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INNOVATIVENESS IN THE POLISH INDUSTRY, 2006-2017: GROWTH OR STAGNATION?[1]

Summary

Purpose – an attempt to evaluate the development of innovativeness in the Polish industry in 2006-2017.

Research methods – literature studies and statistical analysis. The analysis here is at the mezoeconomic level based on the statistical data published by the Central Statistical Office of Poland (Główny Urząd Statystyczny – GUS).

*Result*s – an observation that innovation stagnation appeared in the Polish industry and an identification of its reasons.

Originality / value – a proof of the existence of this stagnation in the period under analysis and a set of author's own proposals for the actions to overcome it.

Keywords: innovation, innovativeness, industry, stagnation, R&D

JEL Classification: O31

1. Introduction

Innovation has recently become a very fashionable word, unfortunately. What is, however, more important is that nowadays innovation – especially that in the field of technology – plays the role of a key driving force in the development of markets and sectors of the economy. A natural place where innovation usually appears is an enterprise. Innovation is a symptom of the enterprise's innovativeness or, in other words, its innovative activities. Hence, an evaluation of the development of innovativeness in time and in its present state is necessary for the public innovation policy that is mainly addressed to industrial enterprises.

The basic object of interest here is industry due to the fact that the European Commission is now emphasising a tremendous significance of the development of

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industry [*Innovation Union*, 2010]. According to Tajani [2010], 'industry is at the heart of Europe and indispensable for finding solutions to the challenges of our societies, today and in the future'. He even calls for a fourth industrial revolution leading to Industry 4.0.

The main aim of this paper is an attempt to evaluate the development of innovativeness in the Polish industry in 2006-2017, i.e. in the period of twelve years. 2007 was the first year of the European Union's Financial Perspective for 2007-2013. Therefore, we treat 2006 as a basal year (0-year) of analysis. What is more, there is a lack of some data for 2007 and the relevant data for 2018 and 2019 is not available yet.

Firstly, however, a question must be answered: How to measure industry's innovativeness and its development in time? Providing the answer is an additional aim of the article.

We shall try to prove that there was no visible progress in the field of innovativeness in the Polish industry in the analysed period. Therefore, some proposals will be formulated for the future.

2. Terminology and methodology

Defining a broadly used concept of 'innovativeness' presents many difficulties. Different authors understand it in different ways; some researchers even avoid defining this concept. For example, Mielcarek [2019], in his book chapter on *The essence and conceptualization of a phenomenon of innovativeness*, does not define it at all.

Tidd and Bessant [2011] define innovativeness very briefly as a successful application of new ideas, and add that the essence of innovativeness is a selective search for (and implementation of) new or different technological solutions on the ground of a competitive fight between economic entities to increase market shares.

In the Polish literature, innovativeness is being understood slightly differently. For instance, Pomykalski [2001] defines it as organization's capabilities to constantly search for, implement and disseminate innovation. Nowadays, innovativeness should become the main force of the development of each organization permanently included in its management system and culture.

Matusiak [2010] represents a broader approach to this concept. According to him, a firm's innovativeness is its inclination to innovate (innovation motivation) and, at the same time, its capability to innovate (innovation competence). In turn, according to Brzeziński [2009, p. 36], 'organization's innovativeness as a capability to stimulate innovations is a sequence (in a time depiction) and a result of creative processes.

Some authors treat innovativeness and innovation activeness as synonyms[2]. For example, Białoń [2008, p. 15] states that 'an organization's innovation activeness should be understood as a set of attitudes and actions leading to the creation and

[2] It is noteworthy that the word *innovativeness* is a combination of two words – *innovation* and *activeness* (innova-tiveness).

development of its innovation potential and to dynamize the innovation processes'. According to her, such activeness or activity is a relatively broad concept and includes as many as seven types of action [Białoń, 2008, p. 23]. Nota bene, it is easier to measure the level of enterprise's innovation activities than its capability to innovate.

We shall use both concepts, i.e. innovativeness and innovation activeness, interchangeably. Moreover, many foreign authors simply use 'innovation' as a synonym of the two concepts. We are interested in technical/technological innovativeness here.[3] It is possible to speak not only about the innovativeness of a firm or another organization, but also about the innovativeness of a region, sector (here – industry) or the whole national economy.

How to measure the level of innovativeness in a national economy, regions, sectors and enterprises? Unfortunately, the Economics of Innovation does not give an explicit answer to this question. An evolution of approach to indicators measuring firms' innovativeness is broadly discussed by Kamińska [2017], starting with an indicator of Expenditure on R&D in the 1950s, to the Summary Innovation Index (SII) within the European Innovation Scoreboard (EIS) at the beginning of the 21st century.

