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SUICIDES FOR ECONOMIC REASONS AS A MEASURE OF THE STATE OF THE ECONOMY: THE CASE OF POLAND

Abstract. Suicides are a phenomenon observed in many countries. The causes of a decision so drastic as far as the consequences are concerned include i.a. economic reasons. The question arises whether the changing number of suicides reflects the state of the economy. The direct link between the state of the economy and suicides has not been sufficiently studied so far. The authors of this article attempted to identify the links between selected economic indicators and the number of suicides using statistical and econometric methods. The end result is a description of the connection between indicators determining economic tendencies and suicides for economic reasons. Finding such a connection constitutes an alternative, much cheaper method of assessing the tendencies (climate) of the economy compared to the methods used currently by the Central Statistical Office in Poland or the Ipsos company. In addition, the results of the study allowed to propose an original linear regression model taking into account new variables, compared to the available studies of other authors. The authors' model is an expansion of rather modest scientific discourse on the impact of the economy on the number of suicides.

More than 10 years have passed since the beginning of the global financial crisis. In the years 2008–2009, Poland was considered to be 'a green island', i.e. the only country in Europe that did not experience a decline in GDP. The image of this country from the perspective of the consumer looks very different. The increasing number of suicides for economic reasons prompts the analysis of the reasons for this kind of decision. There are relatively few available research papers that would illustrate the link between the state of the economy and the phenomenon of suicides. The authors of this publication, using statistical methods (statistical description and statistical inference), attempted to link the number of suicides for economic reasons to selected economic indicators. The result of the research was the indication of an alternative method for the measurement of selected economic tendency indices of the Polish Central Statistical Office and the Economic Climate Indicator published by Ipsos Polska Sp. z o.o. [1] In addition, a single-equation linear regression model was proposed which not only explains the association of selected indicators describing the condi-

[1] The Ipsos Polska Sp. z o.o. company is part of the international Ipsos institution which operates in 84 countries.

tion of an economy with the phenomenon of suicides but can also serve as an early-warning indicator of future suicides.

Keywords: suicides, suicide warning model, suicides for economic reasons, economic climate indicator, economic tendency index

Formulas: 10, tabl.: 4, fig.: 1, bibl.: 71

JEL Classification: E20, I31, J17

Introduction. Until 1989, Poland was ruled by a Communist regime which imposed centrally controlled economy, commonly referred to as the economy of scarcity. Since 1990, the democratic system and the free market economy are present. It would seem that in an economy that provides much more goods and services consumer concerns about the quality of life should be minimized. Meanwhile, the recorded number of suicides for economic reasons in 2000 amounted to 416 cases, while in 2014 it reached 554 cases [Kronenberg, Boehnke 2019; Cyfert, Chwiłkowska-Kubala, Szumowski, Miśkiewicz 2021; Czyżewski, Matuszczak, Miśkiewicz 2019]. The increase in this phenomenon by 138 cases (over 33 per cent) over 14 years seems disturbing, especially in view of the fact that since 2010 the number of suicides for economic reasons has risen on average by 12 per cent a year.

The authors of this paper have asked themselves how the number of committed suicides changed (and what it depended on) during the studied period, as well as whether the condition of the economy affects the number of suicides committed for economic reasons – and if so, how.

In connection with the research problem, the adopted main objective of the study was to evaluate the correlation between the number of suicides for economic reasons or for the reasons of a sudden loss of livelihoods and the selected economic indicators: tendency indices (business tendency index, trade tendency index, retail trade tendency index), macroeconomic indicators (GDP growth rate, unemployment rate) and consumption indicators (the number of new car registrations and the consumption of spirits and beer). The existence of a statistically significant correlation between the tested variables would not only confirm the results of the various studies conducted so far in different countries in relation to some of the variables but also extend the research into the causes of suicide (the suicide theory) by new indicators for the statistical data from Poland. The additional aim of the study is an attempt at building an original econometric model describing the variability of the number of suicides for economic reasons using selected economic indicators. In order to achieve the above objectives, as an introduction to the study the shaping of the consumer behaviours, the essence of the suicidal behaviours, as well as the background research on models that explain the variability of the number of committed suicides and the suicide rates in various countries of the world were presented. Subsequently, in order to compare the levels of world suicide rates, the total suicide rates per 100 000 inhabitants in Poland and selected OECD countries were presented. Next, the results of statistical data analysis (time series analysis) of the total number of deaths, the total number of suicides, the number of suicides for economic reasons and the number of suicides caused by a sudden loss of livelihoods in Poland in the period 2000–2014 were presented. Then the results of the analysis of the correlation between the number of suicides (for economic reasons and caused by a sudden loss of livelihoods) and the examined economic indicators were presented. Finally, based on the authors' own research, an original econometric model (single-equation linear regression model with multiple explanatory variables) was proposed for the number

of suicides for economic reasons. The statistical data used in the publication come from a secondary material published by the Police Headquarters and the Central Statistical Office in Poland and the OECD in the years 2000–2014. The statistical methods used in the study are methods of statistical description and methods of statistical inference. The statistical calculations were performed in the Microsoft Excel 2016 spreadsheet, in the STATISTICA 12 statistical package, as well as in the open-access GRETL 2000 econometric package.

