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Konrad Rojek*

Development of the Polish non-life insurance market and macroeconomic stabilization of the Polish economy in 2000-2020

Abstract

The paper presents the results of research on the relationship between the development of the Polish non-life insurance market and macroeconomic stability of the Polish economy in 2000-2020. The research was based on The Method of Zero Unitarization (construction of a synthetic indicator of the Polish non-life insurance market development), the Pentagon of Macroeconomic Stabilization and a cross-correlogram (study of the relationship between the two variables).

***Keywords*:** insurance market, macroeconomic stabilization

***JEL classification*:** E63, G22, P00

Paper type: Research paper

Introduction

The insurance market is influenced by many different factors, starting from economic, to demographic, to social and cultural. Many studies have shown that individual factors can affect the development of the insurance market in both positive and negative ways. Such

* **mgr inż. Konrad Rojek** – PhD candidate, Kazimierz Pułaski University of Technology and Humanities in Radom, Faculty of Economics and Finance, e-mail: k.rojek@uthrad.pl

a multiplicity and diversity of determinants can generate difficulties in identifying the quantities that have a leading influence on the development of this phenomenon. It is also not an easy task to choose or create appropriate indicators that can most accurately reflect the changes taking place in the insurance market. It should be noted, however, that in practice all determinants of insurance market development ultimately manifest themselves primarily in the form of increasing number of insurance products, their growing availability and increasing value of insurance premiums. Therefore, the process of measuring insurance development is based mainly on three measures: the value of gross written premiums, insurance density ratio and insurance penetration ratio. The second and third indicator, taking into account the relationship to GDP and the size of the population, are further based on the value of premiums, so it can be considered that these measures, due to their main component, are also not able to comprehensively reflect the changes taking place in the insurance market. Therefore in the research a synthetic indicator of development of Polish non-life insurance market was constructed, which in its construction, in addition to the above mentioned indicators, includes also other important phenomena for this market (number of companies and the associated indicator of market concentration). For this purpose The Method of Zero Unitarization was used.

It was decided to examine the created indicator in comparison with an important economic category, which is macroeconomic stabilization. Achieving it is a difficult task, because just like the insurance market, it is influenced by many factors dependent on each other. It often happens that the growth of one economic indicator generates negative trends in the case of another (for example, the relationship between economic growth and inflation). Therefore, it is problematic to find optimal relationships between factors determining this stability. This complexity also generates difficulties in precise definition of this phenomenon. Therefore, generalizing it can be said that macroeconomic stabilization can be identified with a positive economic situation in close relationship with the political and socio-demographic sphere. An important element is also the links of the economy in the international arena. Therefore, macroeconomic stabilization includes the internal and external balance state of the economy.

The analysis of macroeconomic stabilization was conducted using the Pentagon of Macroeconomic Stabilization. The relationship between changes in the synthetic indicator of the Polish non-life insurance market and changes in macroeconomic stabilization of the Polish economy in the analyzed period (2004-2020) was examined using a cross-correlogram.

The main aim of the research was to examine the relationship between the development of the Polish non-life insurance market

and changes taking place in the sphere of macroeconomic stabilization. According to the research aim, the research hypothesis was formulated: There are statistically significant relationships between changes in the Polish non-life insurance market and changes in the macroeconomic stabilization of the Polish economy.

1. Overview of research findings

1.1. Insurance market development and its measurement

Insurance development is a category characterized by great complexity. In the literature this process is usually considered in two aspects. It is seen as a key factor in the financial development of the economy and more broadly, as a determinant of long-term economic growth (Bednarczyk, 2011, p. 86).

The development of insurance is identified by J. Handschke, as various aspects of transformations occurring in this area (Handschke, 2009, pp. 56-69). T. H. Bednarczyk (2011, p. 86) is of the opinion that insurance development is a long-term process of "improvement of the insurance market, insurance institutions and instruments, aimed at increasing the volume of insurance transactions and improving their efficiency".

On the other hand, in the practical sphere, insurance development occurs primarily in the form of increasing number of insurance products, their growing availability and increasing value of insurance premiums. Therefore, the process of measuring insurance development is based primarily on three measures (Bednarczyk, 2011, pp. 86-87):

- the value of gross written premiums and the dynamics of their growth;
- insurance density ratio;
- insurance penetration rate.

It is accepted in the literature that the development of insurance markets is determined by many different factors. These usually include:

- economic;
- demographic
- social and cultural;
- structural.

A number of studies have shown that individual factors can affect the development of the insurance market in both positive and negative ways. Table 1 provides an overview of such factors.

Table 1. The economic and demographic factors shaping demand for insurance according to empirical studies

Variable	Effect	Example of research
Economic factors		
Disposable income	Positive	All research
Permanent income	Positive	Fortune (1972); Outreville (1980, 1985); Beck, Webb (2003); D. Li et al. (2007); Nguyen et al. (2010); Chien-Chiang Lee, Chiu (2012).
Inequality in income distribution	Ambiguous	Beenstock i inni (1986); Beck, Webb (2003); Nakata, Sawada (2007); Feyen i inni (2010); Wicka, Miedzik (2010)
Insurance price	Negative	Mantis, Farmer (1968); Fortune (1973); Babbel (1985); Outreville (1985); Outreville (1990); Browne i inni (2000); Esho i inni (2004); Ward, Zurbruegg (2000); Arena (2006); Wicka, Miedzik (2010).
Expected inflation rate	Negative	Neumann (1969); Browne, Kim (1993); Outreville (1996); Beck, Webb (2003); Li i inni (2007).
Real interest rates	Ambiguous	Outreville (1996); Beck, Webb (2003); Lim, Haberman (2003); Li i inni (2007); Sen (2008); Chen, Lee, Lee (2011).
Impact of the stock market	Ambiguous	Headen, Lee (1974); Lim, Haberman (2003); Chui, Kwok (2009); Chui, Kwok (2009); Avram i inni (2010); Chen, Lee, Lee (2011); Hamydova (2014).
Unemployment rate	Negative	Mantis,Farmer (1968); Outreville (1980); Beenstock i inni (1986); Lenten, Rulli (2006).
Pension funds	Positive	Davis, Hu (2004)
Demographic factors		
Population size	Positive	Mantis, Farmer (1968); Nakata, Sawada (2007); Feyen i inni (2011).
Number of family members (number of children)	Positive	Berekson (1972); Burnett and Palmer (1984); Ward, Zurbruegg (2002); Li et al. (2007); Kurdyś-Kujawska, Sompolska-Rzechuła (2019); Abdul-Fatawu et al. (2019).
Gender	Ambiguous	Sarkodie, Yusif (2015); Narradda Gamage et al. (2016); Kurdyś-Kujawska, Sompolska-Rzechuła (2019).
Urbanization	Positive (with exceptions)	Outreville (1996); Browne i inni (2000); Szablicki (2002); Beck, Webb (2003); Hwang, Gao (2003); Esho i inni (2004); Hwang, Greenford (2005); Sen (2008); Chen, Lee, Lee (2011); Park, Lemaire (2011).
Age structure	Ambiguous	Berekson (1972); Truett, Truett (1990); Browne i inni (2000); Chen i inni (2001), Nowotarska-Romaniak, Ogrodnik (2011); Feyen i inni (2013); Bugajski (2017).
Age dependency ratio	Ambiguous	Beenstock i inni (1986); Truett, Truett (1990); Browne, Kim (1993); Beck, Webb (2003); Li i inni (2007); Sen (2008); Chui, Kwok (2008 i 2009); Feyen i inni (2011); Cheng and Yu (2018); G. Li et al. (2020).
Life expectancy	Ambiguous	Beenstock i inni (1986); Browne, Kim (1993); Outreville (1996); Ward, Zurbruegg (2000); Beck, Webb (2003); Lim, Haberman (2003); Li i inni (2007); Sen (2008); Chui, Kwok (2009); Chen, Lee, Lee (2011); Feyen i inni (2011); Bugajski (2017).

Source: Own study based on Bednarczyk T. H. (2011). Ekonomiczne i instytucjonalne czynniki rozwoju ubezpieczeń, „Wiadomości Ubezpieczeniowe", No. 4, p. 86 and a literature review

Economic factors play a very important role in both life and non-life insurance. The demand for insurance has a very strong correlation with the savings rate and the amount of disposable income per capita. The development of insurance increases with the growth of the propensity to save and the amount of household income, assuming a relatively low level of inflation. This is because high inflation is a phenomenon that negatively affects long-term savings and therefore also the demand for insurance (especially life insurance, which also has a long-term nature) (Carmichael, Pomerleano, 2002, pp.78-81).

Empirical studies of individual economic factors have shown that the demand for insurance is more sensitive to income than to prices. The demand for insurance services manifests a relatively low price elasticity (Babbel, 1985, Skipper, Kwon, 2007, p. 522). Income elasticity of demand, on the other hand, is determined by the level of development of a country. It was found that the income elasticity of demand index manifests low values in the case of countries with low and very high GDP per capita. However, the average level of GDP per capita determines the occurrence of the elasticity index above 1 (Enz, 2000, pp. 396-406).

As in the case of economic factors, also non-economic factors can affect the development of insurance both positively and negatively. The stimulants of demand for insurance services include in the literature mainly the level of education, financial development, the degree of market openness, or the enforcement of property rights. Examples of these factors and destimulants are presented in Table 2.

Table 2. Social, cultural and structural factors shaping the demand for insurance according to empirical research

Variable	Effect	Example of research
Social and cultural factors		
Risk aversion	Ambiguous (toward positive)	Burnett, Palmer (1984); Browne, Kim (1993); Browne i inni (2000); Park i inni (2002); Esho i inni (2004); Chang, Berdiev (2013); Fier, Carson (2015); Kujawska, Sompolska-Rzechuła (2018).
Education	Positive	Hammond et al. (1967); Burnett and Palmer (1984); Truett, Truett (1990); Browne, Kim (1993); Ward, Zurbruegg (2002); Webb i inni (2002); Hwang, Gao (2003); Hwang, Greenford (2005); Li i inni (2007); Arena (2008); Han i inni (2010); Curak i inni (2009); Chen, Lee, Lee (2011); Feyen i inni (2011).
Religion (Islam)	Negative	Browne, Kim (1993); Outreville (1996); Webb i inni (2002); Ward, Zurbruegg (2002); Beck, Webb (2003); Chui, Kwok (2008 i 2009); Feyen i inni (2011); Park i Lemaire (2011).
Cultural factors	Ambiguous	Burnett, Palmer (1984); Park i inni (2002); Esho i inni (2004); Chui, Kwok (2008, 2009); Park, Lemaire (2011).

cd. Table 2.

