# ECONOMIC CYCLE AND REGIONAL INNOVATIVE ACTIVITY IN THE POMERANIAN INDUSTRIAL SYSTEM IN 2009-11

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**Abstract**: Industrial systems in countries with a significant technological gap is generally characterized by low competitiveness, manifested, among others, the low share of high technology products in international trade. The aim of the study was to determine the impact of the various phases of the directions of the economic cycle on the behavior of innovative firms with the determination of the strength of this effect. Achieved results confirmed the presence of cyclic of innovative activity in the Pomeranian region. Based on the analysis performed on a group of 680 industrial companies using probit regression can be stated that in the period boom innovative activity occurs much more frequently than in other phases of the business cycle - recession and stagnation. The economic situation is therefore an important and time-varying factor in the decisions of innovative enterprises. On this basis, there is a need for a reference to the current market conditions, the impact of the phenomenon of programming innovation processes in our country.

**Key words:** innovation, economic cycle, system, region, industry.

## Introduction

Currently, we are observing the slow process of the European economy coming out of the crisis, what is confirmed by various economic measures. This allows for an optimistic look into the future. Nonetheless, the current condition of the crisis may still last for a certain period of time. Companies being in this phase of the cycle, being under the forced economic pressure, generally select in a short period of time strategies of cost-cutting, devoting less time to searching and building the long-term comparative advantage based on the innovative activity [1]. In the shorter term this means the limitation of the financing of such activity, what may cause its extension in time or the reduction of budgets for innovations. This will lead to delays in the implementation of new technologies, will influence their quality, and even may result in the withholding of innovative projects.

At the level of particular companies, the economic literature indicates the diversified effects of particular phases of the economic cycle on the dynamics of innovative expenditures. In this scope there is a widely described dispute among scientists. Traditionally, in fact, investments in innovations are treated as the anti-cyclical argument for the economic subjects working in the market. Restrictions being the effect of slowing down transfer to their profitability, and this in turn forces them to look for new ways of maintaining high productivity. According to the concept of “creative destruction" by J. Schumpeter, the crisis thus creates new possibilities for companies. As a result, many of them should seek to reconfigure

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and improve the quality of the conducted innovative activity. An example of such behaviour is the R&D department, which in the crisis is subject to the phenomenon of "work storage" [2]. While this is the potential possibility of developing the organisation. Besides, the revenue lost in the company resulting from a smaller demand for the previously manufactured products may be a stimulus for the companies during the recession for investments in new technologies [3,4,5].

Despite many rational arguments in favour of that innovative activity has a anti-cyclical character, in the economic literature we often encounter the view that companies do not treat the innovative activity differently than other types of activity, what means that this activity has a purely cyclical character. Previous experiences has shown that the implementation of new technologies, especially the radical ones, is delayed in the recession phase, and the companies await the next boom in the economy [6,7]. At the same time there is no consensus in the area of the hypothesis of "accelerating the innovation" of Gerhard Mensch from 1975, assuming that innovation are more often implemented during recession as the effect of looking for chances to survive in the shrinking market [9].

The current phase of the economic cycle is an important factor, which repeatedly influences the decisions about undertaking or leaving the innovation activity in industrial companies, both in Poland and in more developed countries [8]. Polish provinces due to their low technological advancement are considered peripheral regions, and their development depends more often on the changes in their surroundings, and therefore in the more developed areas. This is an important premise to conduct research on the intensity of the advancement of national companies in particular areas of the innovative activity as the result of changes of the stages of the economic cycle.

Recent research carried out by Joint Research Centre in the area of the business phases impact in the innovative activity of companies became the main theme and inspiration to undertake an attempt to evaluate the analogous phenomena occurring in Poland [10]. The results of the research conducted there are not clear and because of that foreign literature raises a question: is the economic growth or recession the factor accelerating technological changes in companies?

The main objective of the conducted research was the attempt to search crucial directions and the power of influence of the economic cycle phases on the innovative behaviours of companies within the Pomeranian industrial system. As a result this allowed to determine the critical areas of support for the functioning of the regional industrial system and its innovative activity, taking into account its specificity. The effects of original research presented in this article are only a small part of conclusions obtained as a result of the conducted analyses in this province.

