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Assessing the Impact of Marketing and Organizational Innovations on Firm Performance

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Abstract:

Research and Development policies, aiming at stimulating national R&D investments in order to reach the "fatidic" 3% level of GDP, have become ones of the main priorities of European Union countries through the Lisbon strategy. Numerous studies have used R&D expenditures as a measure for firms' innovative capacity. While emphasizing innovation inputs and support instruments, these works did not take into account other innovation strategies such as marketing or organizational innovations undertaken by the firm. The theoretical literature on innovation highlights nevertheless the feedback character of innovation processes where non-technological activities play a crucial role. Therefore, the purpose of this paper is to highlight the effects of non-technological innovation strategies (organizational and marketing innovations) on firms' technological innovation. We test our hypotheses on a sample of 555 firms in Luxembourg which responded to the 4th Community Innovation Survey (CIS). The results strongly highlight the importance of marketing innovations as a innovation activity for both the propensity to innovate and the innovative performance. This is in line with the idea that firms focusing attention on marketing initiatives are likely to have a better ability to increase customer satisfaction in comparison to competitors, to adapt successfully to changing market needs, to discover and exploit business ideas and to access new information and resources for developing new competitive products or processes - which in turn enhance their capacity to innovate. In contrast, results show that organizational innovation that firms introduced enhances only their propensity to innovate, not their innovative performance. Another important result indicates that firms engaging in knowledge management are likely to have a higher ability to innovate. This tends to indicate that knowledge management strategies are associated with more flexibility, adaptability, competitive advantage and better organizational performance as suggested in the theoretical literature. The results also show that cooperation with customers has a positive impact on performance. This is consistent with previous literature arguing that external relations with customers constituting internal organizational competencies are crucial for firms' performance. To sum up, the paper shows that while the role of R&D expenditures (intramural and/or extramural) in enhancing innovative capacity and performance is largely acknowledged, other strategies may also be crucial for firms' competitiveness. The results offer some clues for policy-makers in order to support non-technological innovations within the firm.

Keywords: complementary, marketing, organizational innovation, performance, CIS

1. Introduction

Research and development policy has become one of the main priorities of European Union countries through the Lisbon strategy, aiming at stimulating national R&D investments in order to reach the "fatidic" 3% level of GDP. Numerous studies have used R&D expenditures as a measure for firms' innovative capacity. While emphasizing innovation inputs and support instruments, these works did not take into account other innovation strategies such as marketing or organizational innovations undertaken by the firm. The theoretical literature on innovation nevertheless highlights the feedback character of innovation processes where non-technological activities play a crucial role. Numerous theoretical contributions, particularly those of Penrose (1959), Nelson and Winter (1982), Wernerfelt (1984), Teece (1988), which constitute the base of a new theory about competences and internal resources (resource-based view) highlight the importance of managing different types of resources. Indeed, firms are constrained to organize the innovation process efficiently by combining technological capabilities with competencies in marketing, finance, management and entrepreneurship knowledge. As suggested by Teece (1986, 1988) and Langlois and Robertson (1995), these often specific, tacit and inimitable competencies strongly depend on firms' capability to capture and assimilate external information, as well as to adapt to environmental changes.

If empirical research has separately tested the relationship between cooperation or R&D expenditures and firm performance, little has been said on the attention firms should pay to other types of innovation that may also be complementary to technological innovation. Thus, the impact of organizational and marketing innovations on technological innovation remains largely unknown. This is an important issue as it questions the determinants of technological innovation by introducing factors that could be key for firms' innovative performance. Therefore, the purpose of this paper is to highlight, in a multidisciplinary view of innovation (Tatikonda and Montoya-Weiss 2001), the effects of non-technological innovation strategies (organizational and marketing innovations) on firms' technological innovation (innovative performance). For this purpose, the fourth Community Innovation Survey (CIS4) carried out in Luxembourg over the period 2002-2004 is used.

The third section presents the dataset, variables and methodology. Results are presented and discussed in the fourth section.

2. Theory and Hypotheses

Recent works have emphasized the impact of complementary assets' management on firm's innovativeness (Stieglitz and Heine 2007). Teece (1986) view complementary assets as raising the value of a firm's technological innovations. Examples for complementary assets include marketing or organizational capabilities, regulatory knowledge, and contacts with clients, etc. Firms should therefore try to vertically integrate complementary downstream assets (Teece 1988; Afuah 2001). Besides, complementary assets help innovators to successfully appropriate Schumpeterian rents as they constitute important barriers to imitation. Having access to complementary assets is also one of the objectives pursued by firms entering collaborative arrangements and networks (Teece 1986; Mowery *et al*. 1998; Harrison *et al*. 2001). However, "*despite the apparent importance of complementary assets for the understanding of corporate strategy, innovations, and industry evolution, the management of complementary assets has received only limited attention*" (Stieglitz and Heine 2007).

Following Stieglitz and Heine (2007), we see assets or activities as mutually complementary if the marginal return of an activity increases the level of the other activity. For example, when a firm invests into organizational innovation activities by introducing knowledge management systems, it becomes easier to develop technological innovations. We here also find the traditional link between strategy and organization, changes in strategy inducing changes in organization and vice-versa. Complementarity giving rise to synergies among the complementary activities, not taking it into account may lead to a loss in value creation, and firm's performance, because it fails to realize its full potential. For example, if a new product requires a new sale organization, that the firm does not undertake, the firm might be in a position to be able to reap the benefits of its technological innovation. In line with Stieglitz and Heine (2007), we focus here on two types of activities: organizational and marketing, seen as complementary to technological innovation.

