Sources of differences in the pattern of adoption of organizational and managerial innovations from early to late 1990s, in the UK

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Abstract[1]

This paper explores empirically how the pattern of adoption of an organizational and managerial innovation changes as diffusion occurs. In particular, the paper investigates whether and how differences over time in the patterns of use of organisational innovation are related to changes in the characteristics of the innovation in terms of its functionality and relative complementary with other innovations, as well as to changes in the needs and capabilities of firms. For this purpose, firm level data from the British Workplace Industrial Relations Survey, in 1990 and 1998, are used.

Key words: innovation diffusion, organizational innovation, timing of adoption, evolutionary processes

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1 - Introduction

One means of firms updating their technological, management and market capabilities, and keeping their international competitiveness is through the adoption of innovations. For policy-makers, who aim at fostering innovation diffusion, the understanding of the sources of differences in the patterns of innovation adoption, as innovation diffuses, seems to be an important issue. Moreover, managers are also interested in getting a better understanding of how to avoid getting 'locked-out' from using innovations, which adoption has been delayed by technical or financial reasons, or getting 'locked-in' to technologies that may later prove not to be the most efficient ones.

Several studies have provided evidence that early and late-adopters of innovations differ in their managerial and technical capabilities (Abrahamson and Rosenkopf, 1993; Rogers, 1995; Massini et al., 2005). Based on these differences, some policy implications were derived, mainly related to the type of public incentives to innovation adoption available at different stages of the innovation diffusion process (Teubal, 1997; Egmond et al., 2006). Other studies have shown that during different phases of diffusion of an innovation, diverse complementary business activities are stimulated (Park and Yoon, 2005). However, despite being a great source of uncertainty affecting future adoption and the outcome of innovation diffusion policies, changes in the use of innovation over time, especially involving the characteristics, functionality and relative complementarity of an innovation, have been mostly neglected in the literature, especially for organizational and managerial innovations (OMIs).

According to Metcalfe (2005), the cost and the profitability of adopting an innovation are endogenous to the diffusion process rather than exogenous. Consequently, they are expected to change over time to reflect the mix of demand and supply of the innovation at each stage of the diffusion process. Moreover, as innovation diffusion is a process of technology improvement, which occurs simultaneously to the improvement and diffusion of complementary and competing technologies (Geroski, 2000; Metcalfe, 2005), the characteristics, functionality and relative complementarity of the innovation may change over time. Therefore, the patterns of use of an innovation may change during the diffusion process (Metcalfe, 2005, p.173).

This paper aims to analyse the sources of differences in the patterns of use an innovation throughout its diffusion. In particular, great focus is given to the understanding of whether and how changes in the functionality of an innovation and its relative complementarity with other innovations as well as in the characteristics and objectives of firms affect the pattern of adoption of OMIs over time. To analyse empirically these issues, this paper focuses on two different OMIs: Quality Circles (i.e. problem solving groups) and Business Process Re-engineering (i.e. reorganization of processes and work practices for downsizing costs). Quality Circles (QC) and Business Process Re-engineering (BPR) are examples of organisational arrangements adopted by firms that want to improve their problem-solving and innovative capabilities as well as to reduce costs and inefficiencies. QC and BPR reflect the two most popular management philosophies among by firms during the 1990s to maintain competitiveness in increasingly globalized markets (Goldstein, 1997; Massini et al., 2002). Thus, focussing on QC and BPR, we aim at improving our understanding of the evolution of the uses of OMIs as well as of how the implementation of their major underlying management objectives – problem-solving and operational efficiency – has evolved during the 1990s. Data at firm level on the characteristics of firms, as well as on their decision to adopt several organizational practices, collected from the British *Workplace Industrial Relations Survey* (WIRS) in 1990 and 1998, are used.

This paper shows that the patterns of adoption of QC and BPR changed during the 1990s, as these OMIs diffuse. These changes result both from developments in the relationship of complementarity and substitutability with other innovations and from changes in the characteristics and objectives of users.

This paper is organized as follows. Section 2 reviews the factors affecting innovation adoption as well as the sources of changes in the uses of OMIs as the diffusion occurs. Section 3 explores the concept and provides some historical background on QC and BPR. Section 4 presents the Data and the Methodology used to undertake empirically the analysis of the evolution of adoption patterns of these two OMIs. Section 5 presents the results. Section 6 concludes.

2 - Innovation Adoption during the Diffusion process

In the literature, the development and diffusion of an innovation has been intrinsically understood as a dynamic process in which the characteristics of the innovation, as well as of adopters and their environment, change as the time passes and the innovation diffuses. This section explores the existing literature on the factors influencing innovation adoption, as well as the evolution of adoption patterns throughout the diffusion process, especially of OMIs.

2.1 – Factors affecting innovation adoption during the diffusion process

According to the timing of innovation adoption, firms can be labelled as 'innovators', 'early-adopters', 'early or late majority', or 'laggards' (Rogers, 1995). In particular, early-adopters may be somewhat different from subsequent users because they start using the new technology, without having had access to the experience of previous users and when the new technology is not yet fully developed (Rogers, 1995; Geroski, 2000; Egmond et al., 2006). Therefore, early-adopters are argued to have higher technical, as well as organizational and managerial capabilities, which allow them to overcome both the technological and managerial problems and resistance that may rise from adopting a new, but not yet completely established technology (Metcalfe, 2005; Metcalfe and Ramlogan, 2005). Moreover, great differences are found between the strategic vision, the enthusiasm for a new technology, and the risk-taking attitude of early-adopters; and the more functional and problem-solving decision-making of the late-adopters (Egmond et al., 2006). In addition, firms' decision to be among the first to implement an innovation, in their sector, seem to be mainly influenced by their objective of maintaining centrality and leadership within their networks, as well as of improving their competitiveness (price, quality, diversity, timing, customer service, etc) (Becker, 1970). Firms in highly competitive markets are also thought to be more likely to be early-adopters of an innovation

(Moore, 1991; Egmond et al., 2006).

Especially in the case of organisational and managerial innovations, the role of reference groups and channels of communication of the innovation (i.e. professional and technical agents, consultants, opinion leaders or early-adopters) need to be acknowledged as a factor affecting the timing of adoption of an innovation by firms (Abrahamson and Rosenkopf, 1993; Rogers, 1995; Nelson et al., 2004, Massini et al., 2005). In particular, external advice seems to be particularly helpful in making firms aware of their problems, as well as of the advantages of OMIs (Huczynski, 1993; SESSI, 1998; Garcia, 2000). Moreover, Valente (1996) found that individuals, with the same propensity to adopt innovations, adopt at different times because the behaviour of their personal network partners influences when they are exposed to innovation. Additionally, Massini et al. (2005) provided evidence on the importance of different reference groups in the decision for adoption of OMIs by early- and late-adopters, respectively the top quartile or the population average. Thus, laggards can be either those who did not hear about the innovation and their advantages or those who had high innovation resistance (Becker, 1970; Rogers, 1995; Valente, 1996; Geroski, 2000). Hence, the expected profitability and the timing of innovation adoption may depend on the specific technological and managerial capabilities, as well as on the position of firms in a network.

Additionally, firms may not take their decision to adopt an innovation based solely on the expected individual benefit and cost of adoption. Network, social and emotive benefits also influence positively the expected financial returns from innovation adoption (Abrahamson, 1991; Abrahamson and Rosenkopf, 1993; Nelson et al., 2004). Within this perspective, innovation diffusion and rejection might as well occur because of network-effects, coercive forces, fads (i.e. socially constructed bandwagons) and fashions (Abrahamson, 1991; Nelson et al., 2004). The importance of these aspects in the decision making depends on the context in which innovations emerge and diffuse, in particular on degree of ambiguity of the innovation benefit, power of outside organizations, and uncertainty of firms in their own goals. Moreover, their relative importance depends on whether benefits of adoption increase with the number of adopters, as well as whether or not imitation creates uncertainty about organizational goals and technical efficiency.

