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# Influence the intensity of industrial relations on the innovative activity. Case of Lubuskie voivodeship in 2008-2010

## 1. Introduction

Currently, in literature there is a view that traditional factors of competitive advantage were lost in last thirty years, due to globalization and computer and telecommunications revolution (Audretsch 1998). Moreover, it is believed that these factors do not sufficiently explain the variability of the economic growth on macroeconomic level. Analyzes carried out by Solow showed that nearly half of the economic growth was insufficiently pictured by traditional causes. The interpretation of this phenomenon regarded as the variance error has been defined as the influence of technological changes (Stough 1998). Thus, the very innovation became the single most important accelerator of the long-term level of competition.

According to „The Economist" the lack of costs connected with the overcoming of the distance in communication will probably be one of the most significant determinants shaping the society in the first half of the XXI c. The growth of innovation activity's significance is documented by, among others, the leap of patent application in the United

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States, on average on the level of 40-60 thousand in the twentieth century, to 120 thousands only in 1985 and a "dramatic" decrease of the demand for workers with low skills (Kortum, Levner 1997).

Although, geographically the market of most goods and services is subject to globalization, the importance of innovation activity is growing in countries leading the economic development, what is interpreted as the effect of growth of the significance of local regions being the key sources of the comparative advantage (Audretsch 1998). Although technology, as the resource, becomes international (mobility), regional systems are really growing, and the geographical approximation still plays an essential role in the process of knowledge flow in technologically advanced countries (Guerrieri 1999). Significance of the regional dimension in such countries grows with the level of technological advancement (Beaudry, Breschi 2003). In the process of creating the dynamic advantage important is the real interest in the regional R&D activity, innovations and advanced skills, and that's why the creation and implementation of the industrial politics should take place on the regional level (Sturn 2000). Despite the increasing globalization, or maybe as a result of this process, there is a conviction that the innovation activity is less connected with multinational corporations, and more often with highly technological innovation regional clusters (Silicon Valley, Research Triangle, R122 around Boston) (Audretsch 1998). On this basis there appears a question whether and to what extent are the discussed phenomena in the advanced countries adequate to the economies of countries on a much lower level, and the solutions used there are possible to be transferred directly?

The catching-up process, although it is not automatic, depends on the ability of the countries to overcome the technological gap. M. Abramowitz introduced the concept of "social skills", also including organisational and institutional factors, on the country's level. Such concept assumes the country's ability to imitate solutions implemented abroad, by dynamic spread of adaptation skills of the imported technologies on a national scale. What's more, catching-up economies can show a dynamic economic growth and structural changes in a rather short time horizon (if they can build the absorptive and imitative capacity), but sooner or later they will face the necessity to build their own scientific and technological base (Abramowitz 1994). Until then, however, such countries are "doomed" to overcome the geographical barrier, to mitigate the existing economic disproportions.

The essence of innovation systems' action are the relations taking place between particular participants of the created links. They can be either vertical

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or horizontal interactions, where the technological proximity has a great significance (Fischer 2001). Due to the level of complexity of the discussed work, we have focused only on vertical interactions, so in relation towards the suppliers and consumer of products manufactured in the industrial system.

Contemporary regional networks aim to diversify the links, by the initiation of interactions with various groups in the supply chain. While in traditional conditions, these dependencies should focus on specialized narrow interdependencies, which are connected with the matter of specialization. Therefore, what is interesting is whether the innovation of regional systems in Poland is determined by:

- varied or narrow interactions,
- occurring in a short or long distance,
- based on strong and at the same time lasting or loose inter-organizational relations.

The outlined conceptual framework contributed to the undertaking of issues of the influence of enterprises' connections in the supply chain on the innovation of the industrial system in Lubuskie Voivodeship. The basic hypothesis of the conducted research was the statement that innovative mechanisms functioning in national industrial systems are essentially determined by the nature of vertical relations with the environment. They include the number of suppliers and consumers, and the existence in the supply chain. The ability to correctly identify the nature of innovative processes together with their limitations in the country, creates foundations to create adequate solutions to stimulate the development of innovative networks.

The main goal of the research was the attempt to look for the influence of the number of industrial relations taking place between enterprises and the functioning in the supply chain on the innovation activity of the selected regional system, and consequently to determine the boundary conditions for the model regional structure of the innovation network, taking into account the specificity of the examined region. The presented effects of the research constitute only a selected part of conclusions obtained as a result of the conducted analyzes.

