

# Innovative Behaviour of High-Tech Internationalized Firms: Survey Results from Poland

Krzysztof Wach

## ABSTRACT

**Objective:** The aim of the article is to identify and verify the relationship between internationalization and innovativeness as well as innovative behaviour of high-tech businesses in Polish context.

**Research Design & Methods:** A quantitative research design was employed. A survey was conducted on the sample of 263 firms operating in high-tech industries in Poland. To verify the assumed relationships statistical instruments were used, including descriptive statistics, Chi-Square test, the Kruskal-Wallis test and multivariate regression.

**Findings:** The level of innovativeness of investigated hi-tech firms was relatively high. Results suggest that the innovativeness of a business contributes to the intensification of the internationalization process of firms operating in high-tech industries. The regression model confirms the dependence of internationalization on three innovative behaviours, such as the general evaluation of innovativeness of the firm), the pace of innovation diffusion and the number of implemented innovations.

**Implications & Recommendations:** Polish high-tech businesses seem to be relatively well internationalized, especially in comparisons to general business population. Policy makers should continue to support innovativeness of Polish economy, but especially these industries which are highly innovative.

**Contribution & Value Added:** The research presented in the article seems to be one of the first in Poland investigating into internationalization and innovation in high-tech industries. The results are in line with the majority of empirical evidence worldwide. The preliminary link between innovation and internationalization among Polish high-tech businesses was confirmed.

**Article type:** research article

**Keywords:** innovation; innovativeness; i-models; international business; internationalization; international entrepreneurship

**JEL codes:** F23, O30, M16

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## INTRODUCTION

Currently, innovations are considered to be the heart of the present-day international entrepreneurship research (Onetti, Zuchella, Jones & McDougall, 2012). Few previous decades have caused that the global economy has undergone a dramatic change, and the “new economic landscape requires a combination of entrepreneurship, innovation, and internationalization” (Hagen, Denicolai & Zucchella, 2014, p. 111). Innovation, innovativeness and/or innovative resources are widely recognized as a major driver of firm internationalization either in traditional industries (Veglio & Zuchella, 2015) and especially in high-tech industries (Spence & Crick, 2006) or at least in knowledge-intensive industries (Bell, McNaughton, Young, Crick, 20013). Innovation is the key value creation and export performance either for large multinational enterprises (MNEs) (Cano-Kollmann, Cantwell, Hannigan, Mudambi & Song, 2016) or for small and medium-sized enterprises (SMEs) (Kosała, 2015). Nevertheless, the recent empirical evidence and literature show that “the links between innovation and internationalization tend to be less clear” (Zuchella & Siano, 2014) as it is quite difficult to capture empirically these relations.

The aim of the article is to identify and verify the links between internationalization and innovativeness as well as innovative behaviour of high-tech business in Polish realities. Empirical research is based on survey research. The article is designed in three conventional sections. The first section presents the literature review on the potential relationship between innovation and internationalization. The second section introduces the basic description of the material and methods used in the empirical study. The third section discussed the empirical results obtained on the sample of 263 firms operating in high-tech industries in Poland.

## LITERATURE REVIEW

According to Schumpeter (1934), one of five forms of innovation is entering new markets, thus internationalization, as the expansion into a new foreign market or markets, can be considered innovation itself (more specifically, marketing innovation, while using a popular 4-element classification of innovation). Usually it is reported that the relation between innovation and internationalization dates back to 1970s (Szymura-Tyc, 2015, p. 70), at first at the macroeconomic level and then in business studies.

