For a review of the literature on the issues related to financial difficulties in funding (risky) innovation and R&D, see Hall (2002a).

[9] From a management perspective, these obstacles to a firm's innovation could be either internal "weaknesses" (Penrose, 1959) or external "threats" (Porter, 1980, 1985).

process, collaborating with other firms, outsourcing, etc. However, due to uncertainty, a lack of important organisational resources is likely to increase a firm's fear of failure, i.e. hinder a firm's risk-taking behaviour (Cyert and March, 1963). Therefore, this problem usually discourages the decision to invest in organisational innovation. Sirilli and Evangelista (1998) and Galia and Legros (2004) provide evidence to support the view that firms commonly consider innovation as being a costly activity, and this places particular pressure on their decision to innovate.

Because a firm never has, and can never obtain, a complete set of perfect information (Nelson and Winter, 1982), the consequences of changing are generally less foreseeable than the consequences of not changing (Greve, 1998). Such obstacles would, therefore, increase managerial reluctance to pursue organisational innovation.

H2: *Managerial perceptions of obstacles decrease the probability of attempts at organisational innovation*

3.2 Persistency and Complementarity

Evidence from recent studies suggests a notion of innovation persistence (although largely in the technological sense), for example, Crepon and Duguet (1997), Flaig and Stadler (1994), Peters (2009).[10] This topic, which is increasingly gaining more interest from innovation research at the firm level, is essentially concerned with a firm's probability to innovate over time (Clausen et al., 2010). Based more or less implicitly on a linear view of innovation, innovation persistence can be seen as a result of sunk costs (Sutton, 1991). In this respect, a decision to make (either technological or organisational) innovation investment is naturally one for the long term. Once a firm has taken this decision, it can be expected to innovate persistently. This argument does not contradict the evolutionary view of innovation (Dosi, 1988; Nelson and Winter, 1982). Through this lens, a firm may be seen to be persisting in innovation in the way in which it learns and collects knowledge to further its innovation capability. Because of the cumulative nature of learning itself (Rosenberg, 1976), a firm can continually extend and use this capability to develop new products or processes (Raymond et al., 2006), as well as to improve its organisational routines, at decreasing marginal costs

[10] To the author's knowledge, the present study is probably one of the first research attempts which, in part, looks at the topic of persistence of innovation in an organisational aspect. See, for instance, Raymond et al. (2006) and Clausen et al. (2010) for detailed discussions of research on the topic of persistence of technological innovation.

(Amburgey et al., 1993). As Amburgey and Miner (1992) and Kelly and Amburgey (1991) argue, organisational change may be seen to be a self-reinforcing process, which has repetitive momentum.

H3: *Past attempts at organisational innovation increase the probability of (new) attempts at organisational innovation*

Because a change in organisational routines can disrupt reliable performance (Hannan and Freeman, 1984), persistence of organisational innovation may, on the one hand, be disadvantageous and result in decreasing returns on a firm's performance. This particularly holds for a firm which changes too frequently and does not have sufficient time to fix the problems which arise from disruption (Amburgey et al., 1993). On the other hand, innovation persistence may be understood to be a process of 'creative accumulation' (Schumpeter, 1942). This process is fundamental to the success of innovative firms, since knowledge obtained through learning from past innovation(s) can support a new round of innovation. Firms learn (to change) by changing, as in conformity with "learning by doing" (see, for example, Arrow, 1962; Nelson and Winter, 1982; Dosi, 1988). This also means that having changed increases firms' experience with change, which may, in turn, make them more able to routinise change (Kelly and Amburgey, 1991), i.e. to develop a 'modification routine' (Nelson and Winter, 1982; Aldrich, 1999). Hence, persistent organisational innovators are possibly more capable of effectively reorganising repeatedly, and benefiting from doing so. This viewpoint supports the competence-based theory at the firm level (Nelson and Winter, 1982), and implies that persistence of organisational innovation yields dynamic increasing returns.[11] Malerba and Orsenigo (1999), for example, provide evidence to demonstrate that firms which persistently innovate possess a great advantage in being able to consistently improve their performance.

H4: *Persistent organisational innovation increases the effects of (current) organisational innovation on firm performance*

[11] Built upon the seminal work of Hannan and Freeman (1984), Amburgey et al. (1993) make a claim from a different perspective that organisational change is likely to reset the organisational clock, i.e. the effective alterations of routines, structure, roles and relationships within the organisation possibly make a firm new once more. Therefore, a firm which has changed previously may have its organisational clock reset and become young again. In line with H8 proposing that a younger firm may benefit more from organisational innovation (see below), this claim supports the idea that past or persistent organisational innovation can increase the effects of current organisational innovation on firm performance.

As was argued above, as well as in Sapprasert (2007), technological and organisational innovation are complementary factors, and together they are crucial to improving firm performance. Their joint contribution has been important for innovative firms since the first industrialisation when the steam engine was a new key technology (Bruland and Mowery, 2004). This joint contribution is still important to the modern economy, in which a vast number of firms are attempting to reorganise their business in order to make the most of new technological opportunities which have arisen from, among other things, the introduction and diffusion of ICT (Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000, 2003; Brynjolfsson et al., 2002). For example, many firms re-engineer their business processes on the basis of ICT, such as switching to electronic commerce. Also, because information processing and transfer can be significantly improved by exploiting ICT, decentralisation and task delegation in firms can be done very efficiently nowadays (Brynjolfsson and Mendelson, 1993). These examples support the argument that a great improvement will be achieved in firm performance if technological and organisational innovation are undertaken together (Chandler, 1962; Nelson, 1991).