As for now, there exists no single, synthetic, universal measure/indicator of innovation or innovativeness. Such state of affairs results from the fact that technological innovation is a symptom of technical change/progress which is an unmeasurable phenomenon. But the search for such measure is still under way.

Total factor productivity (TFP) is sometimes used for this purpose (see, e.g. Próchniak [2010; 2016], Rapacki and Próchniak [2006]). 'The analysis of total factor productivity is conducted using the growth accounting framework. Growth accounting is an empirical exercise aimed at calculating how much economic growth is caused by changes in measurable factor inputs and in the level of technology. The level of technology, which cannot be directly observed, is measured as a residual. That means that we define technical progress as that part of economic growth which cannot be explained by changes in measurable factor inputs. This residual technical progress is interpreted as the increase in the total productivity of the inputs, denoted as TFP' [Próchniak, 2010, p. 171].

However, TFP is not appropriate for evaluating innovation or innovativeness development because technological progress is treated as a residual there, while nowadays technical change plays a crucial role in the economic growth. Moreover, an increase (or decrease) in TFP may prove the changing role of innovation only indirectly. So, TFP cannot be treated as such measure here.

Also, the Summary Innovation Index (SII) represents a limited usefulness here because of at least three reasons. Firstly, the European Innovation Scoreboard distinguishes five groups of partial indicators: the first three have a character of INPUT and the other two are OUTPUTS. Secondly, some of these indicators have

[3] According to a classical, very concise definition by Freeman [1982], technical innovation is the first practical application of a new technological solution in a form of new product or process.

nothing in common with innovation, i.e. those which refer to education of the population. Thirdly, the number of indicators creating SII has changed every few years. The number fluctuated from 24 to 29 in the period between 2000 and 2019. So, SII values are not fully comparable in particular years, which presents several methodological difficulties (see further).

In order to analyse the development of innovation in the Polish industry in 2006-2017, the author has decided to use the GUS [*Działalność innowacyjna przedsiębiorstw* …, 2010, 2014, 2018]. The table presented in the latest edition of this publication contains twelve indicators of which eight refer to industrial enterprises and four – to service firms. From among the indicators concerning industry, five may conventionally be treated as outputs or rather outcomes. They are as follows:

1. Innovative enterprises as the share of total industrial firms (employing 10 people or more).
2. Innovative enterprises as the share of total industrial firms (employing 10 people or more) which launched new or significantly improved products.
3. Innovative enterprises as the share of total industrial firms (employing 10 people or more) which launched new or significantly improved products on a scale of the country's market.
4. Innovative enterprises as the share of total industrial firms (employing 10 people or more) which launched new or significantly improved processes.
5. Net revenues from sales of innovative products as the share of total net revenues from sales in all industrial enterprises (employing 10 people or more).

The other three indicators may be conventionally treated as inputs. These are:

1. Percentage of industrial enterprises (employing 50 people or more) spending on innovation activities.
2. Percentage of industrial enterprises (employing 50 people or more) cooperating within innovation activities.
3. Percentage of industrial enterprises (employing 10-249 people or more) participating in cluster initiatives or in other similar formal initiatives.

After conducting an in-depth analysis, we have chosen indicators No. 1, 3 and 5 from the first group, plus 6 and 7 from the second group (see table 1, section 3). Such set of indicators seems proper and sufficient to characterize the development of innovativeness in the Polish industry.

Two main research methods applied in this paper are literature studies and statistical analysis. The analysis here is at a mezoeconomic level based on statistical data published by the Central Statistical Office (GUS) in Warsaw. If the Polish statistics lack sufficient data referring to the industry as a whole, but relevant data for the whole economy is available, then macro-data is taken into account. Moreover, the general population of industrial enterprises is treated by GUS, and also by the author, as a sector of industry.

3. A level of industrial firms' innovativeness

In the Polish literature, a consent prevails among the authors dealing with the evaluation of the present level of innovativeness in the national economy. A highly critical evaluation is presented, for instance, by Krajewski [2015] who analyses the situation in several fields/areas, such as patent capacity, a share of high-tech products in exports, the number of workers in high-tech sectors, firms' incomes on new and modernized products. He adds that taking into account a share of innovation-active industrial enterprises, Poland overtakes only Romania (among the member countries of the European Union).

The reports by Hausner ed. [*Kurs na*…, 2013] and by the National Bank of Poland (NBP) give equally critical assessments [*Potencjał innowacyjny gospodarki*…, 2016]. Also, Jasiński [2018b] evaluates the condition of the Polish innovativeness in 2010-2015 as very poor.

