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Małgorzata Stefania LEWANDOWSKA*
Tomasz GOŁĘBIOWSKI**

Complementarity Between Process and Organizational Innovation of Polish Exporters

Summary: Many studies recognize importance of innovations for the international competitiveness of firms. This applies to both innovations introduced internally and those introduced in cooperation. The paper is based on a survey of 209 Polish manufacturing firms. It focuses on an analysis of the influence of process and organizational innovation on the firms' export intensity and on new product sales intensity. The study reveals that process innovation (undertaken both internally and in cooperation with business partners) is positively related to the firms' export intensity, while rejective the hypothesis that organizational innovation has an impact on export intensity. Moreover, the analysis provides evidence that both process and organizational innovations (introduced either internally or in cooperation) have no statistically significant influence on new product sales intensity of Polish exporters. These findings reflect the traditional competitive strategies based on the cost advantage rather than the differentiation-based advantage. The analysis of the relationships between process and organizational innovation reveals that these two types of innovation are positively related only in the high-export-intensity/high-new-product-sales-intensity cluster of firms. This correlation appears both in the case of internal and collaborative innovation. The authors argue that Polish exporters do not take full advantage of the opportunity to simultaneously implement complementary types of innovation and do not gain potential synergies from innovation.

Keywords: internal innovation, innovation cooperation, process and organizational innovation, innovativeness of Polish exporters

JEL classification codes: L14, O31, C38

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* Warsaw School of Economics, Institute of International Management and Marketing, e-mail: mlewando@sgh.waw.pl
** Warsaw School of Economics, Institute of International Management and Marketing, e-mail: tgoleb@sgh.waw.pl

Introduction

Recent literature as well as business practice provide evidence that innovation is one of the most important sources of competitiveness of firms. The results of numerous empirical studies show that Polish firms implement innovations aimed at maintaining the traditional sources of their competitive advantage (cost- and productivity-related). To a lesser extent, they also innovate to maintain a differentiation-related advantage. This primarily involves efforts based on process and product innovation[1] as well as increased market responsiveness [Gorynia, 2002], [Stankiewicz, 2003], [Pierścionek, Jurek-Stępień, 2006], [Hoshi et al., 2007], [Gołębiowski et al., 2008], [PARP, 2010], [Weresa, 2011], [Stojcic et al., 2011]. Product quality improvement was the most frequently mentioned objective by Polish firms that implemented innovations in 2006-2008, followed by: product mix extension, increase of manufacturing capabilities, increase of market share, market extension, replacement of obsolete product or process, and improvement of production flexibility (Eurostat Statistics Database [inn_cis6_obj]; [PARP, 2010]). The significance of various types of innovation embraced by Polish industrial firms is reflected in the distribution of expenditures on innovation. In 2009, a vast majority of the funds (83.8 percent) were spent on new machines and equipment (62.4 percent) as well as construction projects/infrastructure (21.4 percent). This testifies to a focus on process innovation. Further down the list, 9.9 percent of the funds were spent on R&D, 1.6 percent on software, 1.6 percent on the marketing of new/improved products, 1.3 percent on the acquisition of knowledge from external sources, and 0.2 percent on staff instruction/training [GUS, 2011].

We focus in this paper on the relationship between process and organizational innovations, on the one hand, and the international competitiveness of firms, on the other. The international competitiveness of firms is measured by the intensity of their export sales and the intensity of new product sales. We argue that process and organizational innovations are complementary in character and should be coordinated in order to reach synergistic effects in firms' competitive strategies. Both innovativeness and inter-organizational linkages in the context

[1] We adopt the widely accepted OECD definition of innovation, which distinguishes between four types of innovation: product, process, marketing, and organizational innovation. Product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses, i.e. improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Process innovation involves a new or significantly improved production or delivery method that includes improvements in techniques, equipment and/or software. Marketing innovation involves a new marketing method that includes significant changes in product design or packaging, product positioning, promotion or pricing. Organizational innovation is the implementation of new organizational methods in the firm's business practices, workplace organization or external relations. *Oslo Manual. Guidelines for Collecting and Interpreting Innovation Data.* Joint publication by OECD and Eurostat, 3rd ed., OECD Publishing, 2005, pp. 48-52; Polish edition: *Podręcznik Oslo. Zasady gromadzenia i interpretacji danych dotyczących innowacji.* Ministerstwo Nauki i Szkolnictwa Wyższego, Warszawa 2008.

of innovation are listed among the weaknesses of Polish firms [IBRKK, 2008], [PARP, 2010]. Therefore we also aim to analyze their cooperation practices in process and organizational innovation[2].

Theory and hypotheses development

Numerous studies conducted at both the macroeconomic and industry levels indicate that innovative activities really matter in developing international competitiveness, and that in the long term non-cost/price factors are more important than cost/price-related factors of competitive advantage [Soete, 1981], [Dosi et al., 1990], [Amendola et al., 1993], [Fagerberg, 2002], [Montobbio, 2003] see also [Halpern, 2007] for the literature overview).

Studies also confirm the resource-based, human capital and technological explanations of firms' export behavior. The ability to develop export sales is one of the most important indicators of the international competitiveness of firms. Both the probability of exporting and the intensity of exports are positively influenced by R&D and successful innovations. Investments in R&D resulting in product innovations have a positive impact on firms' propensity to export. New products and technologies resulting from innovative projects contribute to a firm's competitive advantage in the international market [Wagner, 1996], [Roper, Lowe, 2002], [Becker, Egger, 2007].