H5: *Technological and Organisational innovation have a complementary effect on firm performance*

3.3. Age and Size Effects

One strand of research into organisation places emphasis on the importance of environmental selection (Stinchcombe, 1965; Hannan and Freeman 1977, 1984; Aldrich, 1979, among others). This research strand argues that adaptive change is heavily constrained, and that the adjustment to the dynamics of the environment relies chiefly on the birth and death of the organisation.[12] In particular, Hannan and Freeman's (1984) inertia theory indicates *inter alia* that age and size of firms are associated with a strong force which hinders organisational change. They label this force "structural inertia", and explain that it is a product of the development of the reliability and accountability of firm performance. It can be expected that inertia increases monotonically with age as the firm's working relationships become more formalised, routines become more standardised and the structure becomes more stabilised (Kelly and Amburgey, 1991). Size may also increase inertia because being larger makes the firm more rigid and inflexible (Downs, 1967).

[12] For example, see Levinthal (1991), for a review of the two contrasting, albeit interrelated, perspectives on organisational change: organisational adaptation and environmental selection.

Although firm age and size may increase inertia as the theory suggests, when looking separately at their relationships with: (i) the firm's tendency to attempt organisational innovation, and (ii) the effects of this attempt on the firm's performance, age and size may count differently due to their other properties. Firstly, the age and size of a firm are typically associated with some features which may, instead, trigger efforts at organisational innovation. Kimberly and Evanisko (1981) argue that a firm's size not only necessitates, but also facilitates, its innovative behaviour. Larger firms may be more inclined to undertake organisational change because of their 'deep pockets', i.e. higher level of financial and other resources (Kimberly, 1976; Aldrich and Auster, 1986). In other words, since larger firms generally have a greater capability to innovate (Schumpeter, 1942),[13] they are probably more ready and more likely to do so. Kimberly and Evanisko (1981) and Damanpour (1987) point out that this may hold, not only for innovation in the technical aspect, but also in the organisational dimension.

Furthermore, it is also possible that firm age supports organisational innovation since, compared with the immature or undefined routines of younger firms, the greater maturity of routines in older firms may serve as a powerful impetus for change (Amburgey et al., 1993). While younger firms may be busy dealing with many basic business operational issues which usually arise significantly in the early years (maintaining cash-flow, formalising relationships and so on), or paying more attention to innovating new products and/or processes in order to enter and compete in the market, it can be expected that older firms are relatively less occupied with these aspects, so that their management will have more of a chance to perceive or realise the need for improvements in the organisational structure, management systems/methods, and the like. Thus, the rates of organisational change may increase with firm age.

This line of reasoning suggests that, although organisational age and size are often seen to be associated with inertia, which "often blocks structural change completely" (Hannan and Freeman, 1984:155), this is not always the case, since it also depends on other conditions/circumstances, such as the type of change and environmental dynamics (Hannan

[13] There is a large body of literature on the so-called 'Schumpeterian Hypotheses' dealing with the issue of how firm size matters to innovation (For example, see Scherer, 1980; Kamien and Schwartz, 1975, 1982; Cohen and Levin, 1989 for reviews). One standard justification for this Schumpeterian tradition is that larger firms have a greater capability to innovate because of their better access to financial resources.

and Freeman, 1984). It is possible that "the same forces that make organisations inert also make them malleable" (Amburgey et al., 1993:51), i.e. the age and size of firms have other properties which, as discussed above, may largely induce their decision to undertake organisational innovation.

H6: *Firm age increases the probability of attempts at organisational innovation*
H7: *Firm size increases the probability of attempts at organisational innovation*

Secondly, as Hannan and Freeman (1984) point out, it is difficult to predict the relationship between the age and size of a firm, on the one hand, and the effects of organisational change on the other, particularly when looking at the effects of change on performance. It is possible that the property of inertia, which Hannan and Freeman (1984) suggest is more prevalent in large, old firms, has less of an influence on the firm's tendency to change, but more on the success or effects of change. The present study proposes that the age and size of the firm are more likely to impede the effects of organisational innovation on its performance.

On the one hand, aging is naturally accompanied by the accumulation of skills and knowledge, which is fundamental to innovation processes (Nelson and Winter, 1982), especially in the technological sense. On the other hand, as discussed above, older firms are purported to have more standardised routines and rigid structures (Stinchcombe, 1965; Hannan and Freeman 1984), and because it is more difficult for them to unlearn these routines and transform these structures, many of them remain path dependent (Arthur, 1994; David, 1994). Although, in fact, it is managerial authority which leads to most undertakings/actions in a firm (Witt, 1998; Knott, 2001), in practice, this authority is often subject to limits, especially when it comes to organisational change (Leibenstein, 1987). This implies that older firms, which are usually less adaptive and may be committed to the past, will probably have more difficulty in reaping the benefits of organisational change which has been implemented as strategised.

Also, the effects of organisational change may decrease with the size of the firm, which usually complicates the change process. This complication is mainly due to greater difficulties in coordination in larger firms (Greve, 1999). The size of the firm typically increases the distance between decision makers and practitioners because of a hierarchy, and this distance is likely to vary the commands or plans made (Beckmann, 1977), for example, in connection

with reorganisation. Large firms with a structure consisting of many hierarchical levels may, therefore, be less effective at organisational change. In large firms with a lean structure, there are naturally a number of links between each unit, i.e. complexity (Simon, 1962), which, by definition, can also hamper organisational innovation. Moreover, since organisational members usually prefer the *status quo* and thus oppose change, efforts at organisational innovation in larger firms with more people (with any kind of structure) frequently encounter internal opposition or 'political force' (Coch and French, 1948; Pfeffer, 1992). These conditions result in greater ossification and inflexibility, which may cause larger firms to benefit less from attempts at organisational change, if any attempts are made.