Szajt [2016], while analysing innovativeness as one of the pillars of country's competitiveness, states that Poland performs poorly in this respect and calculates that the level of innovativeness in the Polish economy decreased by 5% in 2006-2015. Also, Kamińska [2017] claims emphatically that this level was systematically declining over the same period.

In turn, Świadek [2017], after providing a highly critical evaluation of the development of firms' innovation activities in Poland in 2006-2015, raises two rhetorical questions: Are we catching up with the highly developed countries (HDCs) in this field? and Is the technological gap between Poland and these countries being closed or not?

While analysing the transfer of resources from the EU Structural Funds to the country within the 2007-2013 Financial Perspective, many Polish authors do not notice its positive influence on the Polish economy's innovation activities. For example, from the cited report edited by Hausner ed. [*Kurs na* …, 2013] we can find out that the incoming European resources translate very poorly into the level of innovativeness in the national economy of Poland. Weresa [2015] states that the changes in the Polish innovativeness do not follow the dynamics of the inflow of the EU funds to Poland.; see also Jasiński [2018c].

A very interesting book devoted to innovativeness in the Polish economy was published a couple of years ago [Kotowicz-Jawor, 2016]. The co-authors express their serious concern about the low level of innovativeness in Polish enterprises and about the fact that no major progress was achieved in this field in the analysed period of 2007-2013. According to Kotowicz-Jawor [2016, p. 88], a fundamental reason for the lack of firms' inclination to innovate has been the transitional phase of the development of the Polish economy.

As far as the role of inflow of European resources to Poland is concerned, this author also emphasizes that the stream of non-returnable funds from the EU within the 2007-2013 Financial Perspective did not bring expected effects. Two fundamental reasons for the low efficiency of the European aid are as follows [Kotowicz-Jawor, 2016, p. 105]: (1) lack of proper institutional infrastructure for domestic enterprises and (2) an insufficient level of social capital, especially of trust, in Poland.

One can, however, also find different assessments of the transfer of the EU resources, although isolated. For instance, Lubos [2015] claims that European funds were conducive to an increase in innovativeness of Polish enterprises, but she does not provide convincing proof for such thesis. However, we can agree with the author that the resources received from the EU Structural Funds were one of the reasons for the mild course that the world's economic crisis took in the Polish economy.

TABLE 1

Innovation activities of industrial enterprises in the years 2006-2017 (in %)

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Innovative enterprises as the share of total industrial firms	23.7	.	21.4	18.1	17.1	16.1	16.5	17.1	17.5	17.6	18.7	18.5
Innovative enterprises as the share of total industrial firms launching novelties on a scale of the country/ market	7.8	.	9.4	7.0	6.8	6.1	5.6	5.7	6.2	6.5	6.3	6.0
Net revenues from sales of innovative products as the share of total net revenues from sales in all industrial firms	13.5	.	12.4	10.6	11.3	8.9	11.5	10.7	10.8	11.6	9.7	7.1
Percentage of industrial enterprises spending on innovation activities	11.3	.	8.5	6.4	6.1	5.5	6.0	5.2	5.6	5.5	6.7	5.8
Percentage of industrial enterprises cooperating within innovation activities	37.3	31.8	.	29.6	29.6	29.8	28.8	29.6	29.5	30.0	31.1	30.9

Source: [*Działalność innowacyjna przedsiębiorstw*…, 2010, 2014, 2018; *Nauka i technika* …, 2012, 2016, 2018].

Looking at table 1, one might draw the following conclusions:

– all indicators of industrial firms' innovativeness in Poland in the final year (2017) show a lower level than in the initial year of the study (2006),
– only in the case of two indicators, a certain slowdown of declining tendencies occurred in the last three years of the analysed period,

– a visible breakdown of the level of innovativeness appeared in 2009, although some symptoms of it could have been observed in previous years,
– since 2009 innovation stagnation has prevailed and lasted till the end of the period under analysis,
– the beginning of stagnation coincided with Poland starting to receive sizeable resources for innovation from the European Commission.

