



Indeks 371262  
e-ISSN 2657-9545  
ISSN 0033-2372

# PRZEGLĄD STATYSTYCZNY STATISTICAL REVIEW

Vol. 70 | No. 3 | 2023

GŁÓWNY URZĄD STATYSTYCZNY  
STATISTICS POLAND

## INFORMATION FOR AUTHORS

*Przegląd Statystyczny. Statistical Review* publishes original research papers on theoretical and empirical topics in statistics, econometrics, mathematical economics, operational research, decision science and data analysis. The manuscripts considered for publication should significantly contribute to the theoretical aspects of the aforementioned fields or shed new light on the practical applications of these aspects. Manuscripts reporting important results of research projects are particularly welcome. Review papers, shorter papers reporting on major conferences in the field, and reviews of seminal monographs are eligible for submission on the Editor-in-Chief's request.

Since 1 May 2019, the journal has been publishing articles in English.

Any spelling style is acceptable as long as it is consistent within the manuscript.

All works should be submitted to the journal through the Editorial System (<https://www.editorialsystem.com/pst>).

For details of the submission process and editorial requirements please visit <https://ps.stat.gov.pl/ForAuthors>.

**PRZEGLĄD  
STATYSTYCZNY  
STATISTICAL REVIEW**

---

Vol. 70 No. 3 2023

---

## ADVISORY BOARD

Krzysztof Jajuga – Chairman (Wrocław University of Economics and Business, Poland), Czesław Domański (University of Łódź, Poland), Marek Gruszczyński (SGH Warsaw School of Economics, Poland), Tadeusz Kufel (Nicolaus Copernicus University in Toruń, Poland), Igor G. Mantsurov (Kyiv National Economic University, Ukraine), Jacek Osiewalski (Krakow University of Economics, Poland), D. Stephen G. Pollock (University of Leicester, United Kingdom), Jaroslav Ramík (Silesian University in Opava, Czech Republic), Dominik Rozkrut (Statistics Poland, University of Szczecin, Poland), Sven Schreiber (Macroeconomic Policy Institute of the Hans Böckler Foundation, Germany), Peter Summers (High Point University, United States of America), Mirosław Szreder (University of Gdańsk, Poland), Matti Virén (University of Turku, Finland), Aleksander Welfe (University of Łódź, Poland), Janusz Wywiiał (University of Economics in Katowice, Poland)

---

## EDITORIAL BOARD

Editor-in-Chief: Paweł Miłobędzki (University of Gdańsk, Poland)  
Deputy Editor-in-Chief: Marek Walesiak (Wrocław University of Economics and Business, Poland)  
Co-Editors: Piotr Fiszeder (Nicolaus Copernicus University in Toruń, Poland), Maciej Nowak (University of Economics in Katowice, Poland), Emilia Tomczyk (SGH Warsaw School of Economics, Poland), Łukasz Woźny (SGH Warsaw School of Economics, Poland)  
Managing Editor: Dorota Ciołek (University of Gdańsk, Poland)

---

## EDITORIAL OFFICE'S ADDRESS

University of Gdańsk, ul. Armii Krajowej 101, 81-824 Sopot, Poland

---

Language editing: Scientific Journals Division, Statistics Poland  
Technical editing and typesetting: Statistical Publishing Establishment – team supervised by Maciej Adamowicz



Zakład Wydawnictw  
Statystycznych

Printed and bound: Statistical Publishing Establishment  
al. Niepodległości 208, 00-925 Warsaw, Poland, zws.stat.gov.pl

**Website: [ps.stat.gov.pl](http://ps.stat.gov.pl)**

© Copyright by Główny Urząd Statystyczny and the authors, some rights reserved. CC BY-SA 4.0 licence



**ISSN 0033-2372**  
**e-ISSN 2657-9545**  
**Index 371262**

Information on the sales of the journal: Statistical Publishing Establishment  
phone no. +48 22 608 32 10, +48 22 608 38 10

---

Order no. 369/2023

## CONTENTS

Victor Shevchuk, Roman Kopych Asymmetry in the exchange rate pass-through to consumer prices in Eastern European countries .....	<b>1</b>
Aleksandra Katarzyna Duchalska Analysis of the impact of socio-economic factors on the number of suicide cases in European countries .....	<b>18</b>
Krzysztof Jajuga, Dominik Krężolek, Marek Walesiak Report from the 32nd Scientific Conference of the Classification and Data Analysis Section of the Polish Statistical Association .....	<b>37</b>