Shaping of consumer behaviours. The analysis of the economic aspects of human behaviour is the subject matter of behavioural economics [Tyszka 2004, p.26]. Its basic premise is the rationality of human behaviour[2]. The theory of expected utility of J. von Neumann and O. Morgenstern was the first attempt at ordering the rules of rational behaviour of individuals [Becker 1990]. However, the assumptions made regarding the making of purchasing decisions started to become more complicated. Theories were put forward that did not abandon the postulate of rationality but noted that individuals are not able to easily recognize the possible actions available in a given situation. This also concerned the potential consequences of the decisions under consideration [Edwards 1953, pp. 349–364; Edwards 1954, pp. 380–417][3]. The first to develop the concept of limited rationality was Herbert Simon. He noted that people do not always make decisions in an objective and rational way [Melnychenko 2020; Simon, 1983; Simon, 1955, pp. 99–118; Furmaniak, Gauden, Leżańska, Miśkiewicz, Błajet-Kosicka, Kowalczyk 2019]. This concept was developed by Gerd Gigerenzer, who discussed the so-called adaptive rationality. According to it, people behave in a way that has evolved in an evolutionary way, adapted to the environment [Gigerenzer & Hoffrage, 1995, p. 102].

The behavioural economists began to show differences between the actual behaviour of individuals and that forecast by the commonly used models of rational behaviour [Fryman, Goldberg 2009, p. 11]. An explanation of this phenomenon was supposed to be human nature, characterized by emotions, insufficient ability to predict future and limited ability to process data [Barberis, Thaler 2003; Kharazishvili, Kwilinski, Dzwigol, Liashenko 2021].

The psychologists and economists who study the role of emotions in the decision-making process found that feelings and emotions can influence decision-making processes [Loewenstein, Weber, Hsee, Welch 2001, pp. 267–286; Slovic, Finucane, Peters, MacGregor 2002; Gilovich, Griffin, Kahneman 2002, pp. 397–420]. Some even think that, unlike rational thought, emotions are the direct cause of action [Hill 2010, p. 108]. Studies show that the decisions taken can strongly depend on current emotional states of individuals [Dowling, Lucey 2005, pp. 211–237]. A situation is therefore possible where emotional perceptions first diverge from the rational and logical explanation and then dominate the decision-making process. The more complex and uncertain the circumstances of decision-making situation are, the stronger is the influence of emotions on the decisions taken [Forgas 1995, pp. 39–66]. The emotions accompanying choice-making are therefore important. The mood of a person can be influenced even by weather. Over the last decades, the influence of sun on decision-making has been well documented. Its absence was associated with depressions and even suicides [Nofsinger 2006, p. 185].

When economists speak of economic behaviours, they usually use terms such as profit, loss, rate of return, cost or risk. Obviously, all these quantities are expressed in monetary

[2] Garry Becker claims, for example, that the assumption of rationality is a definitive feature of economics.

[3] The publications on research into the real behaviours of decision makers, including the unreasonable ones, are the merit of Word Edwards.

terms [Tyszka 2004, p. 82]. In one study, however, the authors concluded that two of the seven dimensions that represent the differences in attitudes that people take towards money, are [Wernimont & Fitzpatrick 1972, pp. 248–261]:

- lack of money as a symbol of life's failure,
- sense of security provided by having money.

It can be inferred from this that the deterioration of a consumer's financial situation (such as job loss) should have a significant negative impact on their emotional state.

Earning or spending money often means that human action is influenced by unconscious motives and aspirations [Osadcha, Melnychenko, Spodin 2021]. The appearance of economic activity may hide the attempt to reduce emotional conflicts and hidden fears [Tyszka 2004, p. 188]. Depriving a person of a shopping experience can be perceived as preventing them from suppressing these fears. This is confirmed by studies of consumer sentiment, which show convergence between changes in Gross Domestic Product, household income, wages and a number of other variables describing the economy [Drozdowicz-Bieć 2011, p. 95; Dźwigoł 2021a; Shkodina, Melnychenko, Babenko 2020]. It can be imagined that in the case of an economy of a country that is currently experiencing a long recession, with media reporting lay-offs, poor sales of consumer goods, bankruptcies and other manifestations of hard times, optimism is lacking in economic forecasts. In such circumstances, most people may feel depressed. The conviction that the economy will not start to function better in the near future or that the improvement will be relatively small at best will become more and more frequent [Dzwigol 2021b; Pring 2006, p. 107]. Moreover, it was observed that negative changes of economic nature exert a stronger negative influence on consumer sentiment and opinions than positive changes of the same value [Drozdowicz-Bieć 2011, p. 106]. Another matter that needs clarification is the essence of suicidal behaviours.

The essence of suicidal behaviours. According to data released by the International Health Organization, more than 800,000 people commit suicide each year worldwide[4], and in the last 45 years the rate of suicide has increased by 60 percentage points[5]. Some authors believe that a person who is aware of the limitations of their existence almost always has suicidal thoughts [Kępiński 1997]. Kępiński even said that such thoughts are the physiology of an intelligent human's mind. Moreover, it is also said that "95% of suicides are normal people, only more sensitive and weaker" [Jarosz 1980; Płużek 1974, pp. 945–953]. The eternal question related to suicidal behaviours is the question of the motive that prompted a given individual to make such a drastic decision. Thus, studies on such characteristics of suicides as gender, marital status, origin, etc. can be found [Hillman 1996; Hołyst 1983; Jarosz 1980; Przybylakowa 1958, pp. 779–785; Tetaz 1976]. The motives for suicidal attempts may be different, such as e.g. striving for positive changes in environmental systems or the desire to draw others' attention to one's own problems.