When firms are uncertain about their goals and the efficiency of innovation, fashion related diffusion process not sanctioning non-adopters may occur, especially if firms are under the influence of outside organizations and opinion-leaders. Fads or social bandwagons sanctioning non-adopters might instead drive adoption or rejection of innovations, if firms experience few outside influence, but early-adopters create pressure to adopt rather than information on technical efficiency of innovation (Abrahamson, 1991; Nelson et al., 2004).

The diffusion of an OMI is mainly characterised by not producing clear information on its potential benefits to adopters, since both the circumstances and extent of its implementation tends to differ substantially from firm to firm (Rogers, 1995; Nelson et al., 2004). In addition, the adoption of OMIs seems to permit an external legitimisation of internal managerial choices within and outside their market (Abrahamson and Rosenkopf, 1993; Huczynski, 1993). Moreover, social, network and emotive efficiency of innovations are particularly important characteristics of OMIs (DiMaggio and Powell, 1988; Abrahamson, 1991). Therefore, the diffusion of OMIs tends to be largely driven by fads bandwagons and fashions, which may also be observed in technological innovation if there is ambiguity as to its technological efficiency or network externalities as a result of adoption (Abrahamson, 1991; Haunschild and Miner, 1997; Nelson et al., 2004).

Similar to technological innovations, the diffusion process of an OMI seems to display an inverted U-shaped relationship with the number of successful firms using that OMI (Haverman, 1993). Moreover, early adoption of OMIs usually reflects efforts to improve performance, while fear of appearing different and of under performance are instead the main forces leading late-adopters (DiMaggio and Powell, 1983; Abrahamson, 1991; Abrahamson and Rosenkopf, 1993; Haverman, 1993). Imitation is also revealing of the effort of firms in signalling to the market their attempts at improving performance, as well as in facilitating transactions and in complying with requirements of customers, suppliers and other organizations (DiMaggio and Powell, 1983; Haverman, 1993). The greater the uncertainty of innovation efficiency, the greater the dependence on other organizations for producing and marketing, the more ambiguous the goals of a firm or the greater the internal conflicts, the more likely a firm is to imitate other firms (DiMaggio and Powell, 1983).

Based mostly on mimetic efforts of firms, but also in certain cases on the coercive introduction of new environmental and business rules, as well as on the normative professional forces of managers, an imitation process may take off leading to an organizational isomorphism across firms (DiMaggio and Powell, 1983). Consequently, the organizational arrangements of firms, suppliers and producers within a specific market are often found to be mainly characterised by homogeneity rather than by diversity (DiMaggio and Powell, 1983; Abrahamson, 1991; Haverman, 1993). However, differences in production technologies and in employees' skills can be a constraint for firms, which aim at imitating the organizational arrangements of the most successful firms (Massini et al., 2002; Greenan, 2003).

Hence, efficient choice, coerciveness, network-effects, fad bandwagons and fashion theories may explain several diverse adoption decisions across the innovation diffusion process (Abrahamson, 1991). Consequently, innovation assessment by firms, especially of OMIs, depends both on the expected internal benefits as well as on the social, network and emotive benefits from innovation adoption. Thus, some authors argue that firms decide to keep or change existing practices after analysing the level of their response to the new competitive and technological environment, and to their market targets (Marengo, et al., 2000; Massini et al., 2002).

All in all, the existing literature has extensively analysed the factors affecting innovation adoption throughout the diffusion process, giving special attention to differences between early and late adopters, as well as to the density of adoption leading to the development of bandwagons. Still, as innovation diffusion is also a process of technology improvement, the innovation is not ‘static’ across time. However, the study of the evolution of the patterns of use of an innovation, especially of OMIs, has been mostly neglected, as discussed in the next section.

2.2 – Innovation adoption patterns across the diffusion process

As an innovation diffuses, its technology is further developed, its uses widen and the supply of innovative inputs becomes more stable and less expensive. Therefore, changes in the characteristics and in the uses of an innovation over time can be due to the will of suppliers, to information and learning from early adoption, as well as to changes in the technological, economic, and competitive environment (Rogers, 1995; Geroski, 2000; Metcalfe, 2005).

Additionally, innovations do not diffuse alone and independently of other complementary or competing innovations (Metcalfe, 2005). Innovation diffusion is a process of innovation development and improvement, resulting from learning of suppliers and users of several competing or complementary innovations (Geroski, 2000; Metcalfe, 2005). Consequently, on the one hand, the diffusion curve of an innovation may also refer to improvements in several innovations (Metcalfe, 2005); on the other hand, the characteristics of different innovations may change as their usage increases. Hence, the nature and intensity of complementarity and competition with other innovations may evolve across the diffusion process of an innovation. For instance, Park and Yoon (2005) show that as broadband diffused in Korea, the demand of related applications was also evolving; early-adoption demanded and supported the development of entertainment applications, and late-adoption e-commerce. Therefore, Metcalfe (2005, p.171) points out that the diffusion curve reflects the combined effects of the evolution of demand and supply of a population of innovations.

Hence, the time-gap between early and later adoption of a technology might also reflect the development of a more efficient and appropriate market supply of innovative inputs, the different needs of firms, the evolution of the competitive and technological environment of firms, as well as the technological developments in competitive and complementary innovations. Consequently, not only the characteristics of users and their reasons to adopt a certain innovation are expected to change, but also the concept, functionality, and its relative complementarity with other innovations may evolve as its usage increases within an economy.

The issues of the evolution of innovation characteristics and the use patterns of an innovation are particularly interesting for OMIs. When, on the one hand, several competing and complementary OMIs co-exist at one moment in time; on the other hand, OMIs seem to be characterised by a short-lived popularity (Abrahamson, 1991; Huczynski, 1993; Abrahamson and Fairchild, 1999). Hence, the evolution of the concept, functionality, and the relative complementarity of an OMI with other innovations may not evolve under the same label, but it may instead lead to the emergence of a new OMI (Huczynski, 1993; Garcia, 2000).

Analysing the subject of published papers on OMIs, Abrahamson and Fairchild (1999, p.722-3) found that several OMIs succeed each other in a short period of time. In particular, in 1978, the popularity of 'job enrichment' was substituted by 'QC', in 1982 QC was overtaken by 'total quality management' (TQM), and in 1992 'TQM' was replaced by 'BPR'. Looking at the interdependencies among the lifecycle of these four management practices Abrahamson and Fairchild (1999, p.731-2) propose that a fashionable OMI emerges when the existing one collapses and when there is a widespread performance gap, which is brought to the attention of firms by public discourse. In this sense, an OMI is said to be a product of its specific cultural, economic and social environment (Huczynski, 1993; Abrahamson and Fairchild, 1999). Indeed, several authors argue that within firms, the development and diffusion of specific organizational arrangements reflects the reaction of firms to similar market and technological challenges (Marengo et al., 2000; Massini et al., 2002).

However, there is no consensus on the pattern of emergence and diffusion of OMIs. On the one hand, some authors understand the emergence of OMIs as disruptive and creating substitutive relationships with other existing practices. For example, Goldstein (1997) argues that both TQM and ‘financial restructuring’ philosophies emerged to deal with the difficulties of maintaining international competitiveness although they are driven by different philosophies on how value is created. ‘Financial restructuring’ focuses on the reorganization of activities to eliminate non-conformity and extra costs and time, and to improve profitability, while the TQM focuses on strategies for continuous improvement and customer satisfaction based on the development of high-performing workplaces, external integration with consumers and suppliers, and internal integration of activities and functions (Goldstein, 1997).