In short, despite being factors which may increase the odds of organisational change attempts (H6 and H7, as discussed above), due to their property of inertia, firm age and size are hypothesised as hampering the effects of organisational innovation on firm performance.

H8: *Firm age decreases the effects of organisational innovation on firm performance*
H9: *Firm size decreases the effects of organisational innovation on firm performance*

4. Data, Method and Variables

A unique firm-level dataset from an integration of annual financial accounts (1999 – 2004) and two Norwegian Community Innovation Surveys, CIS3 (1999 – 2001) and CIS4 (2002 – 2004) which include information on 'organisational' innovation, is employed in this analysis. This information, available from the recent waves of CIS, is crucial because it allows issues of organisational change, which are usually scrutinised in a qualitative manner, to be examined quantitatively on the basis of a large-scale database,[14] leading to more generalised findings. The most detailed CIS data is at the firm level. This means that this data can be used to study organisational innovation in individual firms, or can be aggregated for a study at the industry- or country-level, but cannot be broken down to analyse this issue at the plant- or project-level. Therefore, the possibility of some bias in this analysis cannot be denied, for example, larger firms may have a higher probability to report that they are (organisational) innovators based on the data (for example, because they usually have more plants/departments). Nevertheless, when analysing this data, it is not necessarily, and shall not be assumed, that the impact of

[14] It should be noted that it is only after its second wave (around 1996/1997), that the CIS has placed greater emphasis on non-technological innovation like organisational change by including a section about this issue in the questionnaire.

organisational innovation could be more widespread or noticeable in larger firms simply due to their size, since the data provides no information about the scale and number of innovation projects. In other words, some large firms may have introduced just one small innovation project, while some small firms may have introduced many large-scale innovation projects. This is unknown.

Statistics Norway prepared and supplied these CIS and financial data sources. The CIS3 questionnaire was distributed to a representative set of firms registered in Norway with at least 10 employees. 3,899 firms completed and returned the questionnaire, which constituted a high response rate of 93%. This survey was followed three years later by the CIS4, which was also quite successful, judging by its response rate of 95% (receiving responses from 4,655 firms with 10 employees or more). Information on the financial accounts of firms in Norway is collected annually and is available for a large share of these respondents. The three sources were then combined, and the resulting dataset contains around 1,700 respondent firms in the manufacturing, service and other industries (see Table 1). Since this number of firms refers to an overlap of more than 30% of firms from the three sources, the dataset seems to be sufficiently representative.

In order to examine the determinants and effects of organisational innovation on the basis of this integrated dataset, the following two-step model was constructed:

$$ORG = PASTORG + PASTPERF + HAMPi + SIZE + AGE + IND \quad (1)$$

$$EFORG = PASTORG + INCOMP + SIZE + AGE + IND \quad (2)$$

ORG = Dummy for the attempt at organisational innovation (2002 – 2004)
EFORG = Factor score for six types of effects of organisational innovation (2005; see more description below)
PASTORG = Dummy for the past attempt at organisational change (1999 – 2001)
PASTPERF = Past performance in terms of profitability growth (1999 – 2001)
HAMPi = Hampering factors (2002 – 2004; see more description below)
INCOMP = Dummy for the joint contribution of technological and organisational innovation (2002 – 2004; see explanation below)
SIZE = Firm size in terms of employment (LogEmp) and turnover (LogTurn)
AGE = Firm age (LogAge)
IND = A dummy for industrial classifications (NACE)

Because only those firms which reported to the CIS 4 that they had undertaken organisational innovation between 2002 and 2004 were allowed to answer the question about its effects, i.e. since only organisational innovators are included in equation 2, it is important to inspect for the potential of sample selection bias when analysing this data. Thus, Heckman's (1979) two-step estimate, which can indicate the existence/significance of this bias, is employed (see for example, Zucker et al., 1998; Hall, 2002b; Catozzella and Vivarelli, 2007).[15] Based on this estimate, the selection equation explains whether, and the extent to which, the independent variables included in Stage 1 affect firms' decisions to undertake organisational innovation (ORG), while the outcome equation examines the influence of the independent variables included in Stage 2 on the outcome of such an undertaking (EFORG).

The variables of interest in this Heckman two-step procedure are organisational innovation (ORG), its effects (EFORG), past/persistent organisational change (PASTORG), past performance (PASTPERF), hampering factors (HAMP), the complementarity of organisational and technological innovation (INCOMP), firm size (SIZE), firm age (AGE) and industry dummies (IND). The measure of organisational innovation (ORG), employed as a dependent variable in the selection equation (Stage 1), is obtained from the answers to the question in the CIS4 which asks whether or not, between 2002 and 2004, the firm introduced organisational innovation, defined as being a new or significant change in the firm's structure or management methods seeking to improve the firm's use of knowledge, quality of goods or services, or workflow efficiency. The three types of organisational innovation concerned in the survey are: (i) a new or significantly improved knowledge management system implemented to better use or exchange information, knowledge and skills within the firm (ORGSYS); (ii) a major change to the organisation of work within the firm, such as change in the management structure or the integration of different departments or activities (ORGSTR); and (iii) a new or significant change in the firm's relationships with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting (ORGREL). Indeed, it is essential to have details of these contents of change, which involve various modifications of elements and interactions within the firm, as well as linkages between the firm and external actors, insofar as the study of organisational transformation is

[15] Since the Heckman results show no sign of selection bias, the OLS (Ordinary Least Square) estimation is also used in the second stage experiment. Three types of organisational innovation (ORGSYS, ORGSTR and ORGREL) are added, in order to examine their potentially differential impacts. See below.

concerned.[16] Based on the three measures, a dependent variable ORG for Stage 1 (Probit) is constructed.[17] ORG equals one if the firm has a positive answer for at least one of the foregoing three types of organisational innovation, and zero otherwise.

