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Anne-Laure Le Nadant et Frédéric Perdreau

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Résumé de l'article

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Efectos de los LBO en la innovación: el caso de Francia

ANNE-LAURE LE NADANT
Normandie Université
IAE Caen, NIMEC (EA 969)

FRÉDÉRIC PERDREAU
Université de Lyon Saint-Etienne
COACTIS (EA 4161)

Résumé

À partir des données CIS pour la France, nous analysons les efforts d'innovation d'entreprises industrielles ayant fait l'objet d'un LBO. Nous ne trouvons pas d'effet négatif des LBO sur le niveau des dépenses d'innovation des entreprises concernées. En revanche, les résultats suggèrent que les buyouts ont un effet positif sur l'innovation incrémentale et que les capital-investisseurs aident les entreprises à rendre les dépenses d'innovation plus efficaces et même plus efficientes. Il est possible que les capital-investisseurs aident l'entreprise à se concentrer sur ses capacités d'innovation essentielles et à mettre des produits innovants sur le marché sans augmenter les dépenses d'innovation.

Mots-clés : Coûts d'Agence, Leveraged Buyouts, Innovation, Capital-Investissement, Appariement par Score de Propension, Entrepreneuriat Stratégique.

Abstract

Using Community Innovation Survey data from France, we provide an empirical analysis of the innovative efforts of a sample of manufacturing firms that underwent a leveraged buyout. We find no evidence that LBOs have a negative effect on firm level of innovation expenditure. In contrast, results suggest that buyouts have a positive effect on incremental innovation and that private equity firms help to make innovation spending more effective and even more efficient. It could be that private equity firms help the company to focus on its core innovative capabilities and bring innovative products to the market without increasing innovation spending.

Keywords: Agency Costs, Leveraged Buyouts, Innovation, Private Equity, Propensity Score Matching, Strategic Entrepreneurship

Resumen

A partir de los datos CIS por Francia, se analizan los esfuerzos de innovación de empresas industriales que fueron objeto de un LBO. No se encuentran efectos negativos de los LBO sobre el nivel de los gastos de innovación de dichas empresas. Al contrario, los resultados sugieren que los buyouts tienen un efecto positivo sobre la innovación incremental y que los capital inversores ayudan a las empresas a hacer más eficaces y aún más eficientes los gastos de innovación. Es posible que los capital inversores ayuden a la empresa a concentrarse en sus capacidades de innovación esenciales y a lanzar productos innovadores al mercado sin aumentar los gastos de innovación.

Palabras claves: Costes de Agencia, Leveraged Buyouts, Capital inversión, Pareamiento por Puntaje de Propensión, Emprendimiento Estratégico.

Critics of Leveraged Buy-Outs (LBOs) argue that the high leverage characteristic of these deals prevents investment and increases the risk of future bankruptcy whereas private equity supporters point out that investors create value by improving management incentives and by contributing with financial and operational expertise to their portfolio companies. These concerns give rise to the need to assess the impact of LBOs on innovation. France is an interesting setting to investigate the impact of LBOs on innovation because the French private equity market (comprising both venture capital and buyouts) is the second largest in Europe after the United Kingdom (UK), with about 6 billion Euros of funds invested in 2012 (AFIC, 2013). Buyouts constituted the majority of PE funds, reaching 58% of investments.

LBOs usually involve: (1) the acquisition of a divested division or subsidiary or of a private family owned firm by a newly created acquisition vehicle, (2) increased leverage in order to facilitate the acquisition and improve return on equity, (3) an increased concentration of equity held by managers in order to provide high-powered incentives, and (4) active monitoring of strategic decisions and financial performance through taking board seats and specifying detailed reporting requirements. Although the change in governance resulting from LBOs is generally found to exert a positive impact on firm's economic and financial performance (see e.g. Cumming et al., 2007), a common view in the media is that these transactions are associated with cost-cutting activities and short-termism, to the detriment of innovation and Research and Development (R&D) investments. Evidence regarding the impact of LBOs on innovation and R&D is not conclusive. While the early studies found that companies cut their innovation and R&D investments after an LBO (Smith, 1990), more recent studies show no decrease in innovation activities (Ughetto, 2010; Lerner et al., 2011).

In this study, we find no evidence that LBOs have a negative effect on firm level of innovation expenditure. In contrast, results suggest that buyouts have a positive effect on incremental

innovation and that private equity firms help to make innovation spending more effective and even more efficient.

We contribute to the literature on real effects of buyouts in two ways. First, we contribute by using an innovation survey that has never been used to analyze buyouts. Existing studies have focused on expenditures on R&D and patenting activity as measures of innovative activity. However, not all research expenditures are well spent and the literature acknowledges that the use of patents is not a perfect measure of innovative activity. Thanks to broader definition and measures of innovation, CIS data substantially enhance our ability to measure and study the impact of LBOs on innovation. Second, nearly all studies on LBOs and innovation have concentrated on the US and the UK[1]. By shifting the focus to France and following Boucly et al. (2011), this study investigates the possibility that some LBOs aim to seize innovation opportunities and expand the scale and scope of the target's activities. France provides an interesting context to study LBOs and innovation because in this country LBOs often involve private family-managed and family-owned firms[2] that tend to be, on average, smaller than non-family firms and for which access to external finance may be more difficult than in the US or the UK. France has less developed stock markets than do the US or the UK, and the private equity market is also less mature there than in the US or the UK (Engel and Stiebale, 2014). In addition, LBOs involve more mature firms in France than in the US or the UK (Boucly et al., 2011).

The remainder of the paper is as follows. In Section 2, we summarize the relevant literature and outline our research hypotheses. In Section 3, we present our sample and methodology. The empirical findings are presented in Section 4 whereas robustness checks appear in Section 5. Concluding remarks are provided in Section 6.

Related literature and research hypotheses

The term "innovation" is predominantly linked to the R&D associated with creating new products (Armbruster et al., 2008). There are many studies on innovation, which reveal that increased R&D activities lead to innovative products, which enable companies to achieve competitive advantages and to gain market shares (e.g. Freeman and Soete, 1997). However, the Oslo Manual (2005) distinguishes innovation in four areas (product, process, marketing and organizational) and considers a broad definition of innovation as: "an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". In this study, in order to assess the post-LBO targets' innovative activity, we rely on this definition of innovation.