Rogers (1962, p. 8186) developed the process of the sequential adaptation of innovation (Innovation-adoption Process, IAP) on which innovation-related internationalization models are based. The introduction of innovation in stages models enabled to isolate the subgroup of innovation-related models which, in their primary assumptions, based on the behavioural theory and the phase internationalization process, therefore, are *de facto* a variety of stages models (Andersen, 1993, p. 212). The stress, however, is differently distributed as for the mechanism of the internationalization process and its explanation (Table 1). Innovation-related models are based on the sequential learning process, with regard to innovation or adaptation, and decisions of the firm about its internationalization are treated as innovations *sensu largo*. Various authors of various innovation-related models distinguish various stages of the internationalization process. Individual stages differ from each other, starting either from the lack of interest in inter-

nationalization or export awareness, and as a rule ending with the exploration of farther foreign markets. Reid (1981, p. 104) states that “viewing exporting as innovation adoption gives us richer insight into how exporting is initiated and how it is developed”. The innovation-based stages models treat internationalization *per se* as a process of innovation, especially as a learning process – internationalization by learning (Andersen & Kheam, 1998).

**Table 1. The comparison of stages models (U-model) with innovation-based models (I-model)**

Criterion		U-model	I-models
<b>Types of scientific explanation</b>		<b>Genetic historicism</b>	
Analytical assumptions	Unit of analysis	No restrictions (SMEs, Large enterprises)	SMEs
	Time	Unlimited	Limited
Causation	Model type	Causative cycles	Explanatory chain
	Explanatory variables	One variable: knowledge of the enterprise	A lot of variables, mostly concerning organizational factors
Scientificity / Utility	Assumptions with regard to enterprise behaviour	Based on behavioural theories, incremental decision-making process with no or little impact of competitive and market factors	
	Correctness of defining the variables	Examples of possible indicators, no operating definitions	Unclear arguments for the classification of procedures or operationalization of explanatory variables
	Accuracy of delimitation between stages	Considerable generality and ambiguity	Basically intuitive argumentation and reasoning
Usefulness / Intuitiveness		Axiomatic logics. Useless for the needs of management and government policy.	
Conformity between: - theory and operationalization - conceptual and operating definitions		Unclear	Some discrepancies, no testing of validity
Specification of variables adopted to determine the impact on the development process		No variables except for causative cycles	Lack of complete list of variables, unclear argumentation why and how variables should differ between stages
Empirical setting		Case studies: measurement of independent variables based on the observation of dependent variables	Cross-section analyses, unclear causality of internationalization phases from their determinants
Tautologies		Some difficulties in delimitation of theoretical concepts	In some cases independent and dependent variables are almost identical
Testing alternative explanatory variables		none	

Source: own compilation based on Andersen (1993, p. 221 & 226).

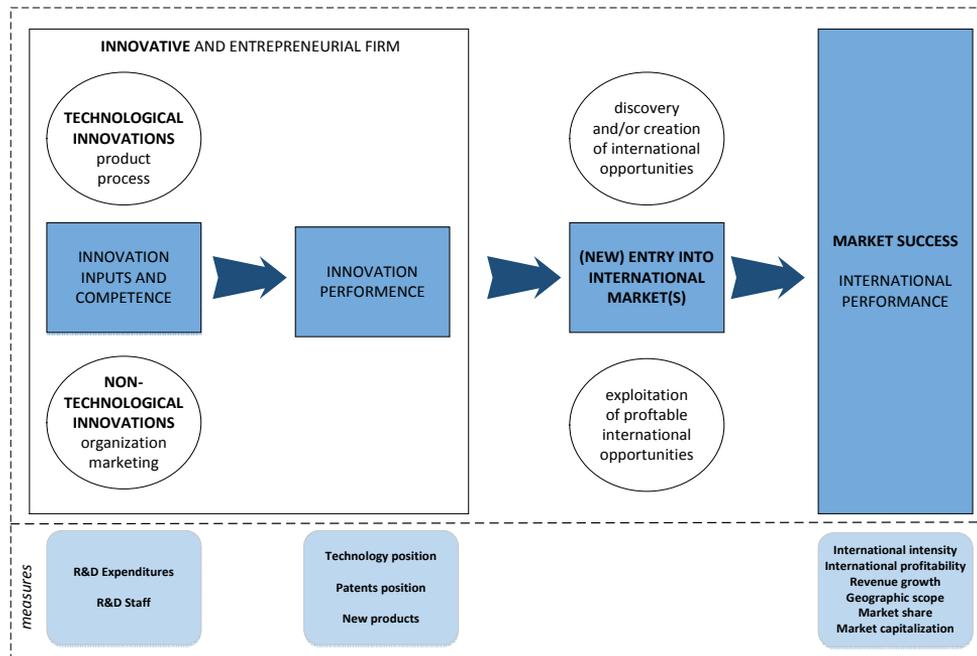
Literature and various empirical evidence reveal a bipolar dependence, innovation can impact internationalization, but also internationalization can influence innovation, thus there are two main streams of research (Daszkiewicz, 2016, p. 105, Szymura-Tyc, 2015, p. 85):