Structural factors		
Financial development	Positive	Outreville (1990 i 1996); Ward, Zurbruegg (2002); Beck, Webb (2003); Li i inni (2007); Arena (2008); Sen (2008); Chui, Kwock (2008 i 2009); Avram i inni (2010); Chen, Lee, Lee (2011); Feyen i inni (2011).
Market monopolization	Negative	Outreville (1990 i 1996).
Foreign companies' presence	Ambiguous	Outreville (1990 i 1996); Browne i inni (2000); Li i inni (2007).
Market concentration	Negative	Outreville (1996); Feyen i inni (2011); Park, Lemaire (2011).
Degree of market opening	Positive	Arena (2008); Curak i inni (2009); Avram i inni (2010); Chen, Lee, Lee (2011).
Level of social security	Ambiguous	Beenstock i inni (1986); Browne, Kim (1993); Outreville (1996); Ward, Zurbruegg (2002); Hwang, Greenford (2005); Li i inni (2007); Chen, Lee, Lee (2011); Feyen i inni (2011).
Legal system	Ambiguous	Browne i inni (2000); Webb i inni (2002); Beck, Webb (2003); Esho i inni (2004); Park, Lemaire (2011).
Enforcement of the right ownership	Positive	Ward, Zurbruegg (2002); Esho i inni (2004); Nataka, Sawada (2007); Chui, Kwok (2008 i 2009); Avram i inni (2010); Feyen i inni (2011).
Political risk	Negative	Ward, Zurbruegg (2002); Webb i inni (2002); Beck, Webb (2003); C. P. Chang, Berdiev (2013).

Source: Own study based on Bednarczyk T. H. (2011). Ekonomiczne i instytucjonalne czynniki rozwoju ubezpie-czeń, „Wiadomości Ubezpieczeniowe", No. 4, p. 93 and a literature review

Based on the review of the literature, it can be noted that the development of insurance markets of individual countries is influenced by many different factors. These are economic and non-economic factors. Each of these categories is important, but their importance changes with the level of economic development. The higher the level of economic development, the insurance market development is less influenced by non-economic factors and more influenced by economic determinants. Therefore, the next part of the study characterizes the phenomenon of macroeconomic stabilization.

1.2. The essence of macroeconomic stabilization

Stability or macroeconomic stabilization is an ambiguous concept and therefore difficult to define precisely. In general, it is identified with a positive economic situation, which is closely correlated with political, social and demographic conditions of a given country. The international connections of the economy also play a very important role. This primarily refers to trade with foreign countries (Grynia, Marcinkiewicz, 2017, p. 43).

Macroeconomic stabilization is also called macroeconomic balance. It occurs in a given country when there is one internally related system of production function, demand function and supply function, both for all production factors and manufactured goods. The occurrence

of such a state of the economy is equivalent to the occurrence of internal and external equilibrium. It should be noted that this phenomenon is impossible to achieve in practice (Siek, 2015. p. 1).

The phenomenon of macroeconomic stabilization has been studied and understood in classical terms as a derivative of the four main goals of economic policy. These include achieving high economic growth, a stable price level, full employment and balance of payments equilibrium. These goals are called the "magic quadrilateral" (Kulbacki, 2021, p. 72).

The assumption presented above was extended by G.W. Kolodko (1993, pp. 48-49). According to him, macroeconomic stability is derived from six basic features that should characterize the economy. G.W. Kolodko included a high and stable rate of economic growth, a low unemployment rate, a low inflation rate, a balanced state budget and a balanced current account balance. To study macroeconomic stability in this way, the PSM model (Pentagon of Macroeconomic Stabilization) is used, which will be discussed in the next part of the paper.

2. Own research

2.1. Synthetic indicator of non-life insurance market development in Poland

The development process of the insurance market is a phenomenon determined by many different variables. Adopting only one of them, in order to represent this phenomenon, may be a significant simplification and prevent its comprehensive analysis. Therefore, it was decided to build a synthetic indicator of development of Polish non-life insurance market, consisting of the most important values, most often used in the literature to describe this issue. For this purpose The Method of Zero Unitarization was applied, which includes the following stages (Kowalik, 2011, pp. 204-210):

a) The selection of variables describing the studied phenomenon and their preliminary analysis.
b) Normalization of the values of diagnostic variables which are stimulants or destimulants (unification in order to make them comparable).
c) Choice of aggregation formula and determination of synthetic value on its basis.

Among the variables qualified[1] to build a synthetic indicator of the development of the Polish non-life insurance market, only one had a destimulant character - it was an indicator of market concentration. In the case of four indicators there was a positive dynamics of change

[1] Selection was based on a review of the literature

between the beginning and the end of the study period. Only changes in the number of insurance companies were negative. There was a decrease from 37 companies in 2004, to 32 in 2020 (-13,51%). Detailed data relating to this issue are presented in Table 3.

Table 3. Development indicators of the Polish non-life insurance market in 2004-2020

Year	Gross written premium [€m]	Density index [€]	Penetration index [%]	Market concentration index* [%]	Number of companies
2004	3 671,93	88	1,64	83,93	37
2005	4 072,80	93	1,44	76,73	37
2006	4 284,26	97	1,35	76,00	42
2007	5 093,36	108	1,31	74,07	36
2008	4 840,50	119	1,24	71,30	36
2009	5 130,71	124	1,49	75,00	34
2010	5 720,50	135	1,41	73,50	32
2011	5 565,72	147	1,47	68,43	43
2012	6 296,02	152	1,48	67,10	30
2013	6 241,48	153	1,48	67,10	30
2014	5 863,29	148	1,37	79,19	30
2015	5 921,81	150	1,32	78,00	32
2016	6 722,45	176	1,56	76,00	33
2017	8 406,03	208	1,69	77,00	33
2018	8 654,39	221	1,68	78,00	33
2019	8 992,23	229	1,64	81,00	33
2020	8 767,27	231	1,68	81,00	32
Δ 2004-2020	138,76	161,31	2,65	- 3,49	- 13,51

* Market share of the top 5 insurance companies
Source: Own study based on Insurance Europe and OECD

After normalizing the values of diagnostic variables and choosing the aggregation formula, the synthetic value (Market_development_index) was determined, the development of which in the studied period is shown in Figure 1.

Figure 1. Synthetic indicator of the Polish non-life insurance market development and its components in 2004-2020
Source: Own study using Grelt software

Based on the analysis of the built synthetic indicator of the development of the Polish non-life insurance market, it can be noted that in the period studied it is characterized by an upward trend (average annual dynamics of change reached 9%) and a significant decline falling in 2014. (-42,9%). Moreover, it is worth pointing out that there are many relationships between the presented indicators, both in relation to each other and in relation to the synthetic indicator of development of the Polish non-life insurance market. An example of such a correlation is the highest y/y decrease in the number of companies recorded in 2012 (-30.23%), which soon after (in 2014) contributed to the highest y/y increase in the market concentration ratio (18.02%). The cross-correlation between these indicators has the highest statistical significance coefficient for lags of 2 and -2. These changes may have generated the largest decreases in gross written premium and density ratio (-6.06% and -3.26% y/y, respectively) and the second largest for penetration ratio (-7.23% y/y) recorded in 2014. All these changes affected the market development and contributed, to the already mentioned, its temporary regression from 2014.

2.2. Pentagon of Macroeconomic Stabilization Pentagon (PSM) of Polish economy

On the basis of the selected method, observations were made of the changing over time of basic economic quantities, such as (Misala, 2011, p. 144):

— the growth rate of gross domestic product (ΔGDP) - a synthetic reflection of the economic development of a country and the level of living standards of its citizens and residents;
— the rate of registered unemployment (U) - a quantity measured as the ratio of the stock of labor able to take up work to the number of employed;
— inflation rate (CPI) - which is an indicator of internal balance, which is measured by the increase in prices of consumer goods;
— the ratio of the state budget balance to GDP (G);
— current account balance to GDP (CA).

The above-mentioned indicators were appropriately scaled and formed five vertices of the pentagon of macroeconomic stabilization. The better the development of the analyzed values, the further the points representing them are located from the center of the system, i.e. the center of the pentagon.

The following scales were adopted for individual macroeconomic quantities[2]:

— the growth rate of gross domestic product (ΔGDP) – od -25% do 10%;
— the rate of registered unemployment (U) – od 0% do 20%;
— inflation rate (CPI) – od 1% do 1000%;
— the ratio of the state budget balance to GDP (G) – od -16% do 4%;
— current account balance to GDP (CA) – od -10% do 4%.

The values (sides) of the pentagon are expressed in percent. On the side representing the level of inflation, a logarithmic scale was used (Figure 2).

[2] The scale has been kept in line with the original adopted by G. Kołodko.

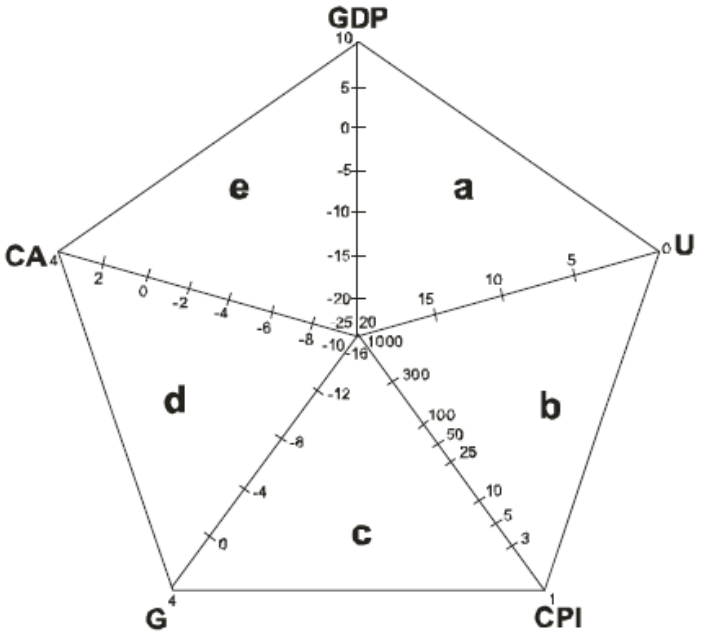


Figure 2. Macroeconomic Stabilization Pentagon
Source: Siek E. J. (2015). Pięciokąt stabilizacji makroekonomicznej. Materiały dydaktyczne, Katedra Biznesu i Finansów Międzynarodowych Uniwersytet Technologiczno-Humanistyczny im. K. Pułaskiego w Radomiu, Radom, s. 3.

If any of the analyzed macroeconomic quantities were smaller or larger than the marginal values on the scale, then those values (marginal values) were taken (Siek, 2015, p. 5).

The total area of the PSM is determined by the formula (Kołodko, 1993, p. 54):

$$\underbrace{(\Delta GDP \times U)}_{a} + \underbrace{(U \times CPI)}_{b} + \underbrace{(CPI \times G)}_{c} + \underbrace{(G \times CA)}_{d} + \underbrace{(CA \times \Delta GDP)}_{e} \times k$$

where the k-factor is defined as:

$$k = \frac{1}{2}\sin 72^{o}$$

Therefore, the factor has a constant value of 0.475. It is half of the sine of the angle located at the central vertex of each triangle of the pentagon. This angle is 72°, which is a fifth of a full angle. The larger the area of the PSM, the more positive the macroeconomic stabilization situation. In the optimal case, the area of the pentagon is 1, and the area of each of its five triangles (a, b, c, d, e) is equal to 0.2.

The total area of the PSM is the sum of five triangles. These include triangle "a" (real sphere triangle), triangle "b" (stagflation triangle), triangle "c" (budget and inflation triangle), triangle "d" (financial balance triangle) and triangle "e" (external sector triangle). The pentagon model of macroeconomic stabilization also allows us to distinguish a field (indicators) of macroeconomic stabilization that depends primarily on internal and external factors. In the first case it is PSM1 consisting of triangles a, b and c. In the second, PSM2 which is the sum of the areas of triangles d and e. Table 4 presents the PSM sub-indices for Poland in 2004-2020.