The research attempt includes the analysis of the region representing a weak level of industrial development in Poland. Research has been carried out based on a questionnaire on a group of 545 enterprises from Lubuskie Voivodeship. The basic data collection path was the procedure combining the initial telephone conversation with submission of the questionnaire form by mail.

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## 2. Methodology of the conducted research

Due to the fact that variables adopted for the research have dichotomous character, and more precisely binary, it has been decided to use the probit modelling, based on the probability theory. This methodology has been successfully used more often not only in international research, but also national (Frenkel, Shefer 1997; Frenkel 2000; JRC 2010; Wziątek-Kubiak, Pęczkowski 2011). The procedure of performing the analysis and interpretation of the achieved results is similar to the classical method of regression. Fundamental differences refer on the other hand to the necessity of performing of more complex and time-consuming calculations and the lack of evaluation of residual graphs (Stanisz 2006).

Probit and logit models, as varieties of a similar way of conducting the econometric specification, differ in the specification of the distribution of the random component in the equation. If F is the distribution of the logit distribution, we are dealing with the logit model, while if the random components have normal distribution, we obtain the probit model (Maddala 2006).

Dependency between Logit and Probit values:

$$\frac{Logit}{\text{Probit}} = \frac{\pi}{\sqrt{3}} = 1{,}8$$

Taking into consideration logical relations occurring between the researched variables, it has been assumed that random components have normal distribution, and as a result the calculations have been performed based on probit modelling. The static verifications of models has been carried out based on Wald's *Chi*-square statistics and the test *p* probability connected with that, while their parameters based on the asymptotic standard error, through *p* significance and *t*-student statistics. All calculations have been performed by using *Statistica* software and taking into consideration analogical conditions of initial conditions when it comes to the evaluation of the significance of the models and their parameters, offered by the used program (among others, the level of parameters' significance – 95%). For the aesthetics of the presentation and results of the research, authors decided to present only the models meeting the criteria of models' significance and parameters, thus giving up the elaborate form of presentation as well as the statistics of evaluation of parameters' significance and the model

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as a whole. This has also been justified by the fact that the structural form of the model is sufficient for the analysis of researched phenomena.

Analysis of indicators developed for OECD countries in brief traditionally focuses on input and output elements. Such measures are standardized in most OECD countries, what allows for a useful interregional and international comparison (OECD 2005). On this basis it has been decided to accept the following dependant variables for research: a) expenditures on innovation activity in relation to their structure (research and development, investments in new machines and technical equipment, investments in buildings, structures and lands, new computer software), b) implementation of new goods and processes, taking into account also the detailed solutions in this area (new products, new technological processes), c) innovative cooperation in subject terms (with suppliers, competitors, consumers, universities, JBRs, foreign research institutions). On the side of independent variables, due to the formulated main goal of the research, we can find the number of industrial suppliers, the number of industrial consumers and the fact of existence of the full industrial chain.

Due to interpretation difficulties connected with probit modelling, it has been decided to build one-factor models. The possibility of autocorrelation of independent variables has been eliminated due to their exclusive nature.

Taking into consideration the fact that all variables accepted for research, both dependent and independent, are binary (reached values 0 or 1), the interpretation of results will be carried out based on the structural form of a model. A positive sign occurring by the parameter means that the probability of the innovative event is higher in the separate group of enterprises in relation to the rest of the community. Probit modelling is an effective research tool in case of large, but static tests, in which the dependent variable has the quality form. The applied methodology allowed to evaluate the chance of occurrence of diverse innovative behaviours depending on the adopted boundary conditions.

Each of the collected questionnaires has been entered into *Excel* spreadsheet, where data have been subject to the initial preparation by using methods of formal logic.

In total, from the perspective of the goal and hypothesis adopted for the research, there have been created four hundred probit models, and the majority of them has achieved statistical significance.

## 3. Characteristics of the research sample

As it has already been mentioned in the introduction, research has been performed based on 545 industrial enterprises from Lubuskie Voivodeship. The table below presents the structure of the researched enterprises from the perspective of firm's size.

**Table 1. Structure of industrial enterprises
in the researched sample from the point of view
of size classes in Lubuskie Voivodeship in 2008-2010
(in percent)**

| No | Size of companies | Lubuskie voivodeship |
|----|-------------------|----------------------|
| 1 | Mikro | 27,2 |
| 2 | Małe | 39,4 |
| 3 | Średnie | 23,7 |
| 4 | Duże | 9,7 |

Source: Own study based on own research

As in the case of size structure, technological structure of enterprises accepted for analysis is at the similar level of national data.