As to the direct impact of process innovation on the export behavior of firms, no such a strong evidence has been found [Brouwer, Kleinknecht, 1996], [Becker, Egger, 2007], [Clausen, Pohjola, 2009]. While product innovations are focused on gaining new markets (due to the differentiation effect), process innovations are often oriented rather toward productivity growth, with a view to increasing the cost-related competitive advantage. In a study on Slovenian firms, Damijan et al. [2008] have found no evidence that either product or process innovation increases the likelihood that a firm will start exporting. They argue, however, that past exporting status increases the probability that medium-sized and large firms will become process innovators. They have found a positive impact of exporting on productivity growth among medium-sized and large first-time exporters, which is indirect evidence of process innovations.

We focus on the relationship between process and organizational innovation, on the one hand, and the intensity of exports among Polish firms, on the other. Export intensity is measured as the share of exports in a firm's total sales revenue. Moreover, we analyze the relationships between these types of innovation and the intensity of new product sales (measured as the share of new product sales in total sales revenue) in Polish firms. Therefore we propose the following hypotheses:

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[2] This material is based on the authors' working paper *Cooperation in Innovations: The Case of Polish Manufacturing Firms* presented at the 37th European International Business Academy (EIBA) Annual Conference, "*Taking International Business to the Next Level – Emerging Issues, Strategies and Economies*", Bucharest, Dec. 8-10, 2011.

H.1. *Internal innovation is positively related to the export intensity of Polish firms.*

H.1a. *Internal process innovation is positively related to export intensity.*

H.1b. *Internal organizational innovation is positively related to export intensity.*

H.2. *Internal innovation is positively related to new product sales intensity of Polish firms.*

H.2a. *Internal process innovation is positively related to new product sales intensity.*

H.2 b. *Internal organizational innovation is positively related to new product sales intensity.*

Both internal and external sources of a competitive advantage are emphasized in the theoretical concepts of firm competitiveness. The resource-based theory of firm emphasizes the role of internal intangible resources and the importance of intellectual capital for firms' competitiveness [Barney, 1991], [Hamel, Heene, 1994], [Collis, Montgomery, 1997]. Capabilities built on technological, market, legal and organizational knowledge create a unique system within an organization based on individual skills and experience, and interrelations within the organization. This system is difficult to imitate/transfer outside the organization, which influences the sustainable competitive advantage. Recent literature suggests that intangible resources also comprise relational resources, i.e. the firm's relationships with its stakeholders and the firm's reputation [de Wit, Meyer, 2005]. The complexity of relationships and a unique selection of external partners result in the inimitability of the firm's relationships, thus adding to the firm's competitive advantage.

The ways to gain access to external resources range from market (transaction)-based to hierarchy-based. The space in between is covered by various forms of cooperative interfirm relationships comprising bilateral partnerships, alliances and multilateral networks [Håkansson, Johansson, 199], Contractor, Lorange, 2002]. Collaborative relationships can contribute to a competitive advantage resulting from relationship-specific assets, joint learning, combining complementary resources, and lower transaction costs due to reduced opportunistic behavior of partners. Therefore the application of relationships is suitable in many aspects of business activity and has strategic potential for a firm [Håkansson, 1982], [Kanter, 1994], [Dyer, Singh, 1998], [Donaldson, O'Toole, 2007].

Cooperation/networking is an important success factor in innovation activities [Freeman, 1991], [Bell, 2005], [Gilsing, 2005], [Laursen, Salter, 2006], [Rothaermel, Hess, 2007]. There are various motives behind firms' engagement in innovation cooperation: access to partners' complementary skills, sharing/reducing costs and risks of innovation projects, shortening innovation cycles, gaining benefits from scale or scope economies, learning through monitoring technology and market trends, dealing with regulatory standards, and responding to government policies [Kogut, 1988], [Sakakibara, 1997], [Belderbos et al., 2004], [Cassiman, Veugelers, 2006].

The growing role of networking in increasing the innovative capabilities of firms is closely related to the knowledge-based economy concept. The idea of innovation networking has also found support in the concept of open innovation[3], which questions the dominant role of internal capabilities as a determinant of the firm's success [Chesbrough, 2003], [von Hippel, 2005], [Chesbrough et al., 2006]. However, there are not many empirical studies that focus on the impact of open innovation practices on firms' performance using large-scale quantitative databases [Clausen, Pohjola, 2009]. Clausen and Pohjola [2009] in their recent study of Norwegian, Finnish and Swedish firms have found that the open innovation approach can be used by firms to improve their international competitiveness, in addition to the development of strong internal capabilities. They argue that firms that conduct both internal and external R&D have higher export propensity and intensity. Product innovation has a positive and significant impact on export propensity and intensity, whereas process innovation has a non-significant influence on firms' export performance. Foreign external cooperation has a strong positive and significant influence on export intensity, whereas domestic external innovation cooperation has a significant negative influence on export propensity and intensity.

Based on the analyses of theoretical concepts and on arguments found in empirical studies, as well as taking into account the innovation practices in Polish firms, we propose the following hypotheses:

H.3. *Innovation cooperation is positively related to the export intensity of Polish firms.*

H.3a. *Process innovation cooperation is positively related to export intensity.*

H.3b. *Organizational innovation cooperation is positively related to export intensity.*

H.4. *Innovation cooperation is positively related to new product sales intensity of Polish firms.*

H.4a. *Process innovation cooperation is positively related to new product sales intensity.*

H.4b. *Organizational innovation cooperation is positively related to new product sales intensity.*

Numerous studies have focused on the relationships between process and organizational innovation. Some of these studies indicate that the implementation of process innovation conduces to organizational innovation, e.g. changes in work organization, quality management systems, information flows, linkages to business partners etc. [Danneels, 2002]. Studies suggest the relevance of organizational innovation in enhancing the technological innovation capabilities due to improvements in the flexibility and adaptability of an organization, personnel creativity and motivation, changes in knowledge management

[3] Open innovation is a systematically performing knowledge exploration, retention and exploitation inside and outside an organization's boundaries throughout the innovation process [Lichtenthaler, 2011, p. 77].

systems, work organization, changes in intra- and inter-organizational linkages etc. All this shows the importance of organizational innovation for the propensity to innovate and for enhancing firms' capacity to innovate [Mothe, Thi, 2010]. Lokshin et. al. [2008] argue that organizational competencies are important co-determinants of innovative performance. The authors provide evidence of a complementarity and synergistic effect on innovation, based on combining technological, product, customer (marketing) and organizational competencies.

