

AN EMPIRICAL ANALYSIS OF THE RELATIONSHIP BETWEEN TECHNOLOGICAL AND MARKETING INNOVATIONS: A CASE OF POLISH MANUFACTURING FIRMS

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Abstract. The article deals with the issue of the links between technological and marketing innovations. The theoretical part of the paper presents definitions and key features of marketing innovations, as well as it indicates the potential cause-effect relations between decisions to introduce process and product innovations and the implementation of new methods in marketing mix. The empirical part of the paper verifies formulated hypotheses using data derived from the survey on innovation activity of Polish manufacturing enterprises in the years 2008–2010. The results of research show the positive impact of propensity to adapt product innovations on marketing innovations activity of enterprises. Moreover, expenditures on acquisition of knowledge from external sources and expenditures on marketing for new and significantly improved products turned out to be factors stimulating enterprises to implement changes in marketing methods.

Key words: marketing innovations, technological innovations, propensity to innovate, expenditures on innovation activity

INTRODUCTION

Innovation is traditionally perceived as the use of technological inventions, and as such it pertains to a new product introduced on the market and/or new process used in the manufacturing. Such an understanding of innovation has dominated the economic and managerial literature since the pioneering work of Schumpeter [1934]. Recently, the technological view on innovation has been extended to marketing domain. Although the importance of new methods in marketing was expressed as far back as the early work of Levitt [Levitt 1960], the literature on marketing innovation is scarce and scattered. This

dearth of knowledge on marketing innovation and its link with technological innovations becomes quite problematic, since advances in marketing methods are seen as key contributors to long-term firm's success [Ren, Xie and Krabbendam 2010].

This paper attempts to address this gap in the literature by providing both a theoretical insight into the nature of marketing innovation and an empirical analysis of technological drivers of new marketing methods in Polish enterprises. The analysis is based on sector-data obtained from the results of survey on innovation activity of Polish industrial enterprises within the framework of Community Innovation Survey. The method used in the research is the logistic regression. Providing estimation results of the logistic regressions allows for a deeper understanding of the relationship between technological and marketing innovations.

LITERATURE REVIEW

This paper addresses two subject areas. Firstly, the paper attempts to find the nature and key features of marketing innovations. Secondly, the paper tries to establish the link between marketing and technological innovations. In the following, this section will give a concise review of the literature dealing with these two issues.

Definition and nature of marketing innovation

The concept of innovation has been defined in a number of ways [Bareghe, Rowley and Sambrook 2009]. Knight's early and straightforward definition just states: "Innovation is an adoption of a new and significant change by an organization" [1967]. A similar definition was proposed more recently by Damanpour, who claimed that: "Innovation is conceived as a means of changing an organization, either as a response to changes in the external environment or as a pre-emptive action to influence the environment" [1996]. These definitions address two important distinctions. Firstly, they make implicitly allowance for difference between innovation and innovation process. The latter term consists of all the decisions and activities that occur from the recognition of a need or a problem, through research, development and commercialization of an invention [Rogers 2003]. Secondly, innovation regarded as a result is tightly coupled to change. Accordingly, innovations are frequently classified in relation to changes they pertain to. The most common typology includes technological innovation and non-technological innovation. The former can be defined as new products and new processes that embody inventions from the industrial arts, engineering, applied sciences and/or pure sciences. Apart from changes in products and processes, the understanding of innovation is extended also to changes in marketing and management techniques or organizational structures (so-called non-technological innovations) [Garcia and Calantone 2002].

Although the literature on economics and management of innovation was focusing solely on technological innovation for many years, non-technological innovation has received particular attention of scholars and practitioners over the last decade. This extension of the view of firms' innovation efforts has resulted from different reasons. Firstly, the concept of technological innovation seems not to fully correspond to inno-

vation in services. However, the current discussion on whether services can be treated like manufacturing in relation to innovation has not been resolved yet. Secondly, innovation may concern many aspects of firms' activities, e.g. technology, organization and marketing, which may complement each other. In a system approach to innovation, a dispute about the drivers and outcomes of marketing innovation is extremely important, since there is an agreement that marketing innovations are crucial for the long-term success of a firm and for the overall innovation process [Alsamydai, Alnawas and Yousif 2010].