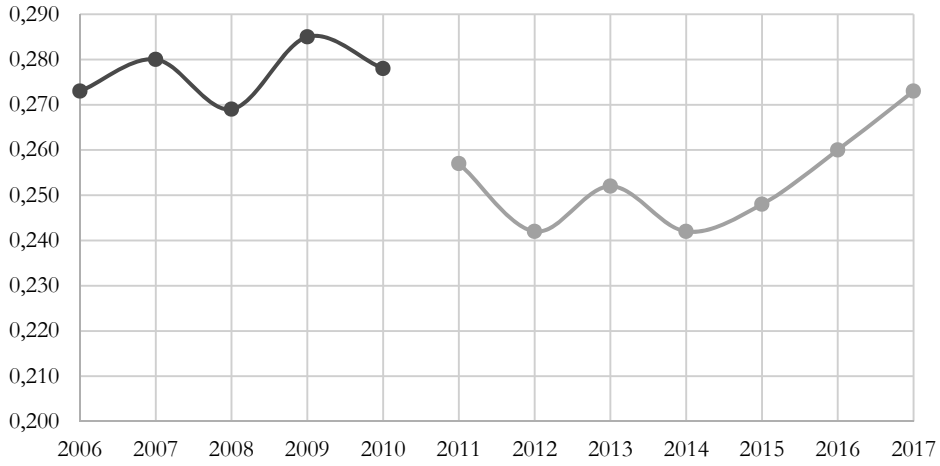
So, instead of the expected abundant innovation 'harvest', Poland has experienced innovation stagnation.

It is noteworthy that, according to the GUS 'Strateg' database [*Działalność innowacyjna przedsiębiorstw*…, 2018], a decrease in eleven indicators of firms' innovation activeness occurred in the ten-year period between 2008 and 2017. Only one indicator – percentage of industrial enterprises (employing 50 people or more) spending on innovation activities – has improved. Even a substantial sum of money received from the European Union for the Operational Programme 'Innovative Economy' (OPIE) did not help.

Despite some methodological doubts mentioned earlier, it is now time to turn to the European Innovation Scoreboards (EIS). We have carefully examined EIS for every year between 2006 and 2019, and decided to choose the Scoreboard dated 2011 for the years 2006-2010 and the latest available Scoreboard [*European Innovation …,* 2019] with data for the years 2011-2017 (chart 1).

CHART 1

Summary Innovation Indices for Poland in the years 2006-2017



Source: [*European Innovation Scoreboard*…, 2007, 2019].

As can be seen, there are two separate curves that cannot be joined due to slightly different methodologies of calculation. Therefore, the interpretation of these figures is difficult. Both sub-periods (2006-10 and 2011-17) must be interpreted separately.

The data for 2006-2009 shows a kind of stabilization of SII with small fluctuations around the average of 0.277. The data for 2011-2016 fluctuates around the average of 0.250, and only in the final year of analysis (2017) there is a visible increase. So, there was no clear tendency in this sub-period and in the whole period either. The data for the final two years (2016 and 2017) might mean that the innovativeness level is beginning to grow, however, none of the data in table 1 confirms it. Perhaps the expected data for 2018-2019 will show a breakthrough.

And how does Poland perform against a background of other European countries? Taking SII into account, in 2006, Poland occupied the fifth position (from the bottom) among the EU member countries, while in 2017, it ranked fourth (from the bottom) overtaking only Romania, Bulgaria and Croatia [*European Innovation*…, 2007, 2018]. Hence, Poland did not improve its position on the European Innovation Scoreboard, which is understandable bearing in mind the lasting stagnation.

4. Stabilization of expenditure

What could have been the reasons behind the innovation stagnation? Examining industrial firms' expenditure on innovation activities in the analysed period might provide an answer (table 2).

TABLE 2

Expenditure on innovation activities in industry by source of funds in the years 2006-2017 (bn zlotys at current prices – upper line; and in percentages – lower line)

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Total expenditure on innovation, including:	16.03	19.80	23.69	21.41	22.38	19.38	20.29	19.52	22.54	28.92	27.16	26.46
	100	100	100	100	100	100	100	100	100	100	100	100
– from firms' own sources	12.88	14.79	17.03	14.93	17.30	14.77	15.23	14.09	16.27	18.40	19.60	21.16
	80.3	74.7	71.9	61.1	77.3	76.2	75.1	72.2	72.2	63.6	72.2	80.0
– from the state budget	0.26	0.22	0.28	0.17	0.23	0.23	0.39	0.28	0.36	0.52	0.36	0.44
	1.6	1.1	1.2	0.8	1.0	1.2	1.9	1.4	1.6	1.8	1.3	1.7
– from abroad (non-returnable)	0.25	0.22	0.38	0.57	1.62	1.34	1.25	1.52	1.89	1.53	0.42	1.03
	1.6	1.1	1.6	2.3	7.2	6.9	6.2	7.8	8.4	5.3	1.5	3.9
– from the bank credit	2.12	2.80	4.89	5.43	1.64	1.74	1.20	1.32	1.94	3.14	.	2.02
	13.2	14.1	20.6	22.2	7.3	9.0	5.9	6.8	8.6	11.0	.	7.6

Notices: data for enterprises employing over 49 workers; 1 Euro = *approx.* 4 zlotys

Source: [*Działalność innowacyjna przedsiębiorstw*…, 2010, 2014, 2018; *Nauka i technika* …, 2012, 2016, 2018] and own calculations.

