

**THE SOURCES OF MANAGEMENT INNOVATION: UNDER WHAT CONDITIONS DO  
FIRMS INTRODUCE NEW MANAGEMENT PRACTICES?**

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**Abstract:**

Management innovation is defined as the introduction of management practices that are new to the firm and intended to enhance firm performance. We replicate existing literature by showing that internal factors like size, employee education level and market scope impact positively on new practices, and extend it by showing how external knowledge sources produce a similar effect, consistent with external search literature in technological innovation. Furthermore we demonstrate a trade-off between internal factors and external sources, in that their joint application produces a negative effect. We also show that management innovation is positively associated with firm performance in the form of future productivity growth.

Key words: Management innovation, management practices, performance, knowledge sources

The phenomenon of innovation continues to attract enormous interest among scholars of organizations. While the research in this area has historically focused on technological or product innovation, over the last decade a number of subfields have emerged, each concerned with a different aspect of innovation, such as business model innovation (e.g. Markides, 1997), service innovation (e.g. Gallouj and Weinstein, 1997) and process innovation (e.g. Pisano, 1996). In this paper we focus on one particular subfield, namely management innovation (also called administrative innovation or organizational innovation) and we seek to understand its causes and consequences for individual firms.

Management innovation is a broad concept and has been defined and studied in a number of ways. While we provide a detailed definition below, it is important to make clear one important distinction at the outset. For some researchers, management innovation refers to a practice or structure that is ‘new-to-the-state-of-the-art’, meaning that it has no known precedent (e.g. Chandler’s (1962) description of the invention of the M-Form structure); for other researchers, management innovation refers to something that is ‘new to the firm’ and is adapted from another context, such as a peer firm (e.g. Zbaracki, 1998). Each approach has developed its own body of literature and, while both fit under the banner of management innovation, it should be emphasized that it is to the latter body of literature we are contributing in this paper. We therefore define management innovation, for this research, as *the introduction of management practices that are new to the firm with the intention to enhance firm performance*.

The introduction of new management practices is recognized as an important issue for firms as they seek to upgrade the productivity of their operations, improve the quality of their offerings to customers and retain their competitiveness in a fast-changing world. (e.g. Ichniowski, Shaw and Crandall, 1995; Pil and MacDuffie, 1996). It is also a concern for policymakers, who see such practices as important drivers of sector-level or national improvements in productivity: For example, the DTI Innovation Survey and ‘Porter Report’ (both published in 2003) highlighted the poor adoption of best practices as contributors to the UK’s relatively weak productivity levels (Leseure, Bauer, Bird, Neely and Denyer, 2004). Good examples of management innovation by UK companies would be BP’s introduction of peer groups (Ghoshal and Gratton, 2002) and the business-cell structure at Litton Interconnection Products

(Birkinshaw and Mol, 2006). In the UK context management innovation may be particularly important, given that the country has been at the forefront of shifting away from a products-based economy to a service-based one. In services, how a company is organized and managed is more likely to provide competitive advantage than technological prowess.

However, the introduction of new management practices is also a contentious issue. Management practices do not always work in new contexts, and firms often struggle to implement even well-established practices, which casts doubts on the soundness of the notion of a single best practice (McCabe, 2002; Sturdy, 2004; Zbaracki, 1998). In the worst-case scenario, the introduction of new management practices can be a slavish pursuit of management fashion for its own sake, an approach which rarely benefits the firm in question (Staw and Epstein, 2000).

Notwithstanding its importance, the literature concerned with why or how firms introduce new management practices is somewhat limited. There are many studies of the diffusion of specific practices over space and time (e.g. Abrahamson and Fairchild, 1999; Burns and Wholey, 1993; Fligstein, 1985; Teece, 1980); and there is a burgeoning literature on the dynamics of the 'fashion driven' market for management practices (e.g. Abrahamson, 1991; 1996; Clark, 2004; Gill and Whittle, 1993; Jackson, 1986); but the number of studies that look specifically at the firm as the level of analysis, with a view to understanding the causes or consequences of its introduction of new management practices, is small and mostly old (e.g. Damanpour, 1987; Kimberly and Evanisko, 1981).

The current paper addresses this gap in the literature by considering two questions. First, *under what conditions do firms introduce new management practices?* Building on the organizational reference group literature (e.g. Massini, Lewin, Greve, 2005; Greve, 1998), we identify certain attributes of firm context that we predict will be associated with the introduction of new management practices. We examine managers' search activities—their propensity to seek out new ideas from outside that they can incorporate within their operations. And we also consider how these two sets of factors—context and search—interact with one another. The second question we address is: *how -if at all- is the introduction of*

*new management practices associated with productivity improvements?* Do the firms that introduce new management practices tend to outperform those that do not, or is there no observable relationship?

The rest of the paper is structured as follows. First we discuss the concept of management innovation and the prior literature in this area, and build a set of hypotheses around its antecedents (context and search) and performance consequences. Next we present the empirical analysis, based on over 3,600 establishment level responses to the UK Community Innovation Survey (CIS 3) which are then linked to the Office for National Statistics' Annual Respondents Database (ARD) for investigation of performance effects. Our findings provide strong support for the hypotheses in our model. We further discuss these findings, research limitations, and possible directions for future research.

## **Background**

An operational definition of management innovation has to address four core issues. First, what is being innovated? Previous research has typically made a distinction between innovation in management ideas or ideologies, which are high-level principles or assumptions about what managers ought to do (Abrahamson, 1996; Barley and Kunda, 1992; Kramer, 1975), and innovation in management practices, processes and structures which affect the day-to-day work of management at an operational level (Guilen, 1994; Alänge, Jacobsson and Jarnehammer, 1998). Our focus in this paper is on the latter, as it is the level at which observable changes take place.

Second, is management innovation defined as something new to the state of the art (Abrahamson, 1996; Hamel, 2006), or is it sufficient for it to simply be new to the firm that is implementing it (McCabe, 2002; Stjernberg and Philips, 1993; Zbaracki, 1998)? While this question is frequently debated in the literature, our position is that both definitions are valid, in their own way, and researchers should simply be clear on which one they are using. And our preference in this study is to focus on the latter definition, i.e. where innovation is defined as something new to the firm. Such innovations are typically incremental

in nature, and are likely to include new approaches to structuring the firm, new management techniques and new marketing methods that have been picked up from other firms<sup>1</sup>.