According to OECD definition, marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing not previously used by the firm [Oslo Manual 2005]. A similar stance on defining marketing innovation was adapted by many authors, i.e.: Harms et al. [2002], Rust et al. [2002], Shergill and Nargundkar [2005], Chen [2006], Halper [2010]. An analysis of the definitions introduced by mentioned authors allows for the identification of key features of marketing innovation that can be described as follows:

1. Its scope that encompasses the four P's of marketing. According to OECD, product design changes generally pertain to changes in product form and appearance that do not affect the product's functional or user features [Oslo Manual 2005]. In turn, new marketing methods in product placement primarily mean the introduction of new sales channels, while innovations in pricing involve the use of new pricing strategies. Finally, changes in product promotion refer to the use of new concepts for promoting a firm's goods and services.
2. Its orientation towards customers and markets. Trienekens, Uffelen and Omta [2008] suggest that marketing innovation main relevance is in the understanding of consumer demand. Hurley and Hult [1998] further argue that market orientation can serve as the catalyst for marketing innovation.
3. Its potential to create competitive advantage. Marketing innovation can be regarded as a primary source of a firm's sustainable competitive advantage, given its difficulty to imitate. Ren, Xie and Krabbendam [2010], adapting a resource-based view of the firm, find characteristics of successful marketing innovations (i.e. a sound marketing strategy, management skills and organizational culture within the firm) which may be both drivers of strategic value and imitation barriers for competitors. On the other hand, Chen [2006] provides an economic analysis of marketing innovation in a dynamic duopoly model and proves that marketing innovation which allows a firm to acquire consumer information benefits the innovating firm. These theoretical arguments were empirically proved by a few studies [Weerawardena 2003, Halper 2010].

In addition to the above characteristics of marketing innovation, Schmidt and Rammer [2013] conclude that the new element of marketing mix like the other forms of innovations are associated with uncertainty. However, the risk of failure of marketing innovation is relatively low and can be limited by employing highly-qualified workers. The mentioned authors also stress that marketing innovations are likely to be subject to spillovers. A frequently given reason for this peculiarity is a weak regime of appropriability due to their intangible nature.

Relationship between technological and marketing innovations

As previously mentioned, the term technological innovation refers to product and process innovation. According to OECD, product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses, while process innovation pertains to the implementation of a new or significantly improved production or delivery method [Oslo Manual 2005]. In the economic and managerial literature on innovation, the dispute on the relationship between technological innovations and marketing innovations finally come to deciding whether they are complements or substitutes.

This is quite intuitive that the introduction of a new process or product calls for changes in marketing strategies. For instance, a new product line often requires changes in packaging and sales channels. Lewis and Wackowski [2006] give an example of the tobacco industry, where the introduction of flavoured cigarettes were intensively supported by marketing innovations. Another point of view presented in the literature is that marketing innovations are more than just supporting activities for technological innovations. It is argued that marketing innovations may replace technological innovations, e.g. a product innovation can be substituted by a product design changes. Following this line of arguments, Bhaskaran [2006] and Rammer, Czarnitzki and Spielkamp [2009] note that small and medium sized enterprises, especially from low- and mid-tech industries, may be more willing to engage in possibly less costly marketing innovations rather than in technological innovations. In spite of these opposite perspectives, Schubert [2010] summarizes that marketing innovations are on average rather complements than substitutes for technological innovations, but this relationship is sensitive to external and internal factors such as a firm's size and technological opportunities.

In few recent studies on technological and marketing innovations the analyses not only focus on the direct relationship between these two types of innovations but also deal with the issue of impact of technological innovation activities on propensity to innovate in marketing [Moreira et al. 2012, Kijek, Lisowski and Starzyńska 2013]. In this stream of research, technological innovation activities encompass both investments in intangible assets (e.g. technological knowledge) and tangible assets (e.g. buildings, constructions and machinery). According to Kijek [2012], technological knowledge is a part of innovation capital, which is a bundle of the firm's resources/assets that renders services in the process of new knowledge (innovation) creation and commercialization. Apart from technological knowledge in the form of R&D or intellectual property rights, innovation capital encompasses intangibles that are embodied in the organizational routines and thinking of employees. It is worth noting that employees' knowledge offers a specific innovation competence for a firm, since it is a driver of absorptive capacity that manifests itself in the firm's ability to acquire, assimilate and utilize new knowledge, including marketing innovations. Among few empirical studies dealing with this subject, Kijek, Lisowski and Starzyńska [2013] produce evidence that expenditures on training positively affect the implementation of marketing innovations in enterprises. Moreover, the results of research by Medrano-Sáez and Olarte-Pascual [2012] show that internal R&D is the principal determining factor of all kinds of marketing innovation. Similarly, Moreira et al. [2012] find that the higher the investments in acquisition of machinery, equipment and software, internal R&D and acquisition of external technological knowledge, the greater the propensity of firms to innovate in marketing.