Innovation has been defined as "*the adoption of an idea or behavior, whether a system, policy, program, device, process, product or service, that is new to the adopting organization*" (Damanpour 1992). If, for Damanpour, organizational innovation pertains to all parts of the organization, thus including all types of innovation, innovation is often divided between technological innovation and organizational innovation. Phillips (1997) for instance distinguishes technological from non-technological innovations, the latter including

novel marketing strategies and changes to management techniques or organizational structures.

In line with these distinctions between different types of innovation, we here define *technological innovation* (TI) as the introduction of products that are new to the firm, which takes into account small and gradual improvements within firms – and not more radical-types of innovations if we had to define it in terms of products that are new to the market. Technological innovation thus refers to the generation and implementation of new ideas, products, processes or services. It provides opportunities for firms to obtain new market share, develop expansion into new areas, thus gaining competitive advantage and reaching performance. We here concentrate on performance in terms of technological innovation, or *innovative performance.* It is approached in terms of outputs, which can be the introduction of new products, or a percentage of sales generated from new or improved products (Cassiman and Veugelers 2006).

2.1. Organizational and technological innovations

Theoretically, *organizational innovation* (OI) is a broad concept that encompasses strategies, structural and behavioral dimensions (Gera and Gu 2004). The notion of OI is subject to various definitions and interpretations (Lam 2004). Black and Lynch (2005) view OI as including components such as workforce training, work design (more decentralized and flexible allocation of labor in the firm), employee voice (allowing workers to have greater autonomy and discretion in their work) and shared rewards (incentives such as profit sharing or stock options). According to Murphy (2002) and Uhlaner *et al.* (2007), OI encompasses three types of practices: (a) management practices (teamwork, knowledge management, flexible work arrangements); (b) production approaches (change to the work organization: total quality management, business re-engineering) and (c) external relations (outsourcing, networking, customer relations). In the present research, and in line with Murphy (2002), we adopt this definition.

Firms who are active in TI usually adopt complementary organizational practices. Numerous studies have investigated the complementarity between OI and TI by highlighting the importance of technological innovation as a driver of organizational changes within the firm (Henderson and Clark 1990; Dougherty 1992; Danneels 2002). These studies have focused on the fact that TI usually conduces to OI. Firms introducing TI would therefore be

constrained to reorganize their production, workforce, sale and distribution systems. Another research stream points out the inverse relationship by stressing the role of OI in enhancing flexibility, creativity - that in turn facilitates the development of TI (Ménard 1994; Greenan *et al.* 1993). Using a sample of firms in the fast-moving consumer goods industry in Germany, Lokshin *et al.* (2008) studied the effect of organizational competencies on firms' innovative performance, showing that firms implementing a combination of customer, organizational and technological competencies tend to introduce more innovations. Whatever the research perspective, the crucial role of organizational practices on competitive advantage and firm performance is acknowledged. Organizational practices are considered as an input of the firm's innovation process and of its innovation capability. Consequently, we consider the following hypothesis:

Hypothesis 1: Firms who implement organizational innovation (a) innovate more and (b) have a higher performance.

The first category of organizational innovation refers to the introduction of knowledge management systems. The knowledge management, here including complementary practices such as management skills, up-skilling of employees, sharing, codification and storage of knowledge is usually associated with more flexibility, adaptability, competitive advantage and better organizational performance (Prahalad and Hamel 1990; Grant 1996; Spicer and Sadler-Smith 2006). Firms have opportunities for higher innovation capabilities and performance when being able to expand, disseminate and exploit organizational knowledge internally, as well as share, transfer and receive knowledge from external partners. Empirical results are more equivocal with regard to the effect of knowledge management on firm performance. Numerous studies recognize the positive impact of KM strategies but few provide conclusive evidence (Becerra-Fernandez and Sabherwal 2001) or even a weak significance of the relationship (Chen *et al.* 2004). Shin (2004) highlights that high costs due to the implementation of such strategy may impede firms' performance. The absence of a positive relation may also be explained by the substantial time lag usually associated with the return on investment of such long-maturity strategy. Using a sample of manufacturing firms surveyed in the third French CIS, Kremp and Mairesse (2004) found, however, that firms having knowledge management policies are likely to innovate more extensively and to have higher productivity performance. Uhlaner *et al.* (2007) showed, for a panel of Dutch firms,

that firms implementing knowledge management grow more quickly than the others. Accordingly, we propose to test the following hypothesis:

Hypothesis 1.1: Firms implementing knowledge management (a) innovate more and (b) have a higher performance.