**Table 2. Structure of industrial enterprises
in the researched sample from the point of view
of the applied technology in Lubuskie Voivodeship in 2008-2010
(in percent)**

| No | Technology advance | Lubuskie voivodeship |
|----|--------------------|----------------------|
| 1 | High | 3,3 |
| 2 | Medium-high | 9,4 |
| 3 | Medium-low | 27,3 |
| 4 | Low | 59,3 |

Source: Own study based on own research

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## 4. The influence of industrial relations on the innovative activity of enterprises in Lubuskie Voivodeship

In the present study of 545 companies in 464 there are connections with industrial suppliers, what constitutes 85,1% of all relations with suppliers. The analysed subjects indicate the existence of 888 different connections, what gives an average of 1,6 interactions for a researched company. The industrial groups most often typified include the production of wood and wood products (108), metals (97), rubber and plastic products (90), food products (70), other non-metallic products (67), machines and devices (58), pulp (58), chemicals (45). Altogether, they represent 66,8% of the total number or links with suppliers.

From the point of view of technological levels, most often the links with suppliers concern industries of low technology, but at the same time this group has most extensive relations (as for one company). The most intensive interactions take place with industries of average-large and average-low technologies.

Industrial enterprises in Lubuskie region rarely accomplish the production for other industrial enterprises (35,4%). Altogether, 193 production links have been indicated with consumers of goods. The most frequently mentioned actions regard sectors 34, 28, 29 and 20. However, taking into consideration the intensity of relations, the highest can be observed for 34 and 29.

According to the technological level industrial consumers, from the point of view of relations' intensity, are mainly sectors of medium-high technologies, wherein the similar number of inter-industrial contacts is observed with enterprises both from low, medium low and medium high technology areas.

**Table 3. Probit probability models of implementation of various forms of innovation under influence of the number of suppliers in Lubuskie Voivodeship**

| Type of innovation activity | Amount of suppliers | Probit model | Probability in selected group | Probability in alternative group |
|---|---|---|---|---|
| R&D expenditure | 2 suppliers | $y_{1a} = -0,57 + 0,30x_{dos}$ | 0,39 | 0,29 |
| Investment in technical equipment and machinery | 3 suppliers | $y_{1Bb} = 0,37 + 0,30x_{dos}$ | 0,75 | 0,64 |
| Software solution | 3 suppliers | $y_{1c} = 0,12 + 0,60x_{odb}$ | 0,76 | 0,55 |
| Launching new products | 4 suppliers | $y_{21} = 0,47 + 0,68x_{odb}$ | 0,88 | 0,68 |
| Implementation of new technology process | 3 suppliers | $y_{22} = 0,61 + 0,34x_{odb}$ | 0,83 | 0,73 |

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| None production systems | 4 suppliers | $y_{2b}$=-0,46+0,55$x_{dos}$ | 0,54 | 0,32 |
|---|---|---|---|---|
| Support systems | 3 suppliers | $y_{2c}$=-0,84+0,39$x_{dos}$ | 0,33 | 0,20 |
| Cooperation with suppliers | 4 suppliers | $y_{3a}$=-0,53+0,35$x_{dos}$ | 0,43 | 0,30 |
| Cooperation with universities | 2 suppliers | $y_{3d}$=-2,07+0,44$x_{dos}$ | 0,05 | 0,02 |
| Cooperation with customers | 1 suppliers | $y_{3g}$=-1,16+0,54$x_{dos}$ | 0,27 | 0,12 |

Source: own study based on research

Models showing the innovative activity from the point of view of diversity of the number of suppliers and consumers indicate several interesting behaviours of companies in the area. The highest tendency to implement new technologies is shown by subjects having a considerable amount of industrial suppliers. Thus, the previous observations regarding the essential significance of external companies in developing innovative processes in the area have been confirmed. Their considerable amount allows to use a wide access to knowledge. The estimated models concern the majority of innovation's surfaces. Industrial enterprises having less than two-three industrial suppliers are characterised by a more diverse, but at the same time weaker, innovation activity. The number of suppliers plays a special role in case of: incurring expenses for the R&D activity, machines and equipment, and computer software, implementation of new products and technologies (none-production and supporting systems) and cooperation in creating new solutions, especially with suppliers, universities and consumers.