Table 4. The PSM sub-indices for Poland in 2004-2020

Rok	a	b	c	PSM1	d	e	PSM2	PSM	PSM1/ PSM	PSM2/ PSM
2004	0,008	0,007	0,094	0,109	0,037	0,055	0,092	0,201	54,16 %	45,84 %
2005	0,017	0,019	0,116	0,152	0,069	0,086	0,155	0,307	49,44 %	50,56 %
2006	0,054	0,059	0,131	0,244	0,058	0,076	0,135	0,379	64,43 %	35,57 %
2007	0,095	0,090	0,126	0,311	0,039	0,048	0,087	0,398	78,13 %	21,87 %
2008	0,107	0,102	0,112	0,321	0,033	0,039	0,072	0,394	81,59 %	18,41 %
2009	0,094	0,095	0,114	0,303	0,061	0,068	0,129	0,432	70,15 %	29,85 %
2010	0,084	0,089	0,111	0,284	0,042	0,054	0,096	0,380	74,72 %	25,28 %
2011	0,088	0,083	0,115	0,286	0,049	0,059	0,108	0,394	72,61 %	27,39 %
2012	0,075	0,080	0,114	0,270	0,064	0,068	0,132	0,402	67,17 %	32,83 %
2013	0,073	0,100	0,139	0,312	0,084	0,094	0,177	0,489	63,77 %	36,23 %
2014	0,089	0,146	0,191	0,426	0,081	0,091	0,172	0,598	71,26 %	28,74 %
2015	0,103	0,131	0,143	0,377	0,091	0,110	0,202	0,579	65,15 %	34,85 %
2016	0,111	0,170	0,166	0,447	0,092	0,109	0,200	0,648	69,04 %	30,96 %
2017	0,129	0,141	0,137	0,406	0,107	0,124	0,231	0,638	63,71 %	36,29 %
2018	0,138	0,157	0,151	0,446	0,100	0,110	0,210	0,656	67,97 %	32,03 %
2019	0,142	0,149	0,136	0,427	0,115	0,127	0,242	0,669	63,86 %	36,14 %
2020	0,108	0,136	0,072	0,317	0,082	0,118	0,200	0,517	61,25 %	38,75 %

Source: Own study based on Eurostat, World Bank and OECD

On the basis of the calculations carried out it can be noted that the macroeconomic stabilization of Poland, considered as an appropriate configuration of economic indicators corresponding to the conditions of economic growth, increases over time. This is evidenced by the increasing area of the pentagon of macroeconomic stability over the years. The y/y declines were recorded only in 2008. (-0,98%),

2010 r. (-12,3%), 2015 r. (-3,4%), 2017 r. (-1.48%) and the largest in 2020. (-22,75%). Despite these few decreases, the overall trend is upward. Which can be observed in Figure 3.

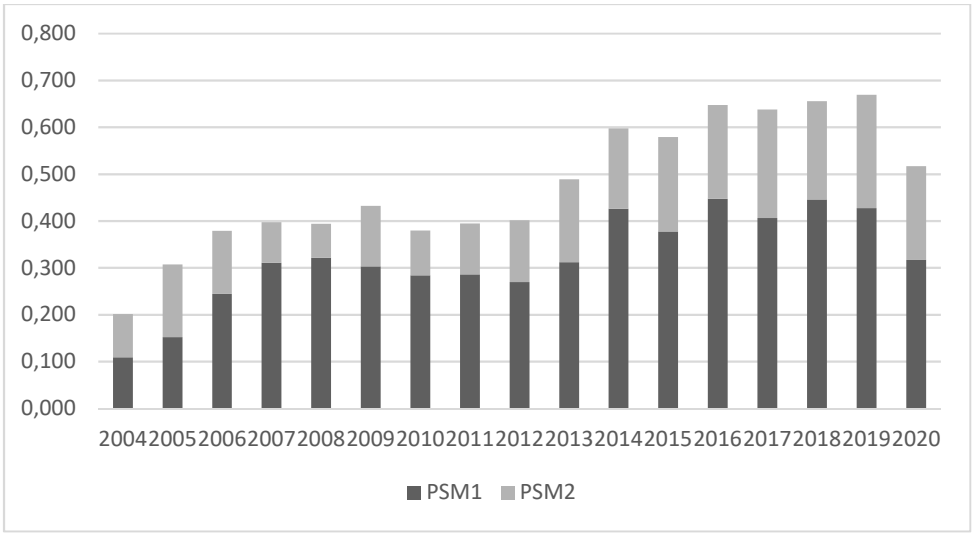


Figure 3. Evolution of the PSM index in Poland in 2004-2020
Source: Own study based on Eurostat, World Bank and OECD

There is also a noticeable advantage of PSM1 over PSM2 in the share of the total PSM index. At the beginning of the analysed period (the first two years) these proportions were similar. Then, internal conditions played a much greater role in shaping the macroeconomic stability of the Polish economy.

It should be pointed out that the most optimal form of the PSM for Poland (from the theoretical point of view) would be a sufficiently high rate of economic growth while maintaining full use of production resources and maintaining internal and external balance. Then, drawing a graph on the PSM, one would move around the edges of its vertices, and the maximum value of the index would be 1. The Polish economy came closest to this in 2016, when the PSM was 0,669.

2.2. Relationship between the development of the non-life insurance market in Poland and macroeconomic stabilization of the Polish economy

The study showed that in the analyzed period there are significant statistical relationships between the changes in the constructed synthetic indicator of the development of the Polish non-life insurance market, and the development of indicators PSM, PSM1 and PSM2, describing

macroeconomic stabilization of the Polish economy. The strength of this correlation (tested by Pearson correlation coefficient) can be described as being on the border of medium and high[3]. Table 5 shows the values of correlation between changes in the synthetic indicator of development of Polish non-life insurance market, and the delay of changes in indicators of macroeconomic stabilization of the Polish economy.

Table 5. Correlogram between market_dev changes and delay of PSM, PSM1 and PSM2 changes

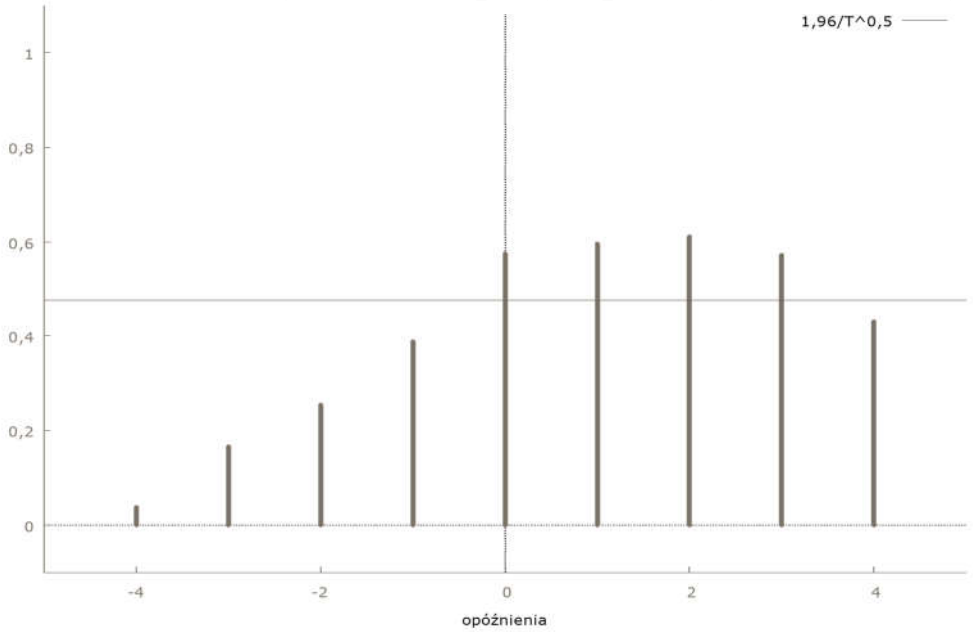
Delays	PSM	PSM1	PSM2
-4	0,0381	-0,0467	0,1816
-3	0,1661	0,0624	0,3125
-2	0,2543	0,1175	0,4393 *
-1	0,3880	0,2993	0,4542 *
0	0,5759 **	0,4876 **	**0,5961 ** **
1	0,5966 **	0,5646 **	0,5106 **
2	**0,6121 ** **	**0,6194 ** **	0,4517 *
3	0,5727 **	0,6108 **	0,3664
4	0,4301 *	0,4617 *	0,2697

* - significance level of 10% , ** - significance level of 5%, *** - significance level of 1%
Bold - the highest value of the correlation index
Source: Own study

The examined correlation relationships are characterized by greater statistical significance in the case of delays of PSM and PSM1, than in period 0. This indicates that the non-life insurance market reacted with a delay to changes occurring in macroeconomic stability, including internal conditions represented by PSM1. Synthetic market_dev indicator also reacted with a delay with high statistical significance to changes occurring in the case of PSM2, but the highest value of correlation was recorded in the period 0. On this basis it can be concluded that the Polish non-life insurance market reacted faster to external factors than to domestic conditions. This phenomenon is illustrated in Figure 4.

[3] Assessed by comparing different scales that describe the strength of correlation between two variables

K Correlogram between Market_development_index changes and delays of PSM changes



Correlogram between Market_development_index changes and delays of PSM1 changes

delays

Correlogram between Market_development_index changes and delays of PSM1 changes

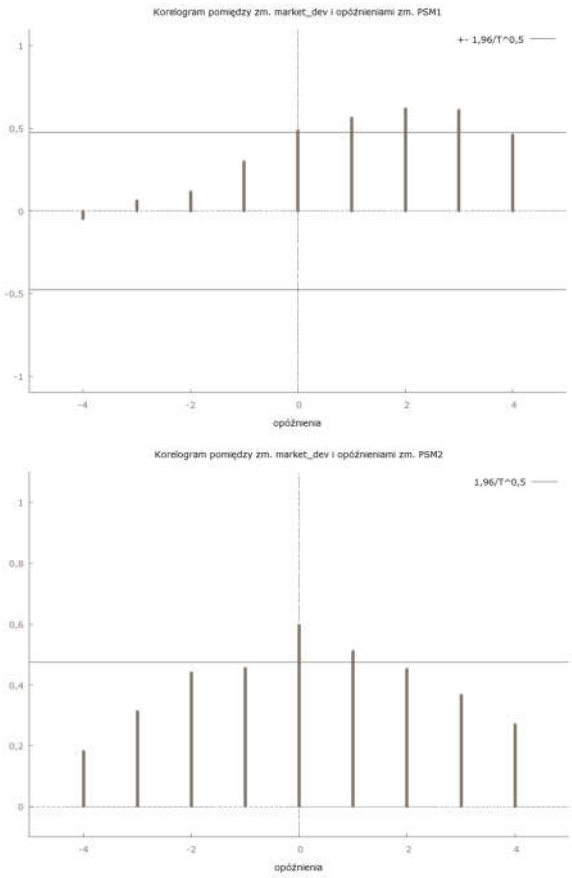


Figure 4. Correlograms between market_dev changes and delays of PSM, PSM1 and PSM2 changes
Source: Own study using Grelt software

Conclusions

The development of insurance market, including non-life insurance market, is characterized by great complexity. This phenomenon can be seen as a series of transformations occurring in this area, conditioned by many different factors. Particular factors may affect the development of insurance market in both positive and negative ways. In the case of non-life insurance, economic factors play a very important role. Their importance increases with the level of economic development. In turn, the conditions for economic development (or economic growth) should be accompanied by an appropriate configuration of economic indicators, which is called macroeconomic stabilization. These indicators directly and indirectly affect the development of the insurance market. The study analyzed the correlation between these categories. However, the changes in time of constructed

synthetic index describing the development of Polish no-life insurance market and PSM index used to analyze macroeconomic stabilization were assessed separately.