Third, does management innovation involve conceptualizing a new practice, implementing a new practice, or both? Here we build on the UK Department of Trade and Industry definition of innovation - the successful *exploitation* of new ideas (DTI, 2005)—and argue that management innovation involves both an idea (typically taken from another context) about what might work *and* the implementation or introduction of that idea. Fourth, we view innovation as a goal-oriented activity (rather than as an activity undertaken for its own sake; Staw and Epstein, 2000), so it is done with the intention of furthering the firm's performance. While performance can be conceived in fairly broad terms to include such intangible things as the quality of working life for employees, our focus in this paper is on firm-level productivity improvements. Taken together, these elements can be combined into the following definition of management innovation: *the introduction of management practices that are new to the firm with the intention to enhance firm performance.*

Building on this definition, we can identify three bodies of literature that have studied management innovation, each with a rather different unit of analysis. The first has focused on *specific management practices or structures*, such as the M-Form, Total Quality Management, or ISO 9000 certification, and has examined their patterns of diffusion across firms, industries, or countries (e.g. Abrahamson & Fairchild, 1999; Guler, Guillen and MacPherson, 2002; Kogut & Parkinson, 1993; Westphal, Gulati and Shortell, 1997). There have also been some related studies concerned with how the institutional conditions in particular countries have affected the take-up of particular sets of management practices (e.g. Cole, 1985; Guillen, 1994; Weitz and Shenhav, 2000).

The second body of literature has focused on what we might call the *market for new management practices*, and in broad terms seeks to understand why and how certain practices like TQM or Business Process Engineering become popular. This large body of work ranges from detailed analysis of the suppliers of new management practices (e.g. Benders and van Veen, 2001; Clark, 2004; Mazza and Alvarez, 2000) and the attributes of managers who buy into them (e.g. Gill & Whittle, 1993; Huczynski,

1993; Jackson, 1986) through to comprehensive theories and discussions of how management fashions emerge (e.g. Abrahamson, 1991; 1996; Kieser, 1997; Mamman, 2002; Sturdy, 2004).

The third body of literature, and the one the current paper fits into, has focused at the firm level, and has examined the range of organizational, individual, and situational factors that influence a *firm's propensity to introduce new management practices*. So this body of research distinguishes itself by not focusing on the introduction of a particular practice, which may be driven by factors specific to that practice, but by the introduction of a range of new practices across the firm. This research has emphasized primarily the role of specific internal features as facilitators of management innovation. For example, Kimberly (1981) and Kimberly and Evanisko (1981) linked the adoption of management innovations to highly educated and cosmopolitan managers, large organizations and high levels of competition, while Damanpour (1987; 1991) examined a wide range of factors including specialization, functional differentiation, external communication and centralization of decision making as predictors of management innovation. More recently, Massini, Lewin and Greve (2005) linked the introduction of new organizational routines to the different types of reference groups adopted by the firm—an approach we build on in this paper.

Finally, it is worth noting that the literature offers very little evidence of the empirical relationship between the introduction of new management practices and firm performance. Of course, there is no shortage of assertion and argument about the likely impact that new management practices will have on performance. For some researchers it is an article of faith that management innovation is a good thing (e.g. Chandler, 1962; Hamel, 2006; Tichy and Sandstrom, 1972), while others are much more skeptical, viewing the introduction of new practices as a way of reaffirming control over workers (Knights and McCabe, 2000) or as a fashion-driven process that benefits only the consultants selling the new practices (Staw and Epstein, 2000). Our preference in the current paper is to avoid the extremes of this debate, and instead to develop a theoretically-grounded argument about the innovation-performance relationship, which we then test using objective performance data.

## Theoretical Development

There are two primary theoretical perspectives in the organizational literature on the conditions that lead firms to introduce new practices or activities<sup>2</sup>. The most widely used is institutional theory, which sees the introduction of new practices as driven by imitation: by the desire to emulate the practices of high-status peers, and thereby gain legitimacy (DiMaggio and Powell, 1983; Meyer and Rowan, 1977; Scott, 1987). According to this view, managers pick up on ‘rational and progressive’ practices (Abrahamson, 1996) from peers and high-status firms, and they introduce them to their own firms primarily for their symbolic value. The other perspective is the behavioural theory of the firm (Cyert and March, 1963; March and Simon, 1958), in which the introduction of new practices is driven by the desire to close a performance shortfall. According to this view, managers will engage in a process of ‘problemistic search’ in which they search for ways of addressing their performance shortfall through interactions with their closer or more well-established contacts, and once a ‘satisficing’ solution has been found and implemented, they move on to address other issues. New practices, in other words, are introduced specifically to address performance concerns, but typically to a ‘satisficing’ rather than ‘optimizing’ level.

A theme that cuts across these two perspectives is the importance of the *reference group* of the firm in influencing the introduction of new management practices. The reference group is simply the set of firms that the focal firm looks to when making choices about how to conduct itself. It serves two key functions: it provides the performance benchmark against which the focal firm evaluates itself, and it exhibits a range of practices and behaviours that the focal firm can learn from. Defined in this way, it should be clear that some reference groups are potentially more valuable than others. For example, a Yorkshire-based packaging company might implicitly define its reference group as other Yorkshire packagers, or as other packagers across Europe, and it is very likely that the latter will offer a greater diversity of practices and behaviours that the focal firm might seek to learn from, as well as a higher performance benchmark as well.

The reference group concept is now fairly well established in the organizational literature (Cyert and March, 1963; Festinger, 1954; Wood, 1989), and it has been used to understand how firms make strategic choices such as how to position themselves in a market, how much to pay their CEO, and whether to innovate (Bromiley, 1991; Greve, 1998; Massini et al, 2005, Porac, Wade and Pollock, 1995). In this paper, we build on these studies to argue that the often-subconscious choice of reference group is a central factor in the introduction of new management practices. We build on the behavioral logic above to suggest that the choice of reference group defines the performance levels the firm aspires to (Greve, 1998): some firms are content with mediocre or poor performance, while others seek to achieve a higher level, and the aspiration-reality gap lies at the heart of this phenomenon. We also build on institutional theory to provide some clues as to where managers look for inspiration—some may interact with their local contacts, while others search more widely on a national or international basis. Our chosen perspective, in other words, blends insights from institutional and behavioral theories (cf. Massini et al, 2005).

### **Framework and Hypotheses**

We propose that the extent to which managers in a firm choose to seek out and introduce new practices is a function of two sets of factors. One is the attributes of the firm—its context—that make it likely for individuals to identify with a lower- or higher-quality reference group, and which therefore influences the overall appetite in the firm for introducing new practices. The other is the process of active search—the deliberate links that are made to actors inside or outside the organization with a view to helping managers address their problems or performance gaps. This can be seen as a conscious desire by managers to seek out new practices in other adjacent areas, and thereby to broaden their reference group. These two sets of factors—context and search- are not entirely independent but they can be usefully separated at a conceptual level. After examining each in turn, we then consider how they interact.