On the other hand, Huczynski (1993) supports the idea that the content of an OMI is constantly recycled as time passes, the innovation diffuses, and the social economic and competitive environment evolves. Indeed, as innovation adoption requires specification and adaptation, it seems difficult to identify when an innovation, which suffered many changes, is already a different one (Geroski, 2000). For instance, in the late 1990s, ‘the Lean Organization’ emerged as a management concept proposing firms, especially suppliers of production-chains, to engage in continuous improvement and quality management, with the right size of personnel and with the most efficient and economic set of working routines (Womack and Jones, 1996; Kinnie et al., 1998). Hence, ‘the Lean Organization’ notion might be seen as resulting from the merging of both TQM and ‘financial restructuring’ concepts, to address the needs of suppliers of production-chains, whose competitiveness depended increasingly both on their innovative capabilities and on their operational efficiency (Brown, 2003; Hines et al., 2004).

The analysis of differences in the patterns of use of an innovation, across its diffusion process, might produce insightful evidence on the emergence and diffusion of OMIs. Some studies have analysed the emergence of bandwagons, the importance of reference groups and differences between early and late adopters of OMIs (Abrahamson and Rosenkopf, 1993; Massini et al., 2005). However, as the usage of an OMI increases within an economy, we expect that not only characteristics of users and their reasons to adopt evolve but also the concept, functionality, and the relative complementarity of the OMI with other innovations evolves. These issues have not been much investigated.

This paper aims to explore empirically whether and how the adoption patterns of OMIs have evolved over time, as well as whether and how this evolution was related to changes in the characteristics of adopters and/or in the functionality and relative complementarity of the innovation. For this purpose, we will focus on two OMIs, QC and BPR, whose use by firms during the 1990s was associated with organizational efforts to deal with increased competition (Goldstein, 1997; Massini et al, 2002).

3 - Quality Circles and Business Process Reengineering

In this section, we review the concept, the historical background and existing empirical evidence on the adoption and diffusion of QC and BPR, which given the attention devoted by managers and researchers, can be considered among the most popular OMIs in the 1980s and 1990s (Goldstein, 1997; Massini et al, 2002).

In the 1980s, QC was widely promoted in the US as a way of closing the productivity gaps and international competition, especially from the Japanese auto industry (Griffin, 1988; Goulden, 1995; Abrahamson and Fairchild, 1999). QC is a technique for firms that aim at improving both problem-solving activities as well as employees' participation. In the management literature, QC is defined as a small group of volunteers from the same work area, who may receive training in problem analysis and statistical techniques, and meet regularly to identify and propose solutions to work-related problems (Griffin, 1988; Barrick and Alexander, 1992; Goulden, 1995). The time lag from adoption to discontinuation of QC has been sometimes found to be quite short (Griffin, 1988; Goulden, 1995). Hence, in the management literature, QC is argued to be a transitional technique for enhancing a participative culture that needs to be later transformed into task forces or work teams and complemented with profit-related schemes.

In the early 1990s, BPR, sometimes also referred as downsizing or financial restructuring, emerged mainly in response to the increasing price competition firms were facing (Freeman and Cameron, 1993; Davenport and Stoddard, 1994; Abrahamson and Fairchild; 1999). In the management literature, BPR is often characterised as a methodology for redesigning business processes with the objective of reducing time, costs and non-conformities, and consequently for improving financial and operational performance of firms (Davenport and Stoddard, 1994; Kettinger et al., 1997). Hence, focusing on decreasing costs and inefficiency, BPR is mainly seen as a strategy to maintain and strengthen the firm's position rather than as an exit strategy (Dewitt, 1998; Kinnie et al., 1998; Budros, 1999, 2002). In particular, BPR leading to staff reduction is more likely to occur among larger firms, firms active in highly competitive industries or in firms with high levels of employee compensation (Budros, 1999). BPR is also more likely in firms that made large investments in labour-saving technologies or introduced information technologies (Harkness et al., 1996; Broadbent et al., 1999; Budros 2002).

Contrary to QC, which is referred as an incremental and transitory technique to improve the participative culture of employees and team-work in firms, BPR tends to be considered as a radical innovative decision towards improved efficiency, since its adoption involves the redesign of working practices and business activities (Griffin, 1988; Davenport and Stoddard, 1994; Budros, 1999).

Though QC and BPR had clearly an impact on innovation process, they seem to differ in content, invasiveness in the firm and in the timing of their diffusion. Consequently, the analysis of the evolution of the pattern of use QC and BPR might provide us with insights on the factors influencing the evolution of the pattern of use of OMIs, independently of their content and their diffusion phase. Moreover, given their underlying philosophies – either to improve problem-solving capabilities through employees' participation and team work or to increase operational efficiency through work and processes restructuring - we expect that this analysis allow us to improve our understanding on how the implementation of these objectives evolved during the

1990s.

4 – Data and Methodology

The goal of this paper is to analyse how the pattern of use of OMIs, in particular QC and BPR, evolved during the 1990s rather than to understand how to apply these OMIs or how early and later-adopters differ. In particular, this paper aims at exploring whether and how changes in the uses of an OMI across time are related to changes in the characteristics of the innovation (content, functionality, and relative complementary), as well as in the characteristics and needs of firms (size, activity, market and competition), their organizational capabilities and their channels of information used to innovate. Consequently, both the characteristics of adopters as well as differences between adopters and non-adopters are expected to change from one period to another, as the innovation is improved, more innovative inputs are supplied, and the content of the innovation, its functionality and its relative complementarity with other innovations evolve.

To explore these changes in innovation uses across time, we will focus on the patterns of adoption of QC and BPR by British firms, in two points in time: 1990 and 1998. As in the US, BPR emerged in the UK during the early 1990s, thus, the 1990s is a representative period to analyse BPR adoption patterns (Dickson, 1995). According to the literature, 1990 and 1998 may not be very representative of diffusion period of QC instead (Goulden, 1995; Abrahamson and Fairchild, 1999). However, the descriptive statistics for our sample of firms, in Table 1, shows that from 1990 to 1998 the rate of use of QC increased significantly and the rate of use of BPR did not significantly increase.[2] Thus, QC and BPR are important management practices in the UK during the 1990s. Still, the way firms understood and used QC and BPR in 1990 might not be exactly the same way they did in 1998. This will be explored.

[2] The variable *QC* measures whether a firm uses QC at the moment of the survey, independently of how long the firm has been using it. The variable *BPR* measures whether a firm was engaged in BPR in the previous 12 months to the moment of answering the questionnaire.

[Table 1 about here]

To proceed empirically, we use data from the WIRS British firms' database for 1990 and 1998, which has unique information on the organisational arrangements of firms.[3] These surveys are independent; consequently, we cannot produce a panel. Nevertheless, the aim of this analysis is to compare the patterns of adoption of QC and BPR (i.e. who are the adopters, what are their characteristics, how do they differ from non-adopters and how do they use these OMIs), during the 1990s rather than comparing the characteristics of early and later adopters, on which the existing literature is already very extensive and rich on evidence.

Table 2 presents the list of the variables we use in the empirical analyses and their description. We select variables from the WIRS related to the adoption of several OMIs, including use of QC (i.e. problem-solving groups) and BPR (i.e. business processes reengineering leading to staff reduction). We also use variables related to the characteristics of firms, in particular size, industrial activity, and market and competition (i.e. number of competitors, share of output sold to the largest customer, UK multinational, and lack of demand). We include as well variables related to use of external advice on Human Resources Management (HRM), both from consultant and from government agencies, and to the adoption of automation technology. Moreover, we include variables related to the performance of the firm (benchmarking, improved efficiency and recruitment of new staff).

