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**DETERMINANTS OF OPEN INNOVATION ADOPTION  
– THE CASE OF POLISH FOOD FIRMS**

*DETERMINANTY STOSOWANIA KONCEPCJI INNOWACJI OTWARTEJ  
– NA PRZYKŁADZIE POLSKICH PRZEDSIĘBIORSTW SPOŻYWCZYCH*

**Key words: open innovation, co-operation, food industry, Poland**

*Słowa kluczowe: innowacja otwarta, kooperacja, przemysł spożywczy, Polska*

**Abstract.** The aim of this paper is twofold. Firstly, an attempt is made to analyze the concept of open innovation and its determinants with particular regard to food industry. Secondly, an investigation of open innovation drivers is conducted, using a small-scale sample of Polish food firms. The sample consists of 15 food producers localized in the Lublin province. The Probit model has been used in the analyses. The results reveal that the level of technology and export orientation are the drivers of co-operation in innovation activities. In turn, expenditures on R&D and employees' training reduce the propensity of enterprises to adopt the open innovation approach.

### **Introduction**

The innovation process in many cases does not rely only on a firm's own resources but also incorporates external knowledge [Kijek 2012]. The idea of knowledge sharing in innovation activity is a building block of the concept of open innovation. The notion of open innovation, introduced by Chesbrough [2003], is defined as the purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation.

The need for open innovation has emerged due to economic and social changes, i.e. globalization, improved market institutions such as intellectual property rights, and new technologies [Dahlander, Gann 2010, Matras-Bolibok 2012]. To date, open innovation has been commonly associated with high technology sectors, e.g. biotechnology and information and communication technology. However, there is growing evidence that this concept may also be applied in traditional industries such as the food industry [Sarkar, Costra 2008]. Acosta et al. [2012] give a few reasons why food firms rely on external knowledge to support their own innovation. First of all, food innovations are initially introduced in smaller companies that may lack know-how necessary for commercialization. Secondly, knowledge useful for food firms comes from multiple scientific and technological sectors, such as pharmaceuticals, chemicals, agriculture, machinery, tools and emergent scientific fields, e.g. nanotechnology or biotechnology. Consequently, the adaptation of equipment and the use of new technologies developed by upstream (high-tech) industries allow for changes in production processes and the creation of new food products [Zakrzewska 2012].

According to Schroll and Mild [2012], there are three categories of factors that stimulate firms to introduce the open innovation approach, i.e. market and technology-based characteristics, organizational capabilities and human resource capabilities. Table 1. shows the expected impact of particular factors on firms' propensity to open innovation.

Although the impacts of these identified factors on open innovation have been studied in different industries, there is little evidence on the drivers of open innovation in food firms. As mentioned previously, firms in the food industry have several well-known characteristics that distinguish them from firms in other industries. To address this gap in literature, the article attempts to verify the presented assumptions on the drivers of open innovation in Polish food companies.

Table 1. Drivers of open innovation

Tabela 1. Determinanty innowacji otwartej

Driver/ Determinanta	Description/Opis	Impact/ Wpływ
Size/Wielkość	Large firms are more likely to undertake collaborative relationships, but they also exhibit “not invented here” -NIH syndrome./Duże przedsiębiorstwa są bardziej skłonne do podejmowania działań kooperacyjnych, jednak często doświadczają zjawiska “nie wynaleziono tutaj”	+/-
Absorptive capacity/ Zdolność do absorpcji	Investing in R&D and training allow external knowledge to become more understandable and usable./Inwestycje w działalność BiR oraz w szkolenia pozwalają na lepsze zrozumienie i wykorzystanie wiedzy zewnętrznej	+
ICT	Application of information and communication technology (ICT) facilitates co-operation among actors in the innovation process./Stosowanie technologii informacyjno-komunikacyjnych usprawnia proces kooperacji pomiędzy partnerami w procesie innowacyjnym	+
Technology level/ Poziom technologii	Firms in a low technology environment should rely more on external knowledge, but high-tech environment creates more possibilities for cooperation./Firmy działające w środowisku niskich technologii powinny polegać w większym zakresie na wiedzy zewnętrznej, ale środowisko wysokich technologii stwarza więcej możliwości do kooperacji	+/-
Export orientation/ Orientacja eksportowa	Internationalisation induces firms to develop more innovative activities./Internacjonalizacja wymusza na firmach wprowadzanie innowacyjnych działań	+

Note: + positive impact, - negative impact, +/- equivocal impact/Uwaga: + wpływ pozytywny, - wpływ negatywny, +/- wpływ niejednoznaczny

Source/Źródło: [Chesbrough 2006, Schroll, Mild 2012]

## Material and methods

The data used to carry out this research were gathered within the project: *Intellectual capital of the Lublin province 2010-2013*. A random sample consists of 40 food producers (classified as division 10 in Section C of Polish Classification of Activity) localized in the Lublin province. The sampling frame was prepared by the Regional Statistical Office. Face to face interviews were conducted. All data refer to the year 2011. Of our total sample of 40 food producers, 15 respondents were innovation-active, and they were used in our analyses. Consequently, it may cause the problem of sample selection bias.