In this context, we propose the following hypotheses:

Hypothesis 5. *Internal process innovation is positively related to process innovation introduced in cooperation with other entities.*

Hypothesis 6. *Internal organizational innovation is positively related to organizational innovation introduced in cooperation with other entities.*

Hypothesis 7. *Process innovation is positively related to organizational innovation.*

Hypothesis 7a. *Internal process innovation is positively related to internal organizational innovation.*

Hypothesis 7b. *Internal process innovation is positively related to organizational innovation introduced in cooperation with other entities.*

Hypothesis 7c. *Process innovation introduced in cooperation is positively related to organizational innovation introduced internally.*

Hypothesis 7d. *Process innovation introduced in cooperation with other entities is positively related to organizational innovation introduced in cooperation.*

Research method

Our paper is based on the results of a pilot study on the innovation cooperation of Polish exporters from manufacturing sectors[4]. The empirical data used in this study were collected with the application of the CATI method from a survey carried out by the Indicator Market Research Center in Warsaw. The interviews were conducted in May 2010. The survey sample consisted of 209 medium-size and large enterprises, of which 54 represented the food processing industry (C10 – NACE, Rev. 2); 52 firms were from the chemical/pharmaceutical industry (C20, C21- NACE, Rev. 2); 51 firms from the automotive industry (C29 – NACE, Rev. 2), and 52 enterprises from the electronic industry (C26 – NACE, Rev. 2). The sample was chosen randomly from a database kept by Indicator, with a similar number of respondents from each industry. The structure of the sample does not reflect the structure of the whole population. A detailed description of the sample is given in Table 1 (see Appendix).

[4] The study was conducted by the World Economy Faculty (*Kolegium Gospodarki Światowej*) at the Warsaw School of Economics as part of its research project No. 05/S/0013/10: "*The International Competitiveness of Polish Enterprises – The Analysis of the Innovation Potential and Innovation Strategies of Polish Enterprises*", authors: T. Gołębiowski, L. Danik, M.S. Lewandowska, J. Żukowska, Warsaw 2010.

As one of the objectives of the study was to analyze differences in innovative activities related to the firms' export intensity and to the intensity of new product sales, the sample was divided into clusters. The dividing criteria were: the level of export intensity, with the borderline set at 30 percent for the share of exports in a firm's total sales revenue; and the level of product innovation intensity, with the borderline set at 30 percent for the share of new/improved products in a firm's total sales revenue.

As a result, four clusters of firms were singled out:

- *LowEx-LowInnpro* (firms in which exports account for no more than 30 percent of total sales revenue, and those in which the share of new/improved products in total sales revenue does not exceed 30 percent),
- *LowEx-HiInnpro* (firms in which exports account for no more than 30 percent of total sales revenue, and those in which the share of new/improved products in total sales revenue exceeds 30 percent),
- *HiEx-LowInnpro* (firms in which exports account for more than 30 percent of total sales revenue, and those in which the share of new/improved products in total sales revenue does not exceed 30 percent),
- *HiEx-HiInnpro* (firms in which exports account for more than 30 percent of total sales revenue, and those in which the share of new/improved products in total sales revenue exceeds 30 percent).

In order to justify the division of the sample into the proposed clusters, we tested the relationship between export intensity and new product sales intensity. There is a significant correlation between export intensity and new product sales intensity: $X^2(1) = 9{,}48$; $p < 0.01$, although the relationship is not very strong (Cramer's $V = 0.213$). See Tables 2 and 3 in Appendix for details.

We applied the following analytical methods:

1. frequency distribution of analyzed variables;
2. analysis of logistic regression. The dependent variable is dichotomous. The independent variables are various types of innovations (undertaken both internally and in cooperation with business partners);
3. spearman correlation analysis to check the hypothesis of a positive relationship between internal process innovation and organizational innovation; process innovation cooperation and organizational innovation cooperation.

Analysis and results

Table 4 presents descriptive statistics for all types of innovation: process innovation introduced internally (mean: 3.16, max: 5); organizational innovation introduced internally (mean: 2.51; max: 9); process innovation introduced in cooperation with other entities (mean: 1.88; max: 5); and organizational innovation introduced in cooperation (mean: 0.95; max: 9). Table 5 shows responses for process and organizational innovations, both those introduced internally and those introduced in cooperation, for the whole sample and by clusters (see Appendix).

We built eight different models of logistic regression analysis to test the probability of correlations between: internal process innovations and the intensity of exports; process innovations introduced in cooperation with other businesses and the intensity of exports; internal organizational innovations and the intensity of exports; organizational innovations introduced in cooperation with other businesses and the intensity of exports; internal process innovations and the intensity of innovative product sales; process innovations introduced in cooperation with other businesses and the intensity of innovative product sales; internal organizational innovations and the intensity of innovative product sales; organizational innovations introduced in cooperation with other businesses and the intensity of innovative product sales.

Based on the data in Tables 6-13 (see Appendix), we found that three of the eight logistic regression models validated our hypotheses.