Additionally, to provide a general measure of the degree of organizational innovativeness of firms, we create the variable *Total*, which refers to the number of other OMIs the firm adopted. *Total* takes the maximum value of seven. To describe the activity of firms, the 30 industrial

[3] The WIRS dataset is based on a British firm survey carried out in 1980, 1984, 1990 and 1998 on the working environment and employment relations. Since for 1980 and 1984 there was no information on the adoption of OMIs, this analysis is only based on data from 1990 and 1998.

activities are grouped into seven categories of industries, according to the taxonomies proposed by Pavitt (1984), and Miozzo and Soete (2001): supplier-dominated manufacturers, scale-intensive manufacturers, specialised-suppliers manufacturers, science-based manufacturers, supply-dominated services, scale-intensive services, technology-intensive services. Overall, there are 2061 observations in 1990 and 1929 in 1998. As missing values affect some variables, a smaller sample is used of 900 observations in 1990 and 813 in 1998. When we consider the market characteristics of firms, the sample is further reduced to 236 and 221 in 1990 and 1998, respectively.[4]

[Table 2 about here]

Using this data, we analyse the differences in the characteristics of adopters and in the patterns of use of QC and BPR in 1990 and 1998, in the UK. In particular, we proceed in two steps. First, Mann-Whitney and Spearman's correlations are computed to compare the evolution of adoption contexts as well as of differences between adopters and non-adopters and the different patterns of use of QC and BPR, in 1990 and 1998. To compare statistically adoption contexts and innovation uses in 1990 and 1998, Mann-Whitney and Spearman's correlation coefficients will be examined for the variable *Year*, using only data relative to adopters. To analyse the differences between adopters and non-adopters in the early and late 1990s, Mann-Whitney and Spearman's coefficients are computed for the variables QC and BPR, using data for 1990 and 1998 separately.

Second, binary LOGIT models are estimated to test whether the influence of each independent predictor on the likelihood of adoption of QC and BPR have changed or not from 1990 to 1998. The likelihood of adoption of each OMI is regressed against size, activity, degree of organizational innovativeness, use of consultant advice as well as the market characteristics of

[4] Firms, which provide information on their market characteristics, have higher degree of organizational innovativeness than those that do not provide this information.

firms.[5] Given the large number of missing values for the market characteristics of firms, we estimate two models for each management practice. Model 1 considers only variables related to size, activity, level of adoption of other innovative organizational practices and use of automation technologies. Besides these variables, Model 2 also includes variables related to the characteristics of market and competitive environment of firms.

To understand the specifics of the likelihood structure in 1990 and in 1998, we run Model 1 and 2 for each year separately. Using the adjusted Wald Chi-square test, we test for the similarity of coefficients in 1990 and 1998 (Allison, 1999; Liao, 2004).[6] Then, to measure the extent of change in the coefficients, Model 1 and 2 are re-estimated by pooling data from 1990 and 1998 together. In particular, Model 1B and 2B include additional variables representing the interaction of each predictor with the variable *Year*. Model 1A and 2A are instead estimated without these additional variables (assuming that the adoption patterns do not change over time). Using the Likelihood ratio, we can compare Model 1A and 1B (2A and 2B) and test whether the inclusion of additional variables improves the model fit or not. Subsequently, looking at the significance of coefficients in the best-fit Model, we can identify which factors influence the likelihood of adoption in each period as well as whether and how much their influence changed over time.

5 - Exploring the evolution of adoption patterns

5.1 – Results for Quality Circles

Table 3 reports significant differences between users of QC in 1990 and 1998, according to the Mann-Whitney test and Spearman's correlations coefficients. These results suggest that during

[5] Correlation tables reveal that multicollinearity is not a problem in our data.

[6] The Wald chi-square test for the similarity of coefficients is the following one.

$$\frac{(b_M - b_W)^2}{[s.e\,(b_M)]^2 + [s.e\,(b_W)]^2}$$

b_M is the coefficient for 1990, b_W is the coefficient for 1998, and s.e. is the estimated standard error. Each statistic has 1 degree of freedom.

the 1990s, the use of QC became much more widespread in services as well as in smaller firms, as suggested by the positive and negative coefficient respectively. Moreover, adopters of QC in 1998 were firms that had a relative lower degree of organizational innovativeness, faced a greater number of competitors, and tended to use more external consultant advice on HRM. Additionally, significant coefficients suggest that, during the 1990s, QC seems to have increasingly become a substitute to other problem-solving and participation practices (such as suggestion schemes, briefgroups, and regular meeting groups), but more complementary to profit related schemes.

[Table 3 about here]

Table 4, instead, reports significant differences between adopters and non-adopters in 1990 and in 1998. Results suggest that the factors that differentiate adopters from non-adopters in 1990 are still the same that differentiate them, in 1998 (i.e. firm size, being active in science-based manufacturing activities, use of consultant advice, degree of organizational innovativeness, and improved efficiency). However, in 1990, adopters differed from non-adopters by the fact that they tended to sell a smaller percentage to their largest customer, to use government advice, to have exited some activities due to lack of demand, and not to be engaged in BPR. In 1998, adopters of QC differed from non-adopters by the fact that adopters were more likely to be scale-intensive manufacturers and to adopt automation technologies.

[Table 4 about here]

Altogether, the descriptive statistics suggest that, during the 1990s, adoption of QC extended to services, to smaller firms and to those that faced a greater number of competitors, despite manufacturing and large firms being still the ones more likely to have QC implemented. As expected, in the late 1990s, users of QC are firms which differed less from non-users by their higher degree of organizational innovativeness, but differed more on the use of market inputs to support innovation, such as consultancy, when compared to users in early 1990s. Moreover, use of QC seems to have become a substitute for other organizational practices, aimed at enhancing information flows and teamwork, while it has become more complementary with profit-related schemes and with automation technologies.

These findings are corroborated by the estimates of the LOGIT models for the use of QC (Table 5 and Table 6). In particular, in Model 1 (Table 5, first three columns and Table 6, first column[7]), the positive and significant coefficient of the variable Total suggests that use of QC is positively affected by the level of organizational innovativeness of the firm, in both years, though the value of the coefficient decreases. Instead, firm size and adoption of automation technologies seem only to influence the use of QC, in 1998. These changes seem partially related to the diffusion of QC in services during the 1990s.[8] Moreover, there is not enough evidence to claim that science-based manufacturers have a higher probability to use QC in 1990 or that adopters of BPR are less likely to use QC, in 1998.

Model 2 also takes into consideration the market characteristics of firms (Table 5, last three columns and Table 6, third column[9]). Results suggest that, in both periods, use of QC is positively affected by the number of competitors and by the degree of adoption of other organizational practices. Moreover, the intensity of influence of the share of output sold to the largest customer and the adoption of automation technologies changed over time, but not the

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[7] According to the Likelihood ratio, Model 1B produces significantly a better fit of the data than model 1A.

[8] As the Wald test suggests, differences in the coefficient of the variable *services* in 1990 and 1998, we re-estimated Models 1 for manufacturers and services separately. The decrease in the value of the coefficient degree of organizational innovativeness (i.e. Total) in 1998 is only observed for services. Moreover, while the use of QC by manufacturers in both periods is only positively influenced by the degree of organizational innovativeness of the firm, in 1998 the use of QC by services is also affected by firm size and by adoption of automation technologies.

[9] According to the Likelihood ratio, Model 2B produces significantly a better fit of the data than model 2A.

level of organizational innovativeness of the firm, as Model 1 suggested. In particular, the share of output sold to the largest customer and adoption of automation technologies seem only to affect negatively the use of QC in 1990, but not in 1998. There is not strong evidence to claim that use of QC in 1990 is more likely among UK multinationals or that in 1998 use of QC is supported by external consultant advice and restrained by BPR. [10]

[Table 5 about here]

[Table 6 about here]

All in all, our empirical evidence suggests that QC seems to be more likely to be adopted by firms that use a great number of other OMIs, especially in manufacturing and by firms with a higher number of competitors. Still, during the 1990s, not only users have changed, but also the degree and direction of the complementarity of QC with innovations have evolved. In particular, the level of organizational innovativeness of the firm, the number of competitors and customers seems to have a greater positive impact on the use of QC by firms, in 1990. Instead, firm size seems only to have stimulated the use of QC in 1998. These findings are quite consistent with what the innovation diffusion theory predicts.

In addition, the use of QC became more a substitute for other organizational practices aimed at enhancing information flows and teamwork and more complementary to adoption of profit-related schemes and automation technologies. Changes in the complementarity of QC with automation technologies, leading to staff reduction, might be related to the diffusion of QC in services as well as to the evolution of its functionality and applications. Nevertheless, no strong evidence is found on the impact of BPR or external advice on the use of QC, in 1998. Moreover, in the late 1990s, QC seems still to be used as a technique to improve problem-solving through employee participation and team work.