Based on the analysis of the synthetic indicator of development of the Polish non-life insurance market it was found that in the period studied it is characterized by a growing trend. Average annual dynamics of changes amounted to nearly 9%. However, the change between the beginning and the end of the period is almost 130%. The growth is also characterized by macroeconomic stabilization of the Polish economy. The PSM indicator increased in the examined period by 157%. Internal balance (PSM1) increased by 190%, while external balance (PSM2) by 117%. The average annual dynamics of change in PSM exceeded 7%, which is similar to the case of a synthetic indicator of development of the Polish non-life insurance market.

After examining the relationship between the two variables it was shown that in the analyzed period there are statistically significant relationships between them. The strength of correlation between changes in the constructed synthetic indicator of the development of the Polish non-life insurance market, and the development of indicators PSM, PSM1 and PSM2 (describing macroeconomic stability of the Polish economy) was assessed as medium to high. The examined correlation relationships show that the Polish non-life insurance market reacted faster to external factors than to domestic conditions. Changes in the insurance market as a result of changes in stabilization determined by internal factors were most visible after two years.

The main aim of the research was to examine the relationship between the development of the Polish non-life insurance market and changes taking place in the sphere of macroeconomic stabilization. According to the research aim, the research hypothesis was formulated: There are statistically significant relationships between changes in the Polish non-life insurance market and changes in the macroeconomic stability of the Polish economy.

On the basis of the research it can be said and the goal has been realized and the hypothesis has been verified positively.

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ARTICLES

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Kazimierz Ortyński*
Jacek Wołoszyn**

Structure of technical efficiency of insurers in the life insurance industry in Poland

Abstract
The primary objective of the article was to examine the level and efficiency structure of insurance companies on life insurance market in Poland.
The study presents critical analysis of the insurance literature relating to technical efficiency of insurers, i.e. methods of estimating efficiency, the form of the efficiency frontier model, the choice of production factors and insurance production. The study used the methods of mathematical and econometric modelling in SFA method.
The results the technical efficiency study for 22 life insurance companies for a period between 2011-2020 using the SFA method, showed high average cost efficiency of insurers (0.9140) and lower profit efficiency (0. 8565). It was confirmed that a group of large companies achieved higher cost efficiency than the remaining companies, suggesting that large companies benefited from the scale of production. In contrast, higher average profit efficiency was recorded for the remaining companies.

Keywords: life insurance market, cost efficiency, profit efficiency, stochastic frontier analysis

JEL Classification: C52, D24, G22, L11

Paper type: Research article

* Professor (Prof Tit) at the Department of Finance and Insurance, Faculty of Economics and Finance of the Kazimierz Pułaski University of Technology and Humanities in Radom, Poland

** Assistant Professor at the Department of Computer Science and Teleinformatics, Faculty of Transport, Electrical Engineering and Computer Science of the Kazimierz Pułaski University of Technology and Humanities in Radom, Poland

Introduction

The Efficient Market Structure Hypothesis, represented primarily by Hicks (Hicks, 1935, pp.1-20) Demsetz (Demsetz, 1973, pp.1-9; Demsetz, 1974, pp.164-184) and Peltzman (Peltzman, 1977, pp.23-34), has a special place in the study of firm efficiency. This hypothesis suggests that the market structure in which firms operate is largely determined by their efficiency. It assumes a positive effect of concentration on the performance of firms-more efficient firms have lower costs (lower marginal costs) and thus earn higher profits. Increasing efficiency of firms leads to an increase in market concentration. In turn, an increase in a firm's market share roughly shows its higher operating efficiency, as well as its higher profitability. In other words, higher profits of firms with high market share result from their higher efficiency, which also affects their market power. The issue of measuring the efficiency of firms, including insurance companies, is among the rapidly developing research areas that use efficiency methods (Biener et al., 2015, pp. 703-714).

The use of the frontier analysis approach in the study of firm efficiency was pioneered by M. Farell (Farrell, 1957, pp.255-260), defining, among other things, technical efficiency as the ability of a firm to produce the maximum output from a given set of production factors, or to produce a given amount of output with minimum factor inputs. Currently, there are two mainstream approaches to measuring technical efficiency i.e. using parametric stochastic frontier models (SFA) (Aigner et al.,1977, pp.21-37; Meeusen and van den Broeck, pp.435-444) and the non-parametric deterministic data envelopment analysis - DEA (Chames et al., 1978, pp.429-444). SFA analysis determines the so-called efficiency frontier (the highest efficiency achieved) on the basis of the efficiency scores of all the companies studied, together with a comparison of this frontier with the performance of companies using the same set of inputs (production factor inputs). Thus, this analysis enables determination of the efficiency of those companies that are outside this frontier and enables to them appropriate decision making to improve their position (Chen and Lin, 2020, p.65-86).

The purpose of the article is to study the level and structure of the efficiency of life insurance companies in Poland.

The following research questions have been formulated in the study i.e. was the cost efficiency of the group of large companies significantly higher than the group of other insurance companies?

Based on the microeconomic theory of production, the article examines the technical efficiency of costs and profit efficiency of insurers operating in the life insurance sector. Statistical methods and econometric modeling in the SFA method were used to estimate the inefficiency of the companies.

The efficiency of the insurance companies studied was determined based on the Jondrov formula (Jondrov et al., 1982, pp. 233-238), which uses previously determined inefficiency values. The study was based on the annual data of selected 22 insurance companies in the life insurance sector in Poland from 2011-2020.

1. Technical efficiency of insurance companies-Review of selected empirical studies

The research conducted on the insurance literature on the technical efficiency of insurance companies confirms their diversity. These include, in particular, such issues as (Cummins and Weiss, 2000, pp. 803-810; Eling and Luhnen, 2009, pp. 1497-1509; Zata, 2019, pp. 40-51 and 55-79):

- efficiency estimation methods
- the form of the efficiency frontier model
- selection of production inputs and outputs.

Most studies in the developed markets have looked at cost efficiency and, to a limited extent, profit efficiency. One of two groups of methods was usually used, i.e. parametric (econometric method) or non-parametric (mathematical programming method).

The SFA method is based on the assumption that all companies in a given sector should be able to obtain efficiency at the level set by so-called "benchmark" companies, i.e. those using best practice methods. A characteristic feature of the SFA method is the separation of the variable that determines inefficiency from the variable that measures random disturbances, but this requires making separate assumptions about their distributions. The parametric method uses the functional form of the frontier values to estimate a given function (production function or translogarithmic cost function). This method allows to estimate the effective cost or production taking into account the stochastic nature of the input data (Aigner et al., 1997, pp. 21-37). The following models are distinguished within the parametric method: SFA (Stochastic Frontier Analysis), DFA (Distribution-Free Approach), TFA (Thick Frontier Approach) or FFA (Flexible Fourier Approach) – the approaches differ in their assumptions about the form of the distributions of the random variables modeling inefficiency and the variables reflecting the influence of random factors and measurement errors.

The non-parametric approach (mathematical programming methods) uses the DEA (data envelopment analysis) method, adapting linear programming techniques.

The SFA approach distinguishes applied forms of functional relationships such as: the linear production function, the Cobb-Douglass production function, the Leontief production function, tobit model functions and logistic

regressions, and the more and more commonly used translogarithmic production function.

Among production factors, the cost of labour, the cost of capital or debt capital, have often been taken into account. In determining the type of products, the value-added approach for policyholders (those entitled under insurance contracts) is most often used.

Among the representative empirical studies in the insurance literature, the following should be noted.

Hardwick and Li (Hardwick and Li, 1997, pp. 37-44) studied the cost efficiency of life insurance companies in the UK from 1989 to 1993 using the SFA method. The authors showed that large companies were more efficient than smaller ones.

Klumpes (Klumpes, 2004, pp. 257-273) focused on studying cost and profit efficiency in the life insurance sector in the UK in 1994-1999. The author showed that insurers with direct sales, compared to those that distributed insurance using insurance intermediary institutions, achieved higher cost and profit efficiency.

Greene and Segal (Greene and Segal, 2004, pp. 229-247) analysed the relationship between cost efficiency and profitability in the U.S. life insurance market in 1995-1998, using data from 136 companies in a final panel model. The authors determined the average cost inefficiency of insurers at 20%, and showed that cost efficiency is crucial to their profitability. They confirmed that inefficiency was negatively correlated with ROE and ROA ratios, and that efficient companies had, on average, a higher cumulative return on capital and assets.

Bikker and Van Leuvensteijn (Bikker and Van Leuvensteijn, 2008, pp. 2063-2084) studied the relationship between efficiency and competition in the Dutch life insurance market between 1995 and 2003. The authors proved presence of great advantages resulting from production scale and from the relationship of inefficiency in the market with limited competition.

Eling and Luhnen (Eling and Luhnen, 2010, pp. 217-265) studied two approaches used in measuring efficiency, i.e. using econometric models, including the SFA method, and using mathematical programming, including the DEA method. Selection criteria for production inputs and products for measuring efficiency of insurers was also analysed.

Biener et al. (Biener et al. , 2016, pp. 703-714) studied the efficiency and productivity of Swiss insurers in the life insurance, non-life insurance and reinsurance markets from 1997 to 2013 using frontier models. The results showed that, among other things, the internationalization of the insurance business had a positive impact on the efficiency

of insurers. It was also confirmed that firm size did not affect the efficiency of insurers.

Cummins et al. (Cummins et al., 2017, pp. 66-78) analysed the relationship between the financial stability of insurers and competition in 10 life insurance markets, in EU countries between 1999 and 2011. The results of the study indicated that competition increases the stability of life insurance markets by reallocating profits from inefficient insurers to efficient ones.

Porębski (Porębski, 2017, pp. 123-136) used the non-parametric DEA method to assess the technical efficiency of 15 non-life insurance companies in Poland in 2012-2015. The highest technical efficiency in the years studied was achieved by two insurance companies, namely PZU SA (100% according to the CCR model and BCC in 2015) and TUnŻ WARTA S.A. (60.13% according to the CCR model and 100% according to the BCC model in 2015).

Eling and Jia (Eling and Jia, 2018, pp. 58-76) studied the relationship between technical efficiency and business volatility in insurance companies from 16 European countries between 2006 and 2013. They found a negative correlation between technical efficiency and the probability of insurer insolvency. The effect of an insurer's turnover growth on its insolvency was also examined, suggesting the existence of a non-linear U-shaped relationship, in the non-life insurance sector (both negative and marginally high growth favour company insolvency).

Ortyński and Wołoszyn (Ortyński and Wołoszyn, 2021, pp. 61-77) determined the cost efficiency and profit efficiency using the SFA method of 18 insurance companies of the non-life insurance sector in Poland in 2011-2019. The study showed that the average cost efficiency was 0.6958, and the average profit efficiency was 0.8382. During the period studied, there was relatively higher variability in cost efficiency than in profit efficiency, and low correlation between the values of these efficiencies.

