The Effect of Leveraged Buyouts on Strategic Innovation and Innovation-Related Activities*

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Abstract: Building on the agency and strategic entrepreneurship theories we study the effect of leveraged buyouts (LBOs) on strategic innovation and innovation-related activities in the UK. The effect varies considerably depending on the technology intensity in the industry of the target company. LBOs increase strategic innovation and innovation-related activities in high-tech manufacturing and knowledge-intensive services. In other industries, LBOs reduce both strategic innovation and innovation-related activities.

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1. Introduction

Leveraged buy-outs (LBOs) are financial transactions in which an acquirer takes over a target company using a significant amount of leverage. An LBO leads to a substantial change in the ownership structure, capital structure and corporate governance of the target company (Jensen, 1989). These changes substantially affect the activities in and performance of target companies. A substantial literature has studied the impact of LBOs on the performance of target firms (Kaplan and Strömberg, 2008). However, there is only a limited understanding of how LBOs influence the innovation in target companies.

Two principal, non-mutually exclusive, theories can be advanced to explain the impact of LBOs on innovation. First, from an agency perspective, the change in corporate governance creates an organizational form that leads to efficiency improvement (Jensen, 1989). Second, the strategic entrepreneurship perspective, grounded in the resource-based view of the firm, indicates that, in a buyout, access to resources and capabilities is also important in generating value creation through growth (Wright et al., 2001).

These two approaches lead to complementary predictions on the impact of LBOs on innovation. The agency view has focused on efficiency-oriented activities and has paid little attention to growth-oriented activities (Meuleman et al., 2009). Hence, the levers of action generally mobilized under the agency view are efficiency-oriented, resulting in a positive impact on efficiency-related innovation and a reduction in resource-consuming innovation activities. From the strategic entrepreneurship perspective, LBOs should also favor growth-oriented innovation and result in an increase in innovation-related activities.

Despite the extensive body of systematic evidence now available on the investment and R&D changes in LBOs, further research is necessary to understand the effect of buyouts on different forms of innovation in target companies. Previous works in the literature have

analyzed the relationship between LBOs and innovation, but historically these studies used indirect measures of innovation (e.g. patenting, productivity) and they made no distinction between the different dimensions of innovation (Zahra, 1995). Innovation is often studies from the restrictive angle of products, services, processes or technology. However, innovation processes are highly interactive in nature and non-technological activities play a crucial role (Battisti and Stoneman, 2010; Tether and Tajar, 2008). Hence, in this study we focus on non-technological innovation and innovation-related activities to analyze the different value creation strategies following LBOs.

In this paper, we attempt to fill this gap by studying the effect of LBOs on different dimensions of non-technological innovation and innovation activities of target companies. We rely on the UK-CIS data to overcome the limitations of previous studies. Specifically, we use a direct measure of innovation based on survey information. We make a distinction between different types of non-technological innovation output (i.e., strategy, marketing, and organization) and innovation activities (R&D, training, design). As common in studies on LBOs, we have to face the problem arising from endogenous selection of the target firms, which may systematically differ from the control group because of unobservable characteristics. We tackle this issue by comparing current LBOs (i.e., LBOs that have happened up to 3 years before or during the CIS observation window) with future LBOs (i.e., LBOs that occur up to 3 years after the CIS observation period). To the extent to which current and future LBOs share similar unobservable characteristics (i.e., to the extent to which the selection process is stationary), the difference in innovation between current and future LBOs can be attributed to the treatment effect of LBOs. We exploit this method in a pseudo-DIF-in-DIF univariate analysis (in which we control for observable characteristics by using a matched sample) and in a probit model (in which the observable characteristics are included as control variables).

In the analysis, we also distinguish high-tech manufacturing and knowledge intensive service (HTKIS) industries from the other industries. This distinction is important because growth-related objectives may be predominant in HTKIS industries, in which innovation is an important source of strategic advantage (Cloodt et al., 2006; Sarooghi et al., 2015). Accordingly, Wright et al. (2001) found that LBOs in technology-based industries are followed by significant increases in product and technology development, R&D and patenting. Conversely, non-high-tech industries are more propitious for efficiency and cost cutting-oriented strategies.

This paper makes two main contributions. First, it extends research on the effects of LBOs on innovation by theoretically analyzing and empirically testing the magnitude of the LBO effect on different forms of non-technological innovation and innovation-related activities. Specifically, we add to the literature by making a distinction between restructuring and efficiency-oriented and entrepreneurial growth-oriented innovation activities that has not been used in the buyout context yet. Second, we show that the effect of LBOs is different depending on the technology and knowledge intensity of the industry. In high-tech industries, LBOs determine an increase in non-technological innovation and innovation related activities. In medium and low-tech industries, instead, we find evidence of a slight decrease in both non-technological innovation and in innovation-related activities.

The paper is organized as follows. In Section 2 we outline the theoretical framework and develop our hypotheses. In Section 3 we describe the data and the research design. In Section 4 we present the results of the analysis. In Section 5 we conclude by drawing the implications and outlining the avenues for future research.

2. Literature and Hypotheses

2.1. Agency and strategic entrepreneurship perspectives

Researchers have used agency theory and strategic entrepreneurship perspective to analyze LBOs (Meuleman et al., 2009). The complementarity of these approaches highlights both the efficiency-driven and the growth-driven value creation efforts that follow an LBO.

From an agency perspective, the changes in ownership structure, corporate governance and capital structure that follow and LBO improve the incentives to reduce inefficiency (Jensen, 1989). Building on this theoretical framework, a large number of empirical studies have shown that indeed LBOs result in an increase in operating performance (Kaplan, 1989; Muscarella and Vesuypens, 1990; Wright et al., 1992; Cressy et al., 2007; Gaspar, 2009).

From a strategic entrepreneurship perspective, LBOs provide the set of resources and capabilities that are needed to unleash the unexpressed entrepreneurial potential in a target company (Wright et al., 2001). While the agency framework the focuses typically on efficiency gains, the strategic entrepreneurship perspective focuses instead on growth-driven value creation. Building on this theoretical framework, several studies have indicated that a significant entrepreneurial activity occurs after an LBO (Bull, 1989; Malone, 1989; Wright et al., 1992; Zahra, 1995; Boucly et al., 2009; Meuleman et al., 2009).