1. **Innovation as the cause.** Innovativeness and innovative behaviour of firms cause (faster or better) internationalization.
2. **Innovation as the effect.** Internationalization and international experience stimulate innovative behaviour of the firm.

In the literature there is an ongoing debate on the role of innovations and the links between innovation and internationalization and sometimes the empirical results are quite contrary. Based on the sample of 299 internationalized Finish firms and using a cluster analyses Kyläheiko *et al.* (2011) found that most of the firms were replicators (79.8%), not innovators (20.2%), and distinguished four clusters, namely (i) international replicators – 29.3% of the sample, (ii) domestic replicators – 50.5%, (iii) domestic innovators – 11%, (iv) international innovators – 9.2%. Innovative capabilities, especially technological ones, are a major driver of international growth of the firm (Pla-Barber & Alegre, 2007). As for various types of innovations, the most important in the internationalization process are product innovations, or generally technological innovations. It seems that there is a positive relationship between product innovation and export performance as the basic mode of internationalization (Cassiman & Golovko, 2011). Innovation can be classified as hard and soft, what is more the innovative behaviour of the entrepreneur, especially in case of SMEs, also impacts the international performance of the business (Denicolai, Hagen & Pisoni, 2015). High-tech businesses, especially small technology-based enterprises (STEs) are international from the inception and called born globals (Kuivalainen, Saarenketo & Puumalainen, 2012; Zou & Ghauri, 2010), and it is a clear evidence that there is a link between innovations (knowledge, high-technology) and internationalization, at least in case of high-tech industries. Also Li, Qian and Qian (2012) confirmed that technological intensity is positively correlated with the early internationalization (born globals). Li, Qian and Qian (2015) proved that radical innovations are positively correlated with internationalization, as small young technology-based entrepreneurial firms (SYTEFs) that “generate radical innovation are more likely to internalize their foreign operations”. Chetty and Stangl (2010) confirmed that internationalized businesses with limited network relationships have incremental internationalization and innovation, but those with diverse network relationships exhibit radical internationalization and innovation. Literature on the role of innovation in international business is very diverse and rich and deals with many detailed aspects like licencing or research and development (R&D). Pinkwart and Proksch (2014) confirmed that going international is positively related with having patents or licences. The above mentioned variables can be put together and integrated into the basic concept of international entrepreneurship (Wach, 2015, p. 19), which can result in the theoretical modelling of innovative internationalization of the firm (Figure 1).

Both, the literature studies, and especially the review of various empirical studies resulted in the following hypothesis to be tested in the empirical reality in Poland:

**H:** Innovativeness and innovative behaviour of a business contributes to the intensification of the internationalization process of the firm operating in the high-technology industries.



**Figure 1. The theoretical modelling of innovative internationalization in international entrepreneurship**

Source: own study based on Wach (2015, p. 19) and Gerybadze (2010, p. 15).

## MATERIAL AND METHODS

To identify and verify the links between innovation and internationalization of high-technology businesses in Poland survey research was employed. The study was conducted at the end of 2015 using Computer Assisted Telephone Interviewing (CATI). Stratified sampling has been selected according to the following criteria (Daszkiewicz, 2016, p. 124):

- firms performing any international activities (at least exports),
- firms belonging to one of the given classes of business activity (NACE), being classified as high-tech or medium-high-tech industries,
- firms fulfilling at least one out of the following three criteria:
  - a) obtaining patents or signing licensing agreements in the areas identified as high-tech,
  - b) employing highly qualified personnel in terms of science and technology,

- c) conducting industrial research, research and development (R&D) activities to prepare these studies and work to implement in the economy.