Bukowski and Lament (Bukowski and Lament, 2021, pp. 502-514) examined the relationship between insurers' financial efficiency, measured by ROE, and the share of insurers' gross written premium in the total premium of the life insurance company market, the premium retention ratio and the so-called combined ratio. The subject of the study was the data of 20 life insurers in Poland, from 2004 to 2019. The authors positively verified the hypothesis that the structure of the life insurance market has a positive effect on the financial efficiency of insurers.

2. Research method and statistics

Cost efficiency is derived from a cost function in which the cost depends on the prices of production inputs, outputs, a variable modeling inefficiency, and a variable determining the impact of the random component.

The cost function of an insurance company in the frontier model was defined as follows, following Ward (Ward, 2002, pp. 1959-1968) :

$C_{it} = f\{Y_{it}, w_{it}, e_{it}\}$ (1)

C_{it}- costs of the insurance company

Y_{it} – vector of the insurance company products

w_{it}- vector of factor prices (inputs)

e_{it}- random variable expressing the impact of independent random components

i-number of the insurance company (i=1, 2, ..., N)

t- number of the year (t=1, 2, ..., T)

It is assumed that the random variable e_{it} includes the following two components:

$e_{it} = u_{it} + v_{it}$, (2)

where:

u_{it} – an independent random variable, asymmetric and positive, modeling inefficiency;

v_{it} – an independent random variable, symmetric with respect to zero and reflecting the influence of random factors and measurement errors.

The frontier model assumes that the component expressing inefficiency $[u_{it}]$ is an independent random variable with an exponential distribution; while the random variable v_{it} is an independent variable with a normal symmetric distribution (with an average equal to zero and a constant variance).

By performing a logarithmic transformation of equation (1), the following expression was obtained:

$\ln C_{it} = f[lny_{it}, \ln w_{it}] + lnu_{it} + lnv_{it}$. (3)

In determining profit efficiency, the approach of efficiency of an alternative profit was adopted (alternative profit efficiency) (Delis et al., 2009, pp.6-8; Wicaksono and Mulyaningsih, 2019, pp. 371-373), which assumes the existence of a market with imperfect competition (Ortyński and Pypeć, 2021, pp.161-163), in contrast to the approach of frontier efficiency of the standard profit used in markets with perfect competition. The alternative approach takes into account differences in the quality of services provided by insurers and in information about the prices of insurance products.

The general model of the profit function is determined by replacing the variable with the variable, which is the net profit, in equations (1) and (3) i.e.:

$\pi_{it} = f[y_{it}, w_{it}, e_{it}]$ (4)

and

$\ln[\pi_{it}] = f[lny_{it}, lnw_{it}] - lnu_{it} + lnv_{it}$ (5)

While there are no major differences in the literature with regards to the selection of production factors (inputs), the views on determining insurance production (outputs) are not unanimous. In the article, the selection of insurance outputs was guided by the reasoning presented in the study by Bikker (Bikker, 2012, pp. 9-10), i.e. for new output, the amount of y_1 was used, which is the difference between the net written premium and the cost of net insurance business, and gross profit (this output represents insurance services to new customers); while for existing customers, y_2- the amount of investments (the state of deposits) was used as output .

A translogarithmic cost function (Eling and Luhnen, 2010, pp. 1508-1509; Alhassan and Biepke, 2016, pp. 889-890) was used to study cost (and profit) efficiency. The profit efficiency model exchanges tc for net income[1] π ; the cost function took the following functional form:

$$\begin{aligned}&(\ln\frac{tc}{w_3})_{it} = \alpha_0 + \alpha_1(lny_1)_{it} + \alpha_2(\ln(y_2))_{it} + \alpha_3 0{,}5(lny_2)^2_{it} + \\ &\alpha_4 0{,}5\,((lny_1)^2)_{it} + \alpha_5(lny_1)_{it}\,(\ln y_2)_{it} + \beta_1(ln\frac{w_1}{w_3})_{it} + \beta_2(ln\frac{w_2}{w_3})_{it} + \\ &\beta_3 0{,}5\,((\ln\frac{w_1}{w_3})^2_{it} + \beta_4 0{,}5\,((ln\frac{w_2}{w_3})^2_{it} + \beta_5\left(ln\frac{w_1}{w_3}\right)_{it}\left(ln\frac{w_2}{w_3}\right)_{it} + \\ &\gamma_1(lny_1)_{it}\,(ln\frac{w_1}{w_3})_{it} + \gamma_2(lny_1)_{it}\,(ln\frac{w_2}{w_3})_{it} + \gamma_3\,(lny_2)_{it}\,(ln\frac{w_2}{w_3})_{it} + \\ &\gamma_4(lny_2)_{it}\,(ln\frac{w_1}{w_3})_{it} + v_{it} + u_{it}\end{aligned} \quad (6)$$

where:

tc- net costs of insurance activity

y_1- net written premiums minus net costs of insurance activity minus gross financial result

y_2 - the amount of investments

w_1 - price of labour and business services

w_2 - price of capital

w_3- price of debt capital

v- independent random variable, symmetrical with respect to zero and reflecting the influence of random factors and measurement errors

u- independent random variable, asymmetric and positive, modeling inefficiency

α, β, γ- parameters of model (6).

In order to ensure the linear homogeneity of the translogarithmic cost function with respect to production factor prices, a normalisation of costs (tc) (as well as profit (π) and prices (w_1, w_2) by the chosen price, in this case by w_3, was carried out.

[1] For the profit function, the inefficiency term changes in equation (6) to "-u".

The presence of inefficiency in the model is tested by the γ variance ratio, i.e. $\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$.

This ratio determines the share of the variance (variability) of the random variable u in the variance (variability) of the random variable e. This ratio takes values between 0 and 1, and values closer to 1 indicate that most deviations from the frontier (optimal) efficiency can be associated with management inefficiency. Efficiency quantities were determined using the formula (Battese and Coelli, 1995, pp. 326-327)

$$TE_{it} = exp(-\hat{u}_{it}) \quad (7)$$

where:

TE_{it}- technical efficiency

i-means the number of the insurance company (i=1, 2, ..., N)

t-number of the year (t=1, 2, ..., T)

Efficiency values are between 0 and 1, closer to 1 mean higher efficiency.

Table 1. Non-transformed primary variables in cost and profit function models

Variables	Description
tc	Net costs of insurance activity
π	Net financial result
y_1	Net written premium minus net costs of insurance activity minus gross financial result
y_2	The amount of investments
w_1- price of labour	Ratio of net cost of insurance activity to assets
w_2- price of capital	Net financial result to equity ratio
w_3- price of debt capital	Ratio of gross claims paid to gross technical provisions

Source: own work

The study used data from 22 life insurance companies in Poland between 2011-2020, included in the "Annual Reports" of the Polish Insurance Chamber (PIU) in Warsaw[2]. The companies provided their statistical data for all 10 years to the "Annual Reports" of the Polish Insurance Association (PIU) in Warsaw. The gross premiums written of the studied insurance companies accounted for more than 99%

[2] The subject of the study was the data of the following insurance companies: AEGON TU na ŻYCIE S.A., TU ALLIANZ ŻYCIE POLSKA S.A., AVIVA tunż S.A., AXA Życie TU SA, tunż CARDIF POLSKA S.A., COMPENSA TU na ŻYCIE S.A. Vienna Insurance Group, stunż ERGO HESTIA SA, TU na ŻYCIE EUROPA S.A., GENERALI ŻYCIE T.U. S.A., TU INTER-ŻYCIE POLSKA S.A., METLIFE tunżir S.A., NATIONALE-NEDERLANDEN tunż S.A., OPEN LIFE TU ŻYCIE S.A., PKO ŻYCIE TU S.A., PZU ŻYCIE SA, TUW REJENT-LIFE, SANTANDER AVIVA TU na ŻYCIE S.A., SIGNAL IDUNA ŻYCIE POLSKA TU S.A., UNIQA TU na ŻYCIE S.A., UNUM ŻYCIE tuir S.A., VIENNA LIFE TU na ŻYCIE S.A. Vienna Insurance Group, tunż WARTA S.A.

of this insurance sector's gross premiums written in 2020. The dataset used was a balanced panel of annual data.

In the study, the estimation of the parameters of the translogarithmic cost function and the profit function (Equation 6) of the SFA model, as well as the estimation of the random component (v_{it}) and the part determining the time-varying inefficiency $\hat{u}_{it}$, were performed by the maximum likelihood method using R software (Battese and Coelli, 1992, , pp. 153-169; Battese and Coelli, 1995, pp.325-332), and the efficiency values were determined from Equation 7.

In addition, Microsoft Excel was used for calculations.

Table 2. Descriptive statistics of non-transformed variables

Variables	Average value	Standard deviation	Minimum Value	Maximum Value	Number of observations
Net costs of insurance activity (thousand PLN)	238 662	244 996	1 117	1137 568	220
Net financial result (thousand PLN)	113832	324 291	-140 507	1845 811	220
Products					
y_1 -(thousand PLN)	732 709	1 144 021	519	6 875 907	220
y_2 (thousand PLN)	4 017 590	5 910 051	25 988	28818225	220
Prices of production factors					
w_1	0.131862866	0.184864921	0.003712672	1.134840602	220
w_2	0.02760051	0.627919362	-7.535	0.568083401	220
w_3	0.340372342	0.323619285	0.0009398	2.454373338	220

y_1 - Net written premium minus net costs of insurance activity minus gross financial result
y_2 - The amount of investments
w_1 - Ratio of net cost of insurance activity to assets
w_2 - Net financial result to equity ratio
w_3 - Ratio of gross claims paid to gross technical provisions
All monetary values are expressed in constant 2011 prices (deflator-CPI).

Source: own work based on KNF, PIU and CSO data.

3. Results of empirical study

In estimating the SFA model for the cost function and profit function using the maximum likelihood method, it was assumed that the random variable u_{it} is a variable with an exponential distribution.