The two theoretical perspectives, and the respective drivers of value creation, are clearly not mutually exclusive and most deals indeed have both efficiency-oriented and growth-oriented objectives (Gottschalg, 2007).

2.2. Innovation strategies: efficiency-oriented *vs.* entrepreneurial growth-oriented activities

Although the positive impact of the LBOs on operating performance has been demonstrated in different contexts, their effect on innovation is mixed. Some authors found that R&D investment decline in LBO targets (Smith, 1990; Long and Ravenscraft, 1993). Other studies,

however, find no decline in R&D expenses after an LBO (Lichtenberg and Siegel, 1990; Lerner et al., 2011).

Using R&D expenses to measure the innovation of LBO targets may be misleading. First, Zahra (1995) finds that LBO companies tend to use R&D expenditures more effectively, which means that a decline in R&D expenses does not necessarily translate in a reduced innovation output. Indeed, LBO targets are found to have higher patenting rates (Ughetto, 2010), increased patent citations and more focused patent portfolios after the LBO (Lerner et al., 2011). Second, many LBOs are in industries with low R&D intensity (Lichtenberg and Siegel, 1990). Accordingly, a reduction in R&D of LBO targets would have an insubstantial overall effect for the economy (Long and Ravenscraft, 1993).

More interestingly, R&D expenses and patents only give us an incomplete vision over innovation. Innovation also takes place through a wide variety of business practices within the enterprise and innovation activities include "all scientific, technological, organizational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations" (Oslo Manual 2005, p. 47). The extant literature only gives us a very limited understanding of the impact of LBOs on innovation and innovative activities in a broad sense.

Based on these definitions, innovation activity that takes place in buyouts companies can be broken down into activities related to restructuring and efficiency-oriented activities and entrepreneurial growth-oriented activities.

Under the agency view, Jensen (1989) suggests that the primary source of value creation in buyouts is cost reduction. The argument relates to the removal of managerial inefficiencies due to a better alignment of interests between managers and shareholders. While not directly affecting the strategic positioning of the firm, these mechanisms should direct managers toward innovations that cut costs and improve margins such as the outsourcing of business functions, the introduction of cross sectional teams, and process improvements. LBOs often

induce innovation in the management of working capital aiming at reducing the invested capital (Easterwood et al., 1989). Hence, from the agency view, LBOs should have a positive impact on innovations that aim at increasing efficiency and, we state that:

H1a: LBOs have a positive effect on efficiency-oriented innovations.

The better alignment of interests of management and investors and the stress created by debt more generally lead the management to adopt a stricter regime regarding the use of capital and capital expenditure. Hitt et al. (1990) argue that even productive expenditure can be foregone in LBO targets, because managers could be short-sighted and go too far in efficiency-oriented activities. Cutting back long-term investment like R&D or innovation, cash consuming activities increases the return on investment in the short term (and can help refund the debt in the case of LBOs). Moreover, managers become more risk averse and avoid projects with uncertain outcomes. LBOs also absorb manager energy and deter them from other strategic matters like innovation (Hitt et al., 1991, Long and Ravenscraft, 1993). Hence, while LBOs should have a positive effect on efficiency-oriented innovations, the managers of LBO targets should simultaneously work to cut costs and these transactions should have a negative impact on innovation-related activities that use resources that are not directly aimed at increasing efficiency.

H1b: LBOs have a negative effect on innovation-related activities.

The strategic entrepreneurship view provides complementary insights to the agency perspective (Makadok, 2003). From this perspective, LBOs should be seen as a means to stimulate strategic change that enables growth opportunities to be realized (Meuleman et al., 2009) and these transactions should have a positive impact on innovations that aim at developing growth and entrepreneurial pursuits and on innovation-related activities. Hence, innovations at the strategic and marketing level can come from the interaction between portfolio company managers and the management of the buyout firm (Berg and Gottschalg,

2005). For example, the target company can be supported in the identification of new markets and of possible targets for a buy-and-build strategy (Meuleman et al., 2009). The innovations at this strategic and marketing level are clearly more growth-oriented. The private equity firm brings new perspectives that should not only favor innovation at the strategic and marketing level but also the innovation related activities. The search for marketing innovation can rely on design activities as some marketing innovations involve significant change in product design or packaging. Innovation at the strategic level also encompass organizational innovations. These organizational innovations can of course be efficiency-oriented as it is the case when the company implements new methods to manage the working capital or outsourcing. They can also be growth-oriented, for instance when they involve gains from new relationships or implementation of practices for employee development and improving worker retention. Organizational innovations linked to new relationships and training can target access to external knowledge. As the private equity firm brings not only financial engineering and control, but also its network, the LBO can instigate new cooperation in the company (Wright et al., 2001). Activities linked to these organizational and strategic innovations, like training in employee, effort to acquire external knowledge and development of cooperation should increase if the LBO entails new entrepreneurial growth-oriented activities.

Hence, we hypothesize:

H2a: LBOs have a positive effect on entrepreneurial growth-oriented innovations.

H2b: LBOs have a positive effect on innovation-related activities.

3. Research design

3.1. Dataset and sample

The Community Innovation Survey (CIS) collects data on firms' innovation behavior over a three-year period, according to the OECD (2005) recommendations. The survey is based on a core questionnaire developed by the European Commission (Eurostat) and Member States. The CIS provides a set of general information concerning the firms (sector of activity, group belonging, number of employees, sales, geographic market) and their technological and non-technological innovation and their information-related activities. The UK-CIS is funded by the Department of Business, Innovation and Skills (BIS) and is conducted BIS by the Office for National Statistics (ONS).

Several iterations of the CIS survey took place, each focusing on innovation output and input in a three-year reference period. In this study, we focus three rounds of the CIS: CIS4, CIS5 and CIS6, which correspond to innovation conducted in 2002-2004, 2004-2006, and 2006-2008. After merging CIS4, CIS5 and CIS6 we obtain 45,598 observations. We delete the 16,000 observations for which the data needed for our analysis (i.e., size, age, human capital characteristics, industry, and region) are missing.