# Asymmetry in the exchange rate pass-through to consumer prices in Eastern European countries<sup>1</sup>

Viktor Shevchuk,<sup>a</sup> Roman Kopych<sup>b</sup>

**Abstract.** Using quarterly data from Q1 2002 to Q4 2021, a Nonlinear Autoregressive Distributed Lag (NARDL) model is utilised to investigate the potential asymmetry in the exchange rate pass-through (ERPT) to consumer prices in 11 Eastern European countries. The findings show that both the appreciations and depreciations of the nominal effective exchange rate (NEER) have significant long-term effects on consumer prices, with the appreciations being stronger in countries with a fixed exchange rate regime, especially the Baltic States. Incomplete long-term ERPT is observed in the majority of countries, except Estonia. Short-term ERPT is much weaker and often of an opposite direction for appreciations and depreciations. Additionally, a strong uniform long-term effect of both the money supply and crude oil prices was observed, while the short-term effects are mixed. As regards economic liberalisation, both long- and short-term effects are country-specific and of a different direction.

**Keywords:** exchange rate pass-through, asymmetry, consumer prices, nonlinear ARDL model

**JEL:** C22, E31, E37

## 1. Introduction

Asymmetry of the exchange rate pass-through (ERPT) means that consumer (or import) prices react differently to the exchange rate appreciations and depreciations, regardless of whether it involves a long-term relationship, short-term dynamics or both (Colavecchio & Rubene, 2020). Recent studies often indicate asymmetry in the ERPT for both industrial (Anderl & Caporale, 2023; Delatte & López-Villavicencio, 2012) and developing countries (Caselli & Roitman, 2016), including Eastern European states (Nasir et al., 2020; Przystupa & Wróbel, 2011; Stoian & Murarușu, 2015). It is also the case for many Euro area countries, although a symmetric ERPT is observed for the whole Euro area (Colavecchio & Rubene, 2020).

The aim of this paper is to investigate the ERPT to consumer prices in the short and long run in 11 Eastern European countries, focusing on any potential asymmetry occurring during periods of appreciation and depreciation. The

---

<sup>1</sup> Conference article from the 16th Professor Aleksander Zelias International Conference on Modelling and Forecasting of Socio-Economic Phenomena, 8–11 May 2023, Zakopane, Poland. The authors would like to thank the anonymous reviewers for their insightful comments and suggestions which improved the quality of the initial manuscript.

<sup>a</sup> Cracow University of Technology, Council of Social Sciences, ul. Warszawska 10, 31-155 Cracow, Poland, e-mail: vshevchuk@pk.edu.pl, ORCID: <https://orcid.org/0000-0002-7125-1267>.

<sup>b</sup> Lviv University of Trade and Economics, Department of International Economic Relations and Computer Sciences, 79005, m. L'viv, vul. Br. Tershakivtsiv, 2a, kim. 314, 315, Ukraine, e-mail: kopych\_r@bigmir.net, ORCID: <https://orcid.org/0000-0002-3986-7694>.

estimates of the Nonlinear Autoregressive Distributed Lag (NARDL) model, which allows for exchange rate asymmetry, are assessed against a benchmark ARDL linear (symmetric) model. More specifically, the research presented in the paper seeks to answer the following questions: Is the ERPT symmetric during periods of appreciation and depreciation? Is the ERPT stronger in the long run? What is the effect of the exchange rate regime on the magnitude of ERPT? The estimates of the ERPT pattern appear to be crucial for an effective disinflationary monetary policy primarily in countries with flexible exchange rates. Nevertheless, it is also important to estimate the strength of inflationary pass-through regardless of the exchange rate regime.

The remaining part of the paper is organised as follows. Section 2 outlines the theoretical issues regarding asymmetry in the ERPT. Section 3 provides a brief account of selected empirical studies, Section 4 presents the data and the statistical model, while Section 5 discusses the empirical results and summarises the key findings. Finally, Section 6 presents the conclusions of the research.