Table 3 . Results of SFA model estimates for cost function and profit function

Variables	Parameters	Cost effectiveness			Profit effectiveness		
		Estimators	Standard deviation	t-value	Estimators	Standard deviation	t-value
Constant	α_0	-0.0954	0.0143	-6.66	-0.1903	0.0123	-15.47
$(\ln y_1)_{it}$	α_1	0.0156	2.7204	0.01	-9.5042	5.0943	-1.87
$\ln(y_2))_{it}$	α_2	-0.4464	3.5009	-0.13	-45.5685	7.3832	-6.17
$0{,}5(lny_2)^2_{it}$	α_3	-1.2271	1.1171	-1.10	0.3686	0.8478	0.43
$0{,}5\ ((lny_1)^2)_{it}$	α_4	0.6284	0.9369	0.67	-0.3865	0.4425	-0.87
$(lny_1)_{it}\ (\ln y_2)_{it}$	α_5	-0.7527	1.8721	-0.40	0.6663	0.9830	0.67
$(ln\frac{w_1}{w_3})_{it}$	β_1	1.9374	0.7382	2.62	-52.9405	4.3403	-12.20
$(ln\frac{w_2}{w_3})_{it}$	β_2	-2.8554	2.7429	-1.04	25.2081	3.4048	7.40
$0{,}5\ ((\ln\frac{w_1}{w_3})^2_{it}$	β_3	-0.1466	0.0265	-5.52	-0.1005	0.6156	-0.16
$0{,}5\ ((ln\frac{w_2}{w_3})^2_{it}$	β_4	0.1493	0.1223	1.22	-0.0258	0.0128	-2.01
$\left(ln\frac{w_1}{w_3}\right)_{it}\left(ln\frac{w_2}{w_3}\right)_{it}$	β_5	0.6700	0.7868	0.85	-25.2806	3.4015	-7.43
$(lny_1)_{it}\ (ln\frac{w_1}{w_3})_{it}$	γ_1	0.0744	0.3756	0.20	13.3852	7.3474	1.82
$(lny_1)_{it}\ (\ ln\frac{w_2}{w_3})_{it}$	γ_2	-0.4083	3.8383	-0.11	0.4845	0.2117	2.20
$(lny_2)_{it}\ \ (ln\frac{w_2}{w_3})_{it}$	γ_3	4.1165	5.4074	0.76	67.6102	11.5027	5.88
$(lny_2)_{it}\ (ln\frac{w_1}{w_3})_{it}$	γ_4	-2.2473	0.3910	-5.75	-0.2143	0.3404	-0.63
(sigma u)^2		0.0091	0.0027	3.32	0.0362	0.0064	5.70
(sigma v)^2		0.0073	0.0016	4.62	0.0080	0.0014	5.84
LR test: sigmau2=0 (inefficiency does not affect the model); H0: sigma u2=0; LR test value: 53.14 at 16 degrees of freedom with p-value: 0.99999; critical value chi2= 26.2962 at α=0.05;					LR test: sigma u2=0 (inefficiency does not affect the model); H0: sigmau2=0; LR test value: 215.916 at 16 degrees of freedom with p-value: 1; critical value of chi2= 26.2962 at α=0.05;		
log-likelihood: 138.5732					log-likelihood: 57.2552		
value of the variance parameter γ: 0.5549					value of the variance parameter γ: 0.8190		

Source: own calculations

The test statistic of the LR log-likelihood quotient reached a value greater than the critical value of the chi2 test, which means that the null hypothesis should be rejected and it can be assumed that inefficiency affected the estimators of the variables in the model.

The variance coefficients (0.5549 for the cost function and 0.8190 for the profit function) indicate that the residual component structure is dominated

by the component depicting inefficiency, which means that the study legitimately used the SFA method instead of deterministic methods.

Table 4. Average cost efficiency and profit efficiency from 2011 to 2020

Years	Cost effectiveness		Efficiency of profits	
	Average value	Standard deviation	Average value	Standard deviation
2011	0.9059	0.0684	0.8583	0.1150
2012	0.9170	0.0541	0.8589	0.1285
2013	0.9030	0.1093	0.8547	0.1116
2014	0.9006	0.0682	0.8396	0.1294
2015	0.9156	0.0582	0.8667	0.1004
2016	0.9278	0.0265	0.8678	0.1160
2017	0.8951	0.1481	0.8773	0.1036
2018	0.9182	0.0566	0.8698	0.1113
2019	0.9294	0.0445	0.8699	0.1148
2020	0.9279	0.0328	0.8025	0.2401
Average value	0.9140	0.0745	0.8565	0.1317

Source: own calculations

The average cost efficiency of 0.9194 indicates that, on average, insurers in the life insurance sector incurred more than 8% higher costs versus a benchmark insurer, i.e. using the principles of so-called best practice. On the other hand, the average profit efficiency was at the level of 0.8565, i.e. on average insurers made more than 14% lower profits than the so-called benchmark insurers, i.e. when applying optimal proportions of inputs of production factors and their prices. However, there was no clear trend of changes in the analysed efficiencies during the considered period.

Pearson's linear correlation coefficient between cost efficiency and profit efficiency was 0.0282, which means a very low correlation. This suggests that cost efficiency does not significantly affect profit efficiency. The literature indicates that revenue may have a greater impact on profit efficiency than company costs (Rogers,1998, pp. 477-482).

Due to the large differences in the revenues of the studied companies, an analysis of the efficiency differential between large and smaller insurance companies was conducted.

Table 5. Average cost efficiency and profit efficiency of large and other insurers

	Smaller companies (n=170)	Large companies (n=50)	Difference in Effectiveness	Test-u U~N(0,1)
Average cost effectiveness	0.9073	0.9371	-0.0298	u=-3.9822
Cost efficiency variance	0.0068	0.0008		x
Average profit efficiency	0.8775	0.7853	0.0922	u=2.5589
Profit efficiency variance	0.0117	0.0305		x

Hypothesis HO: average value (smaller companies) = average value (large companies); while hypothesis H1: average value (smaller companies) ≠ average value (large companies). The criterion for grouping of the insurers was gross premiums written in 2020; large companies included the following insurance companies: Aviva Życie SA, Compensa Życie SA, Nationale-Nederlanden SA, PZU Życie SA, Warta TUnŻ SA; significance level α=0.05.
Source: own calculations

The data in Table 5 above indicate higher average cost efficiency for large companies and higher average profit efficiency for smaller companies. The-u test showed statistically significant differences between average values in cost efficiency and profit efficiency between large and smaller companies, with a significance level of 5%. Relatively high cost efficiency for large companies means better utilisation of their scale of operations, which lowers their costs. This most likely indicates that mergers and consolidations, by increasing their scale of operations, contribute to increasing their cost efficiency.

Conclusions

The results of the study of the technical efficiency of 22 life insurance companies using the SFA method confirmed the hypothesis of their high cost efficiency (with an average value of 0.9140 and a variance of 0.0745, with differential variation in efficiency from year to year) and lower profit efficiency (with an average value of 0, 8565 and a higher average variance: 0.1317 , with fluctuations in efficiency without a clearly defined direction of change).

It was confirmed that the group of large insurers achieved higher cost efficiency than the group of smaller companies, suggesting that large companies achieved benefits from the scale of production. In contrast, higher average profit efficiency was recorded by the so-called "smaller" companies.

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ARTICLES

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Wiesław Łukasz Macierzyński[*], Wojciech Boczoń[**]

The impact of COVID-19 pandemic on cybersecurity in electronic banking in Poland.

Abstract
Purpose: The purpose of the article is to present both theoretical and practical basis for cybersecurity in electronic banking in Poland during the COVID-19 pandemic. During this period a major reorganisation of IT solutions occurred, which allowed to extend the range of online products and services offered both to bank customers and employees. As our life is more and more dependent on digital technologies, cyber attacks have become more costly and more dangerous. Driven by dynamic technological development regulations have changed, which resulted in cybersecurity becoming a key priority in financial institutions.

[*] DSc Wiesław Łukasz Macierzyński is a Professor at the University of Technology and Humanities in Radom, a graduate from the University of Warsaw, the Head of the Chair in Economic Politics and Banking at the Faculty of Economics and Finance at the University of Technology and Humanities in Radom. He is the author of 80 publications (including 11 monographs) covering the areas of banking, investor relations, public relations, advertising, marketing and management. He is a co-founder and a long-time member of the Review Committee of Polish Business Ethics Association – EBEN Poland.

[**] MA Wojciech Boczoń a graduate from Melchior Wańkowicz Higher School of Journalism in Warsaw, and Maria-Sklodowska Curie University in Lublin. He is an author of hundreds of publications covering the areas of personal finance, banking, and cybersecurity. He is the leading editor of PRNews.pl portal, an analyst at Bankier.pl, a journalist for Puls Biznesu newspaper (pb.pl), the winner of the Journalist of the Year 2013 Award, granted by the jury of the competition held during the 9th Congress of Electronic Economy organised by the Polish Bank Association (ZBP). Nominated twice, he is the winner of the Marian Krzak Journalist Award for the year 2014. He is also a finalist of Economic Journalism Award in 2019, organised by Press Club Polska.

All the more so because the rapid technological development has been followed by more and more advanced techniques used by criminals searching for easy financial profits.
Methodology: The paper uses the method of literature review - mostly electronic sources, descriptive and comparative analyses
Findings: From customers' perspective, the impact of COVID-19 pandemic on cybersecurity in electronic banking in Poland may be recognized as negative. The years 2020-2021 brought a dynamic growth in the number of digital banking customers, especially mobile banking. In those years financial institutions recorded an enormous increase in online payments, which was the result of strong, forced by the pandemic, surge in sales in E-commerce. At the same time, there was a sharp rise in the crime rate targeted at banks, but most of all, at bank customers. While the security of the very financial institutions remained unthreatened, there was an explosion in the number of cybercrimes targeted at E-banking users, with the losses giving dozens of millions PLN in total. That is reflected by the data provided by the National Bank of Poland, numerous complaints to the Financial Ombudsman, the Office of Competition and Consumer Protection, as well as the police investigations.
Practical implications: The analysis of relations between theoretical and practical bases of cybersecurity in E-banking in Poland during the COVID-19 pandemic is a key factor for financial institutions. Cybercrime undermines customers' trust in E-channels and therefore negatively influences how banks are perceived, the level of the users' activity in digital channels, and consequently, activity and sales in E-channels. Besides the image and financial risks, banks need to take into consideration the increase in reputation, operation and legal risks. On these grounds, it is possible for state organisations and financial institutions to develop professional education concerning cybersecurity, not only for E-banking customers, but for the whole society.

Kewords: Cybersecurity, cyber threat, ransomware, phishing, smishing, vishing, spoofing, malware

Paper type: Research paper

Introduction

E-banking allows to manage completely both personal and business finances. With a use of a computer or a smartphone, it takes bank customers just a few minutes to open a bank account, apply for complex deposit and credit products. All these operations can be carried out either by the customers themselves, or with remote support of bank staff via a video conference or a text chat. Using chatbots for simple operations is becoming more and more common. A chatbot is a software application designed to conduct an online conversation with a human in a natural language. Chatbots, in a programmed and self-learning way, automate customer support and handle frequently asked customers' questions. In most cases, not only can E-channels replace conventional departments, but also offer a range of additional e-services which are not available in traditional distribution. More and more banks are announcing plans for digitalizing processes of purchasing and servicing more complex products, e.g. the process of granting mortgages. Customers are quickly getting used to purchasing other financial products like insurance, leasing, factoring, but also products which are more loosely related to finances, such as bus tickets, parking fees, motorway tolls, or gitf-cards. All these operations are more and more frequently performed with a smartphone, which in many cases, has become the main distribution channel, as can be contributed to sales of more than a half basic financial products. Smartphones, and even intelligent watches are more and more replacing traditional, plastic paycards.

The rapid development of E-banking is a result of trying to increase the effectiveness measured by, standard for a bank sector, financial indicators – ROA (return on equity) and ROE (return on assets). It is also one of the main factors which influences the universal for all sectors measure of costs level (C/I – Cost to Income). It shows the relation between income and the cost of acquiring that income. Both natural and supported adoptions of E-channels allow to reduce costs quickly, which in the service sector is connected mainly with staff costs. Therefore, the more customers use e-banking, mobile banking and paycards, the more bank branches are closed. This phenomenon is mostly observed in Western Europe, but pandemic increased the pace of this process, which has been in progress since the beginning of 21st century [DW, 08.06.2021].