[10] When we estimate Model 1 using the sample of firms, which provide market information (236 and 221 firms in 1990 and 1998), results turn out similar to those of Model 2. Significant differences are not found in the organizational innovativeness of users in 1990 and 1998.

5.2 – Results for Business Process Reengineering

Table 7 reports the significant differences between users of BPR in 1990 and 1998, according to the Mann-Whitney test and Spearman's correlations. Results suggest that during the 1990s, BPR became more attractive to smaller firms and services. Moreover, adopters of BPR in 1998 are increasingly firms that use external advice on HRM and other innovative practices aimed at improving information flows and employees' participation, including QC. Instead, BPR is each time less adopted as a response to lack of demand or as a complementary strategy to the adoption of labour-saving technologies, such as automation technologies.

[Table 7 about here]

Moreover, significant differences exist between adopters and non-adopters of BPR in 1990 and in 1998. Coefficients in Table 8 suggest that, in both periods, when compared to non-adopters, adopters of BPR seem to evaluate their financial performance below their competitors, sell a greater share of their output to their largest customer and not to be active in scale-intensive services. Surprisingly, and contrary to what is expected, in both periods, lack of demand negatively influences adoption of BPR and the use of external consultant advice does not seem to differentiate users from non-users of BPR. Still, the pattern of differences between adopters and non-adopters changed greatly during the 1990s. In 1990, adopters differ from non-adopters by using automation technologies, identifying a greater number of competitors, being manufacturers, and by having a low number of other OMIs implemented. In 1998, these factors do not seem to be important anymore to differentiate users from non-users. Instead, in 1998, adopters tend to be larger in size than in 1990, to be active in technology-intensive services and having recruited new employees in the previous year.

[Table 8 about here]

Overall, the descriptive statistics suggest that BPR became more common among services, except in scale-intensive ones, but still more used among manufacturers. During the 1990s, users of BPR were firms with low but increasing degree of organizational innovativeness. Moreover, BPR became increasingly a substitute for labour-saving technologies and for exit of activities due to lack of demand, as well as complementary to recruitment of staff and to the adoption of organizational practices aimed at improving the learning and informational environment of firms.

These findings are corroborated by the estimates of the LOGIT models for adoption of BPR (Table 9 and Table 10). Surprisingly, the market and competition characteristics of firms seem not to affect the probability of firms adopting BPR in any of the periods. Consequently, we will not comment on Model 2, which was estimated with a more restricted sample due to missing values of the market and competition variables. Estimates for Model 1 (Table 9, first three columns and Table 10, first column[11]) suggest that in both periods, but especially in 1990, the probability of BPR is higher in firms that have a low level of organizational innovativeness. Moreover, in both periods, manufacturers and firms active in technology-intensive activities[12] have a higher likelihood of engaging in BPR.[13] Moreover, contrary to what is sometimes argued, these estimates confirm that BPR is negatively affected by lack of demand, and consequently more a strategic rather than a passive reactive management option. The adoption

[11] According to the Likelihood ratio, Model 1B produces significantly a better fit of the data than model 1A.

[12] "Technology-intensive activities" refers to science-based and specialised-suppliers manufacturing activities as well as to technology-intensive services.

[13] To explore further differences in adoption patterns, Models 1 were re-estimated for manufacturers and services separately. BPR by manufacturers, in 1990, is negatively affected by the level of organizational innovativeness of firms, but positively affected by adoption of automation technologies. In 1998, automation technologies do not influence adoption; instead, firm size affects positively BPR. In services, the only difference refers to the fact that size always affects positively engagement in BPR, especially in 1998. Moreover, technology-intensive services are the most likely to use BPR as a voluntary strategy rather than a response to lack of demand.

of automation technologies influences positively the adoption of BPR in 1990, but not in 1998. Firm size only affects positively BPR adoption in 1998. The use of consultant advice seems not to affect the probability of firms using BPR in any of the periods. There is not strong evidence of a significant impact of the use of QC in the likelihood of using BPR.[14]

[Table 9 about here]

[Table 10 about here]

To summarise, our empirical evidence suggests that BPR is more likely to be adopted by firms with low degree of organizational innovativeness, especially in manufacturing and in technology-intensive services. Moreover, during the 1990s, not only the type of adopters has changed, but also the degree and direction of the complementarity of BPR with other innovations have evolved. In 1990, firms tended to engage in BPR together with the adoption of labour-saving technologies; however, this complementarity does not characterise adoption, in 1998. In addition, firm size became more influential in the likelihood of adoption, as the negative impact of the innovativeness level of adoption of other organizational practices became less important. Furthermore, as time went by, the use of BPR became more complementary to the use of other organizational practices, aimed at improving the learning and informational environment of firms, and to the recruitment of new staff. Thus, BPR seems to be increasingly a voluntary approach to improve the financial performance rather than an involuntary reduction of activities and personnel due to adoption of labour-saving technologies or to lack of demand.

6 – Discussion and Conclusion

This paper has aimed at exploring whether changes in the pattern of use of OMIs occur during their diffusion process as well as whether these changes depend on the features of adopters

[14] When we estimate Model 1 using the sample of firms, which provide market information (236 and 221 firms in 1990 and 1998), results turn out similar to those of Model 2. Significant differences are not found in the organizational innovativeness of users in 1990 and 1998.

and/or on the evolution of the characteristics of the innovations themselves, in particular functionality and relative complementarity with other innovations. The paper has focused on the analysis of the adoption patterns of QC and BPR, two popular management philosophies of the 1990s aimed at addressing global markets competition as well as at achieving innovative and problem-solving capabilities as well as operational efficiency. This paper has shown that, during the 1990s, in the UK, their diffusion seems to have been characterised by several adoption patterns. The observed evolution on their uses seems to have resulted not only from changes in the characteristics of their adopters, but also from the development of their substitutive-complementarity relation with other innovations.

Our results suggest that the patterns of adoption of these two OMIs suffered some changes, in the 1990s, in the UK. Generally, during the 1990s, firm size increasingly affected positively the likelihood of adoption QC and BPR, while the importance of organizational capabilities for the use of the two innovations decreased. Moreover, during the 1990s manufacturers remained more likely to adopt these practices, despite their adoption extending to services, especially technology-intensive ones. Despite the use of consultant advice increasing from 1990 to 1998, its positive and significant impact on the use of QC and BPR is not evident. Finally, while market characteristics of firms had some impact on the decision of firms to use QC, their impact on the probability of firms engaging in BPR was not significant during the 1990s.

Confronted with such a pattern of use, surprisingly, during the 1990s, the evolution of the organizational capabilities of users of these practices seems to have experienced an opposite pattern. In 1998, QC was used by firms with a less innovative organizational structure, when compared with users in 1990. BPR followed the opposite pattern. In 1990, BPR was adopted by firms with low organizational innovativeness, and in 1998, users were firms with more innovative organizational structures. Nevertheless, in both cases of QC and BPR, differences in the level of organizational innovativeness of adopters and non-adopters decreased during the 1990s.

Moreover, during the 1990s, the relationship between these two OMIs and other practices apparently evolved in opposite directions. QC became more complementary to profit-related schemes and more a substitute for practices aimed at enhancing information and learning flows and teamwork within the firm. BPR instead became more complementary to recruitment of staff and to adoption of these organizational practices. In addition, during the 1990s, QC was increasingly used together with automation technologies, while BPR substituted for the adoption of these labour-saving technologies.