To build the sample of LBO companies, we retrieved from Capital IQ all the deals that (1) involved target companies incorporated in the UK, (2) are reported as being LBOs, (3) were announced between 01/01/1998 and 31/12/2008, (4) were either "closed" or "effective". We identified 4,365 transactions that comply with the above criteria, but many of the targets involved in these deals were not respondents in the CIS surveys. We identify 855 (2.9%) current-LBO companies, which are defined as companies that have been the target of an LBO during the CIS period or in the three previous years (i.e., companies in this group are those for which the LBO occurred between 1999 and 2004 for CIS4, between 2001 and 2006 for CIS5, and between 2003 and 2008 for CIS6). We also identify 232 (0.8%) future-LBO companies, which are defined as companies that have been the target of an LBO in the three years after end of the relevant CIS (i.e., companies in this group are those for which the LBO occurred

between 2005 and 2007 for CIS4, between 2007 and 2009 for CIS5, and between 2008 and 2010 for CIS6). We delete from the sample 448 observations that correspond to LBOs that occurred more than 3 years before the beginning of the corresponding survey. Our final sample comprises 29,150 observations. The timing of current and future LBOs is depicted in Figure 1.

[Figure 1 here]

We report the distribution of our sample across regions, CIS and LBO status in Table 1.

[Table 1 here]

In our analysis we distinguish companies depending on the technology and knowledge intensity of the sectors in which they operate. Specifically, we distinguish high-tech manufacturing and knowledge intensive services (HTKIS) using the Eurostat (2009) industry classification. The distribution of HTKIS and no-HTKIS is also reported in Table 1.

3.2. Measures of innovative activity

We focus in this study on non-technological innovation and on innovation-related activities. Following the Oslo Manual (2005, p. 47), non-technological innovation comprises both marketing and organizational innovations[1]. In the CIS most non-technological innovations are apprehended through a section devoted to wider or strategic innovation. Question 23 asks whether the major changes have been made in the previous three-year period concerning: the implementation of new or significantly changed corporate strategy (STRATEGY); the implementation of major changes to the organization structure (ORGANIZATION); the implementation of changed marketing concepts or strategies (MARKETING); and the implementation of advanced management techniques (MANAGEMENT).

[1] Following the Oslo Manual: "A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing"; "An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations."

With respect to innovation-related activities, the CIS asks whether, in the three previous years, the business has engaged in: internal R&D (INTERNAL R&D); cooperation on any innovation activities (COOPERATE); training for innovative activities (TRAINING); and all forms of non-R&D-related design (DESIGN).

Table 2 reports the definition and type for all innovation activities variables.

[Table 2]

In Table 3, we notice that on average during a 3-year period 20.9% of the companies in our sample implement a new strategy, 25.4% of the companies introduce a new organizational structure, 18.1% new management practices and 23.3% introduce a change in the marketing strategy. We observe several significant differences between HTKIS and non-HTKIS companies. HTKIS companies are in general more likely to introduce strategic innovations and to have innovation-related activities.

[Table 3]

To test our hypotheses, we break down non-technological innovation activities into efficiency-oriented innovation activities and growth-oriented-innovation activities. The next two subsections elaborate on this distinction.

Efficiency-oriented innovations

We use two variables to measure efficiency-oriented organizational innovations: new management techniques and new organizational structure. The CIS questionnaire gives examples such as Total Quality Management for management techniques or the introduction of cross-functional teams and the outsourcing of major business functions for new organizational structures. These organizational innovations can be considered as efficiency-oriented. Several studies have shown that organizational innovations present an immediate source of competitive advantage since they themselves have a significant impact on business

performance with regard to productivity, lead times, and quality (e.g., Womack et al., 1990; Hammer and Champy, 1993; Goldman et al., 1995). Further, implementing new organizational methods could substantially improve organizational flexibility, which in turn leads to improved firm efficiency and performance (Mothe et al., 2014). As a consequence, we argue that new management techniques and new organizational structure innovation are a lever of value creation through improvement in internal efficiency.

Growth-oriented innovations

We use four variables to measure growth-oriented innovations: changes in marketing, changes in corporate strategy, cooperation in any innovation activity, and innovation related activities.

We add the cooperation variable in our analysis of non-technological innovation because it deals with external relations in innovation activities and as such, following Oslo Manual (2005), relates to organizational innovation.

Finally, we include three innovation-related activities (internal R&D, training and design) that entail costs. We consider that these activities are entrepreneurial growth-oriented because they aim at implementing current innovations or are directed to future product or process changes.

Control variables

We include industry, region and period dummies as control variables. We also use the following control variables at the firm-level in our study: firm's age, firm's size (measured as the logarithm of firm's turnover), firm's international sales (a dummy equal to 1 if the company sells outside of the UK), the fraction of employees with technical degrees and the fraction of employees with other degrees.

HTKIS companies exhibit a larger number of graduate employees and they more often cite "international" (as opposed to local or regional or national) as their largest market. HTKIS companies are also older than non-HTKIS ones although they exhibit a smaller turnover.

3.3. Methods

A key issue in this work is to distinguish the extent to an observed difference in innovation between LBO and non-LBO firms may be attributable to selection (i.e., more innovative companies are more likely to be target of an LBO) or treatment (i.e., the LBO changes the propensity of a company to innovate). Most of the works in the literature that deal with this issue use a panel data methodology. Intuitively, having the ability to observe the same company before and after the LBO makes it easier to understand whether any change occurred after the LBO. Unfortunately panel techniques typically require observing a company for a few successive time periods, which makes this approach unfeasible in this setting for two reasons. First, the vast majority of companies only respond to one CIS, and only a handful of companies in our sample responded to the three CISs (and, moreover, three time periods is a very short panel). Second, the three time periods are not independent because the CISs partially overlap (e.g., an innovation in 2006 would appear twice for a company that answered to both the CIS5 and CIS6).