The second category of organizational innovation refers to the change to the work organization. The European Commission's 1997 Green Paper sees it a key priority for higher competitiveness, based on high skill, trust and quality. According to OECD (2001), new work practices are related to lean and just-in-time productions, decentralized decision-making, team work and shared rewards. Implementing new work organization could result in substantial improvements in organizational flexibility which in turn leads to improved firm efficiency and performance. Previous empirical studies show, however, controversial results on benefits of work changes. Ichniowski *et al.* (1997) found, on a sample of 36 homogeneous steel production lines, that using a set of innovative work practices such as teams, flexible job assignments or training leads to higher output level and product quality. Coutrot (2000) also emphasized that firms introducing work organization changes tend to have a higher innovative capacity than firms that do not. In contrast, Greenan (1996) found no positive relationship between the degree of decentralization of decision-making and communication structure and firm productivity. On the other hand, using US detailed firm-level data, Bresnahan *et al.* (2002) highlighted the complementarities among product and service innovation, information technology and workplace reorganization. They showed that new work practices result in firm performance improvements only when they are combined with heavy investments on either human capital or ICT. We therefore propose to test the following hypothesis:

Hypothesis 1.2: Firms introducing changes in their work organization (a) innovate more and (b) have a higher performance.

The third organizational practice refers to relations with other firms or public institutions, through alliances, partnerships, outsourcing or sub-contracting. The growing role of networking in firms' innovative capabilities is closely linked to the context of the emerging knowledge-based global economy. Because of the tacit and non transferable character of

knowledge and of the evolutionary and continual character of the learning process, innovative firms should concentrate on their specific capabilities while involving in cooperative arrangements in order to develop new competencies and extensions of the firm's know-how to new applications. Firms should moreover be encouraged to engage in external relations in order to access partners' complementary or synergistic competencies and capitalize "*incoming spillovers*" (Kogut 1988, Kogut and Zander 1993; Cassiman and Veugelers 2002), to reduce the duplication of R&D efforts as well as risks and costs associated to innovation projects (Sakakibara 1997; Jacquemin 1988), to benefit from economies of scale or scope (Kogut 1988).

Different motivations are attributed to cooperation modes differentiated by types of partners. Vertical cooperation with customers and suppliers is theoretically assumed to enhance firm efficiency through reducing uncertainty associated to the introduction of new products or services on the market, contributing crucial information on technologies and changing market needs, facilitating market expansion, particularly when the innovation is novel and complex (von Hippel 1988; Klomp and van Leeuwen 2001). Interests for horizontal cooperation with competitors can be more complex (Tether 2002; Hamel *et al.* 1989). While sharing principal features of vertical partnership, i.e. reducing costs and risks for large projects, cooperation with competitors can be dangerous because of the potential for anti-competitive behaviour and risks related to involuntary "*outgoing spillovers*" to partners (Cassiman et Veugelers 2002; Tether 2002; Belderbos *et al.* 2004). Firms may also motivated to cooperate with universities and research institutes for new scientific and technological knowledge, i.e. technology evaluation, anticipation of social effects, accessing to equipments and techniques, new technological options, etc. This type of cooperation involves often large firms which have internal R&D structure and benefit from public funding (Sakakibara 1997, 2001). We propose to test the following additional hypothesis:

Hypothesis 1.3: Firms who engage in external relations (a) innovate more and (b) have a higher performance.

2.2. Marketing and technological innovations

Rust *et al.* (2004) view *marketing innovation* (MI) in terms of three dimensions: (1) product strategy; (2) price strategy and (3) promotion strategy. These strategies lead to tactical

marketing actions such as changes in design or packaging, changes in sales or distribution methods, advertising or permanent exhibitions. The objectives are to increase the firms' products or services' attractiveness and/or to enter new markets. Theoretically, marketing initiatives constitute tactical actions and intangible resources that are determinant for firm performance (Barney 1991; Grant 1996; Wernerfelt 1984; Teece *et al.* 1997). Firms focusing attention on marketing initiatives are likely to have a better ability to increase customer satisfaction in comparison to competitors (Baker and Sinkula 1999), to adapt successfully to changing market needs, to discover and exploit business ideas and to access new information and resources for developing new competitive products or processes (Rust *et al.* 2004; Day 1994). Numerous empirical studies acknowledge this positive impact (Day 1994; Slater and Narver 2000). Moreover, they highlight the importance of firms' environmental context: the positive impact of marketing on firm performance would be moderated by a weak economy, great market turbulence and competition (Kohli and Jaworski 1990). Also, market orientation leads to higher business profitability when it relates to learning from external relations such as clients or competitors. Accordingly, we propose to test the following hypothesis:

Hypothesis 2: Firms that implement marketing innovation (a) innovate more and (b) have a higher performance.

Changes to the design and packaging of products as a type of marketing innovation could be an integral part of the innovation process. Packaging is defined as *"a coordinated system of preparing goods for safe, efficient and cost-effective transport, distribution, storage, retailing, consumption and recovery, reuse or disposal combined with maximising consumer value, sales and hence profit*" (Paine 1990). Besides product protection and transport optimization, packaging and design may influence consumer behaviour and the decision process at the purchase point. In other words, they might be an art of communication aiming at carrying information from producers to consumers on a market characterized by abundance of products and increased competition. Moreover, in a context of globalization, expansion and new market shares largely depend on the efficiency of packaging and design adapted to the specific needs, requirements and culture of the importer country consumers as well as on the cost savings enabled by appropriate packaging. Therefore, we test the following hypothesis:

Hypothesis 2.1: Firms implementing changes to the design or packaging of products (a) innovate more and (b) are likely to have a better innovative performance.