**Table 4. Probit probability models of implementation of various innovation forms under the influence of the number of consumers in Lubuskie Voivodeship**

| Type of innovation activity | Amount of customers | Probit model | Probability in selected group | Probability in alternative group |
|---|---|---|---|---|
| R&D expenditure | 3 customers | $y_{1a}$= -0,46+0,80$x_{odb}$ | 0,63 | 0,32 |
| Investment in technical equipment and machinery | 1 customer | $y_{1Bb}$=0,37+0,36$x_{dos}$ | 0,77 | 0,64 |
| Software solution | 3 customers | $y_{1c}$=0,22+1,40$x_{odb}$ | 0,95 | 0,59 |
| Implementation of new technology process | 2 customers | $y_{22}$=0,64+0,58$x_{odb}$ | 0,89 | 0,74 |
| None production systems | 3 customers | $y_{2b}$=-0,42+0,62$x_{odb}$ | 0,58 | 0,34 |

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| Cooperation with universities | 3 customers | $y_{3d}=-1,90+0,90x_{odb}$ | 0,16 | 0,03 |
| Cooperation with customers | 1 customer | $y_{3g}=-0,77+0,35x_{odb}$ | 0,34 | 0,22 |
| Overall innovation cooperation | 1 customer | $y_{3a-f}=-0,09+0,34x_{odb}$ | 0,60 | 0,46 |

Study: own study based on research

On the side of industrial consumers the innovative activity takes a different direction. The high value of probability is reached on condition that the subject has no more than three main industrial clients. Apparent interactions with a greater number are distracted by the company's resources, while the concentration on cooperation with their small amount results in closer relations. This activity relates to the B+R activity, investment in machines and technical devices, computer software, implementation of new technologies (including around-production systems) and cooperation in the area of new solutions, but this time especially with universities and consumers. In relation to previously performed research it can be noticed that the growing number of industrial consumers favours the conducted innovation activity. Thus, Lubuskie system evolves towards more mature industrial systems in Poland by establishing innovation cooperation with a bigger and bigger group of consumers.

**Table 5. Probability of occurrence of different areas of innovation in Lubuskie Voivodeship from the point of view of intra- and inter-industrial chains**

| Type of innovation activity W – intra-industrial M – inter-industrial | Probit model | Probability in | |
|---|---|---|---|
| | | selected group | alternative group |
| **M** R&D expenditure | $y_{1A}=-0,54+0,51x_{łań}$ | 0,49 | 0,29 |
| **W** Investment in new fixed assets | $y_{1B}=0,67+0,67x_{łań}$ | 0,91 | 0,75 |
| **W** Investment in technical equipment and machinery | $y_{1B2}=0,40+0,94x_{łań}$ | 0,61 | 0,66 |
| **M** Software solution | $y_{1C}=0,18+0,39x_{łań}$ | 0,72 | 0,57 |
| **M** Implementation of new technology process (including): | $y_{22}=0,61+0,44x_{łań}$ | 0,85 | 0,73 |
| **M** a) new production methods | $y_{2a}=-0,04+0,28x_{łań}$ | 0,60 | 0,48 |
| **M** b) none production systems | $y_{2b}=-0,49+0,43x_{łań}$ | 0,48 | 0,31 |
| **W** Cooperation with competitors | $y_{3b}=-1,47+0,77x_{łań}$ | 0,24 | 0,07 |

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| **M** Cooperation with universities | $y_{3d}=-2,00+0,55x_{łań}$ | 0,07 | 0,02 |
|---|---|---|---|
| **M** Cooperation with customers | $y_{3g}=-0,76+0,35x_{łań}$ | 0,34 | 0,22 |
| **M** Overall innovation cooperation | $y_{3a-g}=-0,08+0,30x_{łań}$ | 0,59 | 0,47 |

Source: own study based on research

Enterprises being the element of the inter-industrial or specialized, full chain (within the same industrial field) are also responsible for innovation in the area. This is connected with conducting B+R activity, investments in new fixed assets (including machines and technical equipment, as well as computer software) and the implementation of new technologies (methods of manufacturing and around-production systems) or innovation cooperation with competitors, universities and consumers. It is worth paying attention to the fact that the difference of acquired probabilities is relatively higher in comparison to models illustrating one-sided relations with suppliers or consumers. This proves the high influence of full production chains on the innovation activity of enterprises in the area. However, taking into consideration the importance of specialization, we notice that subjects should more often be found in inter-industrial chains (eight models) than mono-industrial (three models). This doesn't change the fact that both of them accelerate technological changes in Lubuskie industry.