They may also be an expression of protest or resignation [Makara-Studzińska 2001, p. 221; Saługa, Szczepańska-Woszczyna, Miśkiewicz, Chład 2020]. Suicidal death is primarily a reflection of the problems and feelings of helplessness of an individual [Płużek 1998, pp. 783–787; Makara-Studzińska 2001, p. 226]. The most common causes of self-destruction included mental illnesses, familial misunderstandings and chronic somatic diseases [Hołyst 2003, p. 203]. It could therefore be concluded that the state of the economy of a given country is not statistically significant as far as its influence on these

[4] World Health Organization http://www.who.int/gho/mental_health/suicide_rates/en/ 9.03.2017

[5] World Health Organization http://www.who.int/mental_health/prevention/suicide/suicideprevent/en/ as of 9.03.2017.

causes is concerned. However, the observations of other authors show interesting relationships concerning social groups or their living situations. The concept of L-A-D Syndrome should be mentioned here. In the above-mentioned abbreviation, L stands for the Loss – of health, a loved one, good living conditions or belief in one's own strength. The letter A stands for Aggression, understood as a desire to harm oneself or others. On the other hand, D stands for Depression, i.e. a violent disturbance of emotional life in which the leading symptom is a feeling of sadness, apathy, discouragement and despondency [Lebiedowicz 2013, pp. 2–3]. The group at high risk of committing a suicide includes i.a. individuals who have problems with livelihoods or financial difficulties or face difficult housing conditions [Hołyst 2003, pp. 204–205; Melnychenko 2021; Wilson, Perak, Tampil, Sidik, Gidion 2020; Coban, Lewicki, Sendek-Matysiak, Łosiewicz, Drożdż, Miśkiewicz 2022]. The reason for this is the fact that one of the types of suicide is anomic suicide [Agathangelou 2019; Hołyst 2002, pp. 39–41; Sudeshna 2018]. It is related to unfavourable changes in economic and social conditions, as well as changes in the individual living situation. It makes people commit suicide because they cannot cope in a new, more difficult situation [Meyer 2003, pp. 153–154]. In this sense, it is a result of certain tensions in the socio-cultural fabric of society [Jou, Mas, Vergara-Alert 2020; Merton 1982, p. 196; Coban, Lewicki, Sendek-Matysiak, Łosiewicz, Drożdż, Miśkiewicz 2022]. The state of anomie occurs in periods of social transformation or all kinds of crises and collapses of the old order, when the principles and norms that have hitherto guaranteed stabilization are shaken [Michalska-Suchanek 2011, p. 69]. The motives related to the economic side of the citizen's situation may reflect the state of the economy. One of the motives for suicide is resignation, which is supposed to be a response to the deteriorating situation of a given social group, e.g. a nation. An individual with suicidal tendencies is guided by emotional impulses rather than in-depth reflection [de Bruin, Agyemang, Chowdhury 2020; Helios 2013, p. 19], hence the conclusion that decisions of suicides are unlikely to be postponed in time, and the number of suicides may reflect the current economic situation of the individuals who commit them.

The statistics collected by the Police in Poland show that it is often difficult to identify only one cause of a suicide decision [Orlewska, Orlewska 2018]. In practice, single suicides frequently have multiple causes.[6] Two of them are: sudden loss of livelihoods and economic conditions[7]. This only confirms the thesis of many authors that the feeling of sense of life can be related to the living conditions of a given individual, including the economic conditions specific to a given social group. The authors of this publication have decided to analyse the changes of the two above-mentioned suicide categories and selected economic indicators.

Research background. Over the course of several decades, various dependencies were sought between the number of committed suicides and the level of the economy. Researchers have developed a variety of models in which they tried to explain the variability of the number of suicides with the following economic variables: income [Dźwigoł 2015; Marcotte D.E., 2003, pp. 628–643; Suzuki 2008; Daly, Wilson, Johnson

[6] http://statystyka.policja.pl/st/wybrane-statystyki/samobojstwa, as of 29.02.2016

[7] A police officer who fills in a suicide attempt form marks appropriate items based on the collected material concerning the event related to the suicide. One of the closed questions in the above-mentioned form is "Reason for the suicide", while one of the answers to this question is "poor economic conditions" . Marking this answer may be related to the fact that the reason could be a poor material or financial situation related e.g. to a loss of housing, financial debts or problems with repayment of loans.

2012], income and cost of living [Dzwigol, Trushkina, Kwilinski 2021; Hamermesh, Soss 1974, pp. 83–98; Melnychenko 2021a; Coban, Lewicki, Miśkiewicz, Drożdż 2022], income and unemployment rate [Bergeron 2014, p. 11; Kwilinski, Lyulyov, Dzwigol, Vakulenko, Pimonenko 2022; Williams 1986, pp. 128–135; Banasik, Miśkiewicz, Cholewa-Domanagić, Janik, Kozłowski 2022], income, cost of living, utility and consumption function and the discount rate [Kwilinski, Dzwigol, Dementyev 2020; Marcotte 2003, p. 630], unemployment and GDP per capita [Whitman 2002, pp. 28–29; Miśkiewicz 2018; Miśkiewicz 2020; Miśkiewicz 2021; Prokopenko, Miśkiewicz 2020], unemployment rate, GDP and poverty [Chu 2006; Huikari, Korhonen 2021; Mattei, Pistoresi 2019], unemployment rate, alcohol consumption and economic activity of women [Jusufbegovic, Ottoson 2011], unemployment rate, fertility rate, number of crimes and alcohol consumption [Chia Chia 2012; Melnychenko 2021b], transfer payments [Melnychenko 2013; Roden 2010, p. 9; Osadcha, Melnychenko 2021], business cycle [Lester, Yang 1997, pp. 37–39; Melnychenko, Hartinger 2017] and the impact of the economic recession on youth suicides [Howden-Chapman, Hales 2005][8].

In all of the above studies, suicides were treated as a homogeneous social group (the studies analysed suicides in general, i.e. all causes of suicides altogether). Such approach seemed to be too generalized for the authors, as it could prove inadequate or insufficient, or even lead to false results as far as finding a correlation relationship with the economy is concerned. Some causes of suicides do not appear to be related to the functioning of the economy (treating the behaviour of individuals who are chronically or mentally ill or suffer from permanent disability, as well as children with school problems or those experiencing a heartbreak on par with individuals having economic problems may have been too generalized). For this reason, the authors of this publication have limited their studies to 2 out of 11 suicide groups[9]: suicides for economic reasons and caused by a sudden loss of livelihoods, as they seem directly related to the state of the economy.