In order to distinguish selection from treatment we follow two approaches. First, we conduct a pseudo dif-in-dif analysis. We begin by building a matched sample using the propensity score matching method. We estimate, for each CIS, a probit model in which the dependent variable is whether a company is a current LBO or not, and the regressors are firm's age, size, international sales, human capital, and a series of region and industry dummies. The predicted probability that a company is an LBO target is its propensity score. For each current LBO we then select (without replacement) the three non-LBO companies with the closest propensity score. By comparing the current LBOs to the matched sample, we measure the total effect of selection on unobservable and treatment, because selection on observables has already been controlled by the matching.

We repeat the same process looking at future LBOs, with the only significant difference that, by definition, the treatment has not yet occurred. The difference between future LBOs and the matched sample thus captures selection based on unobservables. Under the assumption that the selection on unobservable factors is stationary, we can estimate the treatment effect on innovation as the difference between the excess of innovation in the current LBO sample compared to its matched sample, and the excess of innovation in the future LBO sample compared to its matched sample. The logic is illustrated in Figure 2.

[Figure 2 here]

The second approach we follow is a multivariate regression. For each innovation variable we estimate a probit model in which observable characteristics are included as control variables. The two variables of interest are current LBO and future LBO dummies. Again, under the assumption that the selection process is stationary, the difference between these two dummies gauges the treatment effect of LBOs on the innovation variable.

4. Results

4.1. Pseudo Dif-in-dif Analysis

Table 4 shows the results of the pseudo dif-in-dif analysis on the whole sample. Panel A reports the means for current and future LBOs, their matched sample and a respective stratified random sample obtained by randomly extracting, for each LBO company, 3 companies from the relevant CIS. Panel B reports, for current and future LBOs, the difference in means between LBOs and both the random and the matched sample. Panel B also reports the pseudo dif-in-dif, which is the difference in means between the excess innovation of current LBOs over future LBOs, both compared to their respective matched sample.

Overall, current LBOs are substantially more innovative than the average CIS respondent (all strategic innovation and innovation-related activities are greater in the current LBO sample,

with a p-value<0.1%, with the exception of MANAGEMENT for which p-value<1%). Current LBO companies also tend to do strategic innovation more often than their matched companies (p-value<0.1% with the exception of MANAGEMENT for which p-value<5%). With respect to innovation-related activities, current LBOs are more likely than matched companies to have internal R&D (p-value<1%) and innovate the design of their products (p-value<1%), but we do not find any significant difference for COOPERATE and TRAINING.

Overall, results for future LBOs, when compared to their matched sample, are less statistically significant. Future LBOs are more likely than matched companies to innovate organizational methods (p-value<5%) and marketing (p-valuey1%) and, albeit with limited statistical significance, to have internal R&D (p-value<10%). The pseudo-dif-in-dif analysis thus indicates that LBOs increase by 7.9% the probability of a change in business strategy (p-value<1%) but reduce the probability of innovation-related training by 4.3% (p-value<5%). We also find weak evidence of an increase by 3.5% in the probability of a change in design (p-value<10%). These results are somewhere between what predicted by the agency and the strategic entrepreneurship theories. As we will see in the remainder of this section, the distinction between the predictions of the two theories becomes more clear-cut once we analyze HTKIS and non-HTKIS targets separately.

[Table 4 here]

Table 5 shows the results for the subsample of HTKIS companies. LBOs show a positive impact on innovation and on related activities in this subsample, consistently with hypotheses H2a and H2b. An LBO translates into an increase of 17.4% (p-value<0.1%) in the frequency of major changes in corporate strategy and in a 16.4% (p-value<5%) increase in changes in organizational methods. Innovation-related activities exhibit a significant increase due to LBOs: the internal R&D rises by 15.9% (p-value<1%), innovation-related cooperation increases by 9.1% (p-value<5%), and design increases by 16.6% (p-value<1%). These results

corroborate both H2a and H2b: LBOs in HTKIS favor growth-oriented innovation and the innovation-related activities. More surprisingly, LBOs also have a positive impact of 16.4% on the report of new organizational structure, which is an efficiency-oriented innovation. Hence, LBOs in HTKIS lead to ambidextrous capabilities: the increase in innovation-related activities due to LBOs translates into innovations that are growth-oriented and simultaneously innovations that aim at improving efficiency.

[Table 5 here]

In sharp contrast with the results for HTKIS LBOs, results in Table 6 document no evidence of positive treatment in non-HTKIS companies. Two negative effects are observed: innovation in marketing is reduced by 5.9% (p-value<5%), and innovation-related training is reduced by 11.4% (p-value<1%). Overall, hypothesis H1b is supported in this subsample: consistently with agency theory, innovation related activities are substantially reduced.

[Table 6 here]

4.2. Multivariate analysis

We present in Table 7 the results of the multivariate analysis. Overall the propensity to innovate is positively correlated with firm's size, is larger for companies that have international sales and that have a larger portion of employees with scientific and (to a lesser extent) other skills.

Overall the results in Table 7 show that, consistently with what shown in Table 4, other things equal, current LBOs tend to be more innovative than non-LBOs, except for Training, where no significant difference is evidenced. When we compare current to future LBOs, however, we find only one marginally significant difference for strategic change (p-value<10%). Again, we can get a clearer picture by splitting HTKIS from non-HTKIS.

[Table 7 here]

Table 8 reports the results of the multivariate analysis for HTKIS companies. Overall current LBOs are more innovative than non-LBOs on most dimensions (p-value<5% or better) with the exception of Training. When compared to future LBOs, current LBOs do significantly more strategic innovation (p-value<0.1%), internal R&D (p-value<1%) and change in design (p-value<1%). Overall, these results are consistent with those in Table 5 and lend support to the strategic entrepreneurship view of LBOs in HTKIS.

[Table 8 here]

Finally, Table 9 reports the results of the multivariate analysis on non-HTKIS companies. We observe a significant decline in innovation-related training (p-value<5%) and a marginally significant (p-value<10%) decline in changes in marketing and organizational structure. Again, these results are consistent with those in Table 6 and lend support to the agency view of LBOs in non-HTKIS companies.