Whether LBOs have an impact on innovation is not clear, a priori. Both positive and negative effects are likely to occur.

Agency theory has traditionally presented buyouts as a superior governance framework that generates economic efficiencies in the short term. There is an abundant literature on agency theoretical explanations for a focus on restructuring and efficiency after LBOs (see e.g. for an overview Wood and Wright, 2009 and Wright et al., 2009). Increases in operating performance may be achieved through significant reductions in agency costs arising from debt bonding, management equity ownership, and active monitoring by PE investors (Jensen, 1993). But LBO funds, driven by short-term profit motives, might sacrifice long-term growth and innovation to boost short-term performance. Their focus usually lies on a period that will allow them to successfully exit from the investment. So in comparison to investors on the public capital market, they are longer-term investors, while in comparison to owners such as families, they have a shorter-term investment horizon. Therefore, technological matters may be delayed or set aside because managers may be more oriented to day to day operations resulting from the transaction (Hitt et al., 1996) or because private equity firms exert pressure on management to focus on investment opportunities that are less uncertain and more rewarding in the short term (Ughetto, 2010).

The level of debt increases substantially after an LBO (Acharya et al., 2007). In the academic literature, evidence suggests that buyouts result in increased financial constraints in previously unconstrained firms (Bertoni et al., 2013). This could hamper R&D efforts and spending. However, Boucly et al. (2011) show that, instead of reinforcing credit constraints, as it was the case in the 1980s transactions, today's LBOs can alleviate them.

Evidence regarding the impact of LBOs on investment in innovation and R&D is so far limited and rather mixed. Some studies in the US show a decline in R&D spending (Long and Ravenscraft, 1993) whereas others find no decline (Lichtenberg and Siegel, 1990) or stability (Smith, 1990) of research spending after the LBO. However, as most firms involved in LBOs do not belong to technology-intensive industries, the impact of LBOs on cumulative innovation is likely slight (Hall, 1990). In industries where R&D requirements are more crucial, these expenditures are used more effectively. Zahra (1995) finds, on a sample of 47 LBOs, that firms involved develop more new products and intensify their efforts in terms of innovation and productivity (even if at the same time the level of R&D expenditure doesn't change). Wright et al. (2001a) provide several examples of buyouts in technology-based industries followed by significant increases in product and technology development, R&D and patenting. Malone (1989) and Wright et al. (1992) also cite evidence of new product innovation following buyouts. This

1. The only exception we are aware of is the study of Western Europe by Ughetto (2010). More generally, there are hardly LBO studies from continental Europe (see Gilligan and Wright (2010) for an overview).

2. In France, the proportion of family firms is higher than in the UK. As stated by Mandl (2008) using data from FBN International (2008), family firms account for 83 percent of all businesses in France versus 65 percent in the UK.

discrepancy in empirical results could be due to the heterogeneity of the buyouts and it suggests that contextual factors are important. Empirical results are divergent because there are differences in R&D need for different buyout types (Wright et al., 2001b).

Thus, under the agency-theoretical view, being strongly committed to servicing debt obligations and the pressure on management to focus on day-to-day operations and more short term rewarding projects should translate into a negative impact on R&D spending. However, innovation activities and outputs that do not translate directly into costs (organizational method in business practices, workplace organization or external relations) may not be concerned. Furthermore, efficiency gains may arise, enabling innovation outputs to be maintained. Hence, from the agency view, we state the following hypothesis:

Hypothesis 1. LBOs have a negative impact on firm level of technological innovation expenditure.

Although buyout studies with respect to agency theory have stressed the importance of efficiency and restructuring activities, they have neglected the catching up of the radical innovations necessary to achieve a competitive advantage. Recently, a number of studies highlight the fact that private equity firms help portfolio companies to focus their innovation efforts by introducing criteria such as probability of success and economic value of the potential innovation. For instance, Lerner et al. (2011) investigate 472 LBOs with a focus on investments in innovation as measured by patenting activity. They find no evidence that LBOs are associated with a decrease in these activities. They find that patents granted to firms involved in LBOs are more cited (a proxy for economic importance) and show no significant shifts in the fundamental nature of the research. Moreover, Ughetto (2010) has focused on innovation of Western European manufacturing firms undergoing an LBO. She finds that the innovation activity of portfolio firms (measured by the number of patents granted) is affected by different types of investors, pursuing different objectives.

Hence, if some UK and US based studies show a decline in investment expenditure after LBOs, critical investments in R&D seem to be maintained. Overall, private equity appears to be associated with a beneficial refocusing of firms' efforts to deliver increased innovation. This is so because private equity investors also provide corporate governance support and business expertise to improve firms' innovation efforts. A number of studies point to the impact of private equity on improved corporate governance, for example systemization of innovation efforts and improvements to the management of the innovation process. These include Bruining et al. (2013), which used survey evidence from 108 buy-outs in the Netherlands, and Meuleman et al. (2009), which used evidence from 238 private equity-backed buyouts in the UK.

This evidence supports a strategic entrepreneurship perspective of buyouts – grounded in the resource-based view-, which considers that these transactions foster entrepreneurial initiatives, enabling managers to better and more thoroughly exploit firm resources for new innovation projects (Wright et al., 2001a). Innovation requires the entrepreneurial capabilities of opportunity recognition and opportunity exploitation (Withers et al., 2011). The private equity firm's expertise and competencies with regard to strategy, operational and financial management, human resources, marketing policy, and mergers and acquisitions help identify an opportunity for innovation and create value for the target firm (Lee et al., 2001; Wright et al., 2001b). Private equity-backed buyouts can also make use of the private equity firm's extensive network and relationships (customers, suppliers, other investors, access to more sophisticated resources in banking, and legal and other areas) to leverage their capabilities for innovation. In particular, private equity firms' networks may put them in a position to provide resources and capabilities the management of the buyout firm is currently missing (Meuleman et al., 2009). Moreover, inside management does not always own the tacit knowledge and idiosyncratic skills required to seize new opportunities (Hendry, 2002). If major innovation is required, it may be necessary to introduce outside managers who do own these skills (Wright et al., 2001a). In this situation, the private equity firm plays an important role in assessing the skills of the incumbent managers and their potential replacements (Meuleman et al., 2009).