The variable used to assess the impact of these three types of organisational innovation is based on the next question in CIS4, which inquired (in 2005) about the effects of such innovation.[18] As mentioned above, only the firms which carried out organisational innovation, i.e. for which ORG = 1, shall respond to the question about its effects. This question asks the firm to rate (from 0 – 3) the importance of six types of effects: (i) reduced response time to customer needs; (ii) improved quality of goods or services; (iii) reduced costs per unit output; (iv) improved employee satisfaction and/or reduced employee turnover; (v) increased enterprise capacity; and (vi) higher enterprise profitability. This information is deemed suitable for use in investigating the effects of organisational change, as it seems to meet the two criteria suggested by Barnett and Carroll (1995), i.e. it captures the effects at the firm level and is broadly applicable (for example, not specific to one or only a few industries or business categories). A factor analysis was conducted for the six measures (see Table A.1 in the Appendix). One factor was retained from this, and the factor score for each firm is used as a dependent variable (EFORG) in the outcome equation, which examines how the effects of organisational innovation are influenced by the predictors included in Stage 2.

Several explanatory variables are employed in the selection and outcome equation. It should be noted that some, but not all,[19] of them are taken into account in both stages. These include PASTORG, used to determine the influence of prior organisational change (between 1999 and 2001) on the probability of another attempt at organisational change by the firm between 2002 and 2004 (ORG) in Stage 1 (testing H3). As explained above, since only the organisational

[16] See Barnett and Carroll (1995) for a good discussion on the process and content of organisational change.

[17] ORG is applied because this Heckman estimation can have only one dependent variable in a binary format (0 or 1) in the selection equation (Stage 1). This means that such a variable (ORG in this case) cannot be a measure of the 'scale' of organisational innovation and, thus, does not (to a great extent) explain its heterogeneity.

[18] It is important to emphasise that, although the information on organisational innovation and its effects both come from the CIS4 (2002 – 2004) which may seem to provide somewhat little time for the effects to be realised and thus have a 'causality' problem, the question on the effects of organisational innovation was designed to be rather explicit by asking the respondent firms to evaluate in 2005 'the effects of organisational innovation introduced' between 2002 and 2004. The Norwegian CIS4 questionnaire was sent out about 6 months after the year of reference (2004).

[19] This is because of a requirement associated with this regression technique (Heckman, 1976, 1979).

innovators between 2002 and 2004 (ORG = 1) are included Stage 2, PASTORG is used also in the outcome equation to assess the extent to which the combined prior and current efforts at organisational change (between 1999 and 2001 and between 2002 and 2004, i.e. persistence of change) increased the effects of organisational innovation felt in 2005, EFORG (testing H4). In other words, this variable, employed in both equations, helps to answer two questions: to what extent were the sampled firms persistent in organisational innovation? And to what extent did those who were benefit more from being so? PASTORG**,** constructed on the basis of the CIS3 data, has a value equal to one if the firm has introduced change between 1999 and 2001 in at least one of the following types related to reorganisation: corporate strategies, management techniques, and organisational structures.

The age and size of a firm, hypothesised to have different impacts on its decision to pursue organisational change and on the effects of such change, are also taken into account in both equations. As Penrose (1959) suggests, firm age and size will be considered as separate determinants of change, since older firms are not necessarily larger than younger firms, and vice versa.[20] Based on the information from the financial accounts, the explanatory variables for firm age and size are created and included in both Stages 1 and 2 (testing H6, H7, H8, H9). Firm age (LogAge) is calculated as the log value of the time period between the year the firm was established and 2001 (the last year before entering the period of main interest, i.e. 2002 – 2004). Firm size is measured on the basis of information about the number of employees (LogEmp) and the firm's total turnover (LogTurn) in 2001.[21] Also, industrial classification dummies (IND), constructed from the CIS3 information, are employed in both stages to control for the influence of industry heterogeneity on the firm's propensity to innovate, as well as on its effects. IND equals one if the firm belongs to the respective industry (classification based on the standard NACE code), and zero otherwise.

PASTPERF & HAMP, hypothesised to affect the firm's decision to undertake organisational innovation (ORG), are included in the selection equation (Stage 1). PASTPERF, measured based on the financial accounts data as firm growth in profitability (profit per employee)

[20] See Table A.2 in the Appendix for a simple correlation test between firm age and size (in terms of both total turnover and number of employees).

[21] Having both of these proxies is advantageous since they possibly explain the size of the firm in different dimensions. That is, while LogEmp is deemed to relate more to the scale of human resource, and may thus better depict a degree of complexity/hierarchy of the firm's structure, LogTurn represents the size of the firm in terms of financial capacity. A simple correlation test conducted shows that turnover does not necessarily very strongly correlate with the number of employees (see Table A.2 in the Appendix).

between 1999 and 2001, captures a recent change in the firm's economic performance which may have some influence on its efforts at organisational innovation (testing H1), since performance variation usually induces the firm to change (Cyert and March, 1963; Greve, 2003). HAMP represents three types of obstacles to organisational change perceived by the sampled firms between 2002 and 2004. These include high innovation costs (HCOST), a lack of funds (HFUND), and a lack of qualified personnel (HPER), which are often regarded as factors which affect innovation in the literature (see for example, Kline and Rosenberg, 1986; Galia and Legros, 2004). Using information from the CIS4, the three proxies are constructed from the firm's rating (from 0 – 3) of the importance of these three impediments to innovation (testing H2).[22]

Finally, since all the firms included in Stage 2 were organisational innovators between 2002 and 2004 (firms with ORG = 1), a dummy for technological innovation in terms of new or significantly improved product(s) or process(es) (INCOMP) between 2002 and 2004 is simply used to measure the joint contribution of technological and organisational innovation in Stage 2 (testing H5), i.e. INCOMP is equivalent to the result of multiplying itself by ORG (which always equals one in this Stage). This variable, applied to examine their interaction/complementarity effect on firm performance (EFORG), is extracted from the CIS4 data on technological innovation, and equals one if the firm introduced at least one product or process innovation between 2002 and 2004. Table A.2 provides a correlation matrix for the explanatory variables employed, with no indication of a multicollinearity problem.