Based on the above mentioned criteria, the target population was selected, and the survey questionnaire was directed to 4075 businesses from the database, of which 857 businesses, in fact were not eligible for the study, or did not have in the database the current phone number, so the net population was only 3218 of internationalized high-tech firms. In the course of surveying we obtained 263 fully completed questionnaires (the return rate was 8.2%), suitable for further statistical processing, as a basis for inferring.

The study uses six different variables (one measuring the internationalization level and five measuring innovativeness and innovative behaviour) such as:

- the transnationality index (TNI) expressed as a percentage (from 0 to 100%),
- the pace of innovation diffusion measured on 7-point Likert scale (DiffPace),
- the number of implemented innovation from 0 to 8 (InnoNumb),
- the innovation scope (business-level, regional, country-wide, worldwide innovations),
- the innovation types (product, process, organizational, marketing innovations),
- the innovation index (INNO) as a continuous variable (1-100%) and an interval variable (low, moderate, high innovators).

The transnationality index (TNI) was calculated as the average of foreign assets, sales and employment to the total ones and being expressed as a percentage based on the formula:

$$TNI = \frac{\frac{A_F}{A_T} + \frac{S_F}{S_T} + \frac{E_F}{E_T}}{3} * 100 [\%] \quad (1)$$

where:

- $A_T$  - total assets;
- $A_F$  - foreign assets;
- $S_T$  - total sale;
- $S_F$  - foreign sales;
- $E_T$  - total employment;
- $E_F$  - foreign employment.

In order to evaluate the real level of innovativeness of the investigated firms, there was a need to create one indicator expressing the innovative behaviour of business. The innovation index (INNO) enabled to evaluate the innovativeness of the responding firms. This synthetic indicator uses two basic dimensions of innovations, namely (i) the range of innovations measured by their types and numbers and (ii) the scope of innovations measured on the tradition 4-category scale (in numbers expressed from 1 to 4). Each innovation was able to provide from 1 to 4 points. 8 different cases of various innovations enabled to provide up to 32 points. The innovation index, as the overall indicator of innovation evaluation, was constructed by the sum of the values at each of the cases (by multiplying the range and the scope of innovations), and then divided by the sum of the maximum achievable points. Ultimately, it resulted in an average total score, standardized in the range of 0 to 1 (expresses as the percentage in the range from 0 to 100). The

following weights were adopted: (0;25> – low innovators; (25;75> – moderate innovators; (76;100> – high innovators.

The statistical calculations were made by the use of the statistical software Statistica® PL v. 12.5. In the empirical study, the level of the statistical significance (alpha or  $\alpha$ ) for statistical hypotheses testing was considered as 0.05. To verify the assumed relations statistical instruments were used such as descriptive statistics, Chi-Square test, the Kruskal-Wallis test, the linear Pearson correlation and the multivariate regression.

## RESULTS AND DISCUSSION

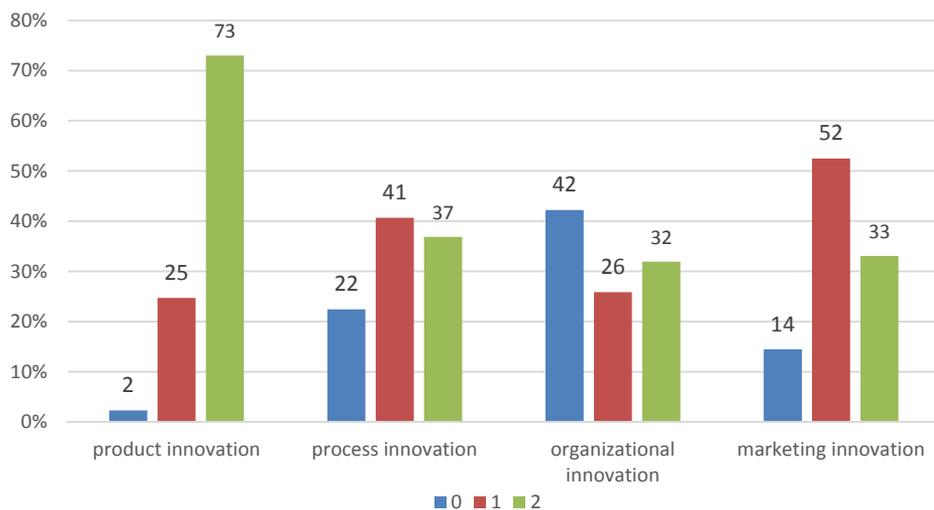
As for the size of the investigating businesses, the sample was diversified, and included: 9% of microenterprises, 26% of small enterprises, 47% of medium-sized enterprises and 18% of large enterprises. The share of enterprises belonging to the SME sector of the surveyed businesses is 82% (216 enterprises), while the share of large enterprises is 18% (47 enterprises). Businesses were located in all 16 regions of Poland, with a clear overrepresentation came from three regions: *mazowieckie*, *śląskie* and *wielkopolskie*. Among the surveyed firms, over 75% had exclusively domestic capital, and less than 15% of the surveyed businesses declared that foreign ownership of assets is 100%.