[Table 9 here]

5. Discussion and Conclusions

Our results show that overall LBOs occur in companies that, because of their characteristics (size, age, human capital, exporting, industry and location), tend to be more innovative than the average company in the CIS sample. They also show that the treatment effect of LBOs on non-technological innovation varies substantially depending upon the technology intensity of the industry of the target company. If the company is in a high-tech manufacturing or knowledge-intensive services (HTKIS) industry (see Appendix 1), our findings indicate that LBOs increase non-technological innovation and innovation activities. In non-HTKIS industries, instead, LBOs only slightly reduce some non-technological innovation and innovation activities.

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Tables and Figures

Figure 1: CIS Surveys and Timing of LBOs

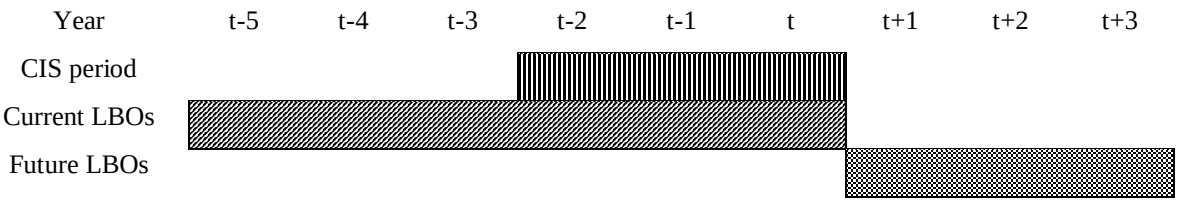

Figure 2: The Pseudo Dif-in-Dif Methodology

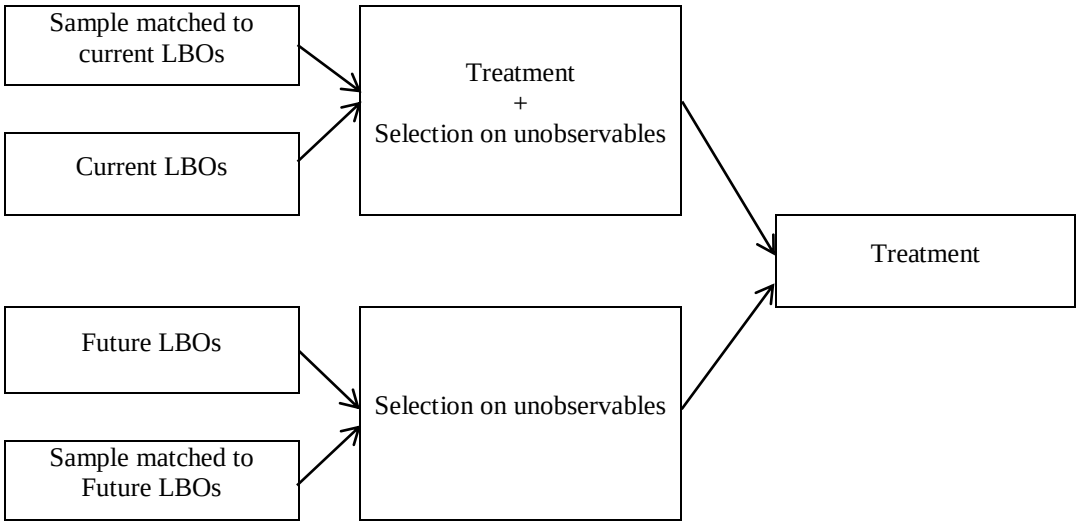

Table 1: Distribution of the Sample

	All		HTKIS		Not HTKIS	
	N	%	N	%	N	%
Region						
AA	1,818	6.2%	682	7.2%	1,136	5.8%
BA	159	0.5%	34	0.4%	125	0.6%
BB	2,465	8.5%	765	8.1%	1,700	8.6%
DC	2,411	8.3%	799	8.4%	1,612	8.2%
ED	2,383	8.2%	809	8.5%	1,574	8.0%
FE	2,602	8.9%	1,048	11.0%	1,554	7.9%
GF	1,120	3.8%	395	4.2%	725	3.7%
GG	1,428	4.9%	467	4.9%	961	4.9%
HH	2,704	9.3%	627	6.6%	2,077	10.6%
JG	2,882	9.9%	970	10.2%	1,912	9.7%
KJ	2,411	8.3%	770	8.1%	1,641	8.3%
WW	2,061	7.1%	726	7.7%	1,335	6.8%
XX	2,347	8.1%	752	7.9%	1,595	8.1%
YY	2,359	8.1%	644	6.8%	1,715	8.7%
CIS						
CIS 4	13,906	47.7%	4,261	44.9%	9,645	49.1%
CIS 5	3,631	12.5%	1,895	20.0%	1,736	8.8%
CIS 6	11,613	39.8%	3,332	35.1%	8,281	42.1%
LBO status						
No LBO	28,063	96.3%	9,120	96.1%	18,943	96.3%
Current LBOs	855	2.9%	290	3.1%	565	2.9%
Future LBOs	232	0.8%	78	0.8%	154	0.8%
Total	29,150	100%	9,488	100%	19,662	100%

HTKIS indicates companies operating in high-tech manufacturing and knowledge intensive industries (Eurostat, 2009). Current LBOs are LBOs that occurred during and up to 3 years before a CIS. Future LBOs are LBOs that occurred up to 3 years after a CIS.