5. Analysis

The descriptive statistics in Table 1 demonstrate that more than one third of the firms in the sample are organisational innovators (having introduced at least one type of organisational innovation between 2002 and 2004).[23] Firm size, in terms of either total turnover or number of employees, seems to have a positive relationship with the rate of organisational innovation since, in comparison with the case of smaller firms, a higher percentage of larger firms

[22] These three variables were selected on the basis of their relevance to organisational innovation (those related only to technological innovation were excluded, for example, a lack of information on technology and an uncertain demand for innovative goods and services), their significance during models tests, and their uniqueness reported in the results of the factor analysis (not reported here; available upon request).

[23] Organisational innovator is defined, in accordance with CIS4's definition of organisational innovation, as a firm which has implemented new or significant change in its structure or management methods in order to improve the firm's use of knowledge, quality of goods and/or services, or efficiency of work flows.

reported that they were organisational innovators (supporting H7),[24] while whether or not firm age monotonically increases this rate is less clear-cut and has yet to be further examined (H6).[25] In terms of the descriptive picture of heterogeneity of organisational innovation (the three measures of organisational innovation obtained from the CIS4), change in the firm's structure (ORGSTR) is the most common, followed by change in the firm's knowledge management systems (ORGSYS) and change in the firm's external relations (ORGREL) respectively, regardless of the firm's age, size and sector. The results from Table 1 also show that only a small share of firms undertook all of the changes considered.

Table 1. Firms' age, size, sector and organisational innovation (2002-2004)

	No. of firms	Organisational innovator	ORGSYS	ORGSTR	ORGREL	1 type of change	2 types of change	3 types of change
Sector								
Manufacturing	947	0.35	0.18	0.28	0.12	0.16	0.15	0.03
Services	580	0.37	0.20	0.28	0.15	0.17	0.13	0.07
Others	210	0.29	0.17	0.22	0.09	0.14	0.12	0.03
Age								
Age1	557	0.41	0.22	0.32	0.16	0.18	0.16	0.07
Age2	591	0.32	0.14	0.25	0.11	0.17	0.12	0.03
Age3	589	0.33	0.19	0.25	0.12	0.14	0.16	0.03
Size								
Emp1	611	0.27	0.14	0.20	0.09	0.13	0.10	0.03
Emp2	477	0.32	0.17	0.23	0.10	0.17	0.10	0.04
Emp3	649	0.46	0.23	0.37	0.18	0.19	0.21	0.06
Turn1	585	0.28	0.14	0.20	0.09	0.14	0.11	0.03
Turn2	589	0.33	0.16	0.25	0.10	0.18	0.11	0.04
Turn3	563	0.46	0.25	0.37	0.19	0.17	0.22	0.07
Total	1,737	0.35	0.18	0.27	0.13	0.16	0.14	0.04

[24] As mentioned above, the CIS data at the firm level as used in this study is the most detailed available. Thus, the study cannot empirically elaborate a detailed relationship, for example, between the number of departments or plants, which are commonly greater in larger firms, and the probability of attempts at organisational innovation.

[25] Age & Size classifications are based on the samples distribution: Age1 = 1-14, Age2 = 15-24, Age3 = 25 years old and over; Emp1 = 10-49, Emp2 = 50-109, Emp3 = 110 employees and over; Turn1 = 1-49,999, Turn2 = 50,000-199,999, Turn3 = 200,000 NOK and over.

Table 2. Firms' age, size, sector, organisational and technological innovation

	No. of firms	Organisational innovator (2002-2004)	Past Organisational Change (1999-2001)	Organisational Innovation Persistence (1999-2001 & 2002-2004)	Technological Innovation (2002-2004)
Sector					
Manufacturing	947	0.35	0.50	0.23	0.54
Services	580	0.37	0.55	0.24	0.42
Others	210	0.29	0.50	0.19	0.26
Age					
Age1	557	0.41	0.57	0.28	0.49
Age2	591	0.32	0.48	0.19	0.46
Age3	589	0.33	0.50	0.22	0.45
Size					
Emp1	611	0.27	0.46	0.16	0.41
Emp2	477	0.32	0.46	0.21	0.48
Emp3	649	0.46	0.61	0.31	0.51
Turn1	585	0.28	0.44	0.17	0.42
Turn2	589	0.33	0.49	0.20	0.47
Turn3	563	0.46	0.63	0.32	0.51
Total	1,737	0.35	0.52	0.23	0.47

Table 2 contains the descriptive statistics of a few other variables in the dataset. The results demonstrate that more than fifty percent of the firms had carried out organisational change between 1999 and 2001, and many of these had made another attempt at organisational change between 2002 and 2004 (supporting H3). Contrary to, for example Geroski et al. (1997) and Cefis and Orsenigo (2001), who found a rather low persistence of technological innovation based on their analyses using patent information, almost one quarter of the sampled Norwegian firms were persistent in organisational innovation between 1999 and 2004. However, the present study finds that technological innovation (product/process) was more common than organisational innovation within the sample between 2002 and 2004 (47 percent of the firms reported undertaking technological innovation, compared with the 35 percent which adopted organisational innovation). When comparing across sectors, it can be seen that a greater share of manufacturing firms engaged in technological innovation, while a greater share of service firms were active in organisational innovation between 2002 and 2004, which is, in fact, reassuring.[26] Finally, despite inconclusive evidence of the influence of firm age, a higher percentage of larger firms, compared with smaller firms, were persistent organisational innovators (i.e., engaged in organisational innovation during both of the time

[26] As usually argued in the literature on service innovation (for example, Evangelista, 2000; Miles, 2004; Sapprasert, 2007), non-technological and intangible characteristics of services are very significant and particularly linked to organisational change.

periods under review), and were innovative between 2002 and 2004 in the technological, organisational sense. The latter point is consistent, for example with Kimberly and Evanisko (1981), which indicates a positive relationship between the size of a firm and its rate of technological and organisational innovation.