We found a positive correlation between process innovations introduced internally and export intensity (H1a) (Table 6). The positive variable B (.245) indicates that the probability of joining the group of intensive exporters rises with the growing number of process innovations introduced internally. The standard deviation is .104 with the *p*-value at .019, meaning that the influence of process innovation on export intensity is significant. Exp (B) shows the relative strength of this influence = (1.277-1) × 100 = 27.7%, meaning that the probability of joining the group of strong exporters rises by 27.7% on average with each additional mention of process innovation introduced internally.

We also found a positive correlation between process innovations introduced in cooperation with other businesses and export intensity (H3a) (Table 7). The positive variable B (.262) indicates that the probability of joining the group of intensive exporters rises with the growing number of process innovations introduced in cooperation with other businesses. The standard deviation is .094 and the significance is .005, meaning that the influence of process innovation on export intensity is significant. Exp (B) shows the strength of this influence = (1.300-1) × 100 = 30%, meaning that the probability of joining the group of strong exporters rises by 30% on average with each additional mention of process innovation introduced in cooperation with other businesses.

A positive correlation between organizational innovations introduced in cooperation with other businesses and the intensity of new product sales (H4b) was confirmed as well (Table 13). The positive variable B (.206) indicates that the probability of being among firms that intensively sell new products rises with the growth in the number of organizational innovations introduced in cooperation with business partners. The standard deviation is .090 and the significance is .023, meaning that the influence is significant. Exp (B) shows the strength of this influence = (1.228-1) × 100 = 22.8%, meaning that, with each additional mention of organizational innovations introduced in cooperation with other businesses, the probability of joining the group of intensive sellers of new products rises by 22.8% on average.

Thus hypotheses H1a *(Internal process innovation is positively related to export intensity)*; H3a *(Process innovation cooperation is positively related to*

export intensity); and H4b. *(Organizational innovation cooperation is positively related to the intensity of new product sales)* were validated, while hypotheses H1b; H2a; H2b; H3b; and H4a were rejected.

Turning to H5, H6, H7a – H7d, we present Tables 14-19 (see Appendix).

The correlation strength will be defined as follows: from 0.10 to 0.20 – "very weak correlation"; from 0.21 to 0.30 – "weak correlation"; from 0.31 to 0.40 – "moderate correlation"; from 0.41 to 0.50 – "strong correlation"; over 0.50 – "very strong correlation". For analytical purposes, only strong and very strong correlations will be taken into account to verify our hypotheses.

Process innovations

The most frequently indicated innovative activities performed **internally** by the whole sample (N = 209) in process (technological) innovations are: the implementation of new machines, equipment or tools; introduction of new technological processes, and purchase of new software (see Table 5). The declarations for innovations introduced **in cooperation** are, in majority of cases, significantly lower than for those undertaken internally. Cooperation takes place in the most frequently declared innovations: introduction of new machines, equipment and tools; introduction of new technological processes, and purchase of new software (see Table 5). We observe a strong correlation between process innovations introduced internally and those implemented in cooperation (see Table 14).

The indications for **internal** innovations in the *LowEx-LowInnpro cluster* (N = 75), in process innovations such as: the introduction of new technological processes; purchase of new software; and the use of new raw materials, materials and components – is lower than the average for the whole sample. The percentage of respondents introducing new ways of providing services, new technological processes, and new software is the lowest among all the clusters. It seems that firms in the LowEx-LowInnpro cluster invest mainly in new machines, equipment and tools, while neglecting other forms of process innovation (see Table 5). As far as innovation **cooperation** is concerned, the introduction of new machines, equipment and tools were mentioned the most often. The percentage of LowEx-LowInnpro cluster firms implementing other process innovations in cooperation with business partners was lower than the average for the sample, and the percentage of firms introducing new ways of providing services and new software was the lowest among all the clusters (see Table 5). There is a very strong correlation between process innovations introduced internally and those introduced in cooperation with business partners (see Table 15).

In the *LowEx-HiInnpro cluster* (N = 33), the percentage of firms **internally** introducing process innovations (except for new ways of providing services) is lower than the average for the whole sample. The percentage of firms introducing new machines, materials and software is the lowest among all the clusters (see

Table 5). As far as innovation **cooperation** is concerned, the introduction of new machines, equipment and tools was mentioned the most often. The percentage of LowEx-HiInnpro cluster firms implementing other process innovations in cooperation was lower than the average for the whole sample and the lowest among all the clusters (see Table 5). There is a moderate correlation between process innovations introduced internally and those introduced in cooperation with business partners (see Table 16).

The *HighEx-LowInnpro cluster* ($N = 49$) may be characterized by the fairly high level of investment in **internal** process innovations. The percentage of firms implementing such innovations is higher than the average for the sample, and the percentage of firms introducing new software is the highest among all the clusters (see Table 5). As far as innovation **cooperation** is concerned, the introduction of new, improved machines, equipment and tools was declared the most often, with the number of indications lower than average. For innovations such as introduction of new technological processes and new ways of providing services, the indications are above the average, and for introduction of new software are the highest among all clusters (see Table 5). There is moderate correlation between process innovations introduced internally and those introduced in cooperation (see Table 17).

The *HighEx-HiInnpro cluster* ($N = 52$) is characterized by high indications for process innovations introduced **internally**, which mainly include the introduction of new technological processes and implementation of new machines. The figures are the highest among all the clusters (see Table 5). As far as innovation **cooperation** is concerned (except for the introduction of new software), the level of cooperation is the highest among all the clusters (see Table 5). There is a very strong correlation between process innovations introduced internally and those introduced in cooperation (see Table 18).

Organizational innovations

The most frequently mentioned organizational innovations implemented **internally** by the whole sample ($N = 209$) are: implementation of new systems of quality management; introduction of new method of division of duties; and the introduction of new methods of personal development (see Table 5). Organizational innovation **cooperation** was declared less frequently than process innovations. Cooperation was especially frequent in the introduction of new systems of quality management, new methods of personal development and new method of division of duties (see Table 5). There is a very high correlation between organizational innovations introduced internally and those introduced in cooperation with other businesses (see Table 14).