#### **Context**

While the concept of a reference group is well established, it is typically viewed as a subconscious cognitive frame rather than as an objective construct. Indeed, prior studies have typically eschewed direct measurement of a firm's reference group, preferring to use it either as an unobservable concept, or by making assumptions about its likely scope. However, it is possible to identify some firm-level attributes that collectively shape the context in which individual managers make decisions about who to emulate and how. The term context is appropriate here because we are referring to the aggregate set of forces that shape the behaviour of multiple individuals across the firm. Specifically, we identify three important attributes: size, education of the workforce, and international scope.

*Size* influences the introduction of new management practices in both substantive and symbolic ways. On a substantive basis, larger firms face a wider variety of challenges than smaller firms, and they face a greater number of competitors of all size (Kimberley and Evanisko, 1981). In order to be able to compete effectively, larger firms are therefore more likely to be stimulated to introduce new practices. On a symbolic basis, larger firms are typically more accountable for their actions than smaller firms: they are often publicly held; they are more visible to the press; and they are an attractive target for unions and other non-governmental organizations. As a result, larger firms are under more pressure to conform to institutional norms than smaller firms, which is likely to result in a more conscious effort to understand and introduce new practices that high-status firms have already implemented. Thus:

Hypothesis 1. The larger the firm, the higher the level of introduction of new management practices.

*The Education of the Workforce*, which we measure as the percentage of employees with a degree, is also potentially an important attribute of the firm. Well-educated employees are more likely to read widely, which increases the extent to which they are aware of issues beyond their immediate location of employment. Well-educated employees are also likely –all else being equal- to travel more, to join professional organizations, and to seek out advancement within their firms. All of which makes firms with

more professional and well-educated employees more prone to develop a broader and/or more international reference group.

As an aside, Chandler's (1962) description of the introduction of the M-Form structure in four US firms in the 1920s includes some specific thoughts on the types of individuals who are most likely to be management innovators. With one exception, these individuals were recent university graduates. As Chandler (1962: 317) put it "[p]ossibly the rigor required in working out scientific and engineering problems led these men to approach management needs in somewhat the same way" and (1962: 318) "[w]hat Taylor, the Ford engineers, the engineering journalists and professors, and the organization builders here studied had in common were not specific ideas, techniques, or methods, but rather the same rational, self-conscious approach to the management of men".

Hypothesis 2. The more highly educated the workforce of the firm, the higher the level of introduction of new management practices.

Finally, we expect a firm's *Market Scope* to be an important predictor of its propensity to introduce new practices. Prior studies of reference groups have underlined the importance of geographical proximity as a factor in defining a reference group (Baum and Lant, 1985), which suggests simply that the more internationally-focused the firm, the more likely it is to view itself as having an international reference group. Again, there are two factors at work. First, participation in international markets may be a source of insight for management innovation, since it exposes firms to a much broader set of management approaches and opportunities in different contexts than the firm would get in its domestic market (Doz, Santos, & Williamson, 2000; Kogut and Parkinson, 1993). Second, the broader the firm's market scope, the greater the number and size of competitors it is likely to face, and the broader its reference group. For example, when Toyota failed to compete successfully in the U.S. market in the 1950s it realized it needed a radical new approach to be successful in international markets, and this stimulus, among others, led to the development of its lean production system (Udagawa, 1995).

Hypothesis 3. The greater the scope of the market the firm is operating in, the higher the level of introduction of new management practices.

### Search

The other side of our framework is the aggregate search behaviours of managers in the firm as they seek out new sources of knowledge and insight. Search for new knowledge sources is widely recognized as a key component of technological innovation - for accessing new knowledge and recombining it with existing knowledge (Fey and Birkinshaw, 2005; Katila and Ahuja, 2002; Laursen and Salter, 2006; Rosenkopf and Nerkar, 2001). We apply similar concepts to our management innovation work, in that new ideas are sought out and are then combined with existing knowledge and conditions in the firm to lead to the introduction of new practices. But of course search is also linked tightly with the concept of a reference group. According to the behavioral theory of the firm (Cyert and March, 1963) search transpires in a simplistic and biased way, so that when faced with a performance problem managers will start looking for solutions close to home, i.e. with regard to the closest members of the reference group. It is only when these referents cannot help that managers typically look further afield, though to the extent that this then happens it is likely to have the useful by-product of increasing the size or scope of the firm's reference group.

Active search, in other words, is an important part of our framework. It would be unlikely for all new practices to result from active search, because as discussed above there are many ongoing processes in firms through which managers learn about others, but we expect active search to be a significant contributor to the introduction of new practices. However, we would also expect there to be decreasing returns to effort in the process of active search. It has been shown in the technology innovation literature that higher levels of investment in search only translate into higher levels of innovation up to a point-

because of problems of absorptive capacity, attention allocation, and timing (Laursen and Salter, 2006)– and we would expect the same to be true here.

What sorts of actors would we expect firms to engage in search with? The technology innovation literature has focused on such actors as lead customers and suppliers (Utterback, 1994), as well as on a more diverse set of external knowledge sources as a driver of innovation (e.g. Hargadon, 2002; Katila & Ahuja, 2002). By using more knowledge sources, it is argued, firms increase their chances to find something useful in two ways—they draw from the pool of knowledge more often, which improves their chances of being lucky, and they stand a greater chance of gaining access to complementary knowledge because of the diversity of sources they consult (Leiponen & Helfat, 2005).

A similar argument can be made for management innovation. External sources of knowledge provide insight into new management ideas and techniques that have worked in other settings. Moreover, the greater the diversity of sources the firm has access to, the more likely it is that the insights gained from these sources can be combined in creative and valuable ways (Hargadon, 2002). Anecdotal evidence from Kaplan (1998), Kleiner (1996) and Whitsett and Yorks (1983) suggests that external parties often play a critical role in the early stages of introducing new management practices. And Abrahamson (1996) describes how the diffusion of management innovations has been aided by third parties such as consultants and business school academics. We therefore argue that the greater the breadth of knowledge sources used by the firm, the higher the level of introduction of new management practices.

It is possible to make this broad hypothesis more specific by considering the different categories of knowledge sources that might exist. We focus here on three such categories - internal sources (i.e. anyone inside the legal boundaries of the firm), market sources (customers, suppliers, competitors, and consultants), and professional sources (industry bodies, professional associations, and trade fairs).

The diffusion and management fashion literature (Abrahamson, 1996; Staw & Epstein, 2000) has stressed the role of market-based sources of knowledge as the primary driver of the uptake of new management practices. Thus, firms mimic their competitors by implementing management practices that appear progressive (Abrahamson & Rosenkopf, 1993), customers provide incentives to encourage firms to

adopt new practices (e.g. Guler et al., 2002), and consultants and suppliers often push management innovations down the value chain because they benefit from the standardization of processes.