Further, even if LBOs have no impact on the level of innovation expenditure, LBOs might affect innovation outcomes. Indeed, LBOs might foster entrepreneurial initiatives and innovation projects that are not costly and do not require important expenditure. Product (goods or services) and process innovations relate to technological innovations and arise from investment in innovation inputs. But important differences exist between service and goods innovations, with service innovations being particularly related to human resource development and closer links to customers (Santamaria et al., 2012). In addition, more effective innovation processes or methods may actually lead to lower innovation expense (De Man and Duysters, 2005). In contrast, non-technological (organizational and marketing) innovations mainly arise from investment in intangible inputs that is less costly. Organizational innovations also "present an immediate source of competitive advantage since they themselves have a significant impact on business performance with regard to productivity, lead times, quality and flexibility" (Armbruster et al., 2008).

Therefore, we formulate:

Hypothesis 2. LBOs have a positive impact on firm innovation outcomes.

The innovation outputs in the hypothesis H2 relate to both technological and non-technological innovation.

Both hypotheses H1 and H2 look at two different kinds of variables (R&D and innovation costs versus innovation activities and outputs) and stem from two research frameworks but they do not compete against each other. Their

combination enables us to evaluate the impact of LBOs on both innovation activities and innovation efficiency and to assess the relative explanatory power of the two frameworks for different innovation dimensions. For example, the corroboration of both H1 and H2 would indicate a strong impact of LBOs on innovation efficiency and a complementarity of agency and strategic entrepreneurship theories in the explanation of this impact. The corroboration of H1 only would indicate that the cost cutting effect predicted by agency theory is at work but does not necessarily translate into efficiency gains (at least for the innovation activities).

LBOs may also have an impact on other innovation-related concepts. In particular, the barriers to innovation might be impacted by the occurrence of an LBO because private equity investors may take a short-term perspective that hamper long-run investments and because the high amount of debt can lead to financial constraints. But, as theoretical and empirical contributions also suggest that LBOs can shift resources to more efficient uses and more active managers, we offer no hypothesis concerning the impact of LBO on the factors constraining innovation.

The use of patents and other protection methods might also be impacted by the occurrence of an LBO because private equity firms, as active shareholders, can bring support and advice to managers to enhance the protection of innovation. In contrast, the use of protection methods is costly, which can be an obstacle within an LBO context. Given the ambiguity about the LBO's effect, we offer no hypothesis concerning the impact of LBO on the factors constraining innovation and the use of protection methods. Hence, we state the following hypotheses:

Hypothesis 3. LBOs have an impact on the factors constraining innovation.

Hypothesis 4. LBOs have an impact on the use of patents and other protection methods.

Finally, it is also important to note that LBOs might affect targets differently according to market conditions. More precisely, a period of low economic growth may entail stronger constraints on innovation because of a lack of in-house financial resource or external finance. In contrast, a period of recovery may be more favorable to innovation activities.

Sample and methodology

Sample construction

To analyze the impact of LBOs on innovation at the company level, we use a new database built from four different databases: Capital IQ (to isolate transactions), CIS 2006 and CIS 2004 (for innovation data) and DIANE (for financial statements). To our knowledge, this is the first study to use CIS surveys (Community Innovation Survey) in relation with LBOs. Community Innovation Surveys are conducted at regular intervals in Europe. Questions are based on the Oslo Manual guidelines, which distinguishes four types of innovations: product innovations, process innovations, organizational innovations and marketing innovations. The Oslo Manual opted for collecting data at the firm level, including all its innovation outputs and activities, which is also the level of available accounting and financial data that can be merged with the innovation data for richer analyses.

CIS data are increasingly being used as a key data source in the study of innovation at the firm level. CIS surveys of innovation are often described as 'subjective' because they ask individual firms directly whether they have been able to produce an innovation and to estimate the share of sales that could be ascribed to new or significantly improved products. The assessment of the innovative character of a particular activity is at least partially dependent on the views of the performer. However, the evidence provided by Mairesse and Mohnen (2005) suggests that the subjective measures appear to be consistent with more objective measures of innovation, such as the probability of holding a patent and the share in sales of products protected by patents. The main advantage of the CIS data is that it contains detailed information on the innovation behaviour at the firm level in much greater detail than in other datasets. Thus, CIS data provide the possibility to study the innovation behaviour of LBO targets in a differentiated and detailed way. The main drawback of the CIS data for the analysis of LBOs activity is that it is a cross-sectional dataset.

CIS 2006 was launched in 2007, based on the reference period 2006, with the observation period 2004 to 2006. The population of the CIS is determined by the size of the enterprise and its principal activity. All enterprises with 20 or more employees in any of the specified sectors were included in the statistical population. The following industries were included in the population of the CIS 2006: mining and quarrying (NACE 10-14), manufacturing (NACE 15-37), electricity, gas and water supply (NACE 40-41). Three reference periods were used in the questionnaire:

The first relates to a set of questions for the whole of the period 2004-2006, for example whether the enterprise introduced an innovation at any time during this three-year period.

- The second set of questions refers uniquely to the reference year 2006, for example, indicators such as innovation expenditure.
- Finally, a limited number of basic economic indicators were requested for both 2004 and 2006, for example the turnover and employment figures.
- Similarly, CIS 2004 is based on the reference period 2004, with the observation period 2002 to 2004.

We first identify 1,140 French deals over 1999-2005 reported as being "LBOs" from Capital IQ. More precisely, we retrieve all the deals from Capital IQ with the following

characteristics: (i) they are announced between 1999 and 2005 (ii) either "closed" or "effective" (iii) reported by Capital IQ as being "LBOs". Most of the targets are medium sized, privately held firms. We then obtain innovation data from CIS 2004 and CIS 2006. Our transaction and innovation data do not have the same identifier so we match them by company name. Names are not always identical in both databases, so in case of ambiguity we resort to company websites and annual reports. The matching process reduces sample size to 154 transactions that have either data in CIS 2004 or in CIS 2006[3]. Our analysis requires availability of financial statements in Diane (Bureau Van Dijk) for the year preceding the transaction. This requirement reduces the final sample to 110 LBOs for which we have both financial data and innovation data (either in CIS2004 or in CIS2006). Table 1 summarizes the characteristics of this sample[4]. Manufacture of electrical equipment (NAF Rev1 31) and Manufacture of chemicals and chemical products (NAF Rev1 24) are the most important sectors in terms of number and value of deals. In terms of size, the sample is mostly constituted of relatively small companies: 37% of targets have less than 20 million (M) Euros in sales at the time of the deal, and 70% have less than 75M. Companies with sales above 75M constitute 30% of number but 73% of the value of deals[5].