The implementation of new sales and distribution methods such as internet sales, franchising, direct sales or distribution licenses can induce substantial improvements in firms' efficiency and performance. Of these methods, internet sales and distribution, considered as the most revolutionary ones, constitute an important and direct channel of marketing between firms and consumers (Lau *et al.* 2001). The development of the internet offers firms the opportunity to reach a broad customer base, identify their needs and interests, rapidly negotiate and communicate with them at a relative low cost. Explanations for internet adoption also revolve around quick launching, experimentation of products or services on the market and observation of how customers respond in a short lapse of time (Wyner 2000). Although costs linked to the implementation of such methods of marketing are high, appropriate sales and distribution methods could contribute to firm effectiveness. We propose to test the additional hypothesis:

Hypothesis 2.2: Firms implementing changes in sales or distribution methods (a) innovate more and (b) are likely to have a better innovative performance.

3. Data and methodology

In a first step, we present our dataset and variables construction. The second subsection presents the model and tests the hypotheses.

3.1 Data and variables

3.1.1 The dataset

The data concern innovation activities of Luxembourgish firms between 2002 and 2004. Despite Luxembourg's outstanding economic growth (see OECD 2007), the innovation system is relatively young and not yet fully developed. The economic growth is mainly due to the performance of the service sector (financial intermediation, transport, storage and communication) which contributes to more than 80% of the total value added. In 2000, R&D intensity (i.e. R&D expenditures as a percentage of GDP) in Luxembourg represented 1.71% - of which 90% from the private sector. For some years, the government has considered

innovation as a national priority while considerably increasing public support for innovation. Luxembourg enjoys an advantageous geographical position within the European Research Area ("La Grande Région"), which enhances researchers' and innovators' favorable conditions (OECD 2007). We used the fourth Community Innovation Survey (CIS4) of Luxembourg's firms over the period 2002-2004. It was coordinated by EUROSTAT and carried out in 2006 by CEPS/INSTEAD[1] in collaboration with STATEC[2]. A sample of 555 representative firms with a least 10 employees in the manufacturing (33%) and the service (68%) sectors is used. Of these 555 firms, 490 (88%) are of small and medium size (< 250 employees).

3.1.2 Dependent variables

Our main objective is to study the effect of non-technological innovation strategies, here defined as organizational and marketing innovations, on technological innovation. Similarly to Veugelers and Cassiman (2004), we determine the first dependent variable *propensity to innovate* (PROD_INN). It is based on the "yes-no" question on the introduction by firms of new or significantly improved products during the three years 2002 to 2004. Of 555 firms, 225 (41%) declare themselves to be innovative. The second dependent variable, namely *innovative performance* (PERFOR), is measured as the percentage of total turnover from product innovations that are new to the firm, similarly to Cassiman and Veugelers (2006).

3.1.3 Explanatory variables

To assess the role of non-technological innovative activities on propensity to innovate and innovative performance, different measures of organizational and marketing innovations are included.

- *Organizational innovation*. We used three types of practices of OI, taking the value 1 if firms performed: (1) new or significantly improved knowledge management systems (ORG_SYS); (2) a major change to the work organization within the firm (ORG_STR); (3) new and significant changes in relation with other firms or public institutions (ORG_REL). A composite measure of OI (ORG_INN) is also introduced, taking the value 1 if firms performed at least one of these above practices. 60%, 56% and 35% of innovative firms implement respectively knowledge management, work organization and external relations.

[1] International Network for Studies in Technology, Environment, Alternatives, Development

[2] Central Service of Statistics and Economic Studies

In line with Murphy (2002), cooperation for innovation is also considered as a form of organizational innovation. In addition to ORG_REL, we added the following dummy variables of cooperation: (1) with clients (CO_CLI); (2) with suppliers (CO_SUP); (3) with public research institutes or government, universities or other higher education institutions, consultants, commercial laboratories or private R&D institutes (CO_INSTI) and (4) with competitors (CO_CONC). Of the 225 innovative firms, 28% indicated they cooperate with customers, 32% with suppliers, 26% with public or private research institutes and 18% with competitors.

- *Marketing innovation.* Two dummy variables of MI are included, taking the value one if firms introduced: (1) significant changes to the design or packaging of good or service (MKT_DES) and (2) changes in sales or distribution methods (MKT_MET). The composite measure of MI (MKT_INN) is equal to 1 if firms introduced at least one of these two practices. Of the innovative firms, 31 and 33% introduced respectively changes in design and packaging and changes in sales and distribution methods. Descriptive statistics are presented in Table 1.

- *R&D intensity*. The R&D intensity measure is equal to total R&D expenditures as a share of total turnover, where the R&D expenditures include both in-house R&D and external R&D performed by other firms, by public or private research organizations (INTEN_RD). This measure takes into account the impact of firms' internal R&D activities but also external acquisition of knowledge and technology.

- *External sources of information.* In the questionnaire, the scores are rated on a scale from 0 (unimportant) to 3 (crucial). We construct five dummy variables of information sources taking the value 1 if the score is crucial and 0 otherwise: (1) public sources as a composite measure of information sources from universities or other higher education institutions, government or public research institutes (SO_PUB); (2) R&D sources from consultants, commercial labs or private R&D institutes (SO_RD); (3) market sources from suppliers, clients or customers, competitors or other firms in the same sector (SO_MAR).