## 2. Theoretical framework

As the relevant literature suggests, there are three main groups of explanations for asymmetry in the ERPT (Aron et al., 2014; de Melo Modenesi et al., 2017):

- Capacity constraints. When the currency of the exporter country depreciates, it creates incentives for exports due to a higher demand for imports abroad. In the presence of quantity constraints, exporters are not able to raise their sales in response to favourable relative prices. Consequently, exporters increase their mark-up instead of lowering prices in the importer's currency, while in the case of an appreciation, exporters can keep their price level stable as their profits expressed in foreign currencies increase (such a situation results in the fact that the ERPT after depreciations is greater than after appreciations);
- Production technology switching. If the producing firm exports the final product but, at the same time, it has the possibility to buy its inputs abroad, appreciations may result in a higher ERPT than depreciations;
- Pricing to market behaviour. It occurs when exporting firms seek to maintain market share by setting the lowest possible price in the importer's currency. If the importing country's currency appreciates, exporters are likely to allow the prices to fall; if the importer's currency depreciates, the mark-ups are adjusted to maintain prices in the local currency. In this case, the ERPT is higher after the appreciation of the domestic currency than after its depreciation.

Thus, two of the three above-mentioned theoretical reasons for asymmetry in the ERPT lead to a higher pass-through after a currency appreciation rather than depreciation. Assuming that prices are rigid downward due to firms being more



likely to increase their mark-up than to reduce it, the ERPT should be greater after a depreciation of the currency rather than after an appreciation. Downward rigidity in Eastern European countries is likely to result from the insufficient competitiveness of the domestic market and excessive labour regulations.<sup>2</sup> In the case of depreciation in a competitive environment, foreign firms may not raise prices in the importing country's market in order to retain market share; the response of domestic prices to appreciation becomes then stronger (Pollard & Coughlin, 2004).

As argued by Bussière (2013), depreciations have a larger effect on import prices than appreciations, as exporters are able to absorb only a part of the currency movements into their mark-up. Asymmetry in the ERPT is even higher in the case of a large appreciation, as it is more difficult for exporters to adjust their mark-up, thus leading to a higher pass-through on the importers' part. On the other hand, it is likely that exporting firms may find it difficult to increase their production capacities and raise their mark-up instead of setting up a new plant, with a lower ERPT on the importer's side (Aron et al., 2014). Capacity constraints which constitute a factor behind a greater ERPT after depreciations are less likely to appear in Eastern European countries.

From a macroeconomic perspective, the ERPT may be asymmetric if the monetary authority is concerned with inflationary pressures arising from exchange rate movements and the central bank reacts more strongly after a currency devaluation than after an appreciation (Delatte & López-Villavicencio, 2012). Furthermore, the ERPT may depend on the level of economic activity. In periods of economic recession, for example, the effects of depreciations in the form of rising prices may be smaller than the effects of appreciations, i.e. the reduction of domestic prices (Goldfajn & Werlang, 2000).

In a wider analytical context, the magnitude of asymmetric ERPT is explained by other institutional factors, such as imperfect competition (Delatte & López-Villavicencio, 2012), the presence of menu costs (Ben Cheikh, 2012), downward rigidity in prices combined with upward rigidity in the supply of goods (Stoian & Marurasu, 2015), or the pricing to market phenomenon (Przystupa & Wróbel, 2011). Institutional environment, measured by the concept of economic freedom comprising monetary, administrative, trade, investment and financial components, could be a factor behind the ERPT. For Eastern European countries, the control of economic freedom curbs the ERPT from 0.272 to 0.191, while the exchange rate effect on output does not change significantly (Shevchuk, 2022). As outlined below, such an outcome is in line with several theoretical concepts.

---

<sup>2</sup> If the level of competitiveness is compared with the persistence of profits, Germany, Portugal, Sweden and the United Kingdom emerge as the most competitive economies in the short term among a sample of European economies (Eklund & Lappi, 2019). On the other hand, Czechia and Hungary have the highest short-run profit persistence, along with Greece and Spain.