Methodology

Gauging effects of LBOs on innovation is not trivial because LBOs do not occur randomly across the population of firms. Investors select LBO targets, presumably because of their value creation potential (Gaspar 2012). If an outside observer concludes that the average level of innovation output of firms targeted by an LBO is higher than in other firms, one cannot rule out the possibility that this finding is due to the fact that LBO investors tend to select better firms on average relative to the population.

To assess the effect of LBOs on innovation variables, we use Propensity Score Matching (PSM) methodologies, which address the problem of sample selection bias (Heckman et al., 1999; Rubin, 1974). We benchmark the level of innovation of LBO firms by selecting appropriate matching control firms to each LBO. The set of matching control firms is composed of firms that share the same financial characteristics as the LBO firm prior to the transaction. To select matching firms that have ex-ante the same probability of being selected by LBO investors, we implement a logit model to estimate the likelihood of being an LBO target in the period and we use the probability estimate from that model to find a matching control for a firm that indeed was the target of an LBO deal[6]. We run the matching procedure in the year before firms receive an LBO in order to exclude any selection effect.

The main steps of the PSM procedure are as follows. First, we introduce filters to obtain a dataset composed of about 1,600 companies. We need to do this because fitting a discrete choice regression model where the number of 'zeros' (that is, observations where the firm is not an LBO target in a given year) is very high relative to the number of 'ones' (that is, observations where the firm is an LBO target in a given year) results in poor estimates. This is the case since CIS 2004 and CIS 2006 contain data for about 12,700 (7,537+ 5,179) manufacturing companies, and the sample contains 154 LBOs (1,2% of the dataset, of which 110 have financial data). We therefore introduce filters to obtain a manageable number of non-LBO observations. For each LBO company in a year, we randomly choose 12 non-LBOs which have financial data available in the preceding year. The matching methodology allows us to retain 1,420 "twin" companies to the sample, i.e. 12.9 twins by target with financial data for the year preceding the transaction. We keep 1,420 as a number that seems reasonable because it means that LBOs constitute about 8% of the regression sample.

Second, we run a logit regression that models the likelihood of a firm being the target of an LBO in a particular year. Denote by h_k^* the latent unobservable variable that represents the net present value of the acquisition of firm k by a bidder and $h_{k,t}$ a dummy that takes the value of 1 if an LBO bid is made in year t: $h_{k,t} = 1$ if $h_{k,t}^* > 0$ or $h_{k,t} = 0$ if $h_{k,t}^* < 0$. The logit regression to be estimated for the probability of $Pr(h_{k,t} = 1)$ is:

$$h_{k,t}^* = \alpha + W_{k,t}\,\delta + \upsilon_{k,t} \quad (1)$$

The matrix $W_{k,t}$ contains firm-specific variables that the literature has identified as determinants of the likelihood that a firm is an LBO target, namely firm size (measured by natural logarithm of turnover), the debt-equity ratio, the level of income taxes (measured by the ratio of income taxes to turnover), the firm's profitability (measured by ROIC), liquidity (proxied by cash divided by assets) and level of working capital. We also include the capitalized R&D expenditures divided by total assets to avoid the situation whereby the buy-out firms will be initially higher/lower on innovation

3. In this study, we focus on the manufacturing sector (industry) while the initial total population of LBOs in France (1,140) takes into account all sectors.

4. Note however that in the following analysis sample sizes will vary for the different outputs as some CIS variables have missing values.

5. To investigate whether our final sample shares the same characteristics as the population of French LBOs, we compare the distribution of size in our sample with (i) histograms of size for the sample of French LBOs reported in Gaspar's study (2012) on a similar period, and (ii) histograms of size for Barclays' LBONet, a proprietary database of LBO deal flow on the French market, as reported by Gaspar (2012). We find that the proportion of small deals is slightly lower in our final sample than in Gaspar's sample but it is similar to the proportion in LBONet (e.g. 70% of firms with pre-LBO sales of less than 75M in our sample vs. 87% in Gaspar and 73% in LBONet). We are not able to compare the distribution of industry affiliation of our sample with histograms for Gaspar's sample or LBONet because in our study we focus on the manufacturing sector.

6. For a binary treatment variable, there is no strong advantage to use the logit vs. probit model. We also ran a probit model and found similar results.

TABLE 1
Descriptive statistics of LBOs sample

This table shows the number and value of deals in the sample. Value is measured using the sum of sales revenue of companies in each category, in thousands of Euros, for the year prior to the deal. Breakdown by sector follows the French classification named NAF revised 1 (Nomenclature d'Activités Française).

Panel A : Breakdown by year

	Number	%	Value	%
1999	13	11.8	611,773.50	9.3
2000	14	12.7	574,996.70	8.7
2001	18	16.4	1,099,627.30	16.7
2002	11	10.0	939,830.70	14.3
2003	16	14.5	1,057,394.70	16.1
2004	18	16.4	928,588.00	14.1
2005	20	18.2	1,364,967.50	20.8
Total	110		6,577,178.40	

Panel B : Breakdown by Sector

	Number	%	Value	%
14 Other mining and quarrying	1	0.91	170,684.00	2.60
15 Manufacture of food products	8	7.27	565,286.18	8.59
17 Manufacture of textiles	3	2.73	139,672.92	2.12
18 Manufacture of wearing apparel	3	2.73	84,633.31	1.29
19 Manufacture of leather and related products	1	0.91	92,269.76	1.40
20 Manufacture of wood and of products of wood	3	2.73	66,303.97	1.01
21Manufacture of paper and paper products	3	2.73	69,327.08	1.05
22 Printing and reproduction of recorded media	4	3.64	160,551.91	2.44
24 Manufacture of chemicals and chemical products	11	10.00	780,754.20	11.87
25 Manufacture of rubber and plastic products	2	1.82	68,648.68	1.04
26 Manufacture of other non-metallic mineral products	6	5.45	332,231.66	5.05
27 Manufacture of basic metals	5	4.55	642,844.39	9.77
28 Manufacture of fabricated metal products	10	9.09	305,491.63	4.64
29 Manufacture of machinery and equipment	8	7.27	434,901.60	6.61
31 Manufacture of electrical equipment	14	12.73	1,184,615.73	18.01
32 Manufacture of radio, television and communication equipment	6	5.45	728,892.58	11.08