Table 2: Definition of Innovation Variables

Innovation Variable	Innovation Type	Definition
STRATEGY	Growth-oriented	Whether a new or significantly changed corporate strategy has been implemented during the previous three year period (see Q23.10).
ORGANIZATION	Efficiency-oriented	Whether major changes to the organisational structure, e.g. introduction of cross-functional teams, outsourcing of major business functions have been implemented during the previous three year period (see Q23.30).
MARKETING	Growth-oriented	Whether changes in marketing concepts or strategies, e.g. packaging or presentational changes to a product to target new markets, new support services to open up new markets etc. have been implemented during the previous three year period (see Q23.40).
MANAGEMENT	Efficiency-oriented	Whether advanced management techniques e.g. knowledge management systems, Investors in People etc have been implemented during the previous three year period (see Q23.20).
INTERNAL R&D	Growth-oriented	Whether the business has engaged in Internal Research & Development, e.g creative work undertaken within the business that increases knowledge for developing new and improved goods or services and processes, during the previous three year period (see Q 13.10).
COOPERATION	Growth-oriented	Whether the business has co-operated on any innovation activities during the previous three year period (If any @1811-@1874=1, COOPERATE=1; 0 otherwise.)
TRAINING	Growth-oriented	Whether the business has engaged in Training for innovative activities, e.g. internal or external training for the personnel specifically for the development and/or introduction of innovations, during the previous three year period (see Q 13.50).
DESIGN	Growth-oriented	Whether the business has engaged in all forms of design (except in the R&D phase), e.g. design activities for the development or implementation of new or improved goods, services and processes, during the previous three year period (see Q 13.60).

Table 3: Summary Statistics

	(1) All	(2) HTKIS	(3) Not HTKIS	(2)-(3)
Strategic Innovation				
New business strategy	0.209	0.271	0.179	0.093***
New organizational structure	0.254	0.331	0.217	0.114***
Changes in marketing	0.233	0.280	0.210	0.070***
New management methods	0.180	0.228	0.157	0.071***
Innovation-Related Activities				
Internal R&D	0.380	0.553	0.297	0.257***
Cooperative R&D	0.238	0.328	0.195	0.133***
Training	0.397	0.498	0.348	0.149***
Design	0.234	0.351	0.177	0.174***
Control Variables				
Log(Age)	2.891	2.907	2.883	0.025**
Log(Sales)	8.053	8.006	8.076	-0.070**
International sales	0.542	0.718	0.457	0.261***
Science degree	0.066	0.135	0.033	0.102***
Other degree	0.086	0.097	0.080	0.017***

HTKIS indicates companies operating in high-tech manufacturing and knowledge intensive industries (Eurostat, 2009).

***: p-value<0.1%; **: p-value<1%.

Table 4: Innovation for LBOs, ALL SAMPLE

Panel A: Means

	(1) Current LBOs	(2) Random Sample for Current LBOs	(3) Matched Sample for Current LBOs	(4) Future LBOs	(5) Random Sample for Future LBOs	(6) Matched Sample for Future LBOs
Strategic Innovation						
New Business Strategy	0.362	0.204	0.273	0.289	0.207	0.280
New Organizational Methods	0.457	0.251	0.365	0.440	0.256	0.352
Changes in Marketing	0.351	0.226	0.290	0.397	0.258	0.302
New Management Methods	0.293	0.178	0.257	0.297	0.185	0.247
Innovation-Related Activities						
Internal R&D	0.530	0.397	0.477	0.491	0.374	0.420
Cooperative R&D	0.330	0.226	0.304	0.254	0.178	0.236
Training	0.473	0.411	0.472	0.547	0.481	0.503
Design	0.351	0.228	0.298	0.293	0.231	0.274
Observations	855	2,565	2,565	232	696	696

Panel B: differences

	Current LBO – Random Sample	Current LBO – Matched Sample	Future LBO – Random Sample	Future LBO – Matched Sample	Pseudo dif-in-dif
	(1)-(2)	(1)-(3)	(4)-(5)	(4)-(6)	[(1)-(3)]-[(4)-(6)]
Strategic Innovation					
New Business Strategy	0.157***	0.089***	0.082**	0.009	0.079**
New Organizational Methods	0.207***	0.092***	0.184***	0.088*	0.004
Changes in Marketing	0.125***	0.061***	0.139***	0.095**	-0.034
New Management Methods	0.116***	0.036*	0.112***	0.050	-0.014
Innovation-Related Activities					
Internal R&D	0.133***	0.053**	0.118**	0.072†	-0.019
Cooperative R&D	0.104***	0.026	0.076*	0.019	0.008
Training	0.062**	0.001	0.066†	0.045	-0.043*
Design	0.123***	0.053**	0.062†	0.019	0.035†

***: p-value<0.1%, **: p-value<1%, *: p-value<5%, †: p-value<10%

Table 5: Innovation for LBOs, ONLY HTKIS

Panel A: Means

	Current LBOs			Future LBOs		
	LBOs	Random Sample	Matched Sample	LBOs	Random Sample	Matched Sample
	(1)	(2)	(3)	(4)	(5)	(6)
Strategic Innovation						
New Business Strategy	0.486	0.248	0.351	0.269	0.184	0.308
New Organizational Methods	0.574	0.319	0.423	0.436	0.274	0.449
Changes in Marketing	0.396	0.262	0.359	0.359	0.222	0.376
New Management Methods	0.377	0.219	0.325	0.321	0.179	0.291
Innovation-Related Activities						
Internal R&D	0.741	0.567	0.646	0.564	0.551	0.628
Cooperative R&D	0.466	0.321	0.409	0.333	0.256	0.367
Training	0.590	0.518	0.565	0.551	0.513	0.577
Design	0.503	0.361	0.436	0.308	0.291	0.406
Observations	290	870	870	78	234	234

Panel B: differences

	Current LBO – Random Sample	Current LBO – Matched Sample	Future LBO – Random Sample	Future LBO – Matched Sample	Pseudo dif-in-dif
	(1)-(2)	(1)-(3)	(4)-(5)	(4)-(6)	[(1)-(3)]-[(4)-(6)]
Strategic Innovation					
New Business Strategy	0.238***	0.135***	0.085	-0.038	0.174***
New Organizational Methods	0.255***	0.152***	0.162**	-0.013	0.164*
Changes in Marketing	0.134***	0.037	0.137*	-0.017	0.054
New Management Methods	0.158***	0.052	0.141**	0.030	0.022
Innovation-Related Activities					
Internal R&D	0.174***	0.095**	0.013	-0.064	0.159**
Cooperative R&D	0.144***	0.056†	0.077	-0.034	0.091*
Training	0.071*	0.024	0.038	-0.026	0.050
Design	0.143***	0.068*	0.017	-0.098	0.166**