While constructing an econometric model explaining the variability of suicides for economic reasons through selected explanatory variables, the authors took into account explanatory variables already investigated by other authors (GDP, unemployment rate or alcohol consumption) and proposed new explanatory variables, i.e. measures describing consumers' propensity to consume (beer consumption, number of new car registrations) and tendency indices (business tendency index, trade tendency index and retail trade tendency index). Alcohol consumption was analysed as regards the consumption of beer and spirits – two variables in the correlation analysis. These two variables were included in the regression analysis but their collinearity led to the use of consumption of spirits only as the explanatory variable for the regression model. The addition of new variables to the econometric model was aimed at improving the accuracy of estimates and taking into account the combined (so far not tested) impact of selected variables on the number of suicides committed for economic reasons.

The present authors' approach allows for an in-depth scientific discourse related to consumer decisions and the state of the economy.

[8] Howden-Chapman, Hales S., The Impact of Economic Recession on Youth Suicide: A comparison of New Zealand and Finland, 2005.

[9] The remaining suicide groups include: family misunderstandings, mental illness, chronic illness, heartbreak, death of a loved one, school problems, permanent disability, unwanted pregnancy and committing a crime or misdemeanour.

Results of statistical analyzes for suicide investigations. This chapter presents a comparison of suicide rates in different countries in the world and the results of statistical analysis of total deaths, total suicide, economic suicide, and sudden loss of livelihoods (subsistence) for Poland.

An analysis of time series was done as well as an analysis of the correlation of economic suicide with 3 variable groups (economic indicators) reflecting the state of the economy (selected economic situation indicators, macroeconomic indicators and consumption indicators were selected). The first group is the following indicators: economic climate indicator, business tendency indicators in trade (trade climate), and business tendency indicators in retail trade (retail business climate)[10].

The authors wanted to study whether the number of suicides for economic reasons correlated statistically with indicators developed by the Central Statistical Office and the Ipsos (Economic Climate). Such a statistically significant correlation would imply an alternative method for estimating economic indicators. The second group included two macroeconomic indicators: Gross Domestic Product (GDP) growth rate and the unemployment rate. The authors wanted to confirm the research of other researchers and to show that the number of suicides for economic reasons and the cause of sudden loss of livelihoods correlated statistically significantly with the above macroeconomic indicators. Such correlation meant a significant interdependence of the economy and the number of suicides for economic reasons. The third group included selected consumer ratios: the number of new cars registrations, the consumption of spirits and beer [in liters per person]. Consumer indicators undoubtedly depend on the economic situation in a given country, but do they really influence the number of committed suicides for economic reasons? Such correlation would mean the impact of changes in sales of the mentioned products on the number of suicides for economic reasons and the impact of the number of suicides because of/due to/on account of economic reasons on changes in the sale of these goods. Alcohol consumption is one of the parallel causes of suicide. In this aspect, the authors wanted to check whether the number of suicides due to economic reasons depends significantly on the level of consumption of alcoholic beverages in a given country.

In order to analyze the assessment of the variability of suicide in Poland, Table 1 presents the population, total deaths and suicides for economic reasons and the cause of sudden loss of livelihoods.

In Poland, the total number of suicides in 2000-2014 (Table 1, column 4) was about 2% (1.35 to 1.64%) of total deaths. The lowest level was reported in 2007 (1.35% of total deaths) and the highest in 2002 (1.65% of total deaths). In year 2000 there were 5968 of total suicides, which accounted for 1.62% of total deaths (15.6 suicides per 100 000 of population). In 2014 there were 5656 total suicides, which accounted for 1.5% of total deaths (14.7 suicides per 100 000 of population). As a result, the total suicide rate in year 2014 was lower than in year 2000. However, at the same time the number of suicides for economic reasons and sudden loss of livelihoods increased significantly (columns 7 and 9 in Table 1).

[10] Methodological notes have been published in: "Business tendency survey", Warsaw 2007, CSO (edited in series Methodologies and Classifications) and "Business tendency survey in industry, construction, trade and services", website of CSO — www.stat.gov.pl.

Table 1 - The population, total deaths and suicides (total, for economic reasons and for the cause of sudden loss of livelihoods) in Poland in 2000 - 2014

Years	Number of suicides for economic reasons	Year 2000 = 100 [in %]	Previous year = 100 [in %]	Growth rate [in %]	Number of suicides for the cause of sudden loss of livelihoods	Year 2000 = 100 [in %]	Previous year = 100 [in %]	Growth rate [in %]
2000	416	100	-	-	152	100	-	-
2001	410	99	99	-1	194	47	128	28
2002	458	110	112	12	158	38	81	-19
2003	410	99	90	-10	138	33	87	-13
2004	422	101	103	3	125	30	91	-9
2005	385	93	91	-9	118	28	94	-6
2006	294	71	76	-24	94	23	80	-20
2007	202	49	69	-31	56	13	60	-40
2008	256	62	127	27	76	18	136	36
2009	377	91	147	47	124	30	163	63
2010	348	84	92	-8	104	25	84	-16
2011	349	84	100	0	99	24	95	-5
2012	369	89	106	6	136	33	137	37
2013	484	116	131	31	135	32	99	-1
2014	554	133	114	14	171	41	127	27

Source: Own study, based on GUS (2017), Population data based on natural movement and migration http://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/struktura-ludnosci,16,1.html

By analyzing changes in the percentages of total suicides, for economic reasons and the sudden loss of livelihoods in Table 1, it can be concluded that separate treatment of this phenomenon by reason appears to be fully justified. The number of suicides for economic reasons in 2000 was 416 and accounted for 6.97% of all suicides. The lowest number of suicides for economic reasons was 202 in 2007 (which accounted for 3.95% of total suicide), and the highest number was 554 in 2014 (9.79% of total suicide). The number of suicides caused by the sudden loss of livelihoods in 2000 was 152 and accounted for 2.55% of total suicide. The lowest number of suicides the cause of sudden loss of livelihoods was 56 in 2007 (1.1% of total suicide), and the highest number of suicides was 194 in 2001 (3.29% of total suicide). The proportion of studied suicide attempts in total suicide (Table 1) has prompted the authors to study and analyze this phenomenon in depth.