As we can see in this table, total expenditure of industrial enterprises on innovation was gradually increasing in 2006-2008. Then, this tendency stopped and a drifting stabilization of spending (at current prices) prevailed till 2014. It is worth noticing that in 2009-2014 the expenditure did not exceed – in any of the years – its level observed in 2008. It was only in 2015 that a visible increase was recorded but afterwards the spending slowed down again. As can be seen, the period of stabilization of firms' expenditure on innovation corresponds roughly to a slow decrease in the level of their innovativeness, which seems understandable. So, it is now worth analysing the individual components of firms' expenses on innovation activities (by sources of finance) over the whole period.

To start with, expenditure coming from abroad will be considered. Its biggest part are the resources from the EU Structural Funds. The table shows their visible upsurge in 2010. Then, the innovation expenditure was rising very quickly till 2015, after which it dropped due to the OPIE ending. A considerable increase occurred again in 2017, when a substantial amount of European resources started to flow to Poland as part of the 2014-2020 Financial Perspective.

In the period under analysis, other unsatisfying phenomena appeared as below:

1. Industrial firms' expenses on innovation from their own sources were growing in 2006-2008 but started to visibly decline afterwards because a new source of finance has appeared, i.e. the Operational Programme 'Innovative Economy' mentioned before. It was only in 2015 that the firms' expenditure resumed gradual growth. Thus, one could observe an undesirable phenomenon of substitution of domestic resources by foreign ones.
2. Budget expenses remained at the level of 0.25 bn zlotys during the first three years of the analysed period. Afterwards, they stayed at the average level of 0.21 bn zlotys in the next three years (2009-2011), so they slowed down slightly. Then, in 2012-2015, the expenditure remained at the average level of 0.39 bn zlotys and in final two years it did not reach the level of 2015. So, there was a kind of fluctuation in firms' expenditure on innovation activities.
3. Firms' expenses from a bank credit showed an upward tendency at the beginning, to drop dramatically in 2010. They displayed a tendency to decline in the next years, till 2015, when they again grew significantly due to the fact that budget grants for innovation had shrunk. In the final year, credit expenditure returned to the level as low as that recorded in 2014. One should bear in mind that it is quite natural, even desirable, that entrepreneurs in highly developed countries use credits as a source of co-finance for innovation. In Poland, however, another substitution appeared, namely non-refundable resources from the European Commission which were used to replace bank credits.

Summarizing, all measurements concerning industrial firms' expenditure on innovation activeness showed fluctuations in 2006-2017. All items of the spending were rising in the first three years. In 2009, a clear slowdown occurred in the total innovation expenditure as well as in the case of enterprises' own funds and of the

state budget expenses. This slowdown period lasted for as long as six years, i.e. till 2014, when the level of these measurements was lower than in the best year of the 2006-2014 period (for individual items of expenditure). Some positive symptoms appeared in 2015-2017, i.e. in the last three years of the period under analysis. They may bring certain improvements in firms' innovativeness in the forthcoming years.

Even if some items of expenditure were increasing nominally, we must be careful while interpreting it because all data in table 2 is expressed at current prices. Therefore, it is necessary to check how the structure of the expenditure on innovation activities in industry has changed. In order to do it we shall compare the initial and the final year of the period under analysis, i.e. 2006 and 2017. Namely:

- the share of firms' own funds in the total innovation expenditure (80.3% at the beginning) has not practically changed (80.0% at the end), although the expenditure – at current prices – grew from 12.9 bn zlotys in 2006 to 21.1 bn zlotys in 2017;
- the share of budget sources did not change either (1.6% in 2006 and 1.7% in 2017); this represents a very low level;
- the share of bank credits decreased from 13.2% in 2006 to 7.6% in 2017, so it dropped almost by half;
- this loss was compensated by foreign sources, the share of which increased from 1.6% in 2006 to 3.9% in 2017; but it is noteworthy that in 2013 and 2014 their share amounted to as much as 7.8% and 8.4% respectively.

As far as, for example, the year 2015 is concerned, it saw an apogee of the expenditure on innovation in industry (28.9 bn zlotys) but the share of firms' own funds in this expenditure amounted to 63.6% only, and the share of the state budget sources (1.8%) was roughly at the level of both the initial and the final year of the period under analysis. In contrast, the share of foreign and bank resources taken together amounted to 16.3%, i.e. relatively a lot.