TABLE 1 (continued)

33 Manufacture of optical, medical instruments, watches and clocks	4	3.64	60,561.15	0.92
34 Manufacture of motor vehicles, trailers and semi-trailers	7	6.36	190,805.03	2.90
35 Manufacture of other transport equipment	4	3.64	134,032.38	2.04
36 Manufacture of furniture and other manufacturing	3	2.73	200,040.48	3.04
40 Electricity, gas, steam and air conditioning supply	2	1.82	158,159.20	2.40
41 Water collection, treatment and supply	2	1.82	6,470.59	0.10
Total	110		6,577,178.43	

Panel C : Sample Breakdown by Sales revenues (Sales in Thousand of Euros)

	Number	**%**	**Value**	**%**
(0;20,000]	41	37.27	393,761.42	5.99
(20,000;75,000]	36	32.73	1,362,636.27	20.72
(75,000;150,000]	22	20.00	2,139,103.25	32.52
(150,000; max]	11	10.00	2,681,677.49	40.77
Total	110		6,577,178.43	

propensity than the rest of the firms. All these variables are measured the year before the transaction. Finally, we include LBO year and sector dummies to control for time effect and sector fixed effect.

The predicted value from regression model (1) is called the propensity score. Its interpretation is that it measures the probability, as predicted by the model, that a firm becomes an LBO target in a given year. In other words, firms with similar propensity scores share similar characteristics that lead to being an LBO target. They constitute therefore adequate benchmarks for LBO innovation capacity.

Third, we use propensity score to match comparison units with treated units. Smith and Todd (2005) note that measuring the proximity of cases as the absolute difference in the propensity score is not an approach that is robust to "choice-based sampling," where the treated are oversampled relative to their frequency in the population of eligible individuals (Caliendo and Kopeinig, 2008). As a consequence, we match on the log odds of the propensity score, defined as p/(1-p), to assure that results are invariant to choice-based sampling. We use the nearest-neighbor matching algorithm. We then measure, for each LBO, its level of innovation relative to the level of innovation of its matching control pair.

While this approach addresses sample selection issues, we also check for robustness using treatment effect models for continuous variables and special regressors estimators proposed by Dong and Lewbel (2012) for binary variables. Results are not presented here.

Results

Table 2 presents summary statistics for accounting measures of LBOs and the non-LBOs firms. Relative to their potential controls, LBO firms are larger (59 M in average turnover vs. 37M) and more profitable (15% vs. 0.004% in terms of average ROIC), and they have higher income taxes expenses the year before the deal (2.08% of sales for LBO vs. 1.64% for non-LBO).

The results of the logit model show that the largest and most profitable firms and those that have the highest levels of income taxes and working capital have a higher probability of being an LBO target (Table 3). To conserve space, industry and LBO year effects are not reported but we find that companies in the manufacture of electrical equipment (NAF 31) have a higher likelihood of being an LBO target. In contrast, firms' financial structure and liquidity do not seem to explain LBO likelihood.

Table 4 reports both unmatched and matching estimates (average treatment on the treated, ATT) of the effect of LBOs on firm level of innovation, measured as innovation expenditure in 2006 (2004) divided by turnover in 2006 (2004)[7]. The matching estimates (average treatment on the treated, ATT) of the effect of LBOs on firm level of innovation show no significant differences between LBO targets and comparable companies that did not go through an LBO whatever the period. Moreover, we find no significant effect of LBOs on innovation expenditure in a shorter term on total sample (no impact of LBOs in years N-2 and N-1 on innovation expenditure in year N). In addition, there is no significant long-term effect (effect of LBOs in years N-6, N-5, N-4, and N-3 on innovation expenditure in year N)[8]. The hypothesis H1 is thus not corroborated and evidence suggests that private equity intervention is not detrimental to investments in innovation.

A listing of the innovation variables used in the empirical analysis along with their definitions is provided in Appendix A. Table 5 presents PSM estimations on innovation outcomes for LBOs that occurred from 1999 to 2004 (82 LBOs). As questions in CIS 2006 relate to the 2004-2006 period, we exclude 20 LBOs that occurred after 2004 from the sample to run these estimates.

Regarding product and process innovations, we find that LBO targets in period 1 are more likely to implement product and service innovation and improved supply chain process. Hence, results suggest that LBOs during this period (1999-2001) lead to the introduction of new or improved

TABLE 2
Summary statistics

This table shows the summary statistics for sample deals for the year before the deal. « LBO companies » refers to statistics of the sample of LBO firms. « Non-LBO companies » refers to statistics of the sample of all non-LBO companies from which matched controls are chosen using a propensity score model. All these accounting variables are obtained from DIANE. Turnover is in thousands of Euros. Income taxes expense and working capital are divided by turnover. Working Capital is divided by net fixed assets. Debt-to-equity is measured by financial debt divided by shareholders' equity (in %). R&D expenditure is divided by net total assets.

	Variable	Obs.	Mean	Std. Dev.	Min	Max
Non-LBO companies	Turnover	1576	37,650,177.2	77,704,193.5	39,775	922,170,688
	ROIC	1576	.00004	4.5809	-180.7912	8.1558
	Income taxes	1576	.0164	.0295	-.2115	.5987
	Working capital	1576	.1460	.2190	-2.0513	2.6037
	Liquidity	1576	.0513	.1445	0	3.0958
	Debt-to-equity	1576	.4992	63.9588	-2066.2487	1060.2071
	R&D expendit.	1576	.0044	.0322	0	.6366
LBO companies	Turnover	110	59,792,531.2	78,314,281.2	20,123	483,000,000
	ROIC	110	.1577	.2148	-1.0488	.7750
	Income taxes	110	.0208	.0307	-.1609	.1098
	Working capital	110	.2052	.6217	-.2257	6.4498
	Liquidity	110	.0424	.0698	0	.4530
	Debt-to-equity	110	.5486	1.9620	-5.8072	17.2100
	R&D expendit.	110	.0026	.0128	0	.0732

7. The Stata psscore command executes a conditional test of differences about groups of propensity scores. The balancing property was satisfied.