We accept this line of argument, but building on the behavioral theory of the firm we also recognize the importance of internal and professional sources. Problemistic search has two important characteristics: it is simple-minded, which means it proceeds on the basis of a simple model first, and it is biased towards the prior experiences of those individuals pursuing it. If we apply this logic to the search process for new management practices, we would expect managers with a problem to first speak to trusted colleagues *inside* the firm, and only once those colleagues had been exhausted to look outside the firm boundaries (Hansen & Løvås, 2004). Moreover, we would also expect managers to put considerable faith in professional peers outside the firm, perhaps more in fact than in the suggestions from customers, suppliers or consultants, because they are trusted and neutral. This is particularly likely in the UK where many managers belong to a professional association, such as the Chartered Institute for Personnel and Development. These professions represent a source of information about what is happening across firm boundaries, without the competitive consequences or costs of working with market-based sources such as customers and consultants (Rosenkopf, Metiu & George, 2001). In sum, we expect all three categories of sources to have a direct effect on the level of introduction of new management practices, but it is an empirical question as to which category has the greatest effect.

Hypothesis 4a. The more internal sources the firm interacts with, the higher the level of introduction of new management practices.

Hypothesis 4b. The more market-based sources the firm interacts with, the higher the level of introduction of new management practices.

Hypothesis 4c. The more professional sources the firm interacts with, the higher the level of introduction of new management practices.

Interaction between Context and Search

Finally, it is important to consider how the attributes of context and search interact with one another. One can envision an argument in which the two sides of the framework are positively reinforcing, so that for example the firms with the highest levels of introduction of new management practices are those that combine their large size, scope and educated workforce with a process of active search. However, our theoretical framing actually suggests the opposite argument, namely that the attributes of context on the one hand, and the process of active search on the other, are partial substitutes: they essentially represent different operational ways of getting to grips with a firm's reference group. To be more specific, the attributes of size, education level and scope create a context in which firms that rate high on some or all of them are automatically up to speed on management innovation: their high quality reference group immediately gives them access to new ideas and practices as they arise. Active search, in contrast, is more useful for those firms that for whatever reason do not currently have a high-quality reference group, and are therefore *not* well linked into the latest management thinking. So those firms with high-quality reference groups are likely—all else being equal- to need less active search, whereas those that are actively engaged in search don't need the same size, education levels, or market coverage.

This argument suggests that the biggest returns to accessing knowledge sources through search are likely to accrue to those firms who, for reasons of tradition or history, have had the lowest quality reference groups and have accordingly been most starved of new ideas and new management practices. We therefore hypothesize a negative interaction effect between the contextual attributes on the one side and the dimensions of search on the other. Specifically:

Hypothesis 5a. The effect of internal sources on the introduction of new management practices is mitigated by size, workforce education level, and geographical market scope of the firm.

Hypothesis 5b. The effect of market-based sources on the introduction of new management practices is mitigated by size, workforce education level, and geographical market scope of the firm.

Hypothesis 5c. The effect of professional sources on the introduction of new management practices is mitigated by size, workforce education level, and geographical market scope of the firm.

## Introduction of New Practices and Firm Productivity Growth

As hinted in the introduction, there are contrasting points of view in the literature about impact of management innovation on firm performance. The institutional perspective views the introduction of new practices as driven by the need to conform, rather than to achieve superior objective performance; and indeed there is research evidence that firms adopting new “fashions” achieve greater reputations but do not actually perform better (Staw and Epstein, 2000). But other perspectives, and the approach take here, point to a more direct link to performance, whether under the guise of behavioural theory of the firm or the more managerial perspective (e.g. Chandler, 1962; Gruber and Niles, 1972; Tichy and Nisberg, 1976),

Specifically, we view the introduction of new management practices as directed towards closing performance gaps, as indicated by the firm’s reference group. One way of visualizing this is in relation to Porter’s (1996) concept of the productivity “frontier” whereby some firms are performing at this frontier, others are not. Those firms on the frontier seek to push it out, typically through new to the world innovations; those who are not tend, for the most part, to seek to move up to the frontier through “new to the firm” innovations (this is analogous to performance gap closing, but at an aggregate level.

This view clarifies two points. One is that we need to use a dynamic performance measure that captures the changes in firm performance over an appropriate period of time, rather than an absolute measure of performance. The other is that we need to use a measure of performance that relates as directly as possible to the consequences of introducing new management practices. Accordingly, we suggest that firm *productivity growth* is the most appropriate measure. Productivity is a measure of the efficiency of conversion of inputs into outputs, and for the most part we would expect the introduction of new management practices to be directed towards the creation of either superior outputs, or the development of more cost-efficient inputs. Productivity is also superior to market-based measures in this context, because it excludes exogenous factors, such as market conditions, that the firm has no control over.

Hypothesis 6. The introduction of new management practices is positively associated with future firm performance.

## **Data and Methods**

To test our hypotheses we used the UK Innovation Survey, which is a national survey of firm-level innovation conducted every four years as part of the Europe-wide Community Innovation Survey (CIS). Specifically, we used the CIS3 data, which were gathered in 2001 and cover the 1998-2000 period. The UK survey is administered by the Office for National Statistics (ONS) and commissioned by the Department of Trade and Industry (DTI)<sup>3</sup>. Stockdale (2002) contains an overview of the methodology and basic descriptive findings of the survey. The UK survey was sent to 19,602 firms, selected through a stratified sample, of which 8,172 (41.7%) responded.

These 8,172 responses form the basis for the empirical analysis of this paper. Only about half of these responses proved complete enough for our purposes though, meaning we test our hypotheses on a sample of 3,635 firms employing 10 or more people<sup>4</sup>. The firms in our sample tend to be larger than the average firm in the UK and indeed the average firm that responded to the survey. Earlier work published with CIS data for instance includes Cassiman and Veugelers (2002) and Laursen and Salter (2006). Over 60 articles have been published using the CIS.

The survey was administered by the ONS and was the third in the series. Lessons from CIS1 and CIS2 were implemented to improve the data collection process. The core questions in the CIS are based on the OECD's Oslo manual, which adds to the comparability of findings across industries and countries. The CIS sample includes manufacturing, construction and services firms. The survey includes a page of definitions, which respondents could refer to, and a help service was provided (Stockdale, 2002). Respondents received a postal survey and two reminders as well as a follow-up telephone call in some cases to maximize the number of responses. Coming from ONS, the survey was sent to the person

responsible for filling out official government surveys. Respondents included many Managing Directors, Chief Financial Officers and heads of Research and Development.

A potential problem that arises with survey data is common method bias, where the strength of correlations between variables is inflated because the method of data collection and the sources are the same. We addressed this potential problem in various ways. For the firm performance hypothesis (H5) we used an entirely separate database to measure our independent variable so the problem was avoided altogether. For the other hypotheses, we used approaches suggested by Podsakoff and Organ (1986): we ran Harman's one-factor test and established that multiple factors emerged from a factor analysis (if common method variance is a problem, one dominant factor will emerge). In addition, the data we used for most of our independent variables were objective in nature, such as what the largest market is the firm operates in, which reduces significantly the possibility of bias in the results (Podsakoff & Organ, 1986).