The above-mentioned data confirms the stabilization of the structure of the expenditure on innovation activities in the Polish industry in the analysed period. Only the resources from the UE have shown a constant increase both in absolute numbers and in percentages, except in the final two years. It means that thanks to the foreign sources there was a nominal increase in the total innovation expenditure in industry.

As can be seen, the period of innovation stagnation corresponds, in principle, with a slowdown period in expenses on innovation activeness incurred by enterprises and by the state budget. This braking surely was one of the main reasons for the stagnation, although some single data for the final two or three years may prove that stagnation started to show signs of ending.

So why did Polish enterprises decrease their expenses on innovation? It was partly because of the global economic crisis that started in 2008 and also reached Poland. It is commonly known that R&D and innovation expenditure are very easy to make savings on. It was also partly because entrepreneurs have found an easier and cheaper way to improve the efficiency of their businesses, namely low payment for the labour force.

In 2009, a few major changes were introduced in the Labour Code with the purpose of making it more flexible. They concerned flexible forms of employment, such as freelancing and temporary job contracts. The results of these changes have been as follows: according to the GUS data, approximately 500,000 people were employed in the national economy under the so-called 'junk' contracts in 2010 while in 2015 there were as many as 1.3 m such employees [*Gazeta*…, 2017]. Therefore, the labour force in Poland, also earlier relatively cheap in comparison with Western countries, has become even cheaper and so Polish entrepreneurs did not have to invest into costly new technologies. According to Mączyńska [2016], cheap wages are not conducive to innovation. The same opinion was shared by Belka [2015] and Marody [2016].

What could have been the other reasons, apart from the slowdown of domestic expenditure on innovation and cheaper labour force, for the stabilization of firms' innovation activities at a very low level?

5. Other reasons for innovation stagnation

There is also another group of reasons for such a poor state of affairs. There exist, as a legacy of the past, still lasting structural weaknesses, called here imperfections in the national economy. The main weaknesses, in the context of research and innovation, are as follows [Jasiński, 2018a]:[4]

1. The Polish R&D sector, consisting of higher education institutions, institutes belonging to the Polish Academy of Sciences and other research institutes, is still practically state-owned and, as such, fully dependent on the condition of public finances.
2. In 2016, 64% of Poland's research and development potential, measured by the number of R&D workers, was located in the R&D sector [*Działalność innowacyjna przedsiębiorstw*…, 2018]. This means that approximately two thirds of 'scientific production' appear outside companies.
3. Polish enterprises very seldom rely on scientific and technological solutions provided by external organizations, i.e. in the R&D sector. The following data proves it:
   – only 22.6% of innovation-active enterprises have mentioned R&D organizations as 'a source of information highly important for innovation' [*Nauka i technika…,* 2014] and
   – in 2017, industrial firms incurred only 22.9% of their total innovation-devoted expenses on R&D, both conducted in-house and ordered externally [*Nauka i technika*…, 2019].

   Hence, one can assume that over three quarters of innovations in the Polish industry are based on enterprises' internal information, ideas, experience and

[4] The data here refers to the whole economy.

solutions while the opposite should be the case in Poland. Therefore, Polish innovations represent a relatively low level of novelty (see table 1).

4. In Poland, the share of basic research in GERD (about 30% in 2017) is much higher that the share of applied research – only about 18% [*Nauka i technika*…, 2019]. As is commonly known, the former is 'further from the market' than the latter.
5. Over half of the expenditure on R&D comes from public sources, i.e. from the state budget and the European resources, whereas the private business sector's contribution to GERD was about 45% in 2016 (according to the author's own calculations based on: [*Nauka i technika…,* 2018; *Rocznik Statystyczny…,* 2016]). It does not obviously mean that public expenditure on R&D should now be limited. On the contrary, private expenses (by firms) should increase much quicker than the public ones. Public spending should act as a kind of 'tag-boat' of private investment into research and development in Poland.

It is worth adding that in Poland:

1. There exists a very low level of trust between firms and scientific and R&D organizations, and so, very often there is a lack of will for cooperation between entrepreneurs and scientists (see, e.g. Świadek [2017]). Mączyńska [2016] refers to this phenomenon as erosion of trust. A percentage of innovation-active enterprises that cooperate with various entities during their innovative activities, which has been relatively small in Poland, declined even further in recent years (see table 1). So, how can we talk about open innovation, the idea of which is based, among other things, on a firm's broad cooperation with its environment during a knowledge exchange [Chesbrough, 2003]?
2. Expenditure on R&D is usually treated as costs, both by entrepreneurs and scientists as well as by politicians, but not perceived as investment in R&D. This old-fashioned approach to science assumes that it is easy to make economies on science ('Professors will not go on strike'). It is adopted instead of the approach which tries to answer the question: How to capitalize on R&D investments in the long term?