8. These results are not reported here.

products and to significant improvements in how services are provided (for example, in terms of their efficiency or speed), the addition of new functions or characteristics to existing services, or the introduction of entirely new services (H2 corroborated). However, as we also find a positive effect on innovations that are new to the firm (for both periods) but no effect on innovations that are new to the market, we can conclude that LBOs lead to minor product innovations that have already been implemented by other firms. Hence, it is likely that the nature of the innovation in LBOs is based upon incrementally improving current products for existing markets rather than developing new products and processes (Zahra and Fescina, 1991).

In contrast, regarding organizational and marketing innovations, we find no significant effects. We also find no effect of LBOs on the methods of protecting innovations for the whole sample (both periods). H4 is thus not corroborated. In particular, contrary to Ughetto (2012) who finds a negative effect on firms' patenting activity, we show that LBOs have no impact on the use of patents. This result is in line with Lerner et al. (2011), who find no evidence that LBOs are associated with a decrease in patenting activity. However, results for period 1 show a positive effect of LBOs on the use of trademarks whereas results for period 2 reveal a positive effect of LBOs on the use of secrecy.

Overall, H2 finds some support (LBOs have a positive impact on innovation outputs) whereas H1 is rejected (LBOs have no negative impact on R&D expenditure). But one must not conclude that these results indicate a better explanation of LBOs effect by strategic entrepreneurship theory compared to agency theory. The picture that emerges shows that the innovations in LBO targets are not radical innovation but minor product innovation, and this result is obtained without increasing R&D spending. The picture fits well with the efficiency gains at the heart of agency theory. However, this efficiency is not obtained through mere cost cutting, but rather through innovations, which support an entrepreneurship perspective.

TABLE 3
Estimations of the Logit model

Turnover is in thousands of Euros. Income taxes and working capital variables are divided by turnover. Liquidity variable is measured by cash and cash equivalents divided by total assets. Debt-to-equity is financial debt divided by shareholders' equity. R&D expenditures is divided by net total assets. Industry and LBO year (dummy variables) are included as control variables.

Independent variables	Coef	Std. Error
Turnover	.3913***	.0544
ROIC	.5307**	.2280
Debt-to-equity	.0001	.0023
Income taxes	4.6658*	2.6196
Liquidity	-.8707	1.2594
Working capital	.5078*	.2794
R&D expenditure	-2.8369	4.9260
Control variables :		
LBO year dummies	Yes	
Industry dummies	Yes	
Constant	-8.5758***	1.1947
Number of Obs. = 1666 (110 LBOs) LR Chi2(35) = 101.52 Prob > Chi2 = 0.0000 Pseudo R2 = 0.1157		

Notes : Significance levels : ***(1 %), **(5 %) and *(10 %).

TABLE 4
Results of Propensity Score Matching : Effects of LBOs on the level of innovation expenditure

For LBOs in period 1 (years 1999, 2000, 2001 and 2002), ex post innovation expenditure is measured by all innovation expenditure in 2004 declared by firms as a percentage of turnover the same year. For LBOs in period 2 (years 2002, 2003, 2004 and 2005), ex post innovation expenditure is measured by all innovation expenditure in 2006 declared by firms as a percentage of turnover the same year.

Variable : innovation expenditure	Treated	Controls	Difference	S.E.
Unmatched	.0145	.0308	-.0162	.0142
ATT	.0152	.0281	-.0129	.0103
Number of observations (period 1)	44	519		
Unmatched	.0201	.0197	.0004	.0078
ATT	.0204	.0196	.0008	.0075
Number of observations (period 2)	64	525		
Total number of observations (period 1+2)	108	1044	-.0047	.0110

Notes : Significance levels : ***(1 %), **(5 %) and *(10 %).

TABLE 5
Results of Propensity Score Matching: ATT estimates of innovation outcomes

The average treatment effect on the treated (ATT) is estimated in terms of different innovation outcomes for firms involved in LBOs. For LBOs in period 1 (years 1999, 2000, 2001, and 2002), innovation outcomes refer to the time period 2002-2004. For LBOs in period 2 (years 2002, 2003, 2004, and 2005), innovation outcomes refer to the time period 2004-2006. Differences between treated and untreated (controls) are computed for each period. A global ATT is computed for the whole period.

Variable type	Variable code	Difference for period 1	Difference for period 2	Global ATT (period 1+2)	Global S.E.
Product innovations	inpdgd	.3333***	.0930	.2025	0.1665
	inpdsv	.3333***	0	.1518	01942
	newmkt	.1388	.0930	.1139	0.1155
	newfrm	.2500***	.1860*	.2151**	0.1151
	turnmar	-.0036	-.0288	-.0173	0.0362
	turnin	.0466	.0234	.0340	0.0295
	turnung	-.0430	.0053	-.0167	0,0537
	Nb obs Treated	36	43	79	
	Nb obs Untreated	419	356	775	
Process innovations	inpspd	.0833	.0232	.0506	.1202
	inpslg	.1944**	0	.0886	.1357
	inpssu	-.0833	0	-.0379	.0966
	Nb obs Treated	36	43	79	
	Nb obs Untreated	419	356	775	
Organizational innovations	oorgbup	na	-.0465	na	na
	oorgkms	-.1111	-.0697	-.0886	.1100
	oorgwkp	.0555	-.0232	.0126	.1218
	oorgexr	.1111	0	.0506	.1125
	Nb obs Treated	36	43	79	
	Nb obs Untreated	419	356	775	

TABLE 5 (continued)

Marketing innovations	mktdgp	.1388	.1875	.1538	.1370
	mktpdp	na	-.0625	na	na
	mktpdl	-.0277	-.1250	-.0576	.1396
	mktpri	na	-.0625	na	na
	Nb obs Treated	36	16	52	
	Nb obs Untreated	419	125	544	
Patents and other protection methods	ProPat	0	-.1162	-.0632	.1278
	ProDsg	-.0277	.0697	.0253	.1157
	ProTm	.3333***	-.0232	.1392	.2092
	ProCp	0	0	0	.0751
	prosol	na	0	na	na
	ProSct	-.1388	.1395**	.0126	.1709
	ProCon	0	-.0930	-.0506	.1184
	ProTech	-.0277	-.0697	-.0506	.1090
	Nb obs Treated	36	43	79	
	Nb obs Untreated	419	356	775	
Factors hampering innovation activities	HFent	.7222***	.0930	.3797	.3966
	Hfout	.3611*	.0465	.1898	.2688
	Hcos	.0555	.3023	.1898	.3033
	Hper	.6111***	.1395	.3544	.3267
	Htec	.0833	-.1162	-.0253	.2304
	Hinf	.2222	-.1395	.0253	.2632
	Hpar	-.2500	-.0697	-.1518	.2302
	Hdom	.6388***	-.1395	.2151	.4594
	Hdem	.0277	.2325	.1392	.2659
	Hprior	-.0277	-.2558	-.1518	.2385
	Hmar	.1388	-.1395	-.0126	.2726
	Nb obs Treated	36	43	79	
	Nb obs Untreated	419	356	775	

Notes : Significance levels : ***(1 %), **(5 %) and *(10 %).