The exemplification part of the article was based on the regional case study of the Pomeranian province. Research was conducted in 2012 for the years 2009-11 based on the questionnaire. There were collected 680 properly filled-in questionnaires. The basic procedure of obtaining data included the initial phone conversation

together with sending the questionnaire by mail or traditionally. The complementary form was the telephone interview.
All tests have been of the static character and have been performed in the three years system, in accordance with methodological standards of tests on innovations used in all OECD countries.
The methodical layer of analyses was based on the theory of probability, and more precisely on probit models. They allowed the evaluation of the statistical significance and chances of the occurrence of the considered innovative phenomena due to particular phases of the business cycle. The probit regression allowed the precise estimation of the parameter value with the determination of their significance for the dependant variables expressed in binary. Such method gives satisfactory and stable results in case of a large and static sample of companies, in which the dependant variable takes the quality form, when it is difficult to present changes in time within the studies phenomena.
All variables adopted for testing – dependent and independent – have binary character, meaning they reach values 0 or 1. As a result of this, the interpretation of the achieved test results was conducted based on the structural form of the model, achieved probability results and necessary statistics (standard errors, t-student's statistics, Chi-square statistics, probability of the model's significance). A positive sign appearing with the main parameter informs us that the probability of the occurrence of the event of the innovative character is statistically significantly higher in the specified group of industrial subjects towards the rest of the community. The negative sign is interpreted opposite. Probit type of modelling constitutes an extremely effective research tool, what has been confirmed with its many usages by the test author in many regions in the country.

## Characteristics of the research sample

As it has already been mentioned in the introduction, the study was conducted based on 680 industrial companies in the Pomeranian region. The structure of the studied companies, from the point of view of the size and technology, is presented in the table below.

**Table 1. Structure of the studied industrial companies in the Pomeranian region from the point of view of the companies' sizes and technological classes in the years 2009-11 [%]**

| No | Size of companies | Pomeranian region | Technology advance | Pomeranian region |
|---|---|---|---|---|
| 1 | Micro | 31,0 | High | 6,2 |
| 2 | Small | 41,6 | Medium-high | 13,0 |
| 3 | Medium | 23,2 | Medium-low | 27,7 |
| 4 | Large | 4,1 | Low | 53,2 |

*Source: Own study based on field research.*

Moreover, from the perspective of the quantitative research, the tests are similar to those conducted by the Central Statistical Office in the discussed issues.

**Innovative activity of companies in particular phases of the economic situation in the Pomeranian region**

The period of economic recovery significantly influences the innovative activity of industrial companies in the Pomeranian region. Probit models with statistically important parameters occurred in sixteen out of eighteen considered areas of innovative activity. The lack of significant relations has only been observed in case of cooperation with universities and PAN units. We can thus formulate a thesis that time of recovery has a systemic influence on the implementation of the innovative activity in the whole region.

**Table 2. Innovative activity in the periods of economic recovery in the Pomeranian region in the years 2009-11**

| Type of innovation activity | coef | Std. Err. | *t-student* | $p_1$ | $p_2$ |
|---|---|---|---|---|---|
| R&D expenditure | +,627 | 0,101 | 6,222 | 0,49 | 0,26 |
| Investment in new fixed assets (including): | +,407 | 0,111 | 3,663 | 0,86 | 0,74 |
| a) buildings and grounds | +,557 | 0,104 | 5,365 | 0,40 | 0,21 |
| b) technical equipment and machinery | +,257 | 0,098 | 2,606 | 0,67 | 0,58 |
| Software solution | +,402 | 0,097 | 4,139 | 0,58 | 0,42 |
| Launching new products | +,719 | 0,098 | 7,364 | 0,77 | 0,50 |
| Implementation of new technology (including): | +,476 | 0,114 | 4,179 | 0,88 | 0,75 |
| a) new production methods | +,485 | 0,098 | 4,978 | 0,59 | 0,40 |
| b) none production systems | +,282 | 0,099 | 2,829 | 0,40 | 0,30 |
| c) support systems | +,373 | 0,106 | 3,503 | 0,31 | 0,19 |
| Cooperation with suppliers | +,555 | 0,106 | 5,259 | 0,37 | 0,19 |
| Cooperation with competitors | +,522 | 0,136 | 3,843 | 0,16 | 0,06 |
| Cooperation with domestic science units | +,648 | 0,145 | 4,477 | 0,15 | 0,05 |
| Cooperation with foreign science units | +,757 | 0,358 | 2,112 | 0,02 | 0,00 |
| Cooperation with customers | +,452 | 0,113 | 4,011 | 0,27 | 0,14 |
| Overall innovation cooperation | +,574 | 0,098 | 5,835 | 0,56 | 0,33 |

*Source: Own calculations based on the research conducted in the field.*

Another important feature characterising this case is the fact that all parameters are higher than zero, what means that the prosperity period behind each positively affects the shaping of the discussed activity. This influence may be defined, outside the system, as cyclical.