Despite this evolution, the concepts of QC and BPR in UK during the 1990s sharpened up, as their rates of adoption increased. In particular, BPR became a voluntary approach to improve the financial performance of firms and differentiated from exiting activities and reducing workforce due to lack of demand or adoption of automation technologies. Still, in both periods, when compared to non-adopters, adopters of BPR tended to consider their financial performance to be below that of their competitors, to sell a greater share of output to their largest customer and to have lower organizational capabilities, but also to be active in technology-intensive sectors. Instead, QC was increasingly associated with practices and technologies that increased the level of participation and autonomy of employees, such as profit-related schemes and adoption of automation technologies. In both periods, QC seems to be seen as a technique to improve problem-solving capabilities, information flows and employee participation, and is associated with firms with high degree of organizational innovativeness, greater number of competitors, active in foreign markets and in science-intensive manufacturing environments.

Thus, to a certain extent, the early differences in their content—employees' participation and reorganisation of work practices—and in their underlying management philosophies—problem solving and operational efficiency—still prevail. Nevertheless, QC and BPR were increasingly used by similar groups of firms - firms with median degree of organizational innovativeness - and their rates of use in services increased substantially. This evidence may be seen as consistent with some existing literature on the OMIs diffusion by suggesting that the functionality of QC and BPR have been developed for use with other technological and organizational innovations or under new management fashions. Under those analytical lenses, our evidence may suggest that managerial and organizational concepts and practices tend to be recycled rather than completely ignored because they diffuse and develop to integrate other existing innovations, and to match future new ones. The evidence presented in this paper also fits with the argument that the quick updating of the functionality and content of OMIs seems both aimed at giving new insights to managers as well as to increase/sustain the market for consultants (Dickson, 1995; Huczynski, 1993; Garcia, 2000). However, this evidence on the evolution of the adoption pattern of OMIs might be limited to this period of analysis, the 1990s in the UK. In the UK, in the 1980s and 1990s, great policy efforts were put on the sponsoring of use of consultancy advice, as well as on the development and diffusion of managerial best practices as a way of supporting the competitiveness of national firms (Sharp, 2000). Hence, greater penetration rates and eventually shorter life of OMIs might be observed during the 1990s in the UK than in other European countries. Unfortunately, we cannot access similar datasets in other European countries to test this hypothesis.

More interesting still, our empirical evidence suggests that the organizational functionality and the complementarity of an OMI with other competing and complementary (technological and organizational) innovations evolved over time. In particular, more than being a random process of change, the content of the OMI seems to be made more concise and more prone to respond to the new competitive and technological challenges, as well as to advances in business management knowledge. QC and teamwork to improve problem-solving capabilities was increasingly used to address different management issues, including adoption of new hardware technologies, while BPR increasingly became a strategy for improving operational efficiency rather than a passive management reaction.

All in all, this paper suggests that patterns of innovation adoption change during diffusion because its functionality and their relationship of complementarity and/or substitutability evolve according to the needs of adopters and in response to the development of other competing and complementary technologies. Consequently, the evolution of patterns of innovation adoption also reflects structural changes in activities and technologies in an economy such as the increasingly prominent role of services in the UK. Moreover, the paper has suggested that the early understanding of the potential relationship of complementarity and/or substitutability of a set of innovations might permit firms not only to customise and enhance the profitability of present and future adoptions, but also to avoid being 'lock-out' from potential crucial technologies, or 'locked-in' previous adoption choices. Hence, to foster competitiveness of firms through support to innovation diffusion, policy-makers might want to search and diffuse to firms information not only on the innovation value added, but also on the interdependencies and complementarities with the other existing technologies and practices. Firms instead, when adopting an innovation, should aim at customising it to their internal specificities by exploring its degree of substitutive-complementarity with existing technologies and organizational practices in use or planned to be in use.

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Table 1: Descriptive analysis of the variables Quality Circles and Business Process Reengineering in 1990 and 1998

		1990		1998	
		Quality Circles	Business Process Reengineering	Quality Circles	Business Process Reengineering
Sample	Std. Error	0.016	0.015	0.017	0.017
	Non-weighted average percentage of adopters	0.40	0.31	0.53	0.34
Population	St. Error	0.027	0.026	0.03	0.023
	Weighted average percentage of adopters	0.34	0.3	0.45	0.27

Note1: 1735 Observations

Note 2: Differences between 1990 and 1998 in the percentages of use are significant for QC, but not for BPR.

Table 2: List of variables taken from the British WIRS database

Type	***Variable***	***Description***
BPR	BPR	Reorganization of work process leading to staff reduction (yes/ no)
QC	QualityCircles	Problem-solving groups/Quality Circles (yes/ no)
Size	Size	Firm's size ranked in 6 classes (25-49; 50-99; 100-199; 200-499; 500-999; +1000 employees)
Activity	SdManuf	Firms' industrial sector belongs to supplier-dominated manufacturing activities
	ScaleManuf	Firms' industrial sector belongs to scale-intensive manufacturing activities
	ScienceManuf	Firms' industrial sector belongs to science-intensive manufacturing activities
	SSmanuf	Firms' industrial sector belongs to specialised-suppliers manufacturing activities
	Services	Firms are active in services (yes/no)
	SdServ	Firms' industrial sector belongs to supplier-dominated services activities
	ScaleServ	Firms' industrial sector belongs to scale-intensive services activities
	TechnServ	Firms' industrial sector belongs to technology-intensive services activities
Market and competition characteristics	Ncompetitors	Number of competitors for (main product/service) 0-none/dominates the market; 2- a few up to 5; 3- many (more than 6)
	Soutput	Percentage of output going to largest customer 1: less than 5%; 2: 5-10%; 3: 11-25%; 4: 26-50; 5: more than 50%
	Tmultinational	Whether part of a UK multi-national (i.e. organization owns units outside UK)
	Red Staff -Demand	Reduction of staff due to lack of demand for products/services (yes/ no)
External Advice	Advicegov	Sought advice from ACAS or other government agency on employees relation (yes/ no)
	Adviceconsult	Sought advice from management consultants on employees relation (yes/ no)
Automation technologies	Red Automation	Adoption of automation technologies leading to staff reduction (yes/ no)
Other OMIs	Regular meetings	Regular meetings between senior management and all workforce (yes/ no)
	Tsuggest	Suggestion schemes (yes/ no)
	JCC	Joint consultative committee (yes/ no)
	Briefgroups	Briefing groups (yes/ no)
	Tinvestplan	Shares information about investment plans (yes/ no)
	Tchain	Systematic use of management chain to communicate (yes/ no)
	Collect information	Collect information on productivity (yes/ no)
	Profit related schemes	Any profit-related pay scheme (yes/ no)
	Share ownership	Any share-ownership scheme (yes/ no)
Degree of Organizational innovativeness	Total	Number of the following practices used by the firm: regular meetings; suggestion schemes; briefgroups; Joint consultative groups; collect information on productivity, share investment plans, profit related schemes
Performance	Benchmarking	Evaluation of financial performance compared with the average in same industry (1Lot better; 2Little better; 3About average; 4 Little below; 5 Lot below)
	Red Efficiency	Reduction of staff due to improved efficiency (yes/ no)
	Recruit new staff	Recruitment of new permanent staff in the last 12 months (yes/ no)

Table 3: Significant differences between adopters of Quality Circles in 1990 and 1998 - Spearman's correlation for significant Mann-Whitney test differences for adopters of Quality Circles – grouping variable: year

	Variables	**Correlations**
Size	Size	-.108(**)
Activity	SdManuf	-.057(*)
	ScaleManuf	-.081(**)
	ScienceManuf	-.091(**)
	SSmanuf	-.108(**)
	Services	.154(**)
	SdServ	.082(**)
Market characteristics	Ncompetitors	.107(**)
	Tmultinational	-.147(**)
	Red Staff -Demand	-.191(**)
Advice	Advicegov	.104(**)
	Adviceconsult	.125(**)
Other OMIs	Regular meetings	-.198(**)
	Briefgroups	-.181(**)
	Tsuggest	-.058(*)
	Tinvestplan	.063(**)
	Profit related schemes	.138(**)
	Share ownership	-.093(**)
Degree of org. innovativeness	Total	-.086(**)

Note 1: * Significant 5%; ** Significant 1%;
Note 2: Nº Observations: 1700 for all the variables, except for market characteristics, performance and automation technologies with 700 observations.