MATERIAL AND METHODS

Based on the considerations in this section with regard to the relationship between marketing and technological innovations, two main hypotheses can be formulated:

Hypothesis 1: The higher a firm's propensity to adopt technological innovations, the higher its propensity to innovate in marketing.

Hypothesis 1a: The higher a firm's propensity to adopt technological innovations, the higher its propensity to innovate in product design.

Hypothesis 1b: The higher a firm's propensity to adopt technological innovations, the higher its propensity to innovate in product placement.

Hypothesis 1c: The higher a firm's propensity to adopt technological innovations, the higher its propensity to innovate in pricing.

Hypothesis 1d: The higher a firm's propensity to adopt technological innovations, the higher its propensity to innovate in product promotion.

Hypothesis 2: The higher a firm's investments in technological innovation activities, the higher its propensity to innovate in marketing.

Hypothesis 2a: The higher a firm's investments in technological innovation activities, the higher its propensity to innovate in product design.

Hypothesis 2b: The higher a firm's investments in technological innovation activities, the higher its propensity to innovate in product placement.

Hypothesis 2c: The higher a firm's investments in technological innovation activities, the higher its propensity to innovate in pricing.

Hypothesis 2d: The higher a firm's investments in technological innovation activities, the higher its propensity to innovate in product promotion.

The data used to carry out this research was obtained from the results of survey on innovation activity of Polish industrial enterprises in the years 2008–2010 conducted by Central Statistical Office of Poland within the framework of Community Innovation Survey. Entities participating in surveys were selected on the basis of the Polish Classification of Activities (PKD 2007) which is consistent with the statistical classification of economic activities in the European Community (NACE Rev. 2). The 20 sectors grouped in D section – manufacturing industry – are the objects of the analysis.

The study is divided into two parts. In the first part, the relationship between propensity to adopt technological innovations and propensity to innovate in marketing is verified. In order to be able to formally test whether the decisions to introduce technological and marketing innovations are related I use a logistic regression which has the following form:

$$Y = \ln \left[\frac{P}{1-P} \right] = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_1 X_3 + \alpha_5 X_2 X_3 + \varepsilon$$

where: P_1 – percentage of firms that introduced marketing innovations, P_2 – percentage of firms that introduced changes in product design, P_3 – percentage of firms that introduced changes in product placement, P_4 – percentage of firms that introduced changes in pricing, P_5 – percentage of firms that introduced changes in product promotion, X_1 – percentage of firms that introduced product innovations, X_2 – percentage of firms that introduced process innovations, X_3 – dummy variable for technological opportunities which takes the value 0 for the low and mid-low technology sector or 1 for the mid-high and high technology sector, $X_1 X_3$ – interaction of X_1 and X_2 variables and $X_2 X_3$ – interaction of X_2 and X_3 variables. Adding interaction terms to the model allows for a more precise understanding of the relationships between propensity to innovate in products and process innovations and propensity to innovate in marketing innovations which is likely to be affected by sector R&D intensity.

In the second part of the study, the impact of a firm's investments in technological innovation activities on propensity to innovate in marketing is examined. Apart from technological capital accumulated by investing in internal R&D, acquisition of software and acquisition of knowledge from external sources, the study takes into account another element of a firm's innovation capital, i.e. employees' knowledge accumulated by investing in personal training connected with innovation activity. As far as tangible capital is concerned, the investments in buildings, constructions, land, machinery and technical equipment are treated as explanatory variables. Moreover, expenditures on marketing for new and significantly improved products is chosen as explanatory factor of a firm's propensity to innovate in marketing. In this part of the study the logistic regression has the following form:

$$Y = \ln \left[\frac{P}{1-P} \right] = \alpha_0 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \varepsilon$$

where: P – the same as previously specified, X_4 – expenditures on R&D, X_5 – expenditures on acquisition of knowledge from external sources, X_6 – expenditures on marketing for new and significantly improved products, X_7 – expenditures on personnel training connected with innovation activity, X_8 – expenditures on acquisition of software, X_9 – expenditures on buildings, constructions and land, X_{10} – expenditures on machinery and technical equipment.