In the area of financial resources the research and development activity and investments in new buildings are particularly prone to economic fluctuations. The probability of their occurrence grows in favourable market conditions by, respectively: 88,4% and 90,5%. In case of investments in new machines and equipment and computer software the increases are not that large, but are significant and are as follows: 15,5% and 38,9%. It is also worth noting that two last categories are responsible for the passive transfer of technologies to the companies in the region and at the same time for the main area of their innovative activity, what is a typical phenomenon in the Polish conditions of management.

In case of the implementation of new solutions, new products are more prone to the economic fluctuations. In the prosperity period they are introduced more often by 54,0%, while the new technologies only by 17,3%. The aspects examined in detail of the last ones indicate, however, that the influence of the economic situation on the innovative behaviours is clearer. Directly productive processes are implemented more often by 47,5%, productive systems by 37,3%, while the support systems by 63,2%. Thus, their variability is quite large in particular phases of the economic cycle.

The innovative cooperation happens less often (lower probability values) than the financing and implementation of new solutions, but the scale of changes is much higher. For example, the cooperation with the competitors and national units of science is three times more likely to occur, while with the suppliers, customers and foreign science centres only two times. Innovative cooperation in total increases in the recovery period by 69,7%.

Therefore, we can observe a significant increase of interest in the conduction of various forms of innovative activity in the time of recovery in the region. What's more, susceptibility to the cycle changes is more visible than in other previously studied provinces. The Pomeranian region is characterised by the above-average changeability to the economic conditions on the Polish map.

**Table 3. Innovative activity in the period of economic recession in the Pomeranian region in the years 2009-11**

| Type of innovation activity | coef | Std. Err. | *t-student* | $p_1$ | $p_2$ |
|---|---|---|---|---|---|
| R&D expenditure | -,587 | 0,154 | -3,820 | 0,21 | 0,41 |
| Investment in new fixed assets (including): | -,476 | 0,146 | -3,256 | 0,67 | 0,83 |
| a) buildings and grounds | -,543 | 0,161 | -3,364 | 0,17 | 0,34 |
| Software solution | -,284 | 0,139 | -2,042 | 0,41 | 0,52 |
| Launching new products | -,531 | 0,139 | -3,824 | 0,47 | 0,67 |
| Implementation of new | -,314 | 0,151 | -2,079 | 0,74 | 0,83 |

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| technology (including): | | | | | |
| a) new production methods | -,351 | 0,139 | -2,512 | 0,39 | 0,52 |
| Cooperation with domestic science units | -,539 | 0,239 | -2,256 | 0,04 | 0,12 |
| Cooperation with customers | -,445 | 0,178 | -2,505 | 0,11 | 0,22 |
| Overall innovation cooperation | -,467 | 0,144 | -3,241 | 0,30 | 0,48 |

*Source: Own calculations based on the research conducted in the field.*

The period of the economic downturn negatively influences the innovative decision-making in industrial companies. However, this is only visible in ten of the considered areas of the innovative activity.
During this period the expenditures on R&D decline by 48,8%, investments in the buildings by 50,0% and the expenditures on the computer software by 21,2%. The implementation of new products decreases by 29,9% and new technologies by 10,8%, including new technological processes by 25,0%. Less common is also the innovative cooperation by 18 percentage points, where the decrease of interest mostly concerns the cooperation with the national research centres (by 75,0%) and customers (by 50,0%).
Cyclicality of innovative behaviours suggested before has been confirmed on the occasion of the examination of the period of the economic downturn. Negative impact of this phenomenon is however not that common (systemic), like in case of the recovery period.

**Table 4. Innovative activity in the period of economic recovery in the Pomeranian region in the years 2009-11**

| Type of innovation activity | coef | Std. Err. | *t-student* | $p_1$ | $p_2$ |
|---|---|---|---|---|---|
| R&D expenditure | -,416 | 0,108 | -3,846 | 0,28 | 0,43 |
| Investment in new buildings | -,367 | 0,112 | -3,284 | 0,23 | 0,35 |
| Software solution | -,301 | 0,104 | -2,903 | 0,42 | 0,54 |
| Launching new products | -,492 | 0,105 | -4,68 | 0,52 | 0,70 |
| Implementation of new technology (including): | -,334 | 0,117 | -2,861 | 0,75 | 0,85 |
| a) new production methods | -,359 | 0,104 | -3,448 | 0,41 | 0,55 |
| b) none production systems | -,291 | 0,108 | -2,690 | 0,28 | 0,39 |
| c) support systems | -,315 | 0,116 | -2,716 | 0,19 | 0,29 |
| Cooperation with suppliers | -,519 | 0,117 | -4,453 | 0,18 | 0,34 |
| Cooperation with competitors | -,429 | 0,151 | -2,846 | 0,06 | 0,14 |
| Cooperation with domestic science units | -,516 | 0,161 | -3,212 | 0,05 | 0,13 |

| | | | | | |
|---|---|---|---|---|---|
| Cooperation with customers | -,302 | 0,122 | -2,476 | 0,15 | 0,23 |
| Overall innovation cooperation | -,404 | 0,106 | -3,817 | 0,35 | 0,50 |