The carried out research has indicated the importance of relations of industrial associations with innovation of enterprises in the area. A number of models showing the significance of the amount of participant on the development of innovation in enterprises and cooperation between them has been identified, documenting the importance of the large number of input channels and relatively smaller in case of the output, showing the parallel essential role of full industrial chains.

## 5. Summary

The main goal of the research was an attempt to search for variable conditions of the influence of the intensity of enterprises' relations on their innovative activity within the Lubuskie regional industrial system, and as a result to determine boundary conditions for the model structure of the regional innovation network taking into consideration the specificity of the examined case.

The obtained results of the conducted research showed that participation of the enterprise in the supply chain both on the side of suppliers and consumers, positively determines the innovation activity of the regional system.

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Occurrence of above-regional network relations in the researched voivodeship between production enterprises influences the shaping of new technological solutions, and their close intensity allows to formulate clear conclusions. In case of suppliers, innovative activity grows, when the researched subjects are in touch with a greater amount of various industries. This means that diversification has a crucial meaning as the source of information about new technological solutions. The very fact of cooperation from suppliers with other industrial entrepreneurs, regardless of their assignment to the particular PKD group, is the condition sufficient for the increased innovative dynamism of the system. Additionally, the progressive diversification and the increase of the number of industrial relations generally accelerates the discussed processes.

In parallel, the similar number of industrial consumers also stimulates the innovative activity of the region. However, the very fact that the consumer should have the industrial character is a sufficient condition to stimulate innovation in enterprises. This results from the fact of a more profitable identification of the market needs without the need to run cost-intensive marketing research. So, on the side of relations with consumers, the thesis closer to the truth is the one saying that relations of diversification nature are a crucial element shaping the current innovation bases among entrepreneurs in Lubuskie Voivodeship.

The conclusions derived from the Lubuskie study are typical of low developed regions in Poland. Strong links with international industrial networks result in acceleration of innovation processes within the region. Foreign companies, which cooperate with the entities operate on foreign markets, where the level of innovation plays an crucial role in maintaining a high level of competitiveness. Therefore, companies in Lubuskie, wanting to maintain economic relations, are obliged to introduce new technology and product solutions.

The complementation of the analysis of the influence of industrial relations on enterprises' innovative activity was the research of the specialized inter-industrial relationships. On the basis of the gathered analytical material we can observe that the intensity of accomplishment of processes creating new solutions is strictly dependent on functioning within the industrial chain. The researched enterprises more often get into strong interactions with subjects representing a different kind of activity, when the specialized chain of supplies has the incidental character. This reflects the increased diversification of the system in Lubuskie region. Taking into account that the state common in Polish reality is the dominating position of low and medium-low sectors of technologies, the existing links with industries, belonging most of all to medium-high sectors of industries, indicate the attempts to establish and maintain contacts with

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more technologically advanced enterprises. In the future, this should boost the innovation processes in the researched group of subjects.

The article pays attention to the fact that subjects functioning in the researched area, in order to introduce innovations, should be the elements of industrial network integration, often transnational. In general, more intensively when they cooperate with a greater number of industrial subjects. The phenomenon of vertical cooperation therefore constitutes the foundation for the transfer of knowledge, both formal and tactical, in the industrial system.

**Summary**
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The main objective of the study was an attempt to search for the conditions affect the intensity of supply chains for enterprises innovative activity within the regional industrial system, and consequently determine the directions for the model of regional system of innovation, taking into account the specificities of Lubuskie Region. The study was based on a questionnaire on a group of 545 companies from Silesia. The study used probity modeling. This method is an effective research tool for large, but the static tests in which the dependent variable has a qualitative character.

*Keywords:*     *innovation, industry, region.*

**Streszczenie**
**Wpływ intensywności powiązań przemysłowych na aktywność innowacyjną.**
**Przypadek województwa lubuskiego w latach 2008-2010**
Głównym celem badania były próby poszukiwania wpływu intensywność łańcuchów dostaw na aktywność innowacyjną regionalnego systemu przemysłowego, i w konsekwencji sformułowanie wytycznych dla modelowej struktury regionalnego systemu innowacji, uwzględniającej specyfikę regionu lubuskiego. Badania zostały zrealizowane w oparciu o kwestionariusz ankietowy na grupie 545 przedsiębiorstw w województwie lubuskim. W analizach posłużono się modelowaniem probitowym. Metoda ta uznawana jest za skuteczny mechanizm badawczy

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w przypadku dużych statycznych prób, w których zmienna
zależna posiada charakter jakościowy.

**Słowa
kluczowe:**     *innowacja, przemysł, region.*

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