All investigated businesses implemented within the previous 3 years at least one type of innovation. Respondents were given a list of 8 different innovations, to be more specific there were two different innovations of each of 4 basic types of innovations (Figure 2). Altogether it was possible to declare 8 different innovations. Between 1 and 3 innovations were implemented by 26.23 investigated firms, while 4 of 5 innovations were introduced by 33.45% of business and the highest number of innovations, between 6 and 8, were declared by 40.32 of the responding firms. The overall level of innovation implementation was rather high, comparing to general empirical studies of internationalized businesses, but as the study included high-tech companies, so the high level cannot be surprising. The innovativeness level of Polish internationalized businesses operating in various industries (sample of 293) conducted by Szymura-Tyc (2015, pp. 165-170) was a bit lower. Almost all investigated firms implemented product innovation (257 out of 263), while organizational innovations were the least popular (152 out of 263). Either process or marketing innovations were also quite popular among the responding firms (respectively 204 and 222).

According to the theory of innovation, the scope of innovation is important while judging innovation behaviour of firms. All investigated business implemented at least one type of innovation, however its scope was very diversified:

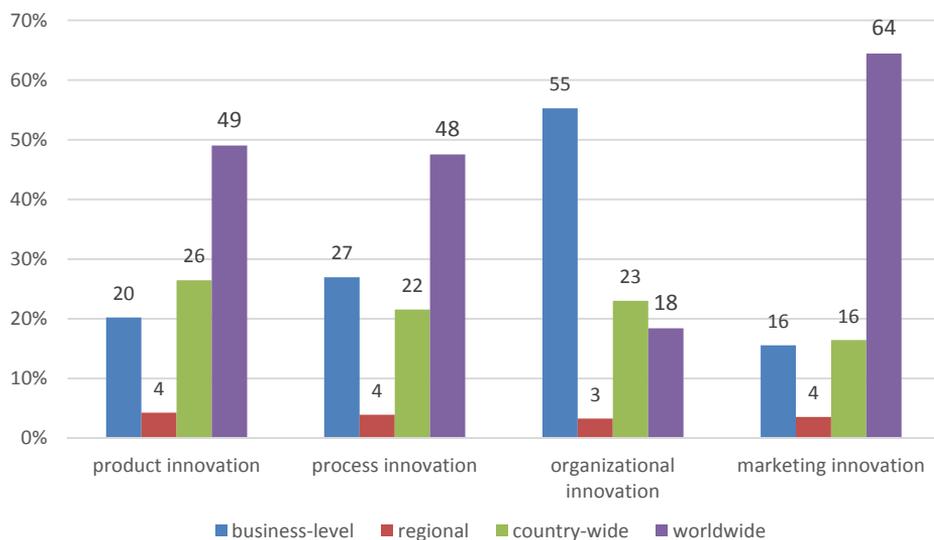
- a) 14.8% investigated firms implemented business-level innovations (39 cases),
- b) 4.2% investigated firms implemented regional level innovations (11 cases),
- c) 18.3% investigated firms implemented country-wide innovations (48 cases),
- d) 62.7% investigated firms implemented worldwide innovations (165 cases).