As demonstrated by a two-country model with imperfect competition and price inertia, the magnitude of ERPT decreases in a low inflation regime due to the weakening of the expected future effect of monetary shocks (Choudhri & Hakura, 2001). Lower variability of monetary shocks also plays a role. Although a change in the exchange rate has a direct impact on the costs, the prices for only a fraction of goods are reset as a result of the staggered price adjustment process, which, in turn, depends on the expected values of future costs. A stronger monetary policy response to the deviations from the regime targets reduces the destabilising effects on the future costs and thus lowers the ERPT. A similar conclusion of a lower ERPT attributed to a low-inflation environment is obtained by the open economy model with the Phillips curve (Takhtamanova, 2008). The argument asserting that ERPT decreases in an environment characterised by lower and rather stable inflation has been empirically supported in relation to the Euro area countries (Ben Cheikh, 2012).

Trade openness, which is another component of economic freedom, implies that foreign exporters become more responsive to the prices of their competitors and find it optimal to increase their prices to a lesser degree when an exchange rate movement occurs, with a lower ERPT to follow (Gust et al., 2010). A two-country model consists of households which consume both domestically-produced goods and imported goods, and of firms which are monopolistically competitive. Among other theoretical aspects, a lower ERPT should be expected in cases of nominal rigidities, price discrimination (Corsetti et al., 2008), lower transportation costs and less labour-intensive services in wholesale and retail trade (Frankel et al., 2012).

Based on the favourable price effects of the monetary and trade freedom, it is likely that the aggregated Index of Economic Freedom (IEF) will have the same impact, assuming that it is also of a disinflationary character. However, price stability in a low inflation regime could have an opposite effect if it is associated with exchange rate stability and expectations of the exchange rate dynamics. If the exchange rate changes are considered permanent, then selling prices are adjusted rapidly, whereas if exchange rate changes are considered as temporary, the price adjustment is delayed (Beirne & Bijsterbosch, 2009).

In general, the literature on the subject suggests that price adjustments to exchange rate fluctuations depend on the monetary regime and other institutional features of the economy, on market structures and firm pricing strategies, which all differ across industries and countries. Although the control of economic freedom is likely to weaken the ERPT for both appreciations and depreciations, especially if the changes in exchange rates are considered to be permanent, the above-mentioned arguments for capacity constraints, production technology switching and pricing to

market remain a source of uncertainty in the study of exchange rate effects on inflation. Considering what was stated above, the existence and direction of asymmetric ERPT to consumer prices may not be asserted *a priori*.

### **3. A brief account of selected empirical studies**

Depreciations are passed through prices more than appreciations over the long run in the study of Germany, Japan, the United Kingdom and the United States (Delatte & López-Villavicencio, 2012). Asymmetry is found in five out of 12 Euro area countries, with no clear evidence about the direction of the asymmetry (Ben Cheikh, 2012). Additionally, it has been confirmed that pass-through decreases in a lower and more stable inflation environment.

As regards Eastern European countries, asymmetry in the ERPT to consumer prices has been found for Czechia (Nasir et al., 2020), Poland (Przystupa & Wróbel, 2011) and Romania (Stoian & Marurasu, 2015). However, it has been empirically established that euro appreciations and depreciations affect the level of the Euro-area ERPT symmetrically; however, the results differ across countries and the impact on headline inflation is limited (Colavecchio & Rubene, 2020). For Germany, Portugal and Spain, the ERPT is stronger for appreciations, while the opposite is true for Belgium and Luxembourg.

The ERPT is higher in the long run for Romania (Stoian & Muraruşu, 2015), although the evidence in favour of the complete ERPT is rather scarce. The incomplete ERPT is found for Czechia, Hungary, Poland and Romania (Przystupa & Wróbel, 2011; Shevchuk, 2022; Stoian & Muraruşu, 2015), which is in line with the earlier studies on Eastern European countries. For example, no evidence in favour of the extreme hypotheses of Local Currency Pricing (zero pass-through) and of Producer Currency Pricing (complete pass-through) is found by María-Dolores (2010). In this context, it is worth noting that in such developed countries as Australia or Sweden the ERPT is close to being complete (Anderl & Caporale, 2023).

For Eastern European countries, there is evidence that the ERPT is higher for countries that have adopted some form of a fixed exchange rate regime, with reduced exchange rate responsiveness to external price shocks (Beirne & Bijsterbosch, 2009; Mirdala, 2014). However, earlier estimates demonstrate that a less volatile exchange rate implies a lower degree of ERPT (María-Dolores, 2010). Pass-through is likely to be stronger in countries targeting inflation with exchange rate flexibility (Anderl & Caporale, 2023). Among the states practising such a monetary regime are Czechia, Hungary, Poland and Romania, where a higher degree of ERPT tends to occur. Under inflation-targeting policies, domestic inflation is expected to be sensitive to oil prices as well (Baharumshah et al., 2017).