This is a kind of background for firms' innovation activeness. All these characteristics are in contrast to the experiences in the field of R&D and innovation that the majority of highly developed countries share (see further). However, Poland's biggest problem here seems to be an extremely low level of the share of gross domestic expenditure on research and development (GERD) in gross domestic product (GDP). The GERD/GDP ratio remained at approximately 1% – level in 2015-2017 [*Nauka i technika*…, 2019], whereas the EU average remains at the level of about 2% [*European Innovation*…, 2018]. Sachs [2018], in his interview, calls it a shame.

One might feel tempted to ask the following question at this stage: Does everything in Poland have to be the other way round? All these seven weaknesses have a character of structural imperfections (the final two of them are moral attitudes/

/postures) and are a legacy of the past. It is true that in certain areas, improvements have recently taken place but they were practically imperceptible as it happened too slowly. The described worrying state of affairs does not allow the development of innovativeness in the national economy to speed up, especially in the Polish industry.

While analysing macroeconomic conditions for innovative development of the Polish economy, Mączyńska [2016] warns against a growing risk of secular stagnation that acts as a barrier to investment and innovativeness.[5] Poland is not free from being threatened by such stagnation. The author formulates the thesis that an antinomic drift increases the receptivity of the Polish economy to secular stagnation [Mączyńska, 2016, p. 80]. Perhaps the observed innovation stagnation is the early symptom of the forthcoming secular stagnation. This hypothesis requires further research.

6. New knowledge is costly

It seems quite obvious that in order to overcome innovation stagnation, one should bear in mind the following advice: a significantly bigger R&D effort is needed in the country in order to produce as much new scientific and technological knowledge as possible. But not only. The new knowledge must then be widely diffused and applied practically in the industry or, more broadly, in the national economy.

However, it is not only knowledge that weighs. There are also costs. As mentioned above, knowledge production requires high expenditure. Therefore, highly developed countries spend more and more on research and development. The mentioned GERD/GDP ratio shows the scale of the R&D effort in a given country. In three of the most innovative countries of the European Union, i.e. Scandinavian ones, this indicator has exceeded 3% for many years [*European Innovation*…, 2018].

Among many sources of high innovativeness in HDCs, besides substantial expenditure on R&D, there is also a pro-innovation structure of research that has the following features: (1) the majority of the R&D expenses are incurred by firms and other private economic entities; (2) expenditure on applied research is much higher than on basic research; (3) most R&D employees work in the business sector.

In this place, we are coming to one of the basic assumptions of the new growth theory [Romer, 1990]. According to this assumption, technical change is, first of all, the result of enterprises' long-term investments in R&D. The creation of new technological solutions (innovations) is a function of a number of researchers employed in a firm and of knowledge accumulated there in the past. The capacity to absorb new technologies depends on the knowledge asset possessed by an enterprise which, in turn, mainly depends on its R&D expenditure. Each innovation

[5] According to Hansen [1938], secular stagnation is, in short, a lasting loss of a possibility to adapt the socio-economic system to the possessed physical, financial and labour assets and to the developing needs of a country [Mączyńska, 2016].

enlarges the assets of accessible knowledge and increases productivity of expenditure on research and development [see also: Kubielas, 2009; Weresa, 2012]. Kotowicz-Jawor [2016] emphasises the fundamental role of a firm's knowledge asset in its competitive fight.

It is time now to analyse the R&D efforts by Polish enterprises. In 2012-2017, the share of R&D expenditure in industrial firms' total expenditure on innovation was as follows (table 3).

TABLE 3

The share of R&D in firms' total expenditure on innovation activities in the years 2012-2017

2012	2013	2014	2015	2016	2017
17.1%	19.3%	18.5%	16.5%	18.3%	22.9%

Source: [*Działalność innowacyjna przedsiębiorstw*…, 2010, 2014, 2018].

The average share in 2012-2016 was about 18% with no visible progress, unfortunately. An upsurge to almost 23% occurred in 2017. This might be seen as a kind of augury for improvements, but we should still wait for the data for 2018 and 2019.

As far as the role of the State is concerned, not only the present government but also the previous governments in Poland have not appreciated the key role of expenditure in the knowledge creation for the country's development towards a modern, innovative, knowledge-based economy (KBE). Moreover, the demand for a new knowledge which will be suitable for commercialization is growing [Grzelońska, 2016]. Unfortunately, science has not been a priority for Polish politicians over the last decades.