The scope of the declaring innovations is indeed very optimistic, especially taking into account the types of the implemented innovations (Figure 3). The product innovations, which are crucial for high-tech firms, were the most frequently implemented in the global scale, which means they were new to the world.



**Figure 2. Number of implemented innovations by their types among the investigated businesses (in %)**

Note: The numbers do not sum up to 100% as respondents could select more than one answer.  
Source: own calculations based on the survey ( $n = 263$ ).



**Figure 3. Scope of implemented innovations by their types among the investigated businesses (in %)**

Note: The numbers might not sum up to 100% due to rounding.  
Source: own calculations based on the survey ( $n = 263$ ).

Rating of the business innovativeness ranges of continuous values from the both sides closed interval in the range of  $\langle 1, 100 \rangle$ . The innovation index of investigated business ranged from 3.12 to 100 (Table 2). Based on the mean, the median, and the mode, it is obvious that the innovation behaviour of investigated firms was average in most cases. Only one fourth of the firms, exceeded its level amounted to 62.50 and these companies can be considered hyper innovative.

**Table 2. Descriptive statistics of innovation index (INNO) of the investigated businesses**

Mean	Median	Mode	Frequency of Mode	Minimum	Maximum	Lower Quartile	Upper Quartile	Std. Dev.
43.91	40.62	37.50	24	3.12	100	25	62.50	24.16

Source: own calculations based on the survey and Statistica 12.5 ( $n = 263$ ).

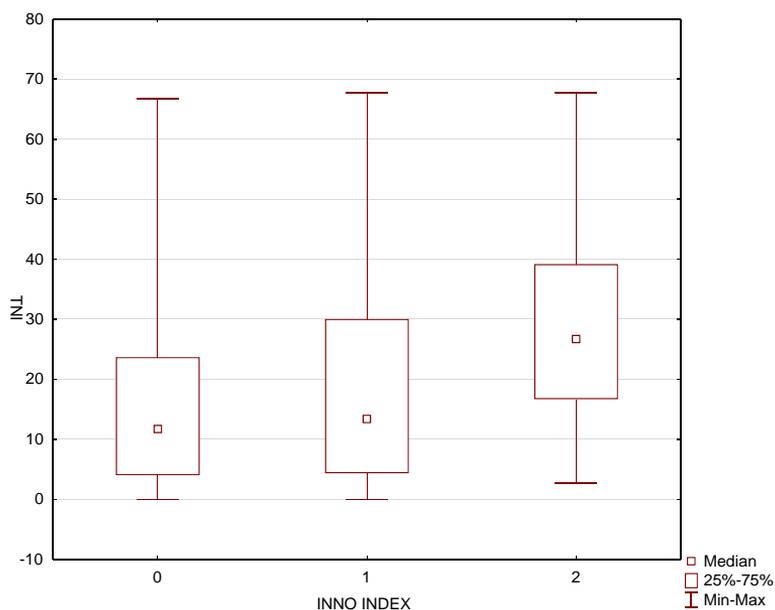
As suggested by prior research there is a theoretical assumption that there is a dependence between the internationalization and innovativeness of firms. The linear Pearson correlation value between TNI (internationalization level of firms) and INNO (the innovation index of firms) is only 0.31 significant at  $p < 0.05$ , which means the average correlation between these variables. Also Szymura-Tyc (2015, p. 177) obtained very similar results based on the sample of 293 internationalized business operating in various industries ( $r = 0.302$ ,  $p < 0.001$ ). Taking the 4-category innovation index and using the Kruskal-Wallis test the dependence between the variables of TNI and INNO was also confirmed (Chi-Square = 10.65,  $df = 2$ ,  $p = 0.0049$ ;  $H(2, 261) = 969935$ ,  $p = 0.0078$ ). It was also confirmed by the median test, and the mean ranks for groups were as follows: 118, 130, 173. Studying the “box & whisker” plot it is noticeable that the better innovator is, the higher TNI value it receives (Figure 4). TNI values was the highest for so called high innovators, and the lowest for the low innovators. Therefore, the hypothesis was confirmed, according to which the innovativeness of a business contributes to the intensification of the internationalization process of the firm operating in the high-technology industries.