Theoretically, taking the appropriate approach to modeling innovation, the explanatory variables in the model should have been measured as stocks, since the flows of services emanating from the capital are proportional to the level of its stock. However, in this study the use of the flows instead of the stocks as the explanatory variables is due primarily to practical reason, i.e. data availability. According to Bosworth and Rogers

[2001], the stability in the R&D expenditure allows for regarding it as a proxy of knowledge capital and in such circumstances the stock becomes proportional to the flow.

RESULTS AND DISCUSSION

Table 1 presents estimation results of the logistic regressions used to test the first hypothesis, assuming the positive impact of technological innovations on propensity to innovate in marketing. Model 1 treats the percentage of firms that introduced marketing innovations as the response variable, while models 2, 3, 4 and 5 treat particular types of marketing innovations as the response variables. The parameters of the models were estimated using the OLS method. In order to identify a set of explanatory variables which have considerable predictive capability, backward elimination was employed.

Table 1. Impact of technological innovations on the introduction of marketing innovations

Specification	P_1	P_2	P_3	P_4	P_5
Constans	-2.219***	-3.757***	-3.421***	-2.739***	-2.898***
X_1	7.689***	5.875***	10.491***	2.193***	7.819***
X_2	-4.335**	×	-7.736***	×	-6.238**
X_3	-0.408**	×	×	×	-1.261**
X_1X_3	×	×	-1.581*	×	×
X_2X_3	×	×	×	×	4.757**
R^2	0.791	0.731	0.779	0.445	0.769
F (p-value)	20.271 (0.000)	48.873 (0.000)	18.804 (0.000)	14.484 (0.001)	12.536 (0.000)
χ^2 (p-value)	4.310 (0.116)	16.986 (0.000)	1.328 (0.514)	10.055 (0.006)	4.202 (0.122)

× – eliminated variable, χ^2 – chi-square statistics in Doornik-Hansen test for normality of random disturbance.
 *Statistical significance at 0.1 level, **statistical significance at 0.05 level, ***statistical significance at 0.01 level.

The results show that the introduction of new products has a positive impact on propensity to innovate in marketing which is in line with the literature. This relationship is sensitive to the type of marketing innovation, i.e. the regression coefficient for this predictor is the largest in the model 3 and is the smallest in the model 4. It means that the introduction of new products induces changes in sales channels and, to a lesser extent, in pricing methods. Surprisingly, implementing process innovations has a negative or insignificant impact on the introduction of marketing innovation. This outcome is unexpected on the assumption that product and process innovations are introduced simultaneously but could be partially explained by the fact that some of marketing innovations, i.e. changes in product placement, are aimed at the same purpose as changes in delivery methods (process innovations), so they may be regarded by firms as substitutes.

As far as technological opportunities are concerned, the models 1 and 5 show that firms in the low and mid-low technology sectors innovate in marketing more frequently than firms in the mid-high and high technology sectors. It supports Grimpe and Sofka's

[2009] finding that firms in high-tech industries take the technology-oriented search pattern while firms in low-tech industries focus more on market knowledge. The interesting point discovered in the model 3 is that the positive effect of the introduction of product innovations on the propensity to adapt changes in product placement is weaker for firms in the mid-high and high technology sectors than it is for firms in low and mid-low technology sectors. On the other hand, the negative effect of the introduction of process innovations on the propensity to adapt changes in product promotion is weaker for firms in the mid-high and high technology sectors than it is for firms in low and mid-low technology sectors.

Table 2 presents estimation results of the logistic regressions used to test the second hypothesis, assuming the positive impact of a firm's technological innovation activities on the propensity to innovate in marketing.