***: p-value<0.1%, **: p-value<1%, *: p-value<5%, †: p-value<10%

Table 6: Innovation for LBOs, ONLY NO HTKIS

Panel A: Means

	Current LBOs			Future LBOs		
	LBOs	Random Sample	Matched Sample	LBOs	Random Sample	Matched Sample
	(1)	(2)	(3)	(4)	(5)	(6)
Strategic Innovation						
New Business Strategy	0.298	0.166	0.262	0.299	0.160	0.275
New Organizational Methods	0.397	0.210	0.331	0.442	0.177	0.295
Changes in Marketing	0.328	0.218	0.286	0.416	0.221	0.315
New Management Practice	0.250	0.154	0.242	0.286	0.156	0.217
Innovation-Related Activities						
Internal R&D	0.421	0.308	0.391	0.455	0.227	0.394
Cooperative R&D	0.260	0.192	0.257	0.214	0.115	0.145
Training	0.413	0.356	0.414	0.545	0.374	0.433
Design	0.273	0.186	0.253	0.286	0.141	0.219
Observations	565	1695	1695	154	462	462

Panel B: differences

	Current LBO – Random Sample	Current LBO – Matched Sample	Future LBO – Random Sample	Future LBO – Matched Sample	Pseudo dif-in-dif
	(1)-(2)	(1)-(3)	(4)-(5)	(4)-(6)	[(1)-(3)]-[(4)-(6)]
Strategic Innovation					
New Business Strategy	0.132***	0.036†	0.139***	0.023	0.012
New Organizational Methods	0.187***	0.066**	0.264***	0.147***	-0.081
Changes in Marketing	0.110***	0.042†	0.195***	0.101*	-0.059*
New Management Methods	0.096***	0.008	0.130***	0.069†	-0.061
Innovation-Related Activities					
Internal R&D	0.113***	0.030	0.227***	0.061	-0.031
Cooperative R&D	0.068***	0.003	0.100**	0.069†	-0.066
Training	0.057*	-0.002	0.171***	0.113*	-0.114**
Design	0.086***	0.020	0.145***	0.067	-0.047

***: p-value<0.1%, **: p-value<1%, *: p-value<5%, †: p-value<10%

Table 7: Innovation for LBOs, All firms

	New business strategy	New organizational structure	Changes in marketing	New management methods	Internal R&D	Cooperative R&D	Training	Design
Log(Age)	-0.0496*	-0.0541*	0.0255	0.0116	0.1025**	0.0156	0.0693*	0.0338
	(0.0229)	(0.0274)	(0.0248)	(0.0237)	(0.0314)	(0.0241)	(0.0287)	(0.0240)
$Log(Age)^2$	0.0031	0.0036	-0.0103*	-0.0045	-0.0251***	-0.0069	-0.0173**	-0.0100*
	(0.0045)	(0.0054)	(0.0049)	(0.0046)	(0.0061)	(0.0049)	(0.0055)	(0.0046)
Log(Sales)	0.0242***	0.0396***	0.0196***	0.0311***	0.0309***	0.0251***	0.0285***	0.0251***
	(0.0015)	(0.0018)	(0.0017)	(0.0014)	(0.0018)	(0.0016)	(0.0018)	(0.0016)
International sales	0.0460***	0.0411***	0.0659***	0.0146**	0.1278***	0.0768***	0.0364***	0.0655***
	(0.0057)	(0.0060)	(0.0063)	(0.0053)	(0.0083)	(0.0064)	(0.0068)	(0.0056)
Scientific skills	0.2143***	0.2132***	0.1774***	0.1125***	0.5449***	0.3029***	0.3251***	0.2831***
	(0.0158)	(0.0157)	(0.0158)	(0.0129)	(0.0242)	(0.0163)	(0.0236)	(0.0190)
Other skills	0.1178***	0.1470***	0.1554***	0.0765***	0.1886***	0.0743***	0.1830***	0.1473***
	(0.0152)	(0.0150)	(0.0150)	(0.0158)	(0.0195)	(0.0150)	(0.0170)	(0.0132)
Current LBO	0.0892***	0.1102***	0.0645***	0.0385**	0.0745***	0.0320*	0.0145	0.0466**
	(0.0154)	(0.0185)	(0.0163)	(0.0139)	(0.0189)	(0.0161)	(0.0173)	(0.0163)
Future LBO	0.0212	0.1111**	0.0964**	0.0436†	0.0611	0.0323	0.0514	0.0154
	(0.0281)	(0.0366)	(0.0319)	(0.0240)	(0.0391)	(0.0281)	(0.0330)	(0.0296)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	29,061	29,051	29,031	29,050	29,045	29,138	29,018	28,955
Current=Future LBO	4.10†	0.00	0.85	0.04	0.11	0.00	1.07	0.84

Marginal effects are reported. Robust standard errors are clustered for 554 period-sector-region clusters and reported in round brackets. Current=Future LBO corresponds to the χ^2 test that the coefficients of Current LBO and Future LBO are equal. ***: p-value<0.1%, **: p-value<1%, *: p-value<5%, †: p-value<10%.