In the *LowEx-LowInnpro cluster*, the figures for all organizational innovations introduced **internally** are below the average (except for outsourcing) and in most cases (except for new systems of quality management) they are the lowest among all clusters (see Table 5). The figures for **cooperation** in organizational innovations are low and very low. The percentage of *LowEx-LowInnpro cluster*

firms implementing new methods of personal development, new methods of know-how development, and new methods of business organization is the lowest among all the clusters. There is a very strong correlation between organizational innovations introduced internally and those introduced in cooperation (see Table 15).

Firms in the *LowEx-HiInnpro cluster* relatively frequently introduce organizational innovations **internally**, and are the most eager of all the clusters to introduce new methods of personal development. At the same time, the figure for outsourcing is the lowest in the sample (see Table 5). The indications for **cooperation** in organizational innovations are relatively low. The number of *LowEx-HiInnpro cluster* firms introducing new methods of personal development and other methods of business organization is above the average, but the figures for the introduction of new methods of division of duties and outsourcing are lower than average, and the figures for new quality management systems and new methods of know-how management are the lowest among all clusters (see Table 5). There is a very high correlation between organizational innovations introduced internally and those introduced in cooperation (see Table 16).

In the *HighEx-LowInnpro cluster*, the indications for the **internal** introduction of organizational innovations are below the average (with the exception for outsourcing) (see Table 5). The number of indications for **cooperation** in organizational innovations is low. Declaration of introduction of new methods of personal development and other methods of business organization are above the average, but those for introduction of new methods of division of duties and outsourcing are the lowest among all the clusters (see Table 5). Organizational innovations implemented internally are highly correlated with those introduced in cooperation (see Table 17).

In the *HighEx-HiInnpro cluster*, the responses for all organizational innovations introduced **internally** are far above the average and those for innovations such as the introduction of new systems of quality management, new methods of division of duties and outsourcing are the highest among all clusters. The indications for **cooperation** in organizational innovations are the highest among all the clusters (see Table 5). Organizational innovations introduced internally and in cooperation are very highly correlated in this cluster (see Table 18).

In the whole sample there is a very strong **correlation between process and organizational innovations** introduced internally. A strong correlation is also observed between process innovations introduced in cooperation and organizational innovations introduced both internally and in cooperation.

For the *LowEx-LowInnpro cluster*, there is a strong correlation between process innovations – both those introduced internally and those introduced in cooperation – as well as organizational innovations introduced internally.

In the *LowEx-HiInnpro cluster*, there is a strong correlation between process and organizational innovations introduced internally.

In the *HighEx-LowInnpro cluster*, there is a very strong correlation between process and organizational innovations introduced internally, and we also

observed a strong correlation between process innovations introduced in cooperation with other businesses and organizational innovations, both those introduced internally and those introduced in cooperation with other businesses.

In the *HighEx-HiInnpro cluster*, there is a very strong correlation between process and organizational innovations, both those introduced internally and those introduced in cooperation with other businesses. There is also a strong correlation between process innovations introduced internally and organizational innovations introduced in cooperation with other businesses, and a very strong correlation between process innovations introduced in cooperation and organizational innovations introduced internally.

A summary of Spearman correlations for the whole sample as well as for clusters is given in Table 19 (see Appendix).

Based on the above results, we conclude that: H5 is supported for *LowEx--LowInnpro* and *HighEx-HiInnpro clusters*; H6 and H7a is supported for all types of clusters; H7b is supported only for the *HighEx-HiInnpro* cluster; H7c is rejected only for the *LowEx-HiInnpro* cluster and; H7d is supported for the *HighEx-LowInnpro* and *HighEx-HiInnpro clusters*.

Conclusions

Numerous studies on competitiveness and competitive strategies of Polish firms provide evidence for the continued predominance of cost/price-based strategies. Moreover, interorganizational linkages in the context of innovation are listed among relative weaknesses of Polish firms.

However, attempts at strategic reorientation focused on product quality improvement, increased market responsiveness and innovations, are visible in business practice. When studying innovation, we focused on the less explored fields of cooperation in innovation among Polish firms [Woodward et al., 2005], [Wziątek-Kubiak et al., 2009]. Analysis of the relationship between innovation and export intensity of Polish firms – in the case of both innovations introduced internally and those introduced in cooperation – reveals that only process innovation (both internal and that conducted in cooperation) is positively related to export intensity. These findings reflect the traditional competitive strategies of Polish exporters, which are predominately based on the cost advantage.

The relationship between introduction of organizational innovations and new product sales intensity and was also confirmed.

Our analysis of the relationships between process and organizational innovations shows that these two types of innovations are strongly related mainly between the same types of innovations introduced internally and in cooperation and in the case where two different types are introduced both internally. The only exception was the *HighEx-HiInnpro cluster*, where all the figures for correlations between process and organizational innovations – introduced either internally or in cooperation – were the highest.

The study supports the results of other research suggesting that the simultaneous introduction of various types of innovation creates a synergy

effect, thus improves firms' innovation performance. We argue that Polish firms do not exploit the opportunities of coordinated introduction of complementary types of innovation, and that they continue to overemphasize the importance of process innovation, which is also reflected in the traditional structure of innovation expenditures.

We are aware that our sample is not representative, therefore the results may be biased by the structure of the sample and the profiles of the identified clusters of firms. Innovation behavior is industry-specific, therefore the results obtained in the selected industries could not reflect the overall innovation picture of the national economy. Moreover, the size of the firms and their ownership structure influence their competitive potential and innovation strategies.