One must also remember that the necessity to ensure high GERD level results from an obligation, which is the so-called Barcelona Target of 2002. It is the duty of each member country of the European Union to speed up the enlargement of the R&D investments to at least 3% of GDP. Moreover, the share of the private business sector should ultimately reach two thirds of this target. It is noteworthy that Denmark, Finland and Sweden have already fulfilled this condition. In Poland, as mentioned before, this share is less than half.

7. "Recipe" for innovation

So, what should we do now? Let's be realistic and assume that Poland's goal is to achieve the present average level of the GERD/GDP ratio in the UE of, as mentioned before, 2%. If so, Polish expenses on R&D should rise by 20-25% every year in the course of the next five years. At the same time, a forced and multi-facet restructuring of the research system ought to start. It should be aimed towards its pro-innovation structure according to the Western model described earlier. The issue is that: (1) the firms' investments in R&D should rise considerably faster than

expenditure on the public R&D sector, (2) expenditure on applied research and experimental development should increase significantly more quickly than that on basic research, and (3) employment of R&D workers in enterprises should grow rapidly.

Of course, there is no direct dependence between expenditure on R&D and the number of innovations. 'More R&D does not mean more innovation' (Freeman's lecture, Brighton, 2002). This is true for a short period because research processes last long by nature. But in the long run, new scientific-technological solutions will not appear without earlier R&D, acting as a springboard for innovation, with the exception of the cases where (like, for example, in the Apple Corporation) some innovations were the result of a new combination of accumulated scientific knowledge.

The above-mentioned proposals come directly from the new growth theory. Briefly speaking, in-house R&D or, in other words, industrial R&D should develop as quickly as possible. The structure of domestic research effort ought to change as a result. Moreover, the attitude to innovation activities as a whole, including research and development, should change considerably. We mean here that:

1. R&D will stop being treated as a field in which decision-makers can make cuts on expenditure and other 'savings'.
2. Budget expenditures will become a 'tag-boat' that will pull higher expenditure on R&D by private enterprises.
3. This kind of expenditure will stop being perceived only as costs but rather as investments that usually bring good return though not at once.
4. Innovative entrepreneurs will put a great emphasis on cooperation with other entities, especially with R&D institutions, including universities; firms will more often use external solutions and offer their own achievements externally, according to the open innovation model.
5. The level of trust among enterprises, research organizations, public institutions and in the Polish society in general will grow considerably. As is commonly known, trust has a direct influence on the level of cooperation between economic entities. According to Świadek [2017], the level of cooperation is a derivative of market trust.

Thus, what Poland needs nowadays are not improvements in the present policy for the R&D financing. What it needs is a real breakthrough. The present government still has a chance to make such a breakthrough. Recently, the Prime Minister of Poland has repeatedly claimed that the condition of the state budget continues to be very good and is supposed to be so in the near future. The government's numerous latest initiatives of social patronage prove that the Prime Minister's words hold true. They also confirm that the current Polish authorities treat social transfers, rather than knowledge creation and its transfer, as a priority.

Finally, let's refer back to the expected role of industrialization mentioned in the Introduction to this article. An important thesis is worth recalling here, namely that deindustrialization processes existent in the Polish economy may turn out to be a strong barrier to innovativeness [Mączyńska, 2016, p. 86]. So, it may be stated that

industrialization can then counteract stagnation tendencies. This statement should be treated as support to Tajani's appeal [2010].

8. Conclusions

Innovation stagnation in the Polish industry started around 2009 and lasted for the whole period under analysis. Some single data for 2016 and 2017 may be treated as the first weak signs of the stagnation ending. However, making such an emphatic statement is not allowed at this moment yet. We must wait for the data for 2018 and 2019.

The stagnation has been caused by two main factors: (1) the slowdown of domestic expenditure on innovation and (2) cheaper labour force. Additionally, there exist various reasons for the low level of innovativeness in the Polish industry. These are still remaining relics of the past.

The quickly growing public and private investments in research and development, together with the parallel essential restructuring of R&D aimed at reversing its structure, should bring about the desirable effect, i.e. a substantially higher number of new scientific and technological solutions suitable for quick practical implementation in enterprises. Especially, the need for significant public support for industrial R&D is a crucial recommendation towards innovation policy.

Obviously, it is quite easy to put forward such proposals as the ones formulated in this paper. It will, however, be very difficult to implement them. Moreover, the focus of the paper was on the R&D component of the innovation process. One must, however, bear in mind that, apart from research and development, there are still two other components of the process. These are production implementation and commercialization of a new product, a technological process or a new service. These two areas are also in need of considerable improvements, some of which were presented by the author earlier [Jasiński, 2014], to be able to adjust to the changes in the R&D system.

Improvements are also needed in the methodology of measuring innovativeness in industry as well as in the whole economy.

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