- *Objectives of innovation.* The data also allow determining different motivations for innovation efforts of the firms. In the questionnaire, firms rated the importance of products or processes innovation effects on a scale from 0 (unimportant) to 3 (crucial). Similarly to Belderbos *et al.* (2004), we generate the cost-push variable (COS_PUSH) by summing the scores of cost-related objectives such as improved flexibility, increased capacity of

production, reduced labor costs, materials or energy. Then, we rescaled the total score to a number between 0 and 1. The demand-pull variable (DEM_PULL) is generated in a similar way, summing scores of demand-related objectives such as increased range of products, increased market share or improved quality of products. The sum is then rescaled between 0 and 1.

Table 1 – Descriptive statistics for main variables used in the model (%)

	# obs.	Innovative firms	Non-innovative firms
Total sample	555	41	59
ORG_INN	336	**77**	**49**
ORG_SYS	258	60	37
ORG_STR	243	56	35
ORG_REL	141	35	19
MKT_INN	167	63	37
MKT_DES	101	31	9
MKT_MET	118	33	13
SIZE (10-250)	490	37	63
SIZE (>250)	65	68	32
NO_GP	238	28	72
EU_GP	151	53	47
EXTRA_GP	55	56	43
Service sectors	370	42	58
Manufacturing industry	185	37	63

Notes: 77% of innovative firms declare to have introduced organizational innovations compared to 49% for non-innovative firms.

- *Protection measures for innovations.* Firms are asked to indicate the effectiveness of different methods of protection on a scale from 0 (unimportant) to 3 (crucial). To evaluate the impact of these measures on firm performance, we create four dummy variables taking the value 1 if firms found crucial the use of patents (PR_PAT) or trademarks (PR_TM) as formal protection methods, and secret (PR_SECR) or lead-time advantage on competitors (PR_AVAN) as strategic protection methods.

- *Obstacles*. We constructed three dummy variables according to the obstacles' nature: (1) cost-related obstacles variable (H_COS) taking the value 1 if the scores of importance of lack of funds or/and high costs of innovation is crucial; (2) knowledge-related obstacles variable (H_KNO) taking the value 1 if the scores of importance of lack of qualified

personnel or/and lack of information on technology or on market or/and difficulty in finding cooperation partners is crucial; (3) market-related obstacles variable (H_MAR) taking the value 1 if the scores of importance of uncertainty of products demand or/and dominance of established firms is crucial.

3.1.4 Control variables

Firm size is measured by the natural logarithm of the number of employees (SIZE). We introduced also a variable taking the value 1 if the firm is independent (reference group), 2 if it is a national firm group (GP_NA), 3 if it is part of a European group (GP_EU) and 4 if it is part of an extra-European group (GP_EX). The public funding for innovation (PUBFUN)[3] is also included as it could incite firms to innovate and thus result in improvement in innovative performance. Seven sectors of activities are included, using OECD classification: High and medium high-tech manufacturing industry (M_HMH); Medium low-tech manufacturing industry (M_MED); Low-tech manufacturing industry (M_LOW); Transport and communication (S_TRANS); Financial intermediation (S_FINAN); Computer activities (S_COMP); R&D – Engineering activities and consultancy, Technical testing and analysis (S_RD) and Wholesale trade (S_TRA) (reference). Precise definitions of variables and correlations matrix of dependent and main independent variables used in the model are respectively in Appendix A and B.

3.2 Econometric model

The objective of the paper is to assess the role of non-technological innovation strategies on firm performance of 225 innovative firms that introduced product innovations between 2002 and 2004. Since we draw on the sub-sample of innovative firms from the dataset, sample selection bias arises. Similarly to Klomp and van Leeuwen (2001), we perform a generalized Tobit which takes the following form:

$$y_i = x_i'\beta + \varepsilon_i$$

$$z_i = w_i'\delta + u_i$$

[3] The CIS4 survey provides information about three sources of public funding, namely local or regional authorities; central government (including central government agencies or ministries); the European Union. In this study, we take only into account funding from central government which is the main source whereas the two other sources are marginal in our sample.

where x_i and w_i are the vectors of independent variables, β and δ the vectors of associated coefficients, ε_i and u_i the error terms drawn from a multivariate normal distribution. y_i is the innovative performance (PERFOR) and z_i is assumed to be the unobserved level of innovativeness, from which the propensity to innovate (PROD_INN) which is the really observed dependent variable is obtained as follows:

$$\begin{cases} z_i^* = 1 \text{ if } z_i > 0 \\ z_i^* = 0 \text{ if } z_i < 0 \end{cases}$$

Heckman's two-steps procedure (1979) is used for estimating the selection model. In a first step, the propensity to innovate was estimated with the explanatory variables available for the total sample. Afterwards, in a second step, the model estimated the innovative performance for the sub-sample of innovative firms.

4. Results and discussion

Table 2 presents estimation results for PERFOR: Model 1 including composite measures of organizational and marketing innovations and Model 2 including different practices of these two types of innovation. Results for the Heckman correction for PROD_IN are presented in Table 3: Model 3 with the composites measures of OI and MI and Model 4 with different practices.

The inverse Mills' ratio included in the model for correcting potential sample correction bias is not significant. This might indicate that estimation results for PERFOR are not influenced by the selectivity issue.

We detect no impact of OI on innovative performance (Table 2), thus invalidating *Hypothesis 1b*. In line with the literature (Dougherty 1992; Danneels 2002), we expected a positive effect of this innovation: firms devoting efforts to managerial practices or new organizational forms should be more able to efficiently use new competences and technologies. However, the aggregated measure of organizational innovation has a strong positive impact on firms' probability to innovate, in line with *Hypothesis 1a* (Table 3).