Table 4: Significant differences between adopters and non-adopters of Quality Circles - Spearman's correlation for significant Mann-Whitney test differences – grouping variable: QC. Observations from 1990 and 1998 are considered separately

	1990		1998	
	Variables	**Correlations**	**Variables**	**Correlations**
Size	Size	.086(**)	Size	.213(**)
Activity	ScienceManuf	.058(**)	ScienceManuf	.103(**)
Market characteristics	Tmultinational	.111(**)	Tmultinational	.142(**)
Advice	Adviceconsult	.060(**)	Adviceconsult	.098(**)
Other OMIs	Regular meetings	.240(**)	Regular meetings	.095(**)
	Briefgroups	.359(**)	Briefgroups	.083(**)
	Tchain	.140(**)	Tchain	.148(**)
	Tsuggest	.228(**)	Tsuggest	.110(**)
	Tinvestplan	.194(**)	Tinvestplan	.212(**)
	JCC	.093(**)	JCC	.182(**)
	Profit related schemes	.108(**)	Profit related schemes	.150(**)
	Share ownership	.095(**)	Share ownership	.136(**)
	Collect information	.082(**)	Collect information	.139(**)
Degree of Org. Innovativeness	Total	.358(**)	Total	.285(**)
Performance	Red Efficiency	.130(**)	Red Efficiency	.097(**)
Market characteristics	Soutput	-.099(**)		
	Red Staff -Demand	.077(*)		
	Downsizing	-.069(*)		
Advice	Advicegov	.069(**)		
Activity			ScaleManuf	.055(*)
			Services	-.088(**)
			SdServ	-.046(*)
Automation technologies			Red Automation	.119(**)

Note 1: * Significant 5%; ** Significant 1%;

Note 2: Nº observations: 2000 (in 1990) and 1900 (in 1998) for all variables, except for market characteristics, performance and automation technologies 850 in each period.

Table 5: Estimates of the likelihood of use of Quality Circles, observations from 1990 and 1998 are considered separately

	MODEL 1			MODEL 2		
	1990	**1998**	**Wald test Y0=Y1**	**1990**	**1998**	**Wald test Y0=Y1**
Intercept	**-2.486*** **	**(-1.086)*** **	**10.129*** **	**-4.752*** **	**-2.484** **	2.215
	(0.305)	*(0.317)*		*(1.042)*	*(1.112)*	
Total	**0.531*** **	**0.277*** **	**12.402*** **	**0.623*** **	**0.411*** **	1.597
	(0.051)	*(0.051)*		*(0.113)*	*(0.124)*	
Adviceconsult	0.155	0.156	0.000	0.037	**0.923** **	1.812
	(0.207)	*(0.172)*		*(0.484)*	*(0.446)*	
Size	-0.003	**0.185*** **	**6.052*** **	0.154	0.027	0.533
	(0.052)	*(0.056)*		*(0.124)*	*(0.122)*	
ScienceManuf	**0.473* **	0.498	0.002	0.305	0.967	0.392
	(0.275)	*(0.455)*		*(0.489)*	*(0.937)*	
Services	0.304	**-0.5** **	**7.048** **	0.4	-0.734	**3.462* **
	(0.186)	*(0.239)*		*(0.388)*	*(0.47)*	
Red Automation	-0.239	0.207	**3.689* **	**-1.074*** **	0.426	**8.089*** **
	(0.172)	*(0.156)*		*(0.413)*	*(0.328)*	
BPR	0.06	**-0.326** **	2.699	-0.012	**-1.051*** **	**4.317** **
	(0.172)	*(0.16)*		*(0.347)*	*(0.36)*	
Tmultinational				**0.777** **	0.322	0.815
				(0.38)	*(0.331)*	
Soutput				-0.228	0.011	2.190
				(0.126)	*(0.101)*	
Ncompetitors				**0.614*** **	0.391	0.373
				(0.226)	*(0.287)*	
Nº observations	900	813		236	221	
Chi-square	154.771***	82.424***		64.1***	51.839***	
-2 Log likelihood	1,053.333	1,042.564		251.513	254.310	
Cox & Snell R^2	0.158	0.096		0.238	0.209	
Nagelkerke R^2	0.214	0.129		0.323	0.279	
% of predicted	69.7	63		72.9	69.2	

Note: * Significant 10%, **Significant 5%, *** Significant 1%

Table 6: Estimates of the likelihood of use of Quality Circles, observations from 1990 and 1998 are pooled together

	Model 1B	**Model 1A**	**Model 2B**	**Model 2A**
Intercept	**-1.844*** **	**-1.826*** **	**-3.752*** **	**-3.67*** **
	(0.216)	*(0.209)*	*(0.751)*	*(0.713)*
Total	**0.477*** **	**0.4*** **	**0.577*** **	**0.491*** **
	(0.047)	*(0.035)*	*(0.105)*	*(0.078)*
Adviceconsult	0.208	**0.323** **	0.083	**0.663** **
	(0.204)	*(0.128)*	*(0.475)*	*(0.305)*
Size	-0.054	0.021	0.108	0.006
	(0.049)	*(0.036)*	*(0.117)*	*(0.081)*
ScienceManuf	0.359	**0.444** **	0.267	0.208
	(0.267)	*(0.225)*	*(0.481)*	*(0.396)*
Services	0.069	0.149	0.222	0.023
	(0.166)	*(0.138)*	*(0.362)*	*(0.273)*
Red Automation	-0.247	-0.006	**-1.03** **	-0.105
	(0.169)	*(0.113)*	*(0.403)*	*(0.242)*
BPR	-0.075	-0.094	-0.05	**-0.559** **
	(0.163)	*(0.113)*	*(0.34)*	*(0.237)*
Tmultinational			0.678	**0.475** **
			(0.364)	*(0.235)*
Soutput			**-0.263** **	-0.048
			(0.122)	*(0.074)*
Ncompetitors			**0.462** **	**0.53*** **
			(0.196)	*(0.169)*
Total*Year	**-0.144** **		-0.104	
	(0.063)		*(0.152)*	
Adviceconsul*Year	-0.05		0.807	
	(0.268)		*(0.654)*	
Size*Year	**0.289*** **		-0.046	
	(0.07)		*(0.164)*	
ScienceManuf *Year	0.481		0.829	
	(0.512)		*(1.06)*	
Services*Year	-0.197		-0.793	
	(0.232)		*(0.564)*	
Red Automation*Year	**0.477** **		**1.531*** **	
	(0.231)		*(0.523)*	
BPR*Year	-0.181		**-0.963***	
	(0.225)		*(0.498)*	
Tmultinational*Year			-0.308	
			(0.49)	
Soutput*Year			**0.303** **	
			(0.155)	
Ncompetitors*Year			0.161	
			(0.26)	
Nº observations	1713	1713	457	457
Chi-square	255.939***	197.836***	121.053***	92.473***
-2 Log likelihood	2,106.153	2,164.256	508.045	536.625
Cox & Snell R^2	0.139	0.109	0.233	0.183
Nagelkerke R^2	0.186	0.146	0.311	0.245
% of predicted	66.2	65.5	71.6	71.1
LR (Model A - Model B)	58.103***		28.580***	

*Significant 10%; ** Significant 5%; *** Significant 1%

Table 7: Significant differences between adopters of Business Process Reengineering in 1990 and 1998 - Spearman's correlation for significant Mann-Whitney test differences for adopters of BPR – grouping variable: year

	Variables	Correlations
Quality Circles	QualityCircles	.154(**)
Size	Size	-.092(*)
Activity	SdManuf	-.131(**)
	ScaleManuf	-.140(**)
	ScienceManuf	-.143(**)
	SSmanuf	-.095(*)
	Services	.275(**)
	SdServ	.195(**)
	TechnServ	.104(*)
Market characteristics	Tmultinational	-.187(**)
	Red Staff - Demand	-.171(**)
Advice	Adviceconsult	.160(**)
	Advicegov	.137(**)
Automation technologies	Red Automation	-.105(*)
Other OMIs	Tsuggest	.096(*)
	Profit related schemes	.156(**)
	Briefgroups	.120(**)
Degree of org. innovativeness	Total	.108(*)

Note 1: * Significant 5%; ** Significant 1%;
Note 2: Nº observations: 500 for all variables, except for market characteristics, performance and automation technologies with 350 observations.