Appendix

Table 1

Sample characteristics

Number of employees	No. of firms	% of the sample
50-249	108	52
More than 249	101	48
% of innovative products sales in total turnover	No. of firms	% of the sample
Less than 30%	124	59
30-50%	55	26
More than 50%	30	14
Industry	No. of firms	% of the sample
Food processing	54	26
Chemical pharmaceutical	52	25
Automotive	51	24
Electronic	52	25

Own R&D department	No. of firms	% of the sample
Yes	131	63
No	78	37
% of export sales in total turnover	No. of firms	% of the sample
Less than 30%	108	52
30-50%	42	20
More than 50%	59	28
Ownership of the firm	No. of firms	% of the sample
Polish-owned	148	71
Mixed (Polish & foreign-owned)	29	14
Foreign-owned	32	15

Table 2

Relation between export sales intensity and new products sales intensity

Relation between export sales intensity and new products sales intensity			Export sales intensity		Total
			less than 30%	more than 30%	
New products sales intensity	less than 30%	Count	**75**	**49**	124
		% within r_sales_intensity	60.5%	39.5%	100.0%
		% within r_export_ intensity_ok	69.4%	48.5%	59.3%
	more than 30%	Count	**33**	**52**	85
		% within r_sales_intensity	38.8%	61.2%	100.0%
		% within r_export_ intensity_ok	30.6%	51.5%	40.7%
Total		Count	108	101	209
		% within r_sales_intensity	51.7%	48.3%	100.0%
		% within r_export_ intensity_ok	100,0%	100.0%	100.0%

Chi-Square Tests for clusters: Pearson Chi-Square = 9,475[a]; df = 1; Asymp. Sig. (2-sided) = .002.
Symmetric Measures for clusters: Phi = ,213; Approx. Sig. = ,002; Cramer's V = ,213;
Pearson's R = ,213; Asymp. Std. Error = ,068; Approx. T = 3,135; Approx. Sig. = ,002

Table 3

Cluster profiles

Clusters profiles	Low export intensity, low product innovation intensity (LowEx-LowInnpro), *n* = 75	Low export intensity, high product innovation intensity (LowEx-HiInnpro), *n* = 33	High export intensity, low product innovation intensity (HiEx-LowInnpro), *n* = 49	High export intensity, high product innovation intensity (HiEx-HiInnpro), *n* = 52
	% of cluster			
50-249 employees	61	55	39	48
More than 249 employees	39	45	61	52
Polish capital	85	88	67	42
Food processing	32	37	19	17
Chemical pharmaceutical	29	27	20	21
Automotive	8	15	41	39
Electronic	31	21	20	23
Own R&D department	57	70	71	58

Table 4

Descriptive statistics of process and organizational innovations introduced internally and in cooperation

Descriptive statistics	Introduced internally		Introduced in cooperation	
	Process innovations	Organizational innovations	Process innovations	Organizational innovations
Mean	3,16	2,51	1,88	0,95
Std. Error of Mean	0,10	0,14	0,11	0,11
Median	3,00	2,00	2,00	0,00
Mode	4,00	0,00	0,00	0,00
Std. Deviation	1,38	2,08	1,54	1,62
Variance	1,90	4,34	2,38	2,63
Skewness	-0,40	0,61	0,40	2,27
Kurtosis	-0,69	-0,41	0,17	0,17
Minimum	0,00	0,00	0,00	0,00
Maximum	5,00	9,00	5,00	9,00

Table 5

Process and organizational innovations introduced internally and in cooperation, total and by clusters

Process and organizational innovations introduced internally and in cooperation by analyzed firms	Total		Low export intensity				High export intensity			
	N = 209		Low InnPro *n* = 75		High InnPro *n* = 33		Low InnPro *n* = 49		High InnPro *n* = 52	
	N	%	*N*	%N	*n*	%N	n	%N	*n*	% N
INTRODUCED INTERNALLY										
Process innovation										
New/improved technological processes	157	75	48	64	23	70	40	82	46	89
New/improved machines, equipment, tools	177	85	63	84	25	76	43	88	46	89
Use of new raw materials, materials, components	120	57	40	53	17	52	31	63	32	62
New software	134	64	45	60	20	61	34	70	35	67
New way of providing services	73	35	23	31	14	42	19	39	17	33
Organizational innovation										
New methods of personal development	90	43	29	39	17	52	20	41	24	46
New systems of quality management	111	53	38	51	18	55	23	47	32	62
Other methods of organization of business	66	32	21	28	10	30	17	35	18	35
New methods of division of duties	92	44	29	39	15	46	21	43	27	52
New methods of know-how management	63	30	18	24	11	33	14	29	20	39
Outsourcing	54	26	20	27	5	15	13	27	16	31
INTRODUCED IN COOPERATION										
Process innovation										
New/improved technological processes	94	45	27	36	11	33	25	51	31	60
New/improved machines, equipment, tools	114	54	38	51	15	46	26	53	35	67
Use of new raw materials, materials, components	74	35	23	31	10	30	17	35	24	46
New software	83	40	25	33	12	36	23	47	23	44
New way of providing services	27	13	6	8	4	12	7	14	10	19

continued Table 5

Process and organizational innovations introduced internally and in cooperation by analyzed firms	Total		Low export intensity				High export intensity			
	N = 209		Low InnPro *n* = 75		High InnPro *n* = 33		Low InnPro *n* = 49		High InnPro *n* = 52	
	N	%	*N*	%N	*n*	%N	n	%N	*n*	% N
Organizational innovation										
New methods of personal development	44	21	9	12	9	27	11	22	15	29
New systems of quality management	50	24	18	24	8	24	6	12	18	35
Other methods of organization of business	24	11	7	9	4	12	5	10	8	15
New methods of division of duties	25	12	8	11	2	6	5	10	10	19
New methods of know-how management	21	10	5	7	3	9	2	4	11	21
Outsourcing	21	10	7	9	2	6	4	8	8	15

Table 6

Logistic regression – internal process innovation/share of exports in total sales

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Process innovations introduced internally	.245	.104	5.523	1	.019	1.277	1.041	1.567
	Constant	-.845	.361	5.473	1	.019	.430		

Model summary: -2 Log likelihood = 283.794[a]; Cox & Snell R Square = .027; Nagelkerke R Square = .036.
Hosmer and Lemenshow Test: Chi-square = .757; df = 3; Sig. = .860.
a. Variable(s) entered on step 1: Process innovations introduced internally.
From classification table – overall percentage 56.9.