The authors wondered why the number of suicides for economic reasons and sudden loss of livelihoods did not change similarly to the total suicide rate (in 2014 the number of total deaths decreased and the number of suicide cases increased). And whether in subsequent years the number of suicides for economic reasons and sudden loss of livelihoods will continue to grow. The authors did also debate why in 2007 the number of suicide for the cause of sudden loss of livelihoods was the lowest and whether was related to the economic situation in the world.

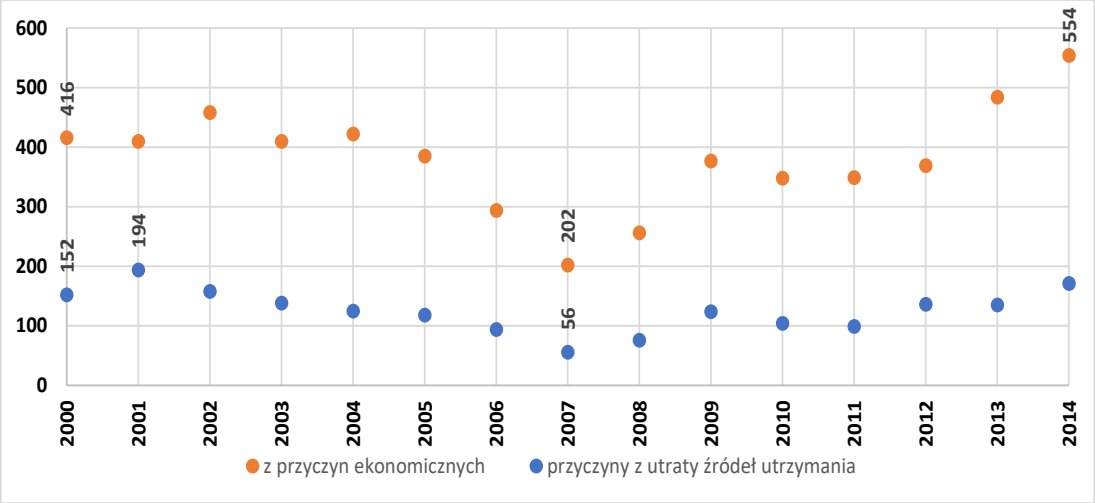

Figure 1 - Number of suicides for economic reasons and the cause of sudden loss of subsistence in Poland in 2000 - 2014
Source: Own study, based on table 1.

In order to find answers to the above questions, the dynamics of suicide for economic reasons and the reasons for sudden loss of livelihoods were examined. Dynamic ratios were calculated (single indexes: year 2000 = 100%, chain indexes: previous year = 100% and growth rate, table 2) and average level of the studied phenomenon according to the formulas

- single-digit indices (year = 100)

$$i_{t/0} = \frac{y_t}{y_0} \cdot 100 \text{ , where } y_0 = y_{2000} \tag{1}$$

- chain indexes (previous year = 100)

$$i_{t/t-1} = \frac{y_t}{y_{t-1}} \cdot 100 \tag{2}$$

- rate of increase (so called relative chain gain, tempo):

$$T = \frac{y_t - y_{t-1}}{y_{t-1}} \cdot 100 = \left(\frac{y_t}{y_{t-1}} - 1 \right) \cdot 100 \tag{3}$$

- average tempo:

$$\overline{T} = \left(\bar{i} - 1 \right) \cdot 100 \tag{4}$$

where, $\bar{i} = \underbrace{\sqrt[n-1]{i_{2/1} \cdot i_{3/2} \cdot \ldots \cdot i_{n/n-1}}}_{n-1 \text{ factors}} = \sqrt[n-1]{\frac{y_n}{y_1}}$ is the average string index

- average level of the researched phenomenon (in time series):

$$\bar{y} = \frac{\sum_{t=1}^{n} y_t}{n} \tag{5}$$

Table 2 - Dynamics of the number of suicides for economic reasons and for the cause of sudden loss of livelihoods (absolute values, chain and single indexes, rate of increase) in Poland in the years 2000 - 2014

Years	Population in thous.	Total number of deaths in thous.	Suicide in total			Suicide for economic reasons		Suicide due to sudden loss of livelihoods	
			number	percentage of deaths	per 100 000 people	number	percentage of suicide in total	number	percentage of suicide in total
2000	38254	368	5968	1,62%	15,6	416	6,97%	152	2,55%
2001	38242	363	5889	1,62%	15,4	410	6,96%	194	3,29%
2002	38219	360	5924	1,65%	15,5	458	7,73%	158	2,67%
2003	38191	365	5805	1,59%	15,2	410	7,06%	138	2,38%
2004	38174	364	5955	1,64%	15,6	422	7,09%	125	2,10%
2005	38157	368	5914	1,61%	15,5	385	6,51%	118	2,00%
2006	38125	370	5643	1,53%	14,8	294	5,21%	94	1,67%
2007	38116	377	5108	1,35%	13,4	202	3,95%	56	1,10%
2008	38136	379	5492	1,45%	14,4	256	4,66%	76	1,38%
2009	38167	385	6221	1,62%	16,3	377	6,06%	124	1,99%
2010	38530	379	6088	1,61%	15,8	348	5,72%	104	1,71%
2011	38538	376	5819	1,55%	15,1	349	6,00%	99	1,70%
2012	38533	385	6050	1,57%	15,7	369	6,10%	136	2,25%
2013	38496	387	5890	1,52%	15,3	484	8,22%	135	2,29%
2014	38479	377	5656	1,50%	**14,7**	554	9,79%	171	3,02%

Source: Own study, based on statistical data published by the General Headquarters of Police in Poland.