The results of the econometric analysis are displayed in Table 3. Firstly, considering the lower part of the first two columns (model I with LogEmp & model II with LogTurn), the Heckman Stage 1 (with ORG as a dependent variable) results provide some evidence of persistence of organisational innovation in line with the descriptive statistics in Table 2 and recent studies, such as Crepon and Duguet (1997) and Peters (2009). Prior organisational change between 1999 and 2001 influenced the probability of another attempt by firms between 2002 and 2004 (ORG), which supports H3. This can be seen from the significant positive coefficients of PASTORG (Past Organisational Change) in models I and II (0.832 and 0.794 respectively, both significant at the 5% level). The results of Heckman Stage 1 also demonstrate the impacts of past performance and hampering factors on the firm's decision to undertake organisational innovation (Cyert and March, 1963; Greve, 1998). The negative coefficients of PASTPERF in both models I and II (-1.513 and -1.488 respectively, both significant at the 10% level) corroborate H1, i.e. attempts at organisational innovation between 2002 and 2004 (ORG) seem to follow a decline in profitability growth (between 1999 and 2001). Nonetheless, the only innovation impediment which is sufficiently significant as a factor to discourage efforts of organisational innovation is the high reported costs of innovation, the negative results of which are significant at the 10% level in both models I and II (coefficients of -0.493 and -0.482 respectively), providing partial support for H2.[27] Having controlled for the influence of age and size, the results seem to support H6, but not H7, i.e. while the (positive) effect of size on the change attempt is not confirmed by the econometric analysis,[28] the evidence suggests that firm age increased the chance of organisational innovation between 2002 and 2004 (ORG), as the coefficients of firm age (LogAge) are positive (0.581 and 0.585) and statistically significant at the 5% and 10% level in models I and II respectively. This is consistent with the above argument that the more mature routines in older firms may

[27] This evidence contradicts that of Veugelers and Cassiman (1999). Using Belgian manufacturing firm data, they found that high innovation costs perceived by firms do not discourage (technological) innovation attempts.

[28] Firm size is however consistently reported to positively influence the rate of organisational innovation in the descriptive part. See Table 1 & 2.

make them more ready, and more likely, to adopt organisational change (Amburgey et al., 1993).

Table 3. Factors explaining organisational innovation and its effects

	EFORG (Heckman 2-stage)		EFORG (OLS estimation)	
	(I) LogEmp	(II) LogTurn	(III) LogEmp	(IV) LogTurn
Constant	-0.235 (0.876)	0.007 (0.899)	-1.387 (0.860)	-1.038 (0.878)
Persistent Organisational Change (PASTORG)	0.129* (0.078)	0.132* (0.078)	0.095 (0.075)	0.099 (0.075)
Complementarity (INCOMP)	0.146* (0.080)	0.154** (0.080)	0.159** (0.079)	0.169** (0.079)
Firm Size				
-*Number of Employees* (LogEmp)	-0.028 (0.030)	-	-0.059** (0.030)	-
-*Total turnover* (LogTurn)	-	-0.035 (0.023)	-	-0.056*** (0.023)
Firm Age (LogAge)	-0.009 (0.055)	-0.004 (0.054)	-0.010 (0.051)	-0.004 (0.051)
Industry Dummies (IND)	Yes	Yes	Yes	Yes
Organisational Innovation (in OLS only)				
-*ORGSYS*	-	-	0.395*** (0.074)	0.397*** (0.074)
-*ORGSTR*	-	-	0.711*** (0.088)	0.712*** (0.088)
-*ORGREL*	-	-	0.199*** (0.074)	0.199*** (0.074)
Selection Equation – Heckman Stage 1 (dependent variable = **ORG**)	----------	----------	----------	----------
Past Organisational Change (PASTORG)	0.832** (0.375)	0.794** (0.380)	-	-
Profitability Growth (PASTPERF)	-1.513* (0.792)	-1.488* (0.798)	-	-
Hampering Factors (HAMP)				
-*High Innovation Costs* (HCOST)	-0.493* (0.258)	-0.482* (0.256)	-	-
-*Lack of Funds* (HFUND)	0.364 (0.232)	0.374 (0.234)	-	-
-*Lack of Qualified Personnel* (HPER)	-0.145 (0.212)	-0.174 (0.215)	-	-
Firm Size				
-*Number of Employees* (LogEmp)	-0.025 (0.138)	-	-	-
-*Total turnover* (LogTurn)	-	0.067 (0.106)	-	-
Firm Age (LogAge)	0.581** (0.324)	0.585* (0.326)	-	-
Industry Dummies (IND)	Yes	Yes	-	-
Mills ratio	0.293 (0.567)	0.277 (0.563)	-	-
Wald-Test	591.52***	429.58***	-	-
R^2	-	-	0.180	0.184
Number of Observations	1737	1737	597	597
Uncensored	597	597	-	-

*,**,*** denote significance at the 10, 5 and 1 % level, respectively. Standard errors in brackets.