To find the drivers of open innovation in the sample firms, the Probit model was applied [Greene 2003]:

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

$$y_i = 0 \text{ if } y_i^* \leq 0$$

$$y_i = 1 \text{ if } y_i^* > 0$$

where:  $y_i^*$  is a latent variable implying the open innovation propensity related to the  $i$ th firm in the year 2011,  $x_i$  is a vector of regressors and  $\varepsilon$  is the error term that is assumed to be normally distributed. Table 2 presents the concise description of variables used in the model.

To address the potential problem of selection bias [Manning et al.1987], the inverse Mill's ratio, termed MIL, was included in the main Tobit model as an additional independent variable. So before running the main Probit model, a selection Probit model had been calculated using all available observations and considering the dummy variable i.e. whether or not the firm was innovative as an independent variable. Consistent with a Schumpeterian tradition, firm size (SIZE), export orientation (EXPO\_ORIENT), and technology level (TECH\_LEV) were included as explanatory variables. This allowed for the calculation of the inverse Mill's ratio, which reflects the probability that an observation will be selected into the truncated sample.

Table 2. Description of the variables (with variable names)

Tabela 2. Opis zmiennych (wraz z ich nazwami)

Variable/Zmienna	Dependent/Zależna
OP_INN	Dummy = 1 if the firm has confirmed the co-operation on innovation/ <i>Sztuczna= 1 jeżeli firma potwierdziła fakt kooperacji w zakresie innowacji</i>
	Independent/Niezależna
SIZE	Log of number of employees/ <i>Logarytm liczby zatrudnionych</i>
R&D	Expenditures on R&D [PLN]/ <i>Wydatki na B+R [zł]</i>
HUM_CAP	Expenditures on employees' training connected with innovation activity [PLN]/ <i>Wydatki na szkolenia pracowników związane z działalnością innowacyjną [zł]</i>
ICT	1 if the firm has declared the possession of basic software, 2 if the firm has declared the possession of tailor-made software, 3 if the firm has declared the possession of integrated information system/ <i>1 jeżeli firma zadeklarowała posiadanie podstawowego oprogramowania komputerowego, 2 jeżeli firma zadeklarowała posiadanie specjalistycznego oprogramowania dostosowanego do profilu firmy, 3 jeżeli firma zadeklarowała posiadanie zintegrowanego systemu informatycznego</i>
TECH_LEV	1 if the firm has declared to operate in high-tech environment, 2 if the firm has declared to operate in medium high-tech environment, 3 if the firm has declared to operate in medium low-tech environment, 4 if the firm has declared to operate in low-tech environment/ <i>1 jeżeli firma zadeklarowała funkcjonowanie w środowisku wysokiej techniki, 2 jeżeli firma zadeklarowała funkcjonowanie w środowisku średnio wysokiej techniki, 3 jeżeli firma zadeklarowała funkcjonowanie w środowisku średnio niskiej techniki, 4 jeżeli firma zadeklarowała funkcjonowanie w środowisku niskiej techniki,</i>
EXPO_ORIENT	Percentage of export sale/ <i>Udział procentowy eksportu w sprzedaży</i>

Source: own study

Źródło: opracowanie własne

## Results of research

Table 3 contains descriptive statistics of the variables included in the model. The first conclusion to be drawn from the data presented is that the food firms are rather reluctant to take part in open innovation adoption, i.e. only 5 firms have declared the fact of co-operation in innovation activities. It is in line with general statistics on open innovation practises in Polish food industry in the years 2008-2010 [*Działalność innowacyjna...2011*]. As far as expenditures on innovation are considered, the sample firms spend about 20 times more (on average) on R&D than on employees'

Table 3. Descriptive statistics for the sample of food firms

Tabela 3. Statystyki opisowe dla próby przedsiębiorstw spożywczych

Variable/ Zmienna	Min/ Minimum	Max/ Maksimum	Mean/ Średnia	Standard Deviation/ Odchylenie standardowe
OP_INN	0	1	0.33	0.49
SIZE	2.19	5.86	3.94	1.29
R&D	0	300 000	76 333	119 050
HUM_CAP	0	25 000	4 200	7 766.2
ICT	1	3	2	0.65
TECH_LEV	1	3	2.13	0.64
EXPO_ORIENT	0	30	7.1	10.78

Source: own study

Źródło: opracowanie własne

training. Moreover, most of the food companies have declared to operate in a medium high-tech environment. Although this finding is not consistent with the OECD classification of manufacturing industries into categories based on R&D intensities [Hatzichronoglou 1997], it should be interpreted as a relative/subjective categorization which reflects the heterogeneity of food industry in relation to technological opportunities.