In years 2010 - 2014, the average number of suicides for economic reasons was 382, and the average number of suicides for the cause of sudden loss of livelihoods was 125. The number of suicides for economic reasons in year2014 (554 suicides) was 14% higher than in 2013 and 33% higher than in year 2000 (table 2).

Throughout the period considered (2010 - 2014), the number of suicides for economic reasons grew, on average, by 12 percent per year. The number of suicides caused by sudden loss of livelihoods in year 2014 (171 suicides) was 27% higher than in 2013 and was 41% higher than in year 2000. The above results confirm the worrying fact that in year 2014 the number of suicide economic reasons and sudden loss of livelihoods increased.

The study also analyzes the correlation between the number of suicides from the examined causes and the selected variables showing the state of the economy. Pearson's linear correlation coefficients (Table 3) were calculated and their statistical significance was determined by means of the Pearson's linear correlation coefficient test according to the formulas:

- Pearson's linear correlation coefficient:

$$r = \frac{n\sum_i X_i Y_i - \sum_i X_i \sum_i Y_i}{\sqrt{\left(n\sum_i X_i^2 - \left[\sum_i X_i\right]^2\right)\left(n\sum_i Y_i^2 - \left[\sum_i Y_i\right]^2\right)}} \quad (6)$$

where n is the number of observations, $X_i Y_i$ are the variables studied;

Student's t-statistics for the significance of Pearson's linear correlation coefficient:

$$t = \frac{r}{\sqrt{1-r^2}}\sqrt{n-2} \quad (7)$$

$$F = \frac{r^2}{\left(1-r^2\right)}\left(n-2\right) \quad (8)$$

Table 3 - Results of the correlation of suicide for economic reasons, the number of suicides due to sudden loss of livelihoods, the number of suicides for economic reasons without sudden livelihoods reasons with selected economic variables (Pearson's linear correlation coefficients, p-value) between 2000 and 2014

Explanatory variables:	Correlation coefficients (p-value)		
	Number of suicides for economic reasons	Number of suicides for the cause of sudden loss of livelihoods	Number of suicides for economic reasons without sudden loss of livelihoods
Economic climate indicator *The indices of the business tendency??*	r=-0,8321 (p=,003)	r=-0,8959 (p=,000)	r=-0,7615 (p=,010)
Business tendency indicators in trade	r=-0,8076 (p=,005)	r=-0,8100 (p=,005)	r=-0,7660 (p=,010)
Business climate indicator in retail trade	r=-0,7835 (p=,007)	r=-0,8796 (p=,001)	r=-0,7008 (p=,024)
GDP growth rate	r=-0,7381 (p=,015)	r=-0,8058 (p=,005)	r=-0,6705 (p=,034)
Unemployment rate	r=0,3677 (p=,296)	r=0,3136 (p=,378)	r=0,3737 (p=,287)
Number of new car registration	r=-0,2735 (p=,444)	r=-0,3304 (p=,351)	r=-0,2341 (p=,515)
Consumption of spirits [in l / 1 person]	r=0,0415 (p=,909)	r=-0,0644 (p=,860)	r=0,0872 (p=,811)
Beer consumption [in l / 1 person]	r=-0,1386 (p=,703)	r=-0,0673 (p=,854)	r=-0,1639 (p=,651)

Values in red are statistically significant with a probability p-value <0.05.
Source: Own study, statistical package Statistica 12

Table 3 shows that the variables: unemployment rate, number of new car registrations, consumption of spirits, beer consumption are not statistically correlated with the suicide numbers tested (probability p-value > 0.05). Variables: the economic climate indicator, trade climate, retail trade climate, and GDP growth rate are statistically significantly negatively correlated with economic suicide, suicide due to sudden loss of livelihoods, economic suicide without sudden loss of sources maintenance (probability p-value <0.05). This means that as the value of the above variables decreases, the num-

ber of suicides decreases (or as the value of the above variables decreases, the number of suicides is increasing). The strength of the interdependence of the number of committed suicides and the above variables are enormous (from 73.81% to 89.59%). The highest correlation coefficients are found for the number of suicides for the cause of sudden loss of livelihoods (80.58% to 89.59%), and the lowest correlation coefficients occur for economic suicides without sudden loss of livelihoods (67.05% to 76.15%). The intensity of interdependence between suicides for economic reasons is between the above values (from 73.81% to 83.21%). For all types of suicide investigations, the least significant statistically values of Pearson's linear correlation coefficients are for GDP growth and the highest values for Pearson's linear correlation coefficients are for the economic climate index. The results show that the number of suicides for economic reasons and sudden loss of livelihoods may be an alternative way to measure business, retail and economic climate.

In the following part of the research, authors wondered if and how a statistical model could be constructed to explain the variability of suicides for economic reasons by using the selected variables at the same time.

Econometric model of the number of suicides for economic reasons

In order to investigate the variability of suicide for economic reasons, an attempt was made to construct an econometric model (a one-line linear regression model of multiple variables) describing the dependence of suicide for economic reasons on a number of determinants.