In order to search for deeper relationships, multiple regression was used. Although the  $p$ -value means very strong presumption against neutral hypotheses, the model explains only 5.6% of the dependence of TNI on three innovative behaviours, such as (i) the innovation index (as the general evaluation of innovativeness of the firm), (ii) the pace of innovation diffusion and (iii) the number of implemented innovations. If the innovation index will increase of 1 p.p., TNI will increase in average of 5.47 p.p. *ceteris paribus*. What can be interesting is the fact that if the number of innovation will increase of 1 p.p., TNI will decrease of 1.98615 p.p. Despite the awkward outlook, these results can be explained quite easily, as we can assume, as the investigated firms introduced between 1 and 8 innovations, so some of them were inessential or even unnecessary. Probably organizational and/or marketing innovations, except for being costly, didn't supported the internationalization process, as we could assume.

**Table 3. Regression Summary for Dependent Variable of TNI**

Effect	R = 0.23656313		R <sup>2</sup> = 0.05596211		Adjusted R <sup>2</sup> = 0.04494221	
	F(3,257) = 5.0783 $p < 0.0019$ Std.Err. of Estimate: 19.174					
	<b>b*</b>	<b>Std.Err. of b*</b>	<b>b</b>	<b>Std.Err. of b</b>	<b>t(257)</b>	<b>p-value</b>
Intercept			22.0314	3.5214	6.2563	<b>0.0000</b>
INNO	0.2618	0.0894	5.4665	1.8670	2.9279	<b>0.0037</b>
DiffPace	0.1431	0.0617	6.0394	2.6063	2.3172	<b>0.0213</b>
InnoNumb	-0.1915	0.0893	-1.9861	0.9268	-2.1429	<b>0.0330</b>

Source: own calculations based on the survey and Statistica 12.5 ( $n = 263$ ).

**Figure 4. Boxplot by group for the variables TNI and INNO INDEX**

Note: 0 – low innovators, 1 – medium innovators, 2 – high innovators.

Source: own calculations based on the survey ( $n = 263$ ).

## CONCLUSIONS

Like all research, this study is not without some notable limitations. First of all, the research sample is not representative for the whole population, thus it is not possible to absolutize the result over the whole population of Polish businesses of high-tech industries, but are quite close to generalization. Secondly, future studies should seek to develop longitudinal research designs.

Based on the statistical calculations presented in the article, the following conclusions can be drawn:

1. The overall level of innovation implementation among the investigated firms was rather high, comparing to general empirical studies of internationalized businesses, but as the study included high-tech companies, so the high level cannot be surprising.
2. Almost all investigated firms implemented product innovation, as for high-tech industries this can be obvious.
3. Most of the investigated businesses implemented worldwide innovations, as the widest range of 4-category classification, and again for high-tech industries this is rather expected.
4. The hypothesis stating that the innovativeness of a business contributes to the intensification of the internationalization process of the firm operating in the high-technology industries, was confirmed (linear Pearson correlation, Kruskal-Wallis test). The higher level of TNI was observed among high innovators and the lowest among low innovators.
5. The regression model showed the dependence of TNI on three innovative behaviours, such as the innovation index, the diffusion of innovation pace and the number of implemented innovation.

The research presented in the article seems to be one of the first in Poland investigating into internationalization and innovation in high-tech industries. The results are in line with the majority of empirical evidence worldwide. The preliminary links between innovation and internationalization among Polish high-tech businesses were confirmed. Further research should seek the links and dependences between technological as well as non-technological innovations and the internationalization intensity.

The empirical results have also great importance for policy makers, as the illustration of Polish high-tech businesses seem to be relatively well internationalized, especially in comparisons to general business population. Policy makers should continue to support innovativeness of Polish economy, but especially these industries which are highly innovative.

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