Table 4. Parameters estimates for the Probit model  
*Tabela 4. Oszacowanie parametrów modelu Probitowego*

Variable/ <i>Zmienna</i>	Coefficiency/ <i>Współczynnik</i>	Standard error/ <i>Błąd standardowy</i>	Z-value/ <i>Wartość Z</i>	p-value/ <i>Wartość p</i>
CONST	-5.64136	2.9944	-1.884	0.0596
SIZE	x			
R&D	-0.00003	0.00001	-2.034	0.0420
HUM_CAP	-0.00054	0.0001	-3.651	0.0003
ICT	x			
TECH_LEV	2.42335	1.08332	2.237	0.0253
EXPO_ORIENT	0.39525	0.18322	2.157	0.0310
MIL	x	-	-	-
McFadden R <sup>2</sup>	0.53			
Likelihood ratio test/ <i>Test ilorazu wiarygodności</i>	Chi-squared/ <i>chi-kwadrat</i> (4) = 10.13 ( <i>p</i> = 0.03)			

Note: x – eliminate dvariable/*Uwaga: x – zmienna wyeliminowana*

Source: own study

*Źródło: opracowanie własne*

Table 4 presents the results of parameter estimates for the Probit model. The maximum likelihood estimates of the coefficients were obtained via the Newton–Raphson method. In order to identify a set of explanatory variables which have considerable predictive capability, backward elimination was employed.

Contrary to our expectations R&D and employees’ training turned out not to be complementary to open innovation. Although the coefficients on these variables are close to zero, they suggest that internal knowledge and external knowledge are substitutes. An explanation for this finding could be not invented here – NIH – syndrome, which denotes a negative attitude to knowledge that originates from a source outside the own institution [Lichtenthaler, Ernst 2006]. The results also show that open innovation might be useful for food firms operating in low technology environment, since it allows for the access to new technologies developed by upstream industries. What is more there is evidence for the hypothesis that exporting increases the probability of cooperating on innovation. It may suggest that internationalisation allows firms to enrich its sources of knowledge by capturing ideas from a greater number of new and different markets. It should be noted that the MIL variable is not significant, thus the hypothesis of sample selection bias can be rejected.

## Conclusions

This paper produces a few important contributions for the theory and practice on the determinants of open innovation. The research results show that the sample firms are generally not willing to undertake co-operation in innovation activities. As stated by Bayona-Sáez et al. [2012], food firms seem to be open in terms of informal linkages with external agents, but when it comes to co-operation agreements, they appear to be very closed. As regards the drivers of open innovation; the level of technology is the most important determinant of co-operation in innovation activities. Firms which operate in a low-technology environment are more eager to incorporate external knowledge into the innovation process. Furthermore, it appears that internationalisation induces the firm to engage in co-operation in innovation practices. Unexpectedly, the hypothesis on absorptive capacity got little support in this research.

The paper is not exempt from some limitations. The main drawback pertains to the limited sample size. Another shortcoming of the paper concerns a narrow set of determinants of open innovation included in the analysis. In order to overcome these limitations future research should be based on a larger sample and incorporate other drivers of open innovation (e.g. market based characteristics).

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## Streszczenie

*Cel prezentowanego artykułu był dwójaki. Po pierwsze, w części teoretycznej opracowania zaprezentowano koncepcję innowacji otwartej oraz jej determinant, ze szczególnym uwzględnieniem specyfiki przemysłu spożywczego. Po drugie, w empirycznej części pracy skoncentrowano się na badaniu czynników warunkujących stosowanie koncepcji innowacji otwartej w polskich przedsiębiorstwach spożywczych. Próba badawcza obejmuje 15 producentów żywności prowadzących działalność na terenie województwa lubelskiego. W badaniu zastosowano model probitowy. Wyniki badań wykazały, że czynnikami stymulującymi przedsiębiorstwa do podejmowania działań kooperacyjnych w zakresie innowacji są możliwości technologiczne oraz orientacja eksportowa. Z kolei, prowadzenie własnej działalności B+R oraz inwestycje w szkolenia pracowników ograniczały skłonność przedsiębiorstw do stosowania koncepcji innowacji otwartej.*

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