Table 8: Significant differences between adopters and non-adopters of Business Process Reengineering - Spearman's correlation for significant Mann-Whitney test differences – grouping variable: BPR. Observations from 1990 and 1998 are considered separately

	1990		1998	
	Variables	**Correlations**	**Variables**	**Correlations**
Activity	Services ScaleServ	-.203(**) -.084(*)	Services ScaleServ	-.124(**) -.141(**)
Market characteristics	Soutput Red Staff - Demand	.185(**) -.133(**)	Soutput Red Staff - Demand	.099(*) -.135(**)
Advice	Advicegov	.132(**)	Advicegov	.155(**)
Other OMIs	Tchain Tsuggest	-.098(**) -.188(**)	Tchain Tsuggest	-.103(**) -.106(**)
Performance	Benchmarking	.130(*)	Benchmarking	.131(**)
Activity	ScaleManuf SdManuf ScienceManuf SdServ	.106(**) .097(**) .088(**) -.164(**)	Services technology-intensive	.110(**)
Quality circles	QualityCircles	-.069(*)		
Market characteristics	Ncompetitors	.140(**)		
Other OMIS	Briefgroups JCC Regular meetings Share ownership	-.179(**) -.160(**) -.111(**) -.141(**)		
Automation technologies	Red Automation	.100(**)		
Degree of Org. Innovativeness	Total	-.167(**)		
Size			Size	.142(**)
Performance			Recruit any new staff	.129(**)

Note 1: * significant 5%; ** significant 1%;
Note 2: Nº Observations: 900 (in 1990) and 800 (in 1998) for all variables, except for market characteristics, performance and automation technologies with 400 in each period.

Table 9: Estimation of the likelihood of use of Business Process Re-engineering, observations from 1990 and 1998 are considered separately

	MODEL 1			MODEL 2		
	1990	**1998**	**Wald test Y0=Y1**	**1990**	**1998**	**Wald test Y0=Y1**
Intercept	**0.847***** *(0.273)*	-0.474 *(0.31)*	**10.227*****	-0.175 *(0.974)*	0.556 *(1.115)*	0.244
Total	**-0.299***** *(0.054)*	**-0.088*** *(0.053)*	**7.777*****	**-0.256**** *(0.107)*	**-0.257**** *(0.124)*	0.000
Adviceconsult	0.291 *(0.216)*	-0.015 *(0.178)*	1.195	0.103 *(0.469)*	-0.148 *(0.453)*	0.148
Size	-0.046 *(0.055)*	**0.286***** *(0.06)*	**16.637*****	-0.124 *(0.122)*	0.139 *(0.129)*	2.194
Services	**-0.927***** *(0.168)*	**-0.537***** *(0.208)*	2.128	-0.469 *(0.35)*	**-1.028**** *(0.449)*	0.964
Technology activities	**0.632***** *(0.186)*	**0.654***** *(0.192)*	0.007	**0.669**** *(0.341)*	0.461 *(0.396)*	0.158
QualityCircles	0.035 *(0.175)*	**-0.354**** *(0.163)*	2.646	0.003 *(0.359)*	**-1.163***** *(0.373)*	**5.073****
Red Automation	**0.865***** *(0.188)*	0.155 *(0.171)*	**7.805*****	**1.562***** *(0.428)*	**0.973***** *(0.372)*	1.079
Red Staff- Demand	**-0.837***** *(0.198)*	**-0.707***** *(0.167)*	0.252	**-1.265***** *(0.41)*	**-1.104***** *(0.361=*	0.087
Tmultinational				0.298 *(0.38)*	-0.46 *(0.37)*	2.043
Soutput				0.105 *(0.119)*	-0.052 *(0.11)*	0.939
Ncompetitors				0.245 *(0.227)*	0.43 *(0.303)*	0.239
Nº observations	900	813		236	221	
Chi-square	120.414***	68.7***		44.631***	43.015***	
-2 Log likelihood	995.563	973.066		258.936	229.806	
Cox & Snell R Square	0.125	0.081		0.172	0.177	
Nagelkerke R Square	0.176	0.112		0.238	0.249	
% of predicted	71.30%	67.80%		72.00%	75.60%	

Note: * Significant 10% ** Significant 5%, *** Significant 1%

Table 10: Estimates of the likelihood of use of Business Process Re-engineering, observations from 1990 and 1998 are pooled together

	Model 1B	Model 1A	Model 2B	Model 2A
Intercept	0.272 *(-0.203)*	0.272 *(0.197)*	0.14 *(0.733)*	-0.087 *(0.697)*
Total	**-0.263***** *(-0.052)*	**-0.193***** *(0.037)*	**-0.265**** *(0.106)*	**-0.218***** *(0.077)*
Adviceconsult	0.22 *(-0.212)*	0.168 *(0.134)*	0.118 *(0.468)*	-0.051 *(0.312)*
Size	0.002 *(0.052)*	**0.082**** *(0.038)*	-0.137 *(0.119)*	0.025 *(0.084)*
Services	**-0.733***** *(0.156)*	**-0.676***** *(0.124)*	-0.519 *(0.335)*	**-0.581**** *(0.257)*
Technology- intensive activities	**0.681***** *(0.183)*	**0.62***** *(0.131)*	**0.679**** *(0.341)*	**0.557**** *(0.248)*
QualityCircles	0.032 *(0.174)*	-0.14 *(0.116)*	0.018 *(0.358)*	**-0.62**** *(0.245)*
Red Automation	**0.877***** *(0.187)*	**0.466***** *(0.124)*	**1.576***** *(0.427)*	**1.129***** *(0.265)*
Red Staff- Demand	**-0.706***** *(0.194)*	**-0.802***** *(0.125)*	-1.307*** *(0.401)*	**-1.146***** *(0.261)*
Tmultinational			0.271 *(0.375)*	-0.07 *(0.252)*
Soutput			0.089 *(0.115)*	0.026 *(0.077)*
Ncompetitors			0.193 *(0.2)*	**0.319*** *(0.177)*
Total*Year	**0.123*** *(0.07)*		0.022 *(0.158)*	
Adviceconsult*Year	-0.225 *(0.277)*		-0.281 *(0.649)*	
Size*Year	**0.23***** *(0.074)*		**0.288*** *(0.17)*	
Services*Year	-0.115 *(0.215)*		-0.449 *(0.523)*	
Technology-intensive activities*Year	-0.129 *(0.262)*		-0.223 *(0.522)*	
QualityCircles*Year	**-0.435*** *(0.238)*		**-1.178**** *(0.517)*	
Red Automation*Year	**-0.742***** *(0.253)*		-0.585 *(0.567)*	
Red Staff- Demand*Year	-0.048 *(0.253)*		0.214 *(0.536)*	
Tmultinational*Year			-0.713 *(0.522)*	
Soutput*Year			-0.128 *(0.151)*	
Ncompetitors*Year			0.317 *(0.27)*	
Nº observations	1713	1713	457	457
Chi-square	180.358***	150.102***	88.058***	75.028***
-2 Log likelihood	1978.95	2009.207	488.985	501.835
Cox & Snell R Square	0.1	0.084	0.175	0.152
Nagelkerke R Square	0.139	0.117	0.244	0.212
% of predicted	69.50%	69.00%	73.10%	71.10%
LR (Model A - Model B)	30.257***		12.850	

* Significant 10%, ** Significant 5%, *** Significant 1%