The worldwide phenomenon of adopting e-banking by retail customers and MSP appears both in Poland and European Union, which is reflected by statistic data. While at the end of 2006 in Poland there were 4.3 million of e-banking users [Związek Banków Polskich, 2010, p. 5], in the second quarter of 2022 the number of users was five times bigger – over 21.6 million ! [Związek Banków Polskich, 2022, p. 6]. Over those 16 years another technological revolution emerged. During this time an absolutely new

channel of bank distribution appeared – mobile banking using mobile applications. In 2006, customers generally did not use mobile phones for bank services. The first mobile application was introduced in Poland in 2009 by now-defunct Raiffeisen Bank Polska [Macierzyński, 06.03.2009]. The application worked only for certain telephones, those operating on system Symbian OS or MS Windows Mobile. Along with the rapid growth in the number of smartphones, other banks subsequently introduced mobile applications into their offer, which resulted in a significant increase in the number of mobile banking customers – 18 million at the end of the second quarter of 2022. While the number of e-banking customers remains stable, the number of users of mobile banking is increasing rapidly. Another important phenomenon is the appearance of the so called 'mobile only' group of customers. Their contacts with the bank rely exclusively on a mobile phone, and only in exceptional situations either use e-banking or visit a bank branch. According to market data, in 2022 there were nearly 13 million of such customers[Boczoń, 09.11.2022].

Along with the growing number of e-banking customers, the importance of these channels increased – not only in the ongoing customer service, but also in the sales of banking services and products. It can be observed with one of the most profitable, high-interest products – cash loans for individual customers. In 2019 sales of these loans in e-channels constituted a significant share - 20-40% of all cash loans sales in Polish banks [Frączyk, 12.10.2019]. Market leaders sold more than a half of loans via e-channels [Bank Millenium, 20.10.2019]. In 2022 the number of loans sold via e-channels constituted on average more than 50%, and in case of the most digital banks, nearly 90% [ING Bank Śląski S.A., 4.08.2022].

The growing importance of e-channels significantly influences changes in using payment services by bank customers. More and more often, the customers are replacing cash with cashless instruments – not only paycards, but also mobile and Internet payments [Maison, 2021]. The number of issued paycards in Poland is growing dynamically. According to the data provided by Narodowy Bank Polski, by the end of the second quarter of 2022 banks had issued nearly 44 million of paycards, including 39 million of paycards for individual customers. The largest group are debit cards – 36.7 million, followed by credit cards – 5 million. In the same quarter, individual customers (96% of all transactions) made with paycards over 2.2 billion cashless transactions, worth over 150 billion PLN [NBP, 2022a]. The statistics provided by Narodowy Bank Polski take into account also technological changes. Currently, over 96% of all issued paycards allow contactless payments. At the same time, however, card payments are more and more frequently made in a digital way, i.e. with a mobile phone, or other devices with a tokenized paycard number,

such as watches, wristbands, etc. According to market data, more than 20% of paycards on the Polish market have their digital counterpart in the form of the most popular systems, i.e. Apple Pay, Google Pay or HCE [Sikorski, 26.08.2022].]. Also, there is a growing number of alternative forms of payments on the Internet or in physical shops, with BLIK, a solution offered by Polski Standard Płatności (Polish Payment Standard – PPS) being the best example. In 2022 over 11 million customers used this solution [Sikorski, 24.08.2022]. Just only in the second quarter of 2002 there were made 292 million transactions worth nearly 40 billion PLN. Customers use BLIK mainly on the Internet (57% of all transactions), payment terminals (14%) and for cash deposit and withdrawal (4%) [NBP, 2022b]. The popularity of this method of payment is strictly connected with the growing number of Internet payments, which is closely related to the increase in sales in E-Commerce during the pandemic [PWC, 11.07.2022]. At the end of 2021 the most popular with Polish customers payment methods were BLIK, online transfers (PayBy-Link) and paycards. In the Tpay survey conducted by SW Research Agencja Badań Rynku i Opinii (Market and Opinion Research Agency) 70% of the surveyed chose BLIK as their favourite method of payment. As for the online transfer and paycards the numbers were 38% and 34% respectively. The particular choice of a payment method actually depends on the availability of payment methods in a given Internet shop. However, even then, Polish customers usually will choose payment by BLIK [Tpay, 2022].

1. The increase in cybercrime during the COVID-19 pandemic

The global COVID-19 pandemic has dramatically increased the speed of digital transformation of companies, and had considerable influence on customers' shopping preferences. Years 2020-2021 brought a rise in the number of customers using mobile banking, and mobile payments such as BLIK. While at the end of 2019 there were 12 million mobile banking users [Związek Banków Polskich, 2020], two years later there were already 16.5 million of them, which meant an almost 40% increase. At the end of the second quarter of 2022 mobile applications had already 18 million users. At the same time, there had been a rise in the number of transactions made by BLIK – from 72 million in the fourth quarter of 2019, to 240 million two years in the same quarter, which meant a 330% increase! A little less spectacular growth occurred in a similar time in case of other Internet payment instruments. The Pay-by-link-like payments had risen by 21% - from 79 million to 96 million transactions, and paycards – 44% - from 33.7 million to 48.8 million transactions. The above given data prove that Polish citizens willingly use modern forms of payments,

which places Poland among the most developed in this matter countries in European Union [Marciniak, 2020].

The development of modern E-banking services and a fast inflow of less experienced customers have contributed to the occurrence of negative phenomena, among which the rapid growth of cybercrime is of the biggest importance. A larger number of users and remote transactions in connection with fast methods of transferring stolen funds led to a rapid increase in the crime rate and attacks on users of digital banking. Those activities increased especially during the COVID-19 pandemic, which is since the beginning of 2020. The fact that transferring stolen funds, cryptocurrencies included, from Poland abroad was very easy also contributed to the situation. According to the data provided by the Police Headquarters, in 2021 there were recorded 14,500 crimes related to e-banking and phishing (art.287 of the Criminal Code). For comparison, in 2020 – the number of them was 6700, in 2019 – 6300, in 2018 – 3600, and in 2017 – 1800. The data from the first three quarters of 2022 indicated a growing tendency (over 15,000), similarly the number of unique cybersecurity incidents recorded by CERT Polska. In 2021 there were recorded 29,500 incidents, in total, which meant 182% growth in comparison to the previous year, whereas by December 2022 the number had reached more than 37,000 [Wittenberg, Rutkowska, 19.12.2022]. The data provided by the Police include exclusively information about ascertained cases, not taking into account those that are still being investigated. Also, not all cases are obligatorily recorded within the e-banking or phishing categories.

The Financial Ombudsman also connected the growing number of crimes related to bank thefts with the COVID-19 pandemic, emphasising it is the most common reason for complaints of financial market customers concerning breaching the Act on Payment Services of 19th August 2011 [Rzecznik Finansowy, 29.07.2021]. It is confirmed by the data regarding the number of complaints to the Financial Ombudsman Service [PAP, 09.09.2021]. The issue of unauthorised transactions frequently appeared in the interventions conducted by the Financial Ombudsman in years 2020 -2022. He also pointed out new types of cyber attack, including the problem of customers robbed by means of the ‘Click Loans’ [Rzecznik Finansowy, 20.04.2022]. While a few years ago criminals focused on attacking customers who possessed considerable funds on their accounts, nowadays, due to a rapid technological development, also those customers who have borrowing power fall victims more and more frequently. The Internet or a mobile application makes it possible for a customer or a thief who has stolen their identity, to take out, almost automatically, an even several-thousand loan in just a couple of minutes. Then, the money is quickly transferred out of the bank.

The number of such crimes increased steeply in the years 2021-2022. This is confirmed by the data provided by Narodowy Bank Polski. The explicit conclusion based on the data is that most of them is reported neither to the police, nor to the Financial Ombudsman. It is so despite considerable amounts being stolen. An average worth of a fraudulent transaction was 3670 PLN in the second quarter of 2022, and was 23% higher compared to the previous quarter. According to the statistics collected by NBP, based on the data provided by banks, in the fourth quarter of 2019 there were 3007 fraudulent orders. Two years later, the number of such operations increased four times – to 12,034, reaching the number of over 18,000 in the first quarter of 2022. Similarly to the number of fraudulent transactions, NBP reported a high rise in the worth of such operations - from 12 to 41 million PLN comparing the fourth quarter of 2019 to 2021. The given data does not include fraudulent transactions made by paycards, whose number is significantly higher – over 60,000 operations quarterly. However, in this case, the number remained on a similar level in the years researched, and during the very pandemic period even dropped [NBP, 10.2022]. Nevertheless, the quoted data lead to an explicit conclusion that in this period attacks on E-banking users increased. This data is confirmed by the report published by CSIRT (Computer Security Incident Response Team) operating by the Office of the Polish Financial Supervision Authority. The report states that in 2021 nearly 11,500 Internet domains were identified and marked as dangerous, so that the access to them should be blocked. That number comprised almost 4,000 fake advertisement sites, 3,000 – courier services, over 2,200 – fake investments, over 1,000 – banks, over 300 – fake payment gateways. Besides, there were reported over 900 websites that should be blocked, which were classified as ‘other’ [Boczoń, 13.01.2022].

3. New scenarios of attacks on customers of banks and financial institutions

The growth in the Internet activity of bank customers is used by criminals who constantly work on new methods of attacks. For many years, ‘phishing’ and its various mutations have been the major threat to the users. The notion ‘phishing’ is a combination of two English words – ‘password’ and ‘fishing’, and means tricking someone into giving sensitive data, e.g. passwords. This fraudulent technique is a form of fraud in which an attacker masquerades as a reputable entity. An unaware user is substituted a fake Internet site for the original one, which are deceptively similar. The only difference is the text in the address bar, which is usually imperceptible, especially for those less alert bank customers. Sometimes they differ only in one letter, or one word. A common strategy is making use of similar Internet domains. The fraudsters masquerade as banks

or other reputable entities sending out fake emails to randomly chosen customers. On the pretext of blocking the bank account or an alleged cyber attack on the bank, they request an urgent logging in E-banking. Next, they provide a fake site, where the user enters sensitive logging in data, which are taken over by the fraudsters. Fraud methods evolve, which is influenced mainly by applying new security measures in E-banking. In the first decade of 21st century attackers using phishing asked customers for the login and the password to the account, and a few codes from the card with one-time pass-codes. These data allowed to log in to the system, and transfer money to the provided account. When PSD2 (The Revised Payment Services Directive) came into effect, it practically eliminated this method of authorisation [Deloitte, 20.09.2019]. One-time passcodes from the card of passcodes were replaced by text messages with codes connected with the operation in progress. The next step taken to increase customers' security was introducing mobile authorisation using the bank mobile application. In both cases, it was a smartphone which became a necessary device to authorise bank operations. This is the reason why currently, more and more attacks on clients are aimed at taking control over a mobile device [Boczoń, 20.01.2019].

The focus on remote attacks on smartphones could be clearly observed during the pandemic, when criminals impersonated official state applications for detecting threats. Analysts of CSIRT (Computer Security Incident Response Team) operating by the Office of the Polish Financial Supervision Authority gave the attack on the mobile application ProteGo Safe as an example. The fake version supposedly was to diagnose the user with the COVID-19 by the means of cough recording. In fact, it was malicious software (malware) Black Rock, which once having been installed on the device, was able to overlay bank applications. Activities like that were targeted at taking over sensitive data entered on the telephone screen [KNF 09.02.2021]. Another example was a website which looked like the official Google Play shop, from which an unaware user could download a fake application 'Home Quarantine'. The malicious application made use of being given an easy access to the telephone, provided the users with a fake login panel for E-banking [Zagańczyk, 05.02.2021]. The attackers infected a telephone mostly by the means of 'smishing' – a mutation of phising. The criminals used text message campaigns to send out links directing to the infected websites. Analysts of CSIRT by the Office of the Polish Financial Supervision gave as an example fake text messages about sending to home quarantine. The sent link redirected the users to the Cerberus Trojan, which infected the telephone. According to cybersecurity experts, smishing attacks became so common due to the fact that users trust text messages received on their phones much more than e-mail messages.