*Measures.* All variables were measured using items taken from the CIS3 and the UK's Annual Respondents Database (ARD). Specific wording is as follows.

**Introduction of new management practices.** There is a separate header called 'wider innovation' in the CIS3 survey, which stands out from product and process innovation. Under this header respondents were asked 'did your enterprise make major changes in the following areas of business structure and practices during the period 1998-2000? And how far did business performance improve as a result? (a) Implementation of new or significantly changed **corporate strategies** e.g. mission statement, market share, (b) Implementation of advanced **management techniques** within your firm e.g. knowledge management, quality circles, (c) Implementation of new or significantly changed **organisational structures** e.g. Investors in people, diversification, and (d) Changing significantly your firm's marketing concepts / strategies e.g. **marketing methods** (0 = not used; 1 = used)<sup>5</sup>. Because item a, on changed corporate strategies, is not clearly concerned with management innovation as defined earlier, we decided to drop it from our analyses<sup>6</sup>. In order to capture the breadth of management innovation undertaken in each firm, we then created a single scale which takes on the value of 0 for no effective management

innovation activity at all, with 1 added for each type of management innovation the firm engaged in, such that the maximum value is 3. For all practical purposes the measure can be thought of as a count measure that provides an indication of the number of areas of management innovation a firm engaged in<sup>7</sup>.

**Firm size.** This variable was calculated as the logarithm of the number of employees in 2000, since the distribution of firm size tends to be highly skewed. For the performance test the logarithm of turnover in 2000 is used, as we try to predict changes from 2000 to 2003.

**Degrees.** This variable measures the workforce education level. The 'degree' variable was calculated as the number of employees with degree level education or above, as a percentage of all employees of the firm.

**Market scope.** This single-item question identified the firm's largest market as 'local' (0), 'regional' (1), 'national' (2) or 'international' (3).

**Knowledge Sources.** We identified three groups of knowledge sources as detailed below, and we calculated three separate count variables, one for each type of sources<sup>8</sup>. The wording of the scales was as follows: 'Please indicate the sources of knowledge or information used in your innovation activities, and their importance during the period 1998-2000':

*Internal sources:* (a) Within the enterprise, (b) Other enterprises within the enterprise group (not used, low importance, medium importance, high importance)

*Market sources:* (a) Suppliers of equipment, materials, components or software, (b) Clients or customers, (c) Competitors, (d) Consultants, (e) Commercial laboratories / R&D enterprises (not used, low importance, medium importance, high importance).

*Professional Sources:* (a) Professional conferences, meetings, (b) Trade associations, (c) Technical / trade press, computer databases, (d) Fairs, exhibitions (not used, low importance, medium importance, high importance).

In each case, any degree of importance indicated by the respondent was coded as "1" while not used was coded as "0". Given the number of items, the measures take on values between 0 and 2 for internal sources, between 0 and 5 for market sources and between 0 and 4 for professional sources.

**Firm performance.** We measured performance using a separate database, the UK's Annual Respondents Database (ARD). The ARD is the government's official census data exercise and is executed by the Office for National Statistics. Although the CIS contains measures that could be thought of as performance indicators, it has two problems: one is the same-source bias problem that arises when one respondent evaluates both the dependent and independent variables in a study; the other is the lack of a time-lag between the measures of innovation and performance. Fortunately, the ARD allows us to overcome both these problems, in that it is collected separately and it measures firm performance for the three-year period *following* the date the CIS3 data was collected. The implementation of a management innovation takes some time, and for the effects of this implementation to come to light will take even longer. Therefore a time lag is appropriate and preferable over a cross-sectional analysis. The main drawback of our use of the ARD is that not all of our CIS observations are available in the ARD database, due to differences in sampling procedures. The fact that we use ARD data over two years worsens this situation, again primarily because of sampling but partly because of firm exit as well. As a consequence, we have 1,048 observations left to test hypothesis 6 on.

The specific performance measure we use is the change in the firm's productivity. We measure this by first dividing the firm's turnover by number of employees in 2003 and then repeating the calculation for the year 2000. The resulting 2000 number is then subtracted from the 2003 number. By doing so, we automatically control for prior performance and associate management innovation only with deviations in performance from its 2000 base level. This performance measure contains information on both the firm's ability to become more effective by increasing its turnover with a similar number of employees and its ability to become more efficient by reaching similar turnover numbers with fewer employees. This variable is a good success measure of management innovation as it allows us to establish whether management innovation is associated with to lower, unchanged, or higher future growth and efficiency. To summarize we calculate:

$$\text{Productivity growth} = \left( \frac{2003 \text{ turnover}}{2003 \text{ number of employees}} \right) / \left( \frac{2000 \text{ turnover}}{2000 \text{ number of employees}} \right) - 1$$

**Control variables.** The ‘capital intensity’ variable was measured as 1998 capital expenditures over 1998 turnover. Management innovation is not concerned with capital in the traditional sense of the word, though many management innovations deal with human capital. Firms that have high capital intensity might therefore be expected to direct their attention more towards other forms of innovation, like product and process innovation.

The ‘export intensity’ variable was measured as 1998 export levels over 1998 turnover. Export intensity may have a positive impact on the implementation of management innovations because firms that supply to international markets generally have to be more innovative to overcome their liability of foreignness.

While the knowledge sources we discussed earlier are an informal mechanism for understanding innovations, technology alliances are a more formalized means for doing so. Such co-operation agreements are aimed at the exchange of knowledge between parties. Knowledge exchange on management innovations could be part of these alliances. Therefore we control for the presence of ‘alliances’ with other firms, a variable which takes on the value of 1 if the firm had any cooperation arrangements with other enterprises or institutions.

We then control for the occurrence of ‘structural change’. Rapid growth and structural growth can be an important stimulus for management innovation. Firms typically grow through a process of punctuated equilibrium (Tushman and Anderson, 1986) and during the periods of upheaval as they shift from one structure to another some level of management innovation is often required. Equally, divestments can cause upheaval in the internal workings of the firm and can sometimes lead to management innovation. Respondents were asked “did any of the following significant changes occur to your enterprise during the three-year period 1998-2000?” Possible responses were: (a) the enterprise was established, (b) turnover increased by at least 10% due to merger with another enterprise or part of it, (c) Turnover decreased by at least 10% due to sale or closure of part of the enterprise, (d) None of the above. We coded the results as follows: firms recording major structural changes by responding (b) or (c) were coded 1; firms recording no major change by responding (d) were coded 0; firms responding (a) were

removed from the sample because they did not exist throughout the entire time period under investigation.