Table 7

Logistic regression – process innovation in cooperation/share of exports in total sales

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Process innovations introduced in cooperation	.262	.094	7.839	1	.005	1.300	1.082	1.562
	Constant	-.559	.225	6.173	1	.013	.430		

Model summary: -2 Log likelihood = 281.337[a]; Cox & Snell R Square = .038; Nagelkerke R Square = .051.
Hosmer and Lemenshow Test: Chi-square = 1.167; df = 4; Sig. = .884.
a. Variable(s) entered on step 1: Process innovations introduced in cooperation.
From classification table – overall percentage 59.3.

Table 8

Logistic regression – internal organizational innovation/share of exports in total sales

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Organizational innovations introduced internally	.097	.067	2.086	1	.149	1.102	.966	1.258
	Constant	-.311	.219	2.022	1	.155	.733		

Model summary: -2 Log likelihood = 287.390a; Cox & Snell R Square = .010; Nagelkerke R Square = .013.
Hosmer and Lemenshow Test: Chi-square = 9.099; df = 5; Sig. = .105.
a. Variable(s) entered on step 1: Organizational innovations introduced internally.
From classification table – overall percentage 54.5.

Table 9

Logistic regression – organizational innovation in cooperation/share of exports in total sales

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Organizational innovations introduced in cooperation	.126	.088	2.018	1	.155	1.134	.953	1.348
	Constant	-.186	.161	1.323	1	.250	.830		

Model summary: -2 Log likelihood = 287.411[a]; Cox & Snell R Square = .010; Nagelkerke R Square = .013.
Hosmer and Lemenshow Test: Chi-square = .830; df = 2; Sig. = .660.
a. Variable(s) entered on step 1: Organizational innovations introduced in cooperation.
From classification table – overall percentage 52.6.

Table 10

Logistic regression – internal process innovation/share of sales of innovative products in total sales

Variables in the equation		B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Process innovations introduced internally	.065	.103	.400	1	.527	1.067	.872	1.306
	Constant	-.584	.357	2.674	1	.102	.557		

Model summary: -2 Log likelihood = 282.014[a]; Cox & Snell R Square = .002; Nagelkerke R Square = .003.
Hosmer and Lemenshow Test: Chi-square = .427; df = 3; Sig. = .935.
a. Variable(s) entered on step 1: Process innovations introduced internally.
From classification table – overall percentage – 59.3.

Table 11

Logistic regression – process innovation in cooperation/share of sales of innovative products in total sales

Variables in the equation		B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Process innovations introduced in cooperation	.130	.092	2.017	1	.156	1.139	.952	1.354
	Constant	-.626	.227	7.625	1	.006	.535		

Model summary: -2 Log likelihood = 280.386[a]; Cox & Snell R Square = .010; Nagelkerke R Square = .013.
Hosmer and Lemenshow Test: Chi-square = 2.565; df = 4; Sig. = .633.
a. Variable(s) entered on step 1: Process innovations introduced in cooperation.
From classification table – overall percentage – 58.9.

Table 12

Logistic regression – internal organizational innovation/share of sales of innovative products in total sales

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Organizational innovations introduced internally	.119	.068	3.039	1	.081	1.126	.985	1.287
	Constant	-.680	.226	9.053	1	.003	.506		

Model summary: -2 Log likelihood = 279.345[a]; Cox & Snell R Square = .015; Nagelkerke R Square = .020.
Hosmer and Lemenshow Test: Chi-square = 5.342; df = 5; Sig. = .376.
a. Variable(s) entered on step 1: Organizational innovations introduced internally.
From classification table – overall percentage – 58.4.

Table 13

Logistic regression – organizational innovation in cooperation/share of sales of innovative products in total sales

Variables in the equation		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Organizational innovations introduced in cooperation	.206	.090	5.175	1	.023	1.228	1.029	1.466
	Constant	-.577	.167	11.954	1	.001	.562		

Model summary: -2 Log likelihood = 276.923[a]; Cox & Snell R Square = .026; Nagelkerke R Square = .035.
Hosmer and Lemenshow Test: Chi-square = 2.180; df = 2; Sig. = .336.
a. Variable(s) entered on step 1: Organizational innovations introduced in cooperation.
From classification table – overall percentage – 59.8.

Table 14

Spearman correlation between process and organizational innovations introduced internally and in cooperation, whole sample, $N = 209$

Rho Spearman	Introduced internally		Introduced in cooperation	
	Total number of process innovations	Total number of organizational innovations	Total number of process innovations	Total number of organizational innovations
Internally				
Total number of process innovations	1			
Total number of organizational innovations	.530**	1		
In cooperation				
Total number of process innovations	.496**	.399**	1	
Total number of organizational innovations	.292**	.572**	.400**	1

* Correlation is significant at the 0,05 level (2-tailed); ** Correlation is significant at the 0,01 level (2-tailed).