[Trendmicro, 2022]. Also, it is relatively easier for criminals to obtain a mobile phone number than an e-mail address. The thieves send out text messages to random 9-digit numbers from the Office of Electronic Communications register [UKE, 2022]. The reason why such attacks are so effective is, among others, that 98% users reads text messages, and 45% replies to them. For comparison, in case of e-mails, the numbers are 20%, and 6% respectively [Cote, 4.10.2019]. An attack by a text message may occur in a different form, especially when combined with various sociotechniques. A common form of an attack, resulting in customers' financial losses, were impersonating courier companies, parcel lockers operators, energy or gas providers, etc. In such cases, criminals requested surcharges for shipment or an electricity bill. Along the links directing to fake websites or infected software, it is common to provide a telephone number to a fake bank representative requesting an urgent contact.

A dangerous variant of 'smishing' occurred during the pandemic – tricking victims into handing over money by the means of social media. During the pandemic BLIK frauds became very common. The criminals took over accounts on Facebook, then using the Messanger communicator linked to the account, requested the victim's friends for an urgent loan. The scammers asked for a BLIK code to withdraw money from an ATM, or having given their telephone number, had the money transferred to their telephone. Another type of massive attacks via social media were attacks on users of advertisement portals, e.g. OLX.pl, Vinted, Allegro Lokalnie. Scammers used a user's phone number to redirect the chat from official channels to outside communicators, such as, popular in Poland, WhatsApp. Pretending to be interested in goods on sale, they sent out fake links directing to pay for the courier who had been sent by them. In fact, those were fake payment gateways. The templates the victims were provided with had been thoroughly designed, and the cyber criminals came into possession of all the data which had been entered, in real time. [Policja.pl, 23.09.2021]. Having accessed these date, the criminals made Internet transfers, payments by the victims' paycards, and even installed on the victims' behalf mobile applications, which gave them full access to the customer's finances. In such cases, not only did the customer lose all their money, but also fell victim of a cash loan taken on their behalf. The criminals most commonly used the popular with customers payment system – BLIK. The targeted attack on users of this service may serve as an example. The criminals sent text messages to random numbers informing about an alleged transfer from an unknown receiver, with a link directing to a fake bank website. The receiver of the message, having entered the data, shared sensitive information with cybercriminals, and as a result, lost their money [Konieczny, 31.01.2022].

Another dangerous variant of phishing, which intensified during COVID-19 pandemic, became 'vishing' – voice phishing. It was especially dangerous when combined with the so called 'spoofing' (the proper name of this attack is CallerID Spoofing). The attacks are made by the means of telephone calls when criminals disguise their identity so that it appears that the incoming call is from a financial institution, and the caller is a bank representative. Spoofing is a situation in which a person successfully identifies as another telephone number, including a bank help centre, or even the police. The receiver of the call being convinced they are talking to a bank representative, share with them all sensitive data. This is how the scammers gain information which allows them to log in to the victim's bank account. Another variant of this attack is installing common software for screen sharing. Having installed this type of software, the criminals make their unaware victims perform operations. This kind of cyber attack is extremely dangerous, as spoofing does not require advanced hacker techniques. Assuming identity of another number is possible thanks to numerous Internet portals which, for little fees, give the ability to control the Caller ID on all calls and texts. Even though this type of services has to be paid for, they may be used anonymously, e.g. using crypto-currencies for payments. This way makes it harder for the police to detect the culprits. This problem has become so common, that state institutions in collaboration with the Office of Electronic Communications have taken measures to limit it, drafting a Bill concerning fighting malpractice in electronic communication [KPRM, 12.2022]. The suggested solutions aim to create appropriate laws to take action within preventing malpractices in electronic communication by telecommunication entities, and consequently, limit the scope of the malpractices and ensure security of the attacked users.

The weakness in the infrastructure of telecommunication entities is not the only way used by criminals to rob bank customers. Another example is massive using of automatic advertising systems of the biggest technological companies such as Google and Facebook. According to British banks, as much as 75% of their customers' loss was linked to advertisements displayed on the websites connected with the biggest search engine in the world, advertisements on Facebook, or advertisements on dating or e-commerce portals [Finextra, 25.07.2022]. As a result of no effective action taken by such companies, graphic advertisements using the image of renowned companies, people or media appear on sites of the biggest information portals. In this way, criminals gain a wide range, which could not be accessed in a traditional way. They make use of the image of the medium on which the fake advertisement appears. Automating advertising systems leads to practically no control over the content of the advertisements. However,

both Google and Facebook require their users to report suspicious advertisements, shifting the cost on entities which fell victims to fake advertisements, fake sites, but still keeping the profits gained from publishing this type of advertisements for themselves. Users, misled by fake information spotted on websites of the biggest Internet services in Poland, being convinced they invest in shares or crypto-currencies, lose their money. This type of attacks, besides the sociotechniques used by criminals, may not have worked without the use of tools offered by Google or Facebook in order to reach millions of unaware victims.

4. The increase in the number of attack on state and financial institutions during the period of COVID-19 pandemic

Over the years 2019-2021 the increase in cyber attacks concerned also the government administration, but also corporate customers, banks included. The pandemic resulting in the necessity to organise work online has posed a challenge as for the security, as companies became more vulnerable to cyber attacks. It increased the necessity to implement improvements within crisis management, ensure the continuity of operating, but also increase the funds for cybersecurity. The results of research conducted by the European Union Agency for Cybersecurity (ENISA) show that a threat to cybersecurity in European Union has impact on sectors which are crucial for a society. Those who suffered from cyber attacks most were: public administration/ the Government, digital services providers, society in general, healthcare/medicine, and finances/banking [PE, 27.01.2022]. The fast digital transformation, which was enforced by the new situation, triggered new attack vectors. Cybercriminals, taking advantage of the COVID-19 pandemic, targeted particularly at institutions and companies whose employees worked online. According to KPMG – a global network of professional firms providing audit, tax and advisory services, 55% of the surveyed companies in Poland claimed that the outbreak of the pandemic contributed to the increase in the risk of cyber attack. In 2020, as many as 64% of companies had recorded minimum one incident of breaching security. That meant a 10% increase in comparison to the previous year. In the same year 19% companies recorded an increase in cyber attack attempts; whereas only 4% of the surveyed claimed the number had dropped. According to the surveyed, data leak with the use of malware posed the biggest threat, and phishing was placed on a similar level. On the other hand, the least risky cyber threats were: breaking into mobile devices, attacks making use of application errors, and attacks on wireless networks [KPMG, 12.2022]. However, according to the report prepared for Volkswagen Bank GmbH Branch in Poland, as many as 16% of domestic companies had been a target of a cyber attack. Phishing attacks were most frequent – 54%. Ransomware

attacks constituted 7% of total attacks. The consequences of the attacks were listed as: the necessity to suspend the company's operating putting some company processes at halt – 10% of the companies surveyed, data breach or loss – 3%. The remaining 13% chose other answers [PRNews, 18.11.2021]. In case of Polish banks, the most common cyber attack method, especially after the Russian invasion on Ukraine, were DDoS attacks. According to the statistics provided by the Polish Financial Supervision Authority (KNF), the number of such attacks especially increased in 2021 – there were 500% more of them than the year before [Marszycki, 23.02.2022]. In fact, it meant that during this time an average company from the banking-financial sector in Poland was a target of a cyber attack almost one thousand times a week [Duszczyk, 23.02.2022].

According to companies which provide advisory services, from the global perspective, ransomware poses the biggest threat [Morgan, 21.10.2019].This type of attack is a form of a malware that locks the user out of their files or their device, then demands a payment to restore access. It is estimated that in 2021 global losses caused by ransomware may have reached as much as 20 billion USD.

5. Actions undertaken by banks and state administration in order to decrease the number of cyber attacks

During the COVID-19 pandemic, state administration, including the Polish Financial Supervision Authority and the Office of Competition and Consumer Protection were in charge of the issue of cybersecurity. In February 2021 the Chairman of the Polish Financial Supervision Authority in the letter addressed to the banking sector emphasised that financial services providers are obliged to follow the policy 'security first'. In fact, it meant that the issue of security was to be given priority over any other issues [Boczoń, 16.02.2021]. While introducing new services, financial institutions should take into consideration current attack tendencies, methods used by cybercriminals, but also potential risks connected with the provider's planned activities, not only in relation to the customers, but also in relation to the potential impact of those activities on the entire sector of banking services.

The KNF Chairman's letter is an example of the so called 'soft' recommendation. Although, unlike recommendations which are issued by the KNF Authority, it was not binding on banks, in fact it is of similar importance. It is a proof of how important the issues of cybersecurity and education are. Most institutions react to new forms of attacks on a day-to-day basis, informing their users by placing appropriate announcements and alerts on their websites. According to KNF, those activities are not sufficient, they do not bring expected effects, which is reflected by the scope of successful attacks on users

of bank services, and the level of frauds related. The KNF take the view that banks should not focus on their customers exclusively, but they should rather run a broad campaign connected with cybersecurity [Forsal.pl, 15.02.2021].

In 2021, the President of the Office of Competition and Consumer Protection initiated explanatory proceedings in order to examine how banks deal with customers' complaints connected with money thefts from bank accounts, and also what authentication methods they use. Eighteen banks were summoned to present explanations and documents related to this type of cases [UOKiK, 19.07.2021]. The reason for this action was a gradually growing number of consumers' complaints connected with money thefts from accounts, or financial obligations resulting from an identity theft. The customers reported to the Office of Competition and Customer protection problems of losing their savings, and banks rejecting the complaints. The very notifications concerned scammers pretending to be bank Help Line employees, using fake website of the bank, or using spy software in order to obtain data. The explanatory proceedings concerned, in fact all the biggest commercial banks in Poland. The evidence collected over a year allowed to bring a charge of infringing collective interests of consumers against five banks. During the explanatory proceedings, the President of the Office of Competition and Consumer Protection established that banks could have misled their customers responding to complaints concerning unauthorised transactions. It is extremely important, as for infringing collective interests of consumers, the banks may be imposed a fine of up to 10% of its turnover. [UOKiK, 18.07.2022]. At the same time, at the beginning of 2022, the Office of Competition and Consumer Protection launched a countrywide social campaign 'If you lose your data, you will lose your money!' It also warned against the attempts of money and data thefts. [UOKiK, 05.12.2022].

Conclusions

During the COVID-19 pandemic cybercrime in Poland significantly increased. This fact is confirmed by the data provided by Narodowy Bank Polski, supported by numerous customers' complaints to the Financial Ombudsman, to the Office of Competition and Consumer Protection, and the number of cases investigated by the police. The analysis of those cases shows a huge dynamic of the crime increase. Banks did not manage to handle the increased number of cyber attacks. It posed a serious challenge, as it is difficult to introduce security measures against new types of attacks, even more because criminals used sociotechniques combined with 'spoofing'. On the other hand, state institutions, the Polish Financial Supervision Authority included, often took action too late,

and did not take into account the market context. Financial institutions started to put more emphasis on cybersecurity education. However, the growing number of cybercrimes is a proof that the actions taken have not brought the desirable effects. Banks undertook those actions not only because of the growing financial losses, but first and foremost, because of the rising risk of reputation loss, including the rise in image risk, the rise in operation risk and the rise in legal risk.

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