'Innovation inhibitors' is a count variable and measures the number of factors inhibiting a firm's ability to innovate. Respondents were asked 'please rate the importance of the following constraints during the period 1998-2000: (a) Excessive perceived economic risks, (b) Direct innovation costs too high, (c) Costs of finance, (d) Availability of finance, (e) Organisational rigidities within the enterprise, (f) Lack of qualified personnel, (g) Lack of information technology, (h) Lack of information on markets, (i) Impact of regulations or standards, (j) Lack of customer responsiveness to new goods or services'. Respondents were asked to specify 'no effect' or 'low', 'medium', 'high' for each item. We summed the number of cases where the respondent gave a positive response, resulting in a measure varying from 0 to 10<sup>9</sup>. There is a high level of uncertainty associated with innovation, and it typically requires different ways of working than what is required in the more predictable and routinized parts of the firm (Burns & Stalker, 1961; Spender & Kessler, 1995). As a result, there are many well-known obstacles to innovation, including risk-aversion, lack of knowledge-sharing, and a tendency for new ideas to be driven out by old ideas (March, 1991). The introduction of new management practices is one plausible way of overcoming the obstacles that hinder innovation.

We also control for product innovation and process innovation. Ettlie (1988) dubbed the simultaneous use of management innovation and technological innovation 'synchronous innovation', and described in detail how the use of appropriate forms of management innovation made technological innovation more effective in manufacturing firms in the United States in the 1980s. This suggests that it is more beneficial to undertake management innovation when it supports other types of innovation (Ettlie, 1988; Georgantzas & Shapiro, 1993). Therefore 'product innovation' is included and it is a dummy variable, with a value of 1 for firms that introduced 'any technologically new or significantly improved products (goods or services) new to the firm during 1998-2000'. 'Process innovation' similarly is a dummy, measuring the introduction of 'new or significantly improved processes for producing or supplying products'.

Public support is a dummy variable measuring whether firms participated in Management Information Programmes (eg. Industry CLUBs). Finally, we included industry control variables. The firms in the complete sample were distributed over 43 different 2-digit industries and a dummy variable was created for each industry.

## Results

Table 1 contains the means and standard deviations of and correlations between key variables. The table reveals that firms in the UK CIS sample were actively involved in management innovation during the 1998-2001 period, although there also was substantial variance between firms.

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Insert table 1 around here  
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To analyze the antecedents of the introduction of new management practices we use ordered logit regression. Standard OLS regression is not appropriate because the variable is ordinal, with only 4 response categories<sup>10</sup>. In the tables below the results are spelled out. Industries that showed up as engaging more in the introduction of new management practices included furniture and professional services. In all, industry effects did not explain much of the variance, suggesting firm specific factors are better predictors of the likelihood that new management practices will be introduced. Table 2 contains the results for hypotheses 1 to 5. We first present a base model (model 1) excluding interactions and then present nine separate interactions. We ran a Brant test (Long & Freese, 2001) to test for the violation of parallel regression assumptions and it turned out none of our independent variables was significant on this test. This indicates that parallel regression assumptions were not violated, implying that our results hold for all levels of the dependent variable.

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Insert table 2 around here  
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Among the control variables some interesting findings emerged. The introduction of new management practices is more likely to transpire in firms that also engage in product and process innovation, in line with Georgantzas and Shapiro (1993). Technology alliances, however, do not appear to be significantly related to the introduction of new management practices. Export intensity and capital intensity do not play much of a role in predicting the introduction of new management practices. Structural change leads to higher levels of new management practices as does the presence of barriers to technological innovation. The public support variable meanwhile does not seem to be strongly associated with the introduction of new practices.

We find support for hypothesis 1, confirming the effect of size. Hypothesis 2, on the influence of the training level of employees, is also confirmed. And as proposed in hypothesis 3, the wider the geographic scope of the market, the more likely new practices are introduced. Hypothesis 4a, 4b, and 4c are all supported, implying all three types of knowledge sources, internal, market, and professional, matter. For hypotheses 5a, 5b, and 5c the support is mixed. Hypothesis 5a, which suggested an interaction between firm size and the three types of knowledge sources, is confirmed for all three sources. But hypothesis 5b, of an interaction effect between workforce education level and the types of sources, is only confirmed for internal sources. And hypothesis 5c, of an interaction effect between market scope and the types of sources, is confirmed for internal sources and marginally for market sources. We return to this in the discussion.

Table 3 displays the results of the OLS performance regression. It shows that the introduction of new management practices results in higher future performance in the form of productivity growth, thus providing support for hypothesis 6. Interestingly, though, neither product nor process innovation has a significant direct effect on productivity growth. As could be expected larger firms are less good at

increasing their productivity, in what is likely a catching-up effect. And perhaps related to this is the marginally negative effect of degree level training, suggesting that having a well-trained staff results in slightly lower future productivity growth. It should be acknowledged, however, that although our focal variable is significant the overall model does not have a very high explanatory value, which is probably a reflection of our use of a hard performance measure that tracks changes over time. It is difficult to accurately predict future productivity changes. Later we discuss the limitations surrounding this finding.

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Insert table 3 around here  
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### **Post hoc analysis**

We ran some further post hoc analyses to better put our findings into context. First, we ran a sector-by-sector analysis of model 1 in five sectors, which produced a few interesting insights. Process innovation was only significant in assembly manufacturing (NACE codes 28-37). Structural change was only significant in professional and financial services (NACE codes 65-74). Internal knowledge sources were significant in all sectors except professional and financial services. Market sources were significant in all sectors except for construction and utilities (NACE codes 40-45) and other services (NACE codes 51-64). And professional sources were significant in all sectors except professional and financial services. Batch manufacturing (NACE codes 15-27) was the only sector in which all three types of knowledge sources mattered. Although we will refrain from fully analyzing why these differences occur, this strengthens the notion that industry context matters in other ways than determining the level of introduction of new practices.

We also ran model 1 with product and process innovation as dependent variables in light of the observation there do not appear to be major differences between administrative and technical innovation in terms of their determinants (Damanpour, 1991). We found some differences. Although the overall

models were weaker for product and process innovation, industry was a significantly stronger predictor for these types of innovation, implying there are more substantial differences between industries compared to management innovation. We also noted that among the independent variables in hypotheses 1 to 4, only internal and professional sources were significant predictors of process innovation. For product innovation all hypothesized variables held, except for firm size.

## **Discussion**

The strong support for our hypotheses suggests that the external search perspective is a useful complement to internal factors in explaining which firms introduce new management practices. As we suggested in hypothesis 4 internal and professional networks, as well as customers, competitors and consultants, provide important sources of new ideas that can have an influence on the introduction of these new practices. And we also showed that these knowledge sources often interact negatively with the awareness factors of firm size, employee education level and market scope. These factors were significant predictors in their own right.