Table 15

Spearman correlation between process and organizational innovations introduced internally and in cooperation, LowEx -LowInnpro cluster, $n = 75$

Rho Spearman	Introduced internally		Introduced in cooperation	
	Total number of process innovations	Total number of organizational innovations	Total number of process innovations	Total number of organizational innovations
Internally				
Total number of process innovations	1			
Total number of organizational innovations	.395**	1		
In cooperation				
Total number of process innovations	.475**	.431**	1	
Total number of organizational innovations	.172	.535**	.381**	1

* Correlation is significant at the 0,05 level (2-tailed); ** Correlation is significant at the 0,01 level (2-tailed).

Table 16

Spearman correlation between process and organizational innovations introduced internally and in cooperation, LowEx -HiInnpro cluster, *n* = 33

Rho Spearman	Introduced internally		Introduced in cooperation	
	Total number of process innovations	Total number of organizational innovations	Total number of process innovations	Total number of organizational innovations
Internally				
Total number of process innovations	1			
Total number of organizational innovations	.456**	1		
In cooperation				
Total number of process innovations	.331	-.059	1	
Total number of organizational innovations	.380*	.656**	.158	1

* Correlation is significant at the 0,05 level (2-tailed); ** Correlation is significant at the 0,01 level (2-tailed).

Table 17

Spearman correlation between process and organizational innovations introduced internally and in cooperation, HiEx -LowInnpro cluster, *n* = 49

Rho Spearman	Introduced internally		Introduced in cooperation	
	Total number of process innovations	Total number of organizational innovations	Total number of process innovations	Total number of organizational innovations
Internally				
Total number of process innovations	1			
Total number of organizational innovations	.615**	1		
In cooperation				
Total number of process innovations	.400**	.400**	1	
Total number of organizational innovations	.246	.548**	.391**	1

* Correlation is significant at the 0,05 level (2-tailed); ** Correlation is significant at the 0,01 level (2-tailed).

Table 18

Spearman correlation between process and organizational innovations introduced internally and in cooperation, HiEx -HiInnpro cluster, *n* = 52

Rho Spearman	Introduced internally		Introduced in cooperation	
	Total number of process innovations	Total number of organizational innovations	Total number of process innovations	Total number of organizational innovations
Internally				
Total number of process innovations	1			
Total number of organizational innovations	.687**	1		
In cooperation				
Total number of process innovations	.712**	.570**	1	
Total number of organizational innovations	.420**	.595**	.526**	1

* Correlation is significant at the 0,05 level (2-tailed); ** Correlation is significant at the 0,01 level (2-tailed).

Table 19

Spearman correlation between process and organizational innovations – summary

Spearman correlations – summary	Whole sample *n* = 209	LowEx--LowInnpro *n* = 75	LowEx-HiInnpro *n* = 33	HiEx-LowInnpro *n* = 49	HiEx--HiInnpro *n* = 52
Process internally Process in cooperation; H5	STRONG	VERY STRONG	MODERATE	MODERATE	VERY STRONG
Organizational internally Organizational in cooperation; H6	VERY STRONG	VERY STRONG	VERY STRONG	VERY STRONG	VERY STRONG
Process internally Organizational internally; H7a	VERY STRONG	STRONG	STRONG	VERY STRONG	VERY STRONG
Process internally Organizational in cooperation; H7b	WEAK	WEAK	MODERATE	WEAK	STRONG
Process in cooperation Organizational internally; H7c	STRONG	STRONG	NO	STRONG	VERY STRONG
Process in cooperation Organizational in cooperation; H7d	STRONG	MODERATE	WEAK	STRONG	VERY STRONG

Sources of tables 1-19: Results of own research. Calculation in SPSS 19.0.

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KOMPLEMENTARNOŚĆ INNOWACJI PROCESOWYCH I ORGANIZACYJNYCH POLSKICH EKSPORTERÓW

Streszczenie

Wiele badań wskazuje na znaczenie innowacji wprowadzanych przez przedsiębiorstwa zarówno samodzielnie jak i w kooperacji dla ich konkurencyjności międzynarodowej. W artykule opartym na badaniach 209 polskich producentów skupiono się na analizie wpływu innowacji procesowych i organizacyjnych na intensywność eksportu oraz udział sprzedaży nowych produktów w łącznej sprzedaży tych przedsiębiorstw. Stwierdzono pozytywną korelację między innowacjami procesowymi (realizowanymi samodzielnie jak i w kooperacji z innymi podmiotami) i intensywnością eksportu przedsiębiorstwa, natomiast hipoteza o takim związku innowacji organizacyjnych z intensywnością eksportu nie została potwierdzona. Ponadto, wykazano, że innowacje procesowe i organizacyjne (samodzielne i w kooperacji) nie wykazują statystycznie istotnego związku z intensywnością sprzedaży nowych produktów przez polskich eksporterów. Wyniki te są wyrazem realizacji tradycyjnych strategii konkurencji opartych na przewadze kosztowej, a nie na dyferencjacji oferty. Analiza związków między innowacjami procesowymi i organizacyjnymi wykazuje pozytywną korelację między tymi typami innowacji jedynie w przedsiębiorstwach o wysokiej intensywności eksportu i dużym udziale nowych produktów w łącznej sprzedaży. Korelacja ta występuje w przypadku innowacji podejmowanych samodzielnie jak i w kooperacji. Autorzy konkludują, że polscy eksporterzy nie wykorzystują w pełni możliwości równoległego wprowadzania innowacji o charakterze komplementarnym, jakimi są innowacje procesowe i organizacyjne i nie osiągają potencjalnej synergii w działalności innowacyjnej.

Słowa kluczowe: innowacje samodzielne, kooperacja w innowacjach, innowacje procesowe i organizacyjne, innowacyjność polskich eksporterów

JEL: L14, O31, C38