Several studies indicate that the magnitude of ERPT in the aftermath of the global financial crisis of 2008–2009 declined due to a relatively low inflation environment (Poghosyan, 2020). However, it was found that in relation to Czechia, Hungary, Poland and Romania the long-term ERPT became higher over the low-inflationary 2010–2019 period, with inflationary effects of the money supply and economic freedom, as well as an opposite impact of investments (Shevchuk, 2022). Earlier studies on Poland did not find any relationship between the ERPT and inflation (Przystupa & Wróbel, 2011). As in the case of energy-importing countries of Caucasus and Central Asia (Poghosyan, 2020), the same direct relationship between consumer prices and crude oil prices is likely to occur in Eastern European countries. However, the inflationary influence of an increase in oil prices can be significant on impact, but have no effect in the long run (Choi et al., 2018). In general, emerging markets differ from advanced economies in terms of their exposure and sometimes vulnerability to the terms of trade shocks (Caselli & Roitman, 2016).

There are various approaches to studying ERPT asymmetries, including the local projections method (Caselli & Roitman, 2016; Colavecchio & Rubene, 2020; Poghosyan, 2020), vector autoregression models (de Melo Modenesi et al., 2017; Przystupa & Wróbel, 2011), OLS error-correction models (María-Dolores, 2010), smooth transition regression models (Anderl & Caporale, 2023; Ben Cheikh, 2012), or Markov switching models (Baharumshah et al., 2017). Several studies utilise a nonlinear cointegrating ARDL (NARDL) model (Delatte & López-Villavicencio, 2012; Nasir et al., 2020), which provides a framework for the analysis of both long- and short-term relationships by allowing for asymmetries in a nonlinear error correction model while showing weak requirements for data of a functional type.

To sum up, our account of the theoretical and empirical issues leads to three main conclusions. Firstly, the existence and direction of asymmetric ERPT to consumer prices is a country-specific phenomenon, entailing significant monetary policy implications. Secondly, the ERPT is expected to be stronger in the long run. Thirdly, it is important to control any domestic and external conditions as the ERPT can be dependent on the inflation environment, monetary regime, openness of the economy to foreign trade and capital flows, the business cycle, institutional features, commodity prices, etc.

#### **4. Data and statistical model**

All time series for the Q1 2002–Q4 2021 sample have been extracted from the IMF International Financial Statistics and FRED databases.<sup>3</sup> The IEF has been obtained

---

<sup>3</sup> For Estonia, Romania and Slovenia, a shorter sample of Q1 2002–Q1 2020 is used due to the limited availability of data for the money aggregates.

from the Heritage Foundation. The following variables were used: the consumer price index (2016=100),  $p_t$ , the nominal effective exchange rate (NEER) (2010=100),  $e_t$ , the money supply (index, 2010=100),  $m_t$ , the level of economic freedom,  $herit_t$ , the crude oil price (index, 2016=100),  $brent_t$ . The NEER is defined as domestic currency units per unit of foreign currency, so that an increase in the value of  $e_t$  represents a depreciation for the home country.

Among country-specific controls, several extra variables were used: the consumer price index in Germany (2016=100), investments (% of GDP), openness to foreign trade (% of GDP), the U.S. lending rate (%), obtained from the IMF International Financial Statistics, and FRED databases. The liberalisation of trade and higher-level openness are common reasons for a decline in the ERPT in developed countries (Frankel et al., 2012), while the opposite is true for developing countries (Ghosh, 2013). A slightly positive relationship for Eastern European countries between ERPT and openness to foreign trade was reported by María-Dolores (2010), but no impact of trade openness was found by Shevchuk (2022).