But out of the nine proposed interactions four turned out to be insignificant, though they all had negative signs. From this, we draw two conclusions. First, all interaction featuring internal sources were strongly significant. This implies the overlap between internal sources and size, education and scope is greater than between the other types of sources and the three awareness factors. We can explain this through the more limited diversity in knowledge and ideas possessed by internal sources, which will have gone through similar experiences, compared to external sources. Second, decreasing returns are less likely for education level and market scope but do occur consistently for firm size. This again makes sense, since a large firm size can act as a proxy for other factors.

*Implications for Theory and Practice.* A number of insights emerged from the research. One was the importance of knowledge sources of ideas as stimuli for the introduction of new management

practices. This follows the external search literature on technological innovation and complements the existing literatures on management fashion and management innovation as a firm level propensity. The external search literature similarly argues that many of the ideas and implementation skills for innovation come from outside sources. The management fashion literature acknowledges some of these sources, especially outside market parties like consultants and professional associations (Abrahamson and Fairchild, 2001) but we also showed other external sources, like suppliers and customers, and internal sources to play a role. Internal sources in fact were consistent across our analyses, and were the only type of sources for which we found the predicted negative interaction with all three internal factors.

So it would be useful to know more about how new management practices diffuse inside firms and the role geographically disparate units play in such diffusion processes. This result points to the different roles insiders and outsiders may have in the management innovation process. While insiders will be more engaged in actual implementation, outsiders like consultants often fulfill a legitimizing role, although this role is much more important in some institutional contexts than in others. The literature on management innovation as a firm level propensity discussed internal structural features but paid no attention to knowledge sources, as we have done here, thus complementing that literature. In relation to the literature on specific management innovations, the first stream of literature we identified earlier, this paper provides progress by generalizing results to the firm level propensity to do management innovation.

A further finding that we discussed only briefly was that the type of industry provides very little explanation for the introduction of new management practices. Some of the diffusion literature suggests that innovations like TQM spread through competitive mimicking or bandwagoning (Abrahamson & Rosenkopf, 1993). If this is indeed the case, industry should be a prominent explanation for the adoption of individual management practices because some industries ought to be far more involved than others. Our contrary finding could imply that industry is not such a strong force. More likely, it means that although industries have similar levels of management innovation, the set of new management practices in use varies from one industry to the next. Marketing innovations could be more popular in the consumer goods sector while human resource innovations perhaps fit particularly well in the services industry.

From a practitioner's point of view several of our findings carry directly relevant implications. The capacity of organizations for introducing new management practices is a consequence of both the problems they face and the breadth of solutions they obtain from various sources. And the implementation of these new practices is positively related to future productivity growth, while product and process innovation are not. Gruber and Niles (1972: 29) argued some time ago that '[t]he quality of management may be more important to success than performance in the R&D of new products and processes', and our analysis seems to bear this out. Our analysis suggests that while product and process innovation are by no means irrelevant, the introduction of new management practices is potentially an important mechanism by which such innovations are translated into productivity improvements. The implication is that firms stand to benefit from investing in their capacity for management innovation alongside their capacity for product and process innovation. At the same time we want to caution against interpreting this result as saying that any management innovation in any temporal, geographic, and organizational context will produce positive performance outcomes. Indeed, while there will be some highly effective innovations, others will be ineffective or even disruptive. It is the task of researchers to keep investigating how context influences effectiveness.

Our findings suggest that this capacity for management innovation can be increased by using relevant knowledge, specifically knowledge already available internally and knowledge dispersed through networks of professionals and through markets. A presence in wider and international markets adds further to this capacity. It can also be enhanced by well-trained employees, who bring in the analytical capacity needed for management innovation. These findings suggest that firms can consciously and systematically invest in management innovation. As recently argued by two practitioners (Feigenbaum & Feigenbaum, 2005: 96), '[w]e find evidence in a wide range of industry sectors that the systematization of management innovations will be a critical success factor for 21st century companies'. The research suggests that organizations going through rapid structural change or facing consistent barriers to technological innovation prove to be fertile contexts for such systematization.

One interesting avenue for future research is a comparison between countries. Strang and Kim (2005) raised the issue of how the transfer of new management practices across borders between the US and Japan re-shaped these practices. Perhaps the antecedent variables affecting the introduction of new practices differ between countries. In countries like the United States the uptake of new management practices appears to take on a fashion- and crisis-driven character (Abrahamson, 2004). In Japan, on the other hand, the introduction of specific management practices may be more of a response to a specific problem (Strang & Kim, 2005). The CIS data potentially lend themselves to such cross-national comparisons because they are collected in many countries. A replication of our findings for a set of other European countries is therefore desirable to test for cross-national differences.

*Limitations.* Various limitations of the research should be mentioned. By focusing on the introduction of management practices that are new to the firm, rather than new to the “state of the art” (Abrahamson, 1996), we are deliberately restricting ourselves to one aspect of management innovation. Our operational measure also excludes a few specific types of innovation, such as those concerned with changes to accounting or management information systems. Moreover, the data also does not give us any feel for differences in the ways in which new management practices are implemented. Obviously the results can be interpreted with these limitations in mind, but future research should seek to find ways of tapping into the antecedent conditions under which ‘new to the world’ innovations emerge, and the conditions favoring the emergence of new management practices in particular functional areas. Studies might examine a cross-section of innovations and focus on how similar or different they are regarding the creation process, the conditions under which they were created, the types of individuals who created them, and the impact they had on the practice of management.

Some of the variables in our study are open to scrutiny. Productivity is only one possible performance measure and a rather coarse one, although this problem is somewhat alleviated by our use of changes in productivity (rather than productivity itself), which helps us control for biases in the base productivity level. Clearly, alternative performance measures, where available, should be used in future

research. Variables that could further inform our understanding, but which are missing from the CIS survey, include competitive intensity, firm structure and culture. Surveys also have the associated problem that respondents' biases may affect the data. In this survey, self-reporting of innovations is potentially subject to such a bias. This may have led to reported levels of management innovation that are too high, if respondent want to make themselves or their companies look good, or too low, if their understanding of an innovation differs from that intended by the creators of the survey. We have no means of verifying the accuracy of the reported innovation levels.

A further issue with the CIS survey, again common to most surveys, is the use of a single respondent. Using multiple respondents could increase the reliability of the outcomes, especially for those measures that rely heavily on perception - quite a few of our variables, like structural change, market scope, size, and alliances clearly do not but some others do. The survey states that knowledgeable persons should respond to it but we have no way of assessing whether the organizations involved actually followed that guidance. Because the survey is sent to an outside constituent, the chances of individuals deviating from what the company wants them to say are small. But because that constituent is the government, respondents might either feel obliged, but not motivated, to reply, or might want to paint a better picture of their companies (although it is unclear they stand to gain from that, given the anonymous and large-scale processing) which could distort the findings. Again, we are not in a position to assess this.