Last, innovation activity may be hampered by a number of factors. There may be reasons for not starting innovation activities at all, or factors that slow innovation activity or have a negative effect on expected results. These include economic factors, such as high costs or lack of demand, and enterprise factors, such as a lack of skilled personnel or knowledge. Regarding obstacles to innovation, results show a positive effect of LBOs in period 1 on four factors hampering innovation activities: lack of skilled personnel, lack of internal financial resource, lack of external resource and the fact that the market is dominated by established enterprises (H3 corroborated). These results suggest that LBO targets do not have the skilled personnel needed to engage in innovation activities, or their innovation activities may be slowed because they are unable to find the necessary personnel on the labor market. Moreover, contrary to Boucly et al. (2011) who show that LBOs can alleviate financial constraints and foster growth, our results suggest that LBO targets lack external financial resource for their innovation activities. Nevertheless, these results are not confirmed for period 2 (no effect of LBOs on obstacles to innovation). Results highlight a stronger effect of LBOs in period 1 for both innovation outcomes and factors hampering innovation. It could be that LBO targets in period 1, because they may be better innovators, feel more sharply the constraints on innovation than LBO targets in period 2, when the effect of LBOs on innovation variables is less significant.

Results also indicate that LBOs' effect is context-dependent, which may be due to a difference in economic conditions. Effect of LBOs on both innovation outcomes and factors hampering innovation is stronger when firms were surveyed regarding the 2002-2004 period (period 1) than when firms were surveyed regarding the 2004-2006 period (period 2). Yet the first period (2002-2004) refers to years of low economic growth (in particular 2002 and 2003), which may entail stronger constraints on innovation, whereas in the second period (2004-2006), growth recovers. Hence, unexpectedly, it seems that LBOs have a positive effect on innovation when economic conditions are less favorable. In a Schumpeterian view of business cycles and growth, in which "recessions provide a cleansing mechanism for correcting organizational inefficiencies and for encouraging firms to reorganize, innovate or reallocate to new markets" (Aghion et al., 2012), this result suggests that LBO targets are more reactive and adaptive.

Robustness checks

We evaluate the robustness of our results with treatment effects models, which also address the problem of sample selection bias. Classical tools can be used with continuous dependent variables, but a special case arises for binary choice models with endogenous regressors (Dong and Lewbel, 2012; Lewbel et al., 2012). Because our innovation variables are mainly binary, we had to use two different methodologies. Although this robustness check does not aim to offer a comprehensive model of innovation, these methodologies allow controlling for the effect of variables on innovation (initial level of R&D expenditure, group membership dummy, industry dummies).

For continuous dependent variables, we use a two-step selection method, which estimates two regressions simultaneously. In this case, the first equation is an explicit model of the LBO event, which controls for the part of the LBO event that is correlated with the error term of the second equation with innovation continuous output as the dependent variable. Hence, the first regression is a probit regression predicting the probability of treatment (LBO). It includes the same financial determinants of LBO likelihood as in the PSM methodology. The second regression is a linear regression for the continuous innovation outcomes as a function of the "treatment" variable, controlling for observable confounders. In this regression, we include the following variables: LBO (dummy), firm's size at the beginning of the period, group membership (dummy), initial R&D expenditure, industry dummies, LBO year dummies.

For binary dependent variables, we use special regressor estimators proposed by Dong and Lewbel (2012). Baum (2012) has developed a Stata implementation of the simple special regressor method, sspecialreg. We briefly explain the methodology[9]. Special regressor regression assumes that the model includes a particular "special regressor", V, that is exogenous and appears additively in the model. It must be continuously distributed with a large support. We choose the firm's age as special regressor because it has the required characteristics.[10] The excluded instruments for the LBO event are, once again, the same as in the PSM methodology. In the regression explaining the innovation (binary) outcomes, exogenous variables are the same as in the preceding treatment effect model: firm's size at the beginning of the period, group membership (dummy), initial R&D expenditure, industry dummies, and LBO year dummies. This regression also includes the LBO endogenous (instrumented) variable.

This method has advantages over methods that deal with the problem of endogeneity of regressor in binary choice models. In particular, it imposes far fewer assumptions on the error term. The advantage is that it is consistent under more general conditions, but the drawback is that it can be less efficient (if the conditions on the error terms are to be met). As such it is useful in providing robustness checks (Lewbel et al., 2012).

Regressions (available upon request) confirm that LBOs have no negative effect on innovation expenditure and on the percentage of turnover related to innovation. As for LBOs' effects on innovation binary variables, results confirm that LBOs have no effect on patenting activity and

9. For a detailed presentation, the reader is referred to Dong and Lewbel (2012).

10. As the special regressor has to be additive in the model, it can be "age" or "opposite of age" depending on the variable.

organizational innovation. They also confirm a positive effect on innovation new to the firm but no effect on innovation new to the market, and on one factor hampering innovation, the fact that the market is dominated by established enterprises. We also find complementary results as we show a positive effect on innovation in production process and on innovation in marketing methods in product placement. Some industry dummies are positively and significantly associated with innovation variables in several models, which indicates that it was important to control for industry effects in these data.

Conclusions

Hence, although most commentators in the public debate and many financial economists consider LBOs as a way to implement drastic, "cost cutting" measures, this paper provides no evidence that ex-post innovation expenditure is lower for LBO targets than for comparable firms in France. In addition, we find no evidence that, as for contribution to innovation, LBOs alleviate financial constraints or facilitate business relations.

In contrast, we find a positive effect of LBOs on product and service innovation for LBOs in period 1 but this effect is not related to radical or disruptive innovation as LBOs have a positive impact on product innovation that is new only to the firm (whatever the period). Hence, results suggest that buyouts have a positive effect on incremental innovation and that private equity firms help to make innovation spending more effective (i.e. by providing guidance and advice) and even more efficient. It could be that private equity firms help the company to focus on its core innovative capabilities and bring innovative products to the market without increasing innovation spending.