The econometric model for cross-temporal data is a classic linear model with a number of explanatory variables (regressors) as follows:

$$Y_t = \beta_0 + \beta_1 X_{t1} + \beta_2 X_{t2} + \cdots + \beta_k X_{tk} + \xi_t \qquad \text{dla} \quad t=1,\ldots,T \tag{9}$$

where:

Y_t is a dependent (explained, endogenous) variable describing the number of suicides for economic reasons in year t ;

X_{it} is *i*-this independent variable (regressor, exogenous, eg economic climate indicator, business tendency indicators in trade (trade climate indicator), business tendency indicators in retail trade (retail economic climate), GDP growth rate, unemployment rate, number of new car registrations, consumption of spirits, beer consumption) t ;

β_i is the structural parameter of the model $(i = 1,...,K)$;

ξ_t is a random variable (residual) describing the influence of random factors in year t ;

t is the number of consecutive observations $(t = 1,...,T)$;

T is the number of observations; *K* is the number of explanatory variables.

The study examined several variants of the econometric model depending on the number of exogenous variables tested (regressors). The set of potential exogenous variables included all 8 variables presented in Table 3.

Unfortunately, some variables turned out to be irrelevant (economic climate indicator), and using others, the model did not meet the stochastic assumptions. The best results of the estimation of suicide model for economic reasons were obtained for the set of 4 exogenous variables presented in Table 4. Estimation of the econometric model was conducted in the GRETL 2012 econometric free-access program.

Table 4 – Results of the linear regression model estimation of the number of suicides for economic reasons for the selected variables in 2004-2013

Dependent variable is the number of suicides for economic reasons 10 observations used for estimation from 2004 to 2013				
Independent variables (regressor)	Coefficient	Standard error	Statistics t-Student (T-ratio)	p-value (prob)
Constant	−172,630	150,313	−1,148	0,3027
Unemployment rate	16,3659	5,48142	2,986	0,0306
Business indicator in retail trade	−4,78802	1,91166	−2,505	0,0542
Consumption of spirits [in l / 1 person]	120,275	30,9135	3,891	0,0115
GDP growth rate	−21,4164	4,92393	−4,349	0,0074
The arithmetic mean of the dependent variable 348.6		The standard deviation of the dependent variable 81.18319		
Residuals Sum of Squared 1438.771		Standard Error of Regression (residues) S.E. of Regression 16.96332		
The coefficient of determination R-squared 0.975744		Adjusted coefficient of determination R-square (R-bar-squared) 0.956339		
Diagnostic tests F-statistic F(4, 5) = 50,28390 with p-value 0,000315 Autocorrelation of residues rho1 0.330573 SW (Durbin-Watson) statistics 1.293651				
Information Criteria				
Logarithm log-likelihood -39.03418		Akaike'a 88.06837		
Bayesa - Schwarza 89.58129		Hannana-Quinna 86.40869		

White test on Heteroscedasticity residues (variation of the residual variance ;only the variable square) - null hypothesis: Heteroscedasticity residues absent, Test statistics: LM = 5.81474 with probability p-value p = P(Chi-kwadrat(8) > 5.81474) = 0.667975.

Test LM autocorrelation range of 1 - null hypothesis: no autocorrelation of the random component, Test statistics: LMF = 0.550346 with probability p-value p = P(F(1,4) > 0.550346) = 0.499372.

Test for normality of residual distribution - null hypothesis: the random component has a normal distribution, Test statistics: Chi-square (2) = 2.17166 with probability p-value p = 0.337622.

RESET (Regression specification error test) test on specification (only variable square) - null hypothesis: the specification is correct, Test statistics: F(1, 4) = 2.93605 with probability p-value p = P(F(1, 4) > 2.93605) = 0,161778.

Source: own elaboration, in the GRETL econometric program

To estimate the econometric model of suicide numbers for economic reasons, the well-described phenomenon must meet the numerical and stochastic assumptions. Econometric model shown in Table 4 (estimated least squares method (LSM) based on the annual observations from 2004-2013 (T = 10) and four variables (K = 4)) satisfies the assumptions number LSM. The following diagnostic tests were performed to verify the stochastic assumptions of the model: normal distribution of random components, stability of their variance (homoscedasticity) and lack of autocorrelation of the order I. Additionally validation of the function form of the model was performed (table 4). Homoscedasticity was tested by the White[11] test (statistic LM = 5.81474 with probability p-value = 0.667975). With 95% confidence it can be concluded that the variance of random components is constant in time. No autocorrelation of random order of row I was verified using the Breusch-Godfrey[12] test (LMF statistic = 0.550346 with probability p-value = 0.499372). From the 95% confidence it may therefore be concluded that there is no auto-correlation components of the random order of I. Conformity of random distribution of random components was tested with Jarque-Bera[13] test (statistic Chi-square (2) = 2.17166 with probability p-value p = 0.337622). With 95% confidence it can be concluded that the distribution of random components in the model is consistent with the normal distribution. The correctness of the functional form of the model was examined by the Ramsey test (RESET)[14] (statistic F (1, 4) = 2.93605 with probability p-value = 0.161778). From the 95% confidence can be concluded that the functional form of the model is correct, that is, a linear model is appropriate depending on the form of the examined variables.

Econometric model number of suicides for economic reasons, estimated on the basis of statistical data gathered from the years 2004 - 2013 satisfies the assumptions and stochastic numerical of the classical one-equation linear regression model, and has the following form:

(10)

$$\hat{y}_t = \underset{(\pm 150,313)}{-172,36} + \underset{(\pm 5,481)}{16,366}\, x_{t1} - \underset{(\pm 1,912)}{4,788}\, x_{t2} + \underset{(\pm 30,914)}{120,275}\, x_{t3} - \underset{(\pm 4,924)}{21,416}\, x_{t4}$$

where: $\hat{y}_t$ is estimate of the number of suicides for economic reasons,

x_{t1} is the unemployment rate [in%];

x_{t2} is business climate indicator in retail trade (average monthly indicators);

x_{t3} is the consumption of spirits [in liters per person per year];

x_{t4} is GDP growth rate [in%].