Further, the results in Table 3 shed light on how the effects of organisational innovation (EFORG) can be explained by several determinants. Since there is no clear evidence of selection bias (insignificant Mills ratios in both Heckman models I & II), the results of both the Heckman outcome equation (Stage 2 – the upper part of the results for models I and II) and OLS (Ordinary Least Square) estimations (models III and IV in the last two columns), which are quite comparable, are reported and discussed. Firstly, the results of the Heckman outcome equation (coefficients of 0.129 and 0.132, both significant at the 10% level in models I and II respectively)[29] indicate the existence of a positive relationship between persistence of organisational innovation (PASTORG) and firm performance (EFORG). This supports H4 and prior research such as that undertaken by Malerba and Orsenigo (1999), suggesting that innovation persistency is conducive to the consistent improvement of firm performance. Next, the results of all models in Table 3 confirm H5 in terms of the complementarity effect. The coefficients of INCOMP, measuring the complementarity of organisational and technological innovation, are positive and statistically significant at the 10% level in model I (coefficient of 0.146) and at the 5% level in models II, III and IV (coefficients of 0.154, 0.159 and 0.169 respectively), supporting the claim that this combined presence helps to improve firm performance (Chandler, 1962; Nelson, 1991).

With regard to the size effect, the OLS results (coefficients of -0.059 and -0.056, significant at the 5% and 1% level in models III and IV respectively) provide some support for H9, i.e. larger firms (measured in terms of either employment or turnover) benefit less from reorganisation, possibly due to a range of inertia properties associated with firm size, for example, hierarchy, complexity, political force, as pointed out above.[30] However, none of the models concerned provides clear evidence to support H8. The coefficients of firm age are negative but not statistically significant, i.e. older firms do not appear to benefit differentially from organisational innovation as hypothesised. As the literature suggests, the unclear effect of firm age may be because, on the one hand, older firms are generally associated with stronger structural inertia which hampers change (Hannan and Freeman, 1984). However, these firms may have a higher competency for change and many other activities, having

[29] Nonetheless, the same signs are found in the OLS estimations (Model III & IV).

[30] The coefficients in models I and II (Heckman results) are also negative, though insignificant. The coefficients between firm size (LogEmp and LogTurn) and different types of effects of organisational innovation are also found to be significant and negative in the detailed OLS estimates (results not documented here; available upon request).

accumulated more skills and knowledge by means of organisational learning over time (Amburgey et al., 1990; Nelson and Winter, 1982), on the other.

In addition, the OLS results demonstrate that all of the three types of organisational innovation do have a significant effect on firm performance.[31] The Norwegian firms benefited, to a large extent, from a change in firms' structure (ORGSTR), and to a lesser extent, from a change in knowledge management systems (ORGSYS) and a change in external relationships (ORGREL).[32] Nonetheless, it should be noted that, from all of the estimations made, industry heterogeneity does not seem to play a strong role in explaining the rate and effects of organisational innovation at the firm level. This corresponds in part to recent works, for example, by Leiponen and Drejer (2007) and Srholec and Verspagen (2008), which argue that heterogeneity at the firm level is much greater compared with industrial and national ones when it comes to innovation activities.

6. Concluding Discussion

Using a novel dataset based on the firm-level Norwegian CIS (1999 – 2001 and 2002 – 2004) and financial accounts, this study has examined the determinants and performance effects of organisational innovation within firms. In doing so, the study has taken into account the possibility of sample selection bias in the econometric analysis, since only the 'organisational innovators', which account for about one third of the sampled firms from manufacturing, service and other industries in Norway, were included in the analysis of the effects of organisational innovation. Heckman's (1979) two-step estimation was employed, and supported the rejection of significant selection bias.

The study provides some important findings which appear to shed light on the influence of several factors in organisational innovation, as well as to offer a few managerial implications. The evidence shows that the probability of attempting organisational change (again) increases with a prior history of the change itself, i.e. repeated/persistent organisational change, which appears to be essential to the improvement of firm performance. This probability may also be

[31] The results (not reported here; available upon request) of a detailed analysis of different effects (six types of effects as dependent variables, one at a time) of these three types of change also go along similar lines as the evidence discussed here using factor score (EFORG) as a dependent variable.

[32] This finding somewhat conflicts with the basic view of organisational ecologists, that change in an organisation's structural core, which naturally impinges on, or even disrupts, some of its existing major routines (i.e. reduces reliability and accountability), hinders its performance.

higher when profitability declines. On the other hand, such attempts are likely to be discouraged by high reported costs of innovation. Moreover, the study finds that firm age, regarded as a very complex determinant in organisational ecology research (see, for example, Carroll and Hannan, 2000), does not significantly influence the effects of organisational innovation, but does exercise some influence over the likelihood of such innovation being undertaken; that is, older firms seem to be more inclined to pursue organisational innovation. In terms of firm size, the results suggest that this may influence the effects of the organisational innovation undertaken; that is, smaller firms seem to receive greater performance benefits from organisational change. Nevertheless, it is unclear from the econometric analysis how firm size influences the decision to pursue organisational innovation, despite the implication of the descriptive statistics that the larger the firm, the more likely it will be to attempt organisational innovation.

The influence of diversity of organisational change on firm performance has also been partially assessed, and the evidence shows that the three types of change considered affect firm performance to different degrees. In addition, the effects appear to be more impressive within firms with the combined presence of technological and organisational innovation. Put differently, firms can better reap the rewards of reorganisation by jointly reorganising with technological innovation.