Table 2. Impact of technological innovation activities on the introduction of marketing innovations

Specification	P_1	P_2	P_3	P_4	P_5
Constans	-1.910***	-2.979***	-3.153***	-2.479***	-2.766***
X_4	×	×	×	×	×
X_5	0.005**	×	×	0.007***	0.008***
X_6	0.005*	0.015***	0.008**	×	×
X_7	×	×	×	×	×
X_8	×	×	×	0.011**	×
X_9	×	×	×	-0.001**	×
X_{10}	×	×	×	×	×
R ²	0.518	0.405	0.302	0.697	0.464
F (p-value)	9.153 (0.002)	12.292 (0.002)	7.787 (0.012)	12.322 (0.000)	15.631 (0.000)
χ^2 (p-value)	0.971 (0.615)	13.399 (0.001)	2.808 (0.245)	0.272 (0.872)	2.504 (0.285)

× – eliminated variable, χ^2 – chi-square statistics in Doornik-Hansen test for normality of random disturbance.

*Statistical significance at 0.1 level, **statistical significance at 0.05 level, ***statistical significance at 0.01 level.

The results reveal that technological innovation activities induce marketing innovations to a limited extent. In more detail, the expenditures on acquisition of knowledge from external sources have a significantly positive effect on the propensity to innovate in marketing in the models 1, 4 and 5. Surprisingly, another innovation activity allowing for the accumulation of technological knowledge, i.e. R&D, have no effect on propensity to innovate in marketing. One reason for this finding is that there is a lag between R&D and its effect in the form of technological innovation which induces marketing innovation [Ravenscraft and Scherer 1982]. As expected, the expenditures on marketing for new and significantly improved products have a significant impact on the introduction of marketing innovations in the models 1, 2 and 3. It is worth noting that one possible explanation for the fact that other innovation activities have no effects on marketing innovations is that these expenditures affect the changes in marketing indirectly via technological innovations.

CONCLUSIONS

Aiming at a better understanding of the relationship between various types of innovation and using data on Polish manufacturing firms, I analyzed the impact of technological innovations on marketing innovations at the sector level. The results show that product innovations influence the decision to introduce marketing innovations, suggesting a complementary relationship. On the other hand, the findings offer little support for the view that process innovations induce marketing innovations. This indicates that process innovations introducing in isolation to product innovations may be regarded as substitutes for some forms of marketing innovations.

In the second part of the study I found that technology innovation activities induce marketing innovations to a limited extent. It should be mentioned that the expenditures on marketing for new and significantly improved products and the expenditures on acquisition of knowledge from external sources have a major impact on the introduction of marketing innovations. In the case of other technology innovation activities it can be assumed that they have indirect impact on marketing innovations via their effects on technological innovations.

The paper is not exempt from some limitations. The main drawback pertains to the one direction analysis. The study only investigated the effect of technological innovations on marketing innovations, but did not analyze the opposite direction. Another shortcoming of the study concerns the data used in the analyses. The data have been aggregated at the sector level, so there is the possibility that micro-relations may be obscured by aggregation biases. In order to overcome these limitations future research should investigate the direction of the link between technological and marketing innovations using longitudinal micro-data.

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ANALIZA EMPIRYCZNA ZALEŻNOŚCI MIĘDZY INNOWACJAMI TECHNOLOGICZNYMI A INNOWACJAMI MARKETINGOWYMI NA PRZYKŁADZIE POLSKICH PRZEDSIĘBIORSTW PRZEMYSŁOWYCH

Streszczenie. Artykuł podejmuje problematykę związaną z relacjami między innowacjami technologicznymi a innowacjami marketingowymi. W części teoretycznej opracowania przedstawiono definicje i charakterystykę innowacji marketingowych oraz wskazano na potencjalne zależności przyczynowo-skutkowe między decyzjami o wdrożeniu innowacji produktowych i procesowych a implementacją nowych metod w zakresie marketingu mix. W części empirycznej artykułu dokonano weryfikacji sformułowanych hipotez badawczych na podstawie danych pochodzących z badania aktywności innowacyjnej polskich przedsiębiorstw przemysłowych w latach 2008–2010. Wyniki badania wskazują na pozytywny wpływ skłonności do wprowadzania innowacji produktowych na aktywność przedsiębiorstw w zakresie stosowania innowacji marketingowych. Ponadto, czynnikami stymulującymi przedsiębiorstwa do implementacji zmian w metodach marketingowych okazały się nakłady inwestycyjne na zakup wiedzy ze źródeł zewnętrznych oraz nakłady inwestycyjne na marketing dotyczący nowych i istotnie ulepszonych produktów.

Słowa kluczowe: innowacje marketingowe, innowacje technologiczne, skłonność do innowacji, nakłady na działalność innowacyjną

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