*Source: Own calculations based on the research conducted in the field.*

The missing element of the whole image of the region is the time of stagnation. It turns out that not only this has a negative influence on innovative behaviours of the companies but this concerns a greater number of the considered surfaces. Models with statistically important parameters occurred for thirteen areas of the innovative activity. The period of stagnation limits the generation and transfer of new technologies and the creation of innovative cooperation in the Pomeranian region more often and more systemically than the phase of the recession.
Expenditures on the B+R activity drop at that time by 34,4%, for new buildings by 34,3% and the computer software by 22,2%. The implementation of new products takes place less often by 25,7%, new technologies by 11,8%, including technological processes by 25,5%, non-production systems by 28,2% or the support systems by 34,5%.
The phenomenon of innovative cooperation is limited in the stagnation phase by 30,0%, while almost twice with the suppliers, recipients and competitors and as much as by 61,5% with the national research centres.
Based on the presented models we observe similar in direction, but more systematic limitation of the innovative activity in the stagnation range to the economic recession. This interaction is however more shallow (lower drops of the probability of events).

**Summary**

Summing up, the Pomeranian province is classified in the economically medium-strong regions in the country. Innovative activity realized in the industrial companies in this area is strongly dependent on the phases of the economic cycle. This action has a clear cyclical character, therefore the interest in its conduct grows during the recovery and drops in the recession period. The transitional period, meaning the stagnation phase, remained unknown. Approximate results showed that this period also affects negatively on the innovative decisions of the companies. What's more, the system of such impact is even higher than in the recession period, although the scale of limitations is sometimes lower, but sometimes even greater.
In the studied region, the cyclical factor strongly influences the behaviours of the companies and thus the innovative politics in this province should flexibly correspond to the needs of companies in different phases of the economic cycle. Therefore, it should be the important and integral part of the effective implementation of the regional strategy of innovation.

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## KONIUNKTURA GOSPODARCZA A AKTYWNOŚĆ INNOWACYJNA W POMORSKIM SYSTEMIE PRZEMYSŁOWYM W LATACH 2009-11

**Streszczenie:** Systemy przemysłowe w krajach ze znaczną luką technologiczną cechują się na ogół niską konkurencyjnością, przejawiającą się między innymi niskim udziałem produktów wysokiej techniki w międzynarodowym handlu. Celem opracowania było określenie kierunków oddziaływania różnych faz cyklu gospodarczego na zachowania innowacyjne przedsiębiorstw wraz z określeniem siły tego wpływu. Osiągnięte rezultaty badań potwierdziły występowanie cyklicznej aktywności innowacyjnej w regionie pomorskim. Na podstawie analizy wykonanej na grupie 680 przedsiębiorstw przemysłowych przy wykorzystaniu regresji probitowej można stwierdzić, że w okresie ożywienia aktywność innowacyjna występuje znacznie częściej, niż w pozostałych fazach cyklu koniunkturalnego – recesji i stagnacji. Koniunktura gospodarcza jest zatem istotnym i zmiennym w czasie czynnikiem wpływającym na decyzje innowacyjne przedsiębiorstw. Na tej podstawie zachodzi potrzeba odniesienia aktualnych warunków rynkowych do programowania oddziaływania na zjawisko procesu innowacyjnego w naszym kraju.

**Słowa kluczowe:** innowacja, cykl koniunkturalny, system, region, przemysł

## 2009-11年經濟週期及區域創新活動的在波美拉尼亞工業系統

**摘要：**工業系統的一般特點是低競爭力，顯現出來，其中包括，高科技產品在國際貿易中的份額較低的國家具有顯著的技術差距。這項研究的目的是確定影響的方向的創新型企業的行為，這種效果的強度測定經濟週期的各個階段。取得的結果證實存在循環波美拉尼亞地區的創新活動。採用概率單位回歸一組680個工業企業的基礎上進行的分析可以說，在此期間的繁榮創新活動發生更加頻繁地比其他商業週期的階段
衰退和停滯。因此，當前的經濟形勢是一個重要和隨時間變化的創新型企業的決定因素。在此基礎上，有必要參考目前的市場條件下，影響我國的編程創新過程中的現象。