When differentiated by types of practices, whereas the introduction of new or significantly improved knowledge management systems is found to have a significant effect on the propensity to innovate, there is no effect of both organizational practices on innovative performance. The absence of such a relation may be due to the substantial time lag usually

associated with the return on investment of such long-maturity strategy (Askenazy, 2000). When implementing organizational changes such as new work organization or new knowledge management systems, firms employers and employees are involved in a long run process of adaption and learning which does not result immediately in substantial improvement in innovative performance.

Results also show that cooperation with customers has a positive impact on performance. This is in line with the idea that cooperating with customers allows better understanding new market needs and demands, enabling to define the rate and direction of innovations as well as to anticipate market trends (Klomp and van Leeuwen 2001). Surprisingly, cooperation with suppliers has a negative effect: the more collaboration with suppliers, the lower the innovative performance. This result is counter-intuitive but might be explained by the fact that firms use cooperation with suppliers mainly for cost reduction. They are thus likely to focus less attention on other important aspects of innovation processes, such as product innovation. It could also be caused by the fact that suppliers are often large firms which have a high negotiating power towards small firms (which constitute almost 90% of the sample) and tend to collaborate for other reasons than to increase innovative capacities of sub-contractors.

Cooperation with competitors or other firms in the same sector has no impact on performance. Surprisingly, R&D cooperation with universities and research institutes has no impact on innovative performance, but a negative effect on the propensity to innovate. This is in contrast with the findings of Belderbos *et al.* (2004) for Dutch firms or Lööf and Heshmati (2002) for Swedish firms. For our considered sample, the result might be explained by the long-maturity process of this type of cooperation where research tends to be of a more generic and basic nature. Therefore, one could not immediately observe the results of such cooperative alliance, or even a negative effect in the short run.

Results in Table 2 indicate a positive impact of marketing innovation on innovative performance. This confirms *Hypothesis 2b*. We find in contrast no impact of any specific practice on performance. This can be understood as the two types of marketing innovation are quite different: incremental changes on design and packaging of products on one hand (MKT_DES), changes in the sales organization on the other hand (MKT_MET). Thus, a firm (especially a small one and/or a firm in service activities) may do one type of marketing innovation, but not the other one. We find however that MI and all types of practices are

significant for the propensity to innovate. This finding, validating *Hypothesis 2a, 2.1a* and *2.2a,* highlights the fact that firms consolidate, through marketing practices, relations with business partners and customers, learn about changing market needs and capture market information - which in turn enhance their capacity to innovate.

We also found out that propensity to innovate and innovative performance are higher for firms that invest intensively in either intramural or extramural R&D. This is in line with previous empirical findings indicating the crucial role of own R&D expenditures for the innovation process as they condition the knowledge creation as well as the firms' capacity to absorb external knowledge (Grilliches and Mairesse 1984; Crépon *et al*. 1998). Furthermore, our results show that sources of information coming from private R&D institutes matter for propensity to innovate. Firm size affects the propensity to innovate positively but innovative performance negatively. This could be due to mechanical effects as small innovating firms have a smaller product portfolio: thus, when small firms engage in product innovation activities, the part of those innovations will be higher in the overall turnover than for large firms, for which innovative activities are much more diffused. Surprisingly, we find no effect of demand-related objectives on firm performance. In contrast, a positive effect of cost-related objectives on performance is detected. This indicates that cost reduction is considered as an important strategy due to economies of scale and learning-by-doing effects.

Another interesting result is that firms using lead-time advantage on competitors as informal method of innovation protection have a weaker innovative performance (other methods of protection, such as patents and trademarks, have no significant impact). This is in line with the idea that being first-mover does not always provide a significant advantage in terms of innovation, and that second-movers benefit from experience effects that are more useful in terms of performance that being the first on the market (Bocquet *et al.* 2007).

5. Conclusion

The recent literature on innovation highlights the feedback character of innovation processes where non-technological activities play a crucial role. We therefore tested the impact of both organizational and marketing innovations in order to capture such effects.

The study strongly highlights the importance of marketing innovations as a non-technological innovation activity for both the propensity to innovate and the innovative performance. In contrast, results for organizational innovation show that firms enhance their capacity to innovate, but not their innovative performance. These results may, however, be consistent with the idea that small and medium firms (the most dominant category of firms in Luxembourg) do not engage in organizational changes for innovation.

An important result is that firms implementing knowledge management are more likely to have a higher ability to innovate. This tends to corroborate the idea that knowledge management strategies are associated with more flexibility, adaptability, competitive advantage and better organizational performance. Firms have opportunities to increase their innovation capabilities and performance when they are able to expand, disseminate and exploit organizational knowledge internally, as well as to share, transfer and receive knowledge from external partners. This is, moreover, reinforced by the positive effect of sources of information from R&D institutes on firms' innovative capacity in our model.

Overall, the paper shows that while the important role of R&D expenditures (intramural and/or extramural) in enhancing innovative capacity and performance is largely acknowledged, other non-technological strategies may also be crucial. We however observe that the impact of R&D intensity is weak. This could be explained by the fact that R&D investment is usually realized by big firms. In our sample, almost 90% of firms are of small and medium size. Thus, in the case of Luxembourg, it might be important to consider not only R&D investment to explain firm performance, but also other strategies implemented by firms.