This result is in line with the idea that, following an LBO, management is not only focused on "cost cutting" activities that aim to increase value creation. Private equity firms also encourage managers of LBO targets to build new strategies to find and exploit value creation potentials. Further, these results emphasize the resources and capabilities that buyout specialists bring in terms of contribution to innovation to their portfolio companies as they suggest that LBOs do not lead to the acquisition of skills or resources that enable the introduction of disruptive innovation.

Contrary to Boucly et al (2011), results also suggest that LBOs do not alleviate financial constraints as we find a positive effect of LBOs in period 1 on the lack of financial resources as a factor hampering innovation. This result is in line with Bertoni et al. (2013). Moreover, as we find no effect of LBOs on innovations new to the market, it seems that LBOs do not help to achieve "radical" innovation. This result could be a clue that LBOs lead to the strengthening of financial and human resources constraints that hamper radical innovation. But another interpretation is also possible. It could be that, as better innovators, LBO targets feel more acutely the financial and human resources gap that has to be filled to achieve radical innovations. Further research is needed to disentangle these possible explanations.

Results also highlight that the effect of LBOs on innovation depends on macroeconomic conditions. The effect of LBOs on both innovation outcomes and factors hampering innovation is stronger for companies in the first survey reference period (2002-2004) than for those in the following reference period (2004-2006). Hence, it seems that LBOs have more positive effects on innovation when economic conditions are less favorable.

These conclusions have important managerial implications. LBOs are now common in manufacturing industries and managers have to realize that cost saving in innovation is not the main goal of private equity firms. On the contrary, LBOs can be a source of innovative renewal as private equity firms will encourage managers to enhance the competitive position of their products for instance by complementing their offer with services that add value to their products and satisfy more complex customer demands.

Several limitations of the study are worth noting. First, the sample period does not capture LBOs made during the 2006-2007 credit bubble. Financial conditions may influence the company's innovation activity over the post-buyout period and cost-cutting activities might be more crucial for firm survival for LBOs undertaken during this period. Second, the study focuses on French LBOs. A comparison of LBOs' effects on innovation in different European countries is a fruitful area for future research because different financial, fiscal, and legal environments make a difference to private equity finance. A more favorable framework will increase the supply of capital, and this in turn may influence LBO's effects on innovation.

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APPENDIX A
Innovation variables definitions

Variable type	Variable code	Variable definition
Innovation expenditure	Inno2006/ Inno2004	Innovation expenditure in 2006 (2004) as percent of turnover in 2006 (2004)
Product innovations	inpdgd	=1 if firm has introduced a new or significantly improved product on the market between 2004 and 2006 (2002 and 2004)
	inpdsv	= 1 if firm has introduced a new or significantly improved service on the market between 2004 and 2006 (2002 and 2004)
	newmkt	=1 if firm has introduced a product (good or service) new to the market between 2004 and 2006 (2002 and 2004)
	newfrm	=1 if firm has introduced a product (good or service) new to the firm between 2004 and 2006 (2002 and 2004)
	turnmar	Share of total turnover from products (goods or services) new to the market
	turnin	Share of total turnover from products (goods or services) new to the firm
	turnung	Share of total turnover from products that were unchanged or only marginally modified
Process innovations	inpspd	=1 if firm has introduced a new or significantly improved production process on the market between 2004 and 2006 (2002 and 2004)
	inpslg	=1 if firm has introduced a new or significantly improved supply chain process on the market between 2004 and 2006 (2002 and 2004)
	inpssu	=1 if firm has introduced a new or significantly improved support process on the market between 2004 and 2006 (2002 and 2004)
Organizational innovations	oorgbup	=1 if firm has introduced new business practices between 2004 and 2006 (2002 and 2004)
	oorgkms	=1 if firm has introduced new knowledge management systems between 2004 and 2006 (2002 and 2004)
	oorgwkp	=1 if firm has introduced new workplace organisation between 2004 and 2006 (2002 and 2004)
	oorgexr	=1 if firm has introduced new organizational methods in firm's external relations between 2004 and 2006 (2002 and 2004)
Marketing innovations	mktdgp	=1 if firm has introduced significant changes in product design and packaging between 2004 and 2006 (2002 and 2004)
	mktpdp	=1 if firm has introduced new marketing methods in product promotion between 2004 and 2006
	mktpdl	=1 if firm has introduced new marketing methods in product placement between 2004 and 2006 (2002 and 2004)
	mktpri	=1 if firm has introduced innovations in pricing between 2004 and 2006

APPENDIX A (continued)

Variable type	Variable code	Variable definition
Patents and other protection methods	ProPat	=1 if firm has used patents between 2004 and 2006 (2002 and 2004)
	ProDsg	=1 if firm has used registration of design between 2004 and 2006 (2002 and 2004)
	ProTm	=1 if firm has used trademarks between 2004 and 2006 (2002 and 2004)
	ProCp	=1 if firm has used copyrights between 2004 and 2006 (2002 and 2004)
	ProSol	=1 if firm has used "Soleau envelopes" between 2004 and 2006
	ProSct	=1 if firm has used secrecy (not covered by legal agreements) between 2004 and 2006 (2002 and 2004)
	ProCon	=1 if firm has used complexity of product design between 2004 and 2006 (2002 and 2004)
	ProTech	=1 if firm has used lead time advantage over competitors between 2004 and 2006 (2002 and 2004)
Factors hampering innovation activities*	HFent	Lack of funds within the enterprise
	HFout	Lack of finance from sources outside the enterprise
	HCos	Cost too high
	HPer	Lack of qualified personnel
	HTec	Lack of information on technology
	HInf	Lack of information on markets
	HPar	Difficulty in finding cooperation partner
	HDom	Market dominated by established enterprises
	HDem	Uncertain demand for innovative goods or services
	HPrior	No need to innovate due to earlier innovations
	HMar	No need because of lack of demand for innovations

*For factors hampering innovation activities, the survey contains questions regarding their degree of importance and these variables can take values from 0 (no importance) to 3 (high importance). For the special regressor method, these ordinal variables are recoded as binary variables taking the value of 0 (no or weak importance) or 1 (medium and high importance).