However, it is important to acknowledge several limitations in this study. Since the Norwegian CIS4 was conducted around the middle of 2005, there was only a short time for the respondent organisational innovators to realise the effects of organisational innovation introduced between 2002 and 2004. Therefore, the analysis could only show how the firms benefited from organisational change in the near term. This limitation relates to the cross-sectional nature of data from the CIS, which may also lead to a simultaneity problem in some cases, because certain variables (which refer to the same, or an overlapping, time period) included in an estimate may be jointly determined. Furthermore, the relationships between some of the variables included in the analysis in the present study may have been influenced by common method bias, because they were extracted from the CIS questions which used similar scale format and/or anchors.[33] This bias may have been the case, since these questions

[33] Strong correlations between such variables may have been, in part, due to this reason. Criscuolo et al. (2007) explain that, in order to attempt to avoid this bias, the CIS questionnaire was designed to incorporate a mixture of Likert scales and questions which required responses in a binary (yes/no) or numerical format (absolute

were answered based, in part, on the (same) respondents' (subjective) evaluation. The reliance on the respondents' subjective knowledge or perception may also have led to subjective indicators in the estimate, such as in the case of the CIS questions about obstacles to innovation (Clausen, 2008).

More importantly, some of the arguments in the present study were made based primarily on prior research, since the analysis could only be done using a reduced form of (representation of) the complex set of relationships, particularly between age and size on the one hand, and structural inertia or rigidity of organisational routines, on the other. The reason these complex relationships could not be empirically tested is simply that there is no information in the CIS which can directly measure complexity, political force, path dependency and other inertia properties (i.e. 'unobserved heterogeneity' in the model). Beck et al. (2008) indicate that many empirical studies of issues related to organisational change neglect unobserved heterogeneity, which potentially causes bias in estimated results. They suggest that, in order to deal with this methodological problem, fixed-effects models may be used when analysing panel data. This is not applicable to the present study, which is based on cross-sectional data. Nonetheless, a residual analysis was conducted for predicted values (regressions with the effects of organisational innovation as dependent variables), as well as the explanatory variables employed, such as age and size, and the results (not reported here) show no sign of endogeneity or the influence of such unobserved heterogeneity (technically, this is consistent with the normal-errors assumption).

Furthermore, it can be argued that the data on organisational innovation made available by the CIS4 is not very detailed. The CIS4 provides only three measures with no scaling of the magnitude of organisational innovation, and, as discussed earlier, these measures are at the firm level (but not plant- or project-level). Therefore, the heterogeneity of organisational innovation within and among firms could not be taken into account in greater detail in this study. However, there may still be other interesting 'organisational' issues to be investigated on the basis of the CIS data (arguably, the most detailed large-scale survey data currently available for innovation research). For example, it is possible to look further into the

numbers, percentages), so that the respondents needed to answer the questions in different parts in different ways. For example, the variables used to measure organisational innovation and its effects in this analysis were extracted from two (consecutive) question sets which were associated with yes/no and Likert-scale items. As described above, the variables for (the three types of) organisational innovation are binary, while the variables for (the six types of) its effects have a scale of 0 – 3.

differential and complementary effects of different types of organisational innovation (such as by means of a multivariate analysis), or of different combinations of technological and organisational innovation. The relationship between knowledge or skilled workers and organisational change also remains to be explored.[34] These are examples of important research topics which, nonetheless, go well beyond the scope of this study.

[34] For instance, Leiponen (2000, 2005) empirically analyses the relationship between firms' innovation and their employees' skills/competencies, and suggests that this relationship is complementary. However, her analyses concern innovation in a rather technological sense, e.g. R&D and product/process innovation.

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APPENDIX

Table A.1: Principal components analysis for the effects of organisational innovation

Effects of Organisational Innovation	Factor Loadings
	EFORG
Reduced response time to customer needs	0.639
Improved quality of goods or services	0.699
Reduced costs per unit output	0.639
Improved employee satisfaction and/or reduced employee turnover	0.600
Increased enterprise's capacity	0.772
Higher enterprise's profitability	0.734

Note: One factor with eigenvalue greater than 1 detected, which explains 47 % of total variance.

Table A.2: Correlation matrix for the explanatory variables employed in the model

	Age	Emp	Turn	PASTORG	PASTPERF	HCOST	HFUND	HPER	INCOMP	ORGSYS	ORGSTR
Age	1.000										
Emp	0.118	1.000									
Turn	0.050	0.595	1.000								
PASTORG	0.006	0.115	0.051	1.000							
PASTPERF	-0.102	-0.008	-0.050	0.004	1.000						
HCOST	-0.086	0.001	-0.011	0.149	0.016	1.000					
HFUND	-0.096	0.022	-0.006	0.135	0.034	0.762	1.000				
HPER	-0.052	0.054	0.036	0.122	-0.002	0.556	0.555	1.000			
INCOMP	-0.030	0.084	0.039	0.230	-0.002	0.387	0.355	0.330	1.000		
ORGSYS	0.001	0.132	0.080	0.129	-0.024	0.126	0.142	0.138	0.250	1.000	
ORGSTR	-0.009	0.160	0.063	0.181	0.014	0.186	0.200	0.181	0.228	0.434	1.000
ORGREL	-0.013	0.144	0.020	0.123	0.043	0.177	0.163	0.125	0.142	0.257	0.400

Note: Age, Emp (Number of employees), Turn (Total Turnover) and PASTORG (Past/Persistent Organisational Change) are included in Heckman-Stage 1 & 2 and OLS estimation. INCOMP (Complementarity) is included in Heckman-Stage 2 and OLS estimation. PASTPERF (Productivity Growth), HCOST (High Innovation Costs), HFUND (Lack of Funds) and HPER (Lack of Qualified Personnel) are included in Heckman-Stage 1. ORGSYS, ORGSTR and ORGREL are included in OLS estimation.