The individual and combined significance of regressors (the explanatory variables) and the goodness of fit of the model have been also tested in the study.

[11] A null hypothesis has been formed that there is no heteroscedasticity, the variance of random components is constant in time.

[12] The null hypothesis is s no autocorrelation of the random component.

[13] The null hypothesis is that the distribution of random components is consistent with the normal distribution.

[14] The null hypothesis is that the analytical form of the model is correct.

Table 4 shows that, when taking significance level, the number of suicides for economic reasons is significantly affected by the unemployment rate (p-value = 0.0306), the level of consumption of spirits (p-value = 0.0115), GDP growth rate (p-value = 0.0074) and the business tendency indicators in retail trade (p-value = 0.0542). The combined effect of exogenous variables on the number of suicides in 2004-2010 was also checked (F (4.5) = 50.28 with probability p-value = 0.000315). At significance level 0.05 it can be concluded that the combined effect of explanatory variables is statistically significant. Thus, the studied variables explain individually and together significantly affect the number of suicides for economic reasons. In 2004-2013, the arithmetic mean of suicide for economic reasons was 348.6 (± 81.2) of suicide. The number of suicides for economic reasons estimated on the basis of model (10) differs from the empirical number of suicides for economic reasons on average by 16 suicides (standard residue 16.97). The average deviation of the theoretical value from the empirical variable explained is 4.87% of the average level of the explanatory variable (coefficient of variation random V = 4.87%). The econometric model described by the formula (10) in 95.63% explains the phenomenon studied - ie the variability of economic suicide by means of the variables tested, after correction of the so-called number of degrees of freedom (corrected coefficient of determination). On the other hand, on the basis of the adjusted indeterminacy coefficient it can be said that in 4.37% the examined phenomenon was not explained by the model (10), which means that other variables or factors not included in the model are affected by the model (10).

By interpreting the model (10) it can be stated that, with an increase in unemployment by 1 percentage point, the number of suicides for economic reasons increases by an average of 16.36 (plus / minus 5.48) of suicides, assuming ceteris paribus (other variables do not change). With the increase in spirits consumption by 1 liter per person per year, the number of suicides for economic reasons increases on average by 120.275 suicides (plus / minus 30.9135), assuming ceteris paribus. As the rate of GDP growth increases by 1 percentage point, the number of suicides for economic reasons decreases on average by 21,4164 suicides (plus / minus 4.92393), assuming ceteris paribus. With the increase in business tendency indicators in retail trade of 1 (percentage point), the number of suicides for economic reasons decreases on average by 4.78802 suicides (plus / minus 1.91166), assuming ceteris paribus.

In conclusion, the number of suicides for economic reasons increases with increasing unemployment and increased consumption of spirits (ceteris paribus), but decreases with GDP growth and ceteris paribus.

In summary it can be concluded that the factors used in the model (10) as explanatory variables (GDP growth, unemployment rate, the consumption of spirits and the business tendency indicators in retail trade) are early warning indicators before committed suicide.

Discussion. The main purpose of this publication was assessing the correlation of the number of suicides for economic reasons and caused by sudden loss of livelihoods with selected indicators related to the tendencies present in the economy. It should be noted that in the available publications by other authors the suicides were researched in general, without paying attention to their reasons. That is why distinguishing suicides caused by economic factors or a sudden loss of livelihoods allows to form a new perspective of the research on this phenomenon. The results of research on suicides for economic reasons or caused by a sudden loss of livelihoods and differences in both these causes of suicides in Poland showed a statistically significant correlation with the GDP growth rate and indicators

of economic climate or the tendencies in trade (including retail trade). They did not show any significant correlation with the unemployment rate, the number of car registrations, the consumption of spirits and the consumption of beer. As a result, it can be said that the measurement of the above-mentioned suicides can be an alternative and much cheaper method compared to the currently used methods of measuring economic climate or tendencies in trade (including retail trade). Moreover, it should be considered what symptoms of GDP change cause a change in the number of suicides of these types. It is doubtful that suicides make such decisions only on the basis of published data on changes in GDP. The absence of a direct correlation between the above-mentioned types of suicide and unemployment leads to further exploration of the causes of suicidal decisions related to the state of economy.

The additional aim of the study was an attempt at building an original econometric model describing the variability of the number of suicides for economic reasons using selected six economic indicators. The proposed original econometric model illustrates how the numbers of these suicides change in relation to the four tested indicators (unemployment rate, retail trade tendency index, consumption of spirits and change of GDP) . It should be noted that, unlike in the case of previous studies (publications) of other authors, the consumption of alcohol was divided into the consumption of spirits and beer, which gave new insights into the phenomenon of suicides. In the authors' model the number of suicides for economic reasons is positively influenced by the increasing unemployment rate and the rising consumption of spirits, and negatively influenced by the rising values of retail trade tendency indices and GDP growth rate. This means that with the country's economic growth and recovery (GDP growth, rising tendency indices, as well as falling unemployment rate and decreasing consumption of spirits), the number of suicides for economic reasons decreases, while the deterioration of the economic situation (GDP decline accompanied by increasing unemployment rate and consumption of spirits) causes the number of suicides for economic reasons to rise. The proposed econometric model does not explain the complex phenomenon of suicide for economic reasons, but it does explain some of its links with the Polish economy.

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