## **Conclusion**

In this paper we have addressed when management innovation, defined specifically as the firm level introduction of new management practices, emerges and how it is related to future performance. Focusing on internal factors, as well as knowledge sources as suggested by the external search perspective, we developed and found support for a set of hypotheses around the introduction of new management practices.

Management innovation is an important and we believe fascinating phenomenon that warrants continuing scholarly research, and more so than is taking place at present. Research should particularly

focus on those stages of management innovation that we do not understand very well, namely the processes of creation and implementation inside firms; it should also continue to consider both new-to-the-firm practices that are adapted from elsewhere and new-to-the-state-of-the-art practices that have no direct precedent. With such insights academics could provide better advice to practitioners on what they need to do to improve their chances of successfully implementing management innovations.

## Notes

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<sup>1</sup> Of course, new to the firm management innovations can also be new to the world; but such cases of genuine new to the world innovations are seen so seldom that we do not consider them further in our theoretical arguments.

<sup>2</sup> We should also acknowledge a third perspective that has traditionally dominated the microeconomics literature, namely the idea that managers will behave as rational actors who seek out and introduce new practices in order to optimize firm performance. While this perspective has merits in certain settings, it essentially assumes that proven new practices will get picked up by all firms, and the nature of our data suggests that in reality this does not happen. We therefore focus our attention on the two strands of organization theory that help us to understand why some firms introduce new practices while others do not.

<sup>3</sup> The full survey can be found through [http://www2.dti.gov.uk/iese/cis\\_quest.pdf](http://www2.dti.gov.uk/iese/cis_quest.pdf) (last accessed on September 5 2005).

<sup>4</sup> Note that a firm in the CIS database is an “establishment” which may either be an independent firm or may be a subsidiary of a larger parent firm. The establishment is likely to be the relevant level of analysis for investigating the introduction of management innovations. Anderson and Young (2001) for instance show how Activity-Based Costing inside GM and Chrysler started at the establishment level before spreading to other establishments within the corporation.

<sup>5</sup> Note that the original survey incorporates low, medium, and high impact as separate answer categories. We decided to code these three categories simply as ‘used’. The survey confounds usage and impact, and we are only interested in usage.

<sup>6</sup> An empirical argument can be made for including the item as it is part of the ‘wider innovation’ category of the CIS survey and respondents may have interpreted it in the same manner as the other three items. The high correlation between items (Alpha = 0.86) and the fact that omitting the strategies item lowers the reliability of the scale (Alpha = 0.82) suggests this is probably the case. When we do include the item in the analysis the results are highly similar. But the item does not fit our theoretical construct and hence we decided to drop it.

<sup>7</sup> Unfortunately this variable is far from continuous and its distribution is skewed toward ‘0’, causing potential violations of regression assumptions. For that reason we use robust standard errors in the analyses where management innovation is the dependent variable. An alternative approach is to use dummy variables as dependent

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variables. This could either be a single dummy, to measure whether the firm uses any type of management innovation, or three separate dummies, for each of the types of innovation. We also ran logit models for each of these dummies and the outcomes are consistent with the findings presented here. We prefer the count variable for two reasons. First, our interest in this paper is in management innovation as a phenomenon, not in specific forms of management innovation. Second, four answer categories make for a more refined analysis than two categories.

<sup>8</sup> It is possible to sum the three categories of knowledge sources to create a single variable, knowledge sources, given the cohesiveness of the three types of sources. When we do this, all of the results we discuss below still hold. We choose not to do this, as we believe that using the individual sources makes for a richer story.

<sup>9</sup> This variable could arguably be seen as a scale with 10 items as well. Statistically this is certainly possible, as the 10 items produce a unidimensional scale (Alpha = 0.94). We are interested, however, in the number of obstacles and hence prefer to look at this as a count variable. The same applies to the different types of knowledge sources we will discuss shortly. As before with the 'management innovation' variable, we decided to focus on whether an obstacle was in place or not since it was not clear the observations would otherwise be part of a single dimension. Further robustness checks revealed no large differences between these methods though.

<sup>10</sup> As a robustness check we also conducted the analysis using OLS regression as well as tobit, given the double-censored nature of the data, and the findings were broadly similar.

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**TABLE 1**  
**Means, standard deviations and correlations among variables. N = 3,668.**

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Introduction of new mgmt practices	1.31	1.26	1														
2 Capital intensity	.26	9.48	.02	1													
3 Export intensity	.11	.22	.17	-.01	1												
4 Product innovation	.07	.45	.33	.03	.25	1											
5 Process innovation	.06	.43	.26	.03	.11	.33	1										
6 Alliances	.15	2.15	.19	.00	.23	.28	.22	1									
7 Public support	.02	.13	.06	.00	.02	.03	.04	.12	1								
8 Innovation inhibitors	.26	3.87	.36	.01	.12	.26	.21	.15	.04	1							
9 Structural change	.01	.32	.11	.05	.02	.08	.04	.10	-.02	.07	1						
10 Firm size	.10	1.36	.30	.06	.21	.19	.18	.21	.02	.16	.13	1					
11 Degrees	-.40	23.5	.17	.00	.18	.18	.06	.15	.02	.07	.08	.03	1				
12 Market scope	.12	.98	.24	-.01	.52	.24	.10	.17	.00	.13	.05	.31	.19	1			
13 Internal sources	.04	.85	.47	.02	.26	.40	.35	.26	.05	.46	.10	.30	.17	.27	1		
14 Market sources	.09	1.86	.49	.02	.23	.41	.32	.27	.07	.51	.08	.25	.14	.24	.72	1	
15 Professional sources	.09	1.68	.47	.02	.19	.36	.31	.24	.07	.45	.08	.24	.14	.20	.62	.74	1





**TABLE 3**  
**Ordinary least squares regression results for predicting 2000-2003 productivity growth (N = 1,048).**  
 \*\*\* significant at .001; \*\* significant at .01; \* significant at .05; † significant at .10.  
 Industry dummies are not reported to save space but are available upon request.

	<b>Standardized Beta</b>	<b>t-value</b>
Constant		4.01(***)
Introduction of new mgmt practices	.12	3.55(***)
Export intensity	.03	.71
Capital intensity	-.04	-1.34
Degrees	-.08	-2.43(*)
Market scope	-.02	-.56
Product innovation	-.03	-.78
Process innovation	.02	.48
Structural change	.04	1.24
Firm size	-.13	-3.89(***)
F-value 4.97(***)		
R <sup>2</sup> .08		Adjusted R <sup>2</sup> .06