The results therefore offer some clues for policy-makers in order to favor non-technological innovations within the firm. However, further research should be undertaken to better understand the impact of non-technological innovations on performance by taking into account the difference between large firms vs. small and medium ones, industrial vs. service firms, and also to allow for an appropriate time lag in order to assess the long-term impact of

organizational or marketing innovation on performance. Future research should also investigate the impact of firm size on non-technological activity strategies to enhance performance as far as technological innovation is concerned. Moreover, the present study does not provide information about the causality between technological and non-technological innovations which can be an interesting research perspective.

Appendix A - Definition of variables

Variables	Description
Dependent variables	
PROD_INN	Equal to 1 if introduced new or significantly improved goods or/and services during the three years 2002 to 2004, 0 otherwise
PERFOR	Percentage of the total turnover in 2004 from goods and service innovations introduced during 2002 to 2004 that are new to the firm
Independent variables	
Organizational innovations	
ORG_INN	Equal to 1 if introduced at least one of the three organizational innovations: (1) new or significantly improved knowledge management systems; (2) a major change to the organization of work within the firm; (3) new and significant changes in relations with others firms or public institutions, 0 otherwise
ORG_SYS	Equal to 1 if introduced new or significantly improved knowledge management systems, 0 otherwise
ORG_STR	Equal to 1 if introduced a major change to the organization of work within the firm, 0 otherwise
ORG_REL	Equal to 1 if introduced new and significant changes in relations with others firms or public institutions, 0 otherwise
CO_CLI	Equal to 1 if cooperated with clients or customers, 0 otherwise
CO_INSTI	Equal to 1 if cooperated for innovation activities with at least one of three following types of partners: (1) public research institutes or government; (2) universities or other higher education institutions; (3) consultants, commercial laboratories or private R&D institutes, 0 otherwise
CO_SUP	Equal to 1 if cooperated with suppliers of equipments, materials, components, or software, 0 otherwise
CO_CONC	Equal to 1 if cooperated with competitors or enterprises in the same sector, 0 otherwise
Marketing innovations	
MKT_INN	Equal to 1 if introduced at least one of the two marketing innovations: (1) significant changes to the design or packaging of good or service; (2) new or significantly changed sales or distribution methods, 0 otherwise
MKT_DES	Equal to 1 if introduced significant changes to the design or packaging of good or service, 0 otherwise
MKT_MET	Equal to 1 if introduced new or significantly changed sales or distribution methods, 0 otherwise
R&D Intensity	
INTEN_RD	Sum of expenditures for intramural (in-house) R&D and extramural R&D in 2004 divided to total turnover in 2004
Sources of information	
SO_PUB	Equal to 1 if the score of importance of at least one of two following sources of information is "crucial" for the firm's innovation activities: (1) universities or other higher education institutions; (2) governments or public research institutes, 0 otherwise
SO_RD	Equal to 1 if the score of importance of following source of information is "crucial": consultants, commercial laboratories, or private R&D institutes, 0 otherwise
SO_MAR	Equal to 1 if the score of importance of at least one of three following sources of information is "crucial": (1) suppliers of equipments, materials, components, or software; (2) clients or customers; (3) competitors or other enterprises in your sector, 0 otherwise
Other variables	
DEM_PULL	Sum of scores of importance of three demand-related objectives of innovation, number between 0 (unimportant) and 3 (crucial): (1) increased range of goods or services; (2) entered new markets or increased market share; (3) improved quality of goods or services (rescaled between 0 and 1)
COS_PUSH	Sum of scores of importance of four cost-related objectives of innovation, number between 0 (unimportant) and 3 (crucial): (1) improved flexibility of production or service provision; (2) increased capacity of production or service provision; (3) reduced labor costs per units output; (4) reduced materials and energy per unit output (rescaled between 0 and 1)
PR_AVAN	Equal to 1 if the score of importance of protection method "lead-time advantage on competitors" is "crucial", 0 otherwise (scores between 0, unimportant and 3, crucial)
PR_PAT	Equal to 1 if the score of importance of protection method "patent" is "crucial", 0 otherwise
PR_TM	Equal to 1 if the score of importance of protection method "trademarks" is "crucial", 0 otherwise
PR_SECR	Equal to 1 if the score of importance of protection method "secrecy" is "crucial", 0 otherwise
H_COS	Equal to 1 if the score of importance of at least one of three following obstacles (scores between 0 (unimportant) and 3 (crucial)) is "crucial": (1) lack of funds within your enterprise; (2) lack of finance from sources outside your enterprise; (3) innovation costs too high, 0 otherwise
H_KNO	Equal to 1 if the score of importance of at least one of four following obstacles (scores between 0 (unimportant) and 3 (crucial)) is "crucial": (1) lack of qualified personnel; (2) lack of information on technology; (3) lack of information on market, (4) difficulty in finding cooperation partners for innovation, 0 otherwise
H_MAR	Equal to 1 if the score of importance of at least one of two following obstacles (scores between 0 (unimportant) and 3 (crucial)) is "crucial": (1) market dominated by established enterprises; (2) uncertain demand for innovative goods or services, 0 otherwise
SIZE	Logarithm of the number of employees
PUBFUN	Equal to 1 if received financial support for innovation from central government (including central government agencies or ministries), 0 otherwise
GP	Equal to 1 if no part of group (NO_GP) (reference); equal to 2 if part of a national enterprise group (NA_GP); equal to 3 if part of an European enterprise group (EU_GP); equal to 4 if part of extra-European enterprise group (EXTRA_GP)
Sectors	High and medium high-tech manufacturing Industry (M_HMH); Medium low tech manufacturing industry (M_MED); Low tech manufacturing industry (M_LOW); Transport and communication (S_TRANS); Financial intermediation (S_FINAN); Computer activities (S_COMP); R&D – Engineering activities and consultancy, Technical testing and analysis (S_RD) and Wholesale trade (S_TRA) (reference)