Table 8: Innovation for LBOs, HTKIS

	New business strategy	New organizational structure	Changes in marketing	New management methods	Internal R&D	Cooperative R&D	Training	Design
Log(Age)	-0.1408**	-0.1415**	-0.0506	-0.0248	0.0938	-0.0219	0.0532	-0.0466
	(0.0461)	(0.0517)	(0.0533)	(0.0473)	(0.0641)	(0.0560)	(0.0553)	(0.0570)
$Log(Age)^2$	0.0185*	0.0216*	0.0053	0.0016	-0.0238*	-0.0013	-0.0137	0.0036
	(0.0089)	(0.0102)	(0.0103)	(0.0091)	(0.0121)	(0.0109)	(0.0104)	(0.0106)
Log(Sales)	0.0221***	0.0437***	0.0164***	0.0391***	0.0364***	0.0338***	0.0352***	0.0386***
	(0.0029)	(0.0035)	(0.0028)	(0.0024)	(0.0032)	(0.0033)	(0.0033)	(0.0030)
International sales	0.0761***	0.0697***	0.0716***	0.0137	0.1733***	0.1203***	0.0278*	0.0931***
	(0.0127)	(0.0138)	(0.0136)	(0.0114)	(0.0164)	(0.0132)	(0.0126)	(0.0139)
Scientific skills	0.1863***	0.1705***	0.1351***	0.1050***	0.4306***	0.2905***	0.2397***	0.2383***
	(0.0230)	(0.0234)	(0.0247)	(0.0234)	(0.0365)	(0.0250)	(0.0324)	(0.0297)
Other skills	0.0708*	0.0947**	0.0831**	0.0196	0.1209**	0.0075	0.1315***	0.1186***
	(0.0288)	(0.0320)	(0.0285)	(0.0263)	(0.0374)	(0.0307)	(0.0293)	(0.0279)
Current LBO	0.1609***	0.1598***	0.0714*	0.0727**	0.1110***	0.0721*	0.0283	0.0695*
	(0.0295)	(0.0326)	(0.0306)	(0.0266)	(0.0300)	(0.0351)	(0.0318)	(0.0341)
Future LBO	-0.0509	0.0204	0.0255	0.0162	-0.0926	-0.0034	-0.0544	-0.1192*
	(0.0414)	(0.0595)	(0.0475)	(0.0400)	(0.0580)	(0.0521)	(0.0591)	(0.0491)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,463	9,469	9,460	9,464	9,460	9,485	9,452	9,433
Current=Future LBO	13.79***	3.70†	0.58	1.38	9.43**	1.38	1.67	8.62**

Marginal effects are reported. Robust standard errors are clustered for 412 period-sector-region clusters and reported in round brackets. Current=Future LBO corresponds to the χ^2 test that the coefficients of Current LBO and Future LBO are equal. ***: p-value<0.1%, **: p-value<1%, *: p-value<5%, †: p-value<10%.

Table 9: Innovation for LBOs, no HTKIS

	New business strategy	New organizational structure	Changes in marketing	New management methods	Internal R&D	Cooperative R&D	Training	Design
Log(Age)	-0.0290	-0.0278	0.0398	0.0221	0.0759*	0.0161	0.0611†	0.0418†
	(0.0252)	(0.0319)	(0.0269)	(0.0257)	(0.0333)	(0.0254)	(0.0332)	(0.0238)
$Log(Age)^2$	-0.0003	-0.0019	-0.0136*	-0.0062	-0.0200**	-0.0066	-0.0162*	-0.0109*
	(0.0050)	(0.0063)	(0.0053)	(0.0049)	(0.0066)	(0.0051)	(0.0064)	(0.0046)
Log(Sales)	0.0261***	0.0379***	0.0225***	0.0278***	0.0279***	0.0214***	0.0262***	0.0197***
	(0.0017)	(0.0020)	(0.0019)	(0.0017)	(0.0021)	(0.0018)	(0.0020)	(0.0017)
International	0.0306***	0.0246***	0.0575***	0.0142*	0.0881***	0.0552***	0.0311***	0.0452***
	(0.0061)	(0.0069)	(0.0071)	(0.0059)	(0.0083)	(0.0063)	(0.0079)	(0.0059)
Scientific skills	0.2075***	0.2148***	0.1750***	0.1204***	0.4038***	0.2282***	0.2955***	0.2327***
	(0.0245)	(0.0289)	(0.0277)	(0.0233)	(0.0379)	(0.0254)	(0.0371)	(0.0255)
Other skills	0.1279***	0.1587***	0.1792***	0.0932***	0.2034***	0.0992***	0.1952***	0.1438***
	(0.0158)	(0.0151)	(0.0184)	(0.0169)	(0.0190)	(0.0155)	(0.0209)	(0.0159)
Current LBO	0.0496**	0.0827***	0.0572**	0.0234	0.0500*	0.0131	0.0075	0.0335†
	(0.0165)	(0.0209)	(0.0183)	(0.0157)	(0.0220)	(0.0167)	(0.0204)	(0.0172)
Future LBO	0.0514	0.1564***	0.1328**	0.0550†	0.1249**	0.0449	0.1034**	0.0774*
	(0.0352)	(0.0430)	(0.0407)	(0.0288)	(0.0444)	(0.0335)	(0.0396)	(0.0328)
Period dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,598	19,582	19,571	19,586	19,585	19,653	19,566	19,522
Current=Future LBO	0.00	2.74†	3.26†	1.20	2.96	0.80	4.83*	1.54

Marginal effects are reported. Robust standard errors are clustered for 201 period-sector-region clusters and reported in round brackets. Current=Future LBO corresponds to the χ^2 test that the coefficients of Current LBO and Future LBO are equal. ***: p-value<0.1%, **: p-value<1%, *: p-value<5%, †: p-value<10%.

Appendix 1 - Eurostat indicators of High-tech industry and Knowledge - intensive services (HTKIS)

High-tech aggregation by NACE Rev. 1.1

Aggregations of manufacturing based on NACE Rev 1.1

Eurostat uses the following aggregation of the manufacturing industry according to technological intensity and based on NACE Rev. 1.1 at 3-digit level for compiling aggregates related to high-technology, medium high-technology, medium low-technology and low-technology. Please note that in a few cases (R&D, Employment in high-tech and HRST), due to restrictions of the data sources used, the aggregations are only made on a NACE 2-digit level. This means that High-technology includes the NACE codes 30, 32 and 33, Medium-high-technology 24, 29, 31, 34 and 35, Medium-low- technology 23 and 25 to 28 and Low technology 15 to 22 and 36 to 37.Eurostat indicators of High-tech industry and Knowledge - intensive services Annex 2 – High-tech aggregation by NACE Rev. 1.1

Aggregations of services based on NACE Rev 1.1

Following a similar approach as for manufacturing, Eurostat defines the following sector as knowledge-intensive services (KIS) or as less knowledge-intensive services (LKIS):