Appendix B - Correlations matrix of dependent and main independent variables used in the model

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PERFOR (1)	1.00														
ORG_INN (2)	.177	1.00													
ORG_SYS (3)	.190	.752	1.00												
ORG_STR (4)	.168	.712	.523	1.00											
ORG_REL (5)	.130	.470	.285	.347	1.00										
MKT_INN (6)	.266	.319	.317	.259	.221	1.00									
MKT_DES (7)	.239	.217	.243	.242	.153	.718	1.00								
MKT_MET (8)	.201	.274	.283	.206	.232	.791	.348	1.00							
INTEN_RD (9)	.184	.095	.087	.072	.086	.032	.069	.043	1.00						
DEM_PULL (10)	.404	.272	.225	.233	.204	.329	.255	.271	.183	1.00					
COS_PUSH (11)	.293	.279	.200	.194	.226	.221	.195	.196	.102	.573	1.00				
CO_CLI (12)	.197	.1667	.079	.102	.240	.175	.185	.131	.185	.368	.210	1.00			
CO_SUP (13)	.166	.108	.099	.129	.184	.144	.112	.115	.081	.242	.103	-.611	1.00		
CO_INSTI (14)	.135	.154	.064	.078	.226	.192	.194	.126	.200	.356	.195	.723	.571	1.00	
CO_CONC (15)	.140	.211	.113	.157	.223	.197	.165	.195	.195	.310	.208	.686	.445	.670	1.00

Table 2 - Estimation results for PERFOR

	Model 1		Model 2	
Variables	coef.	t-stat	coef.	t-stat
Dependent variable : PERFOR (N=225)				
ORG_INN	-.027	-0.91	-	-
ORG_SYS	-	-	-.004	-0.22
ORG_STR	-	-	.009	0.29
ORG_REL	-	-	.004	0.17
MKT_INN	.066	2.29**	-	-
MKT_DES	-	-	.035	1.01
MKT_MET	-	-	.043	1.36
INTEN_RD	.208	1.94*	.185	1.66*
CO_CLI	.076	2.54**	.076	2.29**
CO_SUP	-.063	-2.34**	-.054	-1.95*
CO_INSTI	-.038	-1.43	-.048	-1.77*
CO_CONC	.017	0.60	.014	0.50
SO_RD	.084	1.38	.082	1.85*
SO_PUB	-.056	-1.01	-.049	-1.16
SO_MAR	-.022	-0.80	-.021	-0.81
DEM_PULL	.013	0.17	.014	0.16
COS_PUSH	.169	3.68***	.154	3.35***
PR_AVAN	-.082	-2.40**	-.082	-2.85***
PR_PAT	-.019	-0.55	-.009	-0.30
PR_TM	-.032	-0.89	-.036	-1.03
PR_SECR	.036	1.09	.032	1.19
SIZE	-.021	-2.38**	-.021	-2.34**
PUBFUN	-.012	-0.37	-.012	-0.42
Constant	.193	2.60***	.176	2.36**
Rho	-0.049		-.0.25	
Wald χ^2	57.7***		97.9***	
p-value	0.000		0.000	

Notes: *, ** and *** denote significance at the level of 10%, 5% and 1% respectively.

Table 3 - Estimation results for the Heckman correction for PROD_IN

	Model 3		Model 4	
Variables	coef.	t-stat	coef	t-stat
Dependent variable: PROD_INN (N=555)				
ORG_INN	.410	2.99***	-	-
ORG_SYS	-	-	.284	1.75*
ORG_STR	-	-	.109	0.91
ORG_REL	-	-	.018	0.15
MKT_INN	.833	5.63***	-	-
MKT_DES	-	-	.602	3.57***
MKT_MET	-	-	.545	3.32***
SIZE	.173	3.84***	.175	3.30***
NA_GP	.217	1.78*	.216	1.40
EU_GP	.395	2.56**	.418	2.66***
EXTRA_GP	.458	2.07**	.433	1.62
H_COS	.334	1.97**	.344	2.12**
H_KNO	.037	0.20	.044	0.25
H_MAR	-.132	-0.84	-.101	-0.59
M_HMH	.637	2.39**	.625	2.40**
M_MED	-.020	-0.08	.009	0.04
M_LOW	-.170	-0.58	-.191	-0.64
S_TRANS	-.313	-1.23	-.349	-1.39
S_FINAN	.642	2.73***	.594	3.11***
S_COMP	1.098	3.87***	1.073	4.18***
S_RD	.823	2.65***	.765	2.43**
Constant	-1.95	-7.64***	-1.848	-6.61***

Notes: *, ** and *** denote significance at the level of 10%, 5% and 1% respectiv

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