Since none of the variables is I(2), it is justifiable to use the ARDL framework to investigate the asymmetric ERPT into consumer prices.<sup>4</sup> The choice of the ARDL model is advantageous for our study, as it is applicable in a situation where the variables are I(0), I(1) or a mixture of I(1) and I(0), and it is possible to estimate both the short-term and the long-term effects simultaneously (Pesaran et al., 1999). Following Kripfganz and Schneider (2022), the statistical model for the CPI is as follows:

$$p_t = c_0 + c_1 t + \sum_{i=1}^l \phi_i p_{t-i} + \sum_{i=1}^q \eta_i e_{t-i} + \sum_{i=0}^q \beta_i' x_{t-i} + \varepsilon_t, \quad (1)$$

$$t = 1 + q^*, \dots, T,$$

where  $c_0$  is the intercept,  $c_1 t$  is the linear trend,  $e_t$  is the NEER,  $x_t$  is the vector of other exogenous variables (money supply, crude oil prices, output gap),  $l \in [1, q^*]$  and  $q \in [0, q^*]$  are lag orders,  $q^*$  is the maximum admissible lag order,  $T$  is the number of observations in the dataset,  $\varepsilon_t$  is a vector of normally distributed, serially uncorrelated and mutually orthogonal white noise disturbances, and  $t$  is the time dimension.

<sup>4</sup> As indicated by the Phillips-Perron (PP) test, variables of CPI, NEER, IEF and money supply are non-stationary in levels and stationary in first differences for all countries (the results of the calculations are available upon request). It means that the variables are integrated of order one or I(1). The Augmented Dickey-Fuller (ADF) test results are very similar, but somewhat weaker in the case of CPI for Hungary, Lithuania, Poland and Slovenia. The output gap measured as a percentage difference between the actual and the Hodrick-Prescott filtered real gross domestic product is stationary at levels across all countries, regardless of the stationarity test used.

The ARDL model can be reformulated into the error-correction representation:

$$\Delta p_t = c_0 + c_1 t - \alpha(p_{t-1} - \gamma e_{t-1} - \theta x_{t-1}) + \sum_{i=1}^l \psi_{pi} \Delta p_{t-i} + \sum_{i=1}^q \psi_{ei} \Delta e_{t-i} + \sum_{i=0}^q \psi'_{xi} \Delta x_{t-i} + \varepsilon_t, \tag{2}$$

where  $\alpha$  is what is called a speed-of-adjustment coefficient, while  $\gamma\alpha$  and  $\theta\alpha$  stand for the long-term coefficients. The speed-of-adjustment coefficient demonstrates how fast the output reverts back to its long-run equilibrium, with  $0 < \alpha < 1$  reflecting a partial-adjustment process, where the gap to the equilibrium is gradually closed over time. The coefficient on the exchange rate,  $\gamma\alpha$ , measures the ERPT as the direct effect of the exchange rate on the CPI level. In order to analyse asymmetries in the ERPT, the NEER is decomposed into its positive ( $e_t^+$ ) and negative ( $e_t^-$ ) partial sums:  $e_t^+ = \sum_{t=1}^k \Delta e_t^+ = \sum_{t=1}^k \max(\Delta e_t, 0)$ ,  $e_t^- = \sum_{t=1}^k \Delta e_t^- = \sum_{t=1}^k \min(\Delta e_t, 0)$ .

For computational purposes, the following NARDL model was estimated:

$$\Delta p_t = c_0 + c_1 t + \pi_p p_{t-1} + \pi_e^+ e_{t-1}^+ + \pi_e^- e_{t-1}^- + \pi_x x_{t-1} + \sum_{i=1}^{p-1} \psi_{pi} \Delta p_{t-i} + \sum_{i=1}^q \psi_{ei}^+ e_{t-1}^+ + \sum_{i=1}^q \psi_{ei}^- e_{t-1}^- + \sum_{i=0}^q \psi'_{xi} \Delta x_{t-i} + \varepsilon_t, \tag{3}$$

from which the speed-of-adjustment coefficient is  $\alpha = -\pi_p$ , and the long-term ERPT coefficients are  $\pi_e^+/\alpha$  and  $\pi_e^-/\alpha$ , respectively. Among the components of vector  $x_t$ , our ARDL and NARDL models included the money supply and the crude oil prices.

It is customary for the ARDL/NARDL models to allow for up to four or eight lags with quarterly data. For the NARDL models, the long-run symmetry used to be tested by a Wald test of joint null hypothesis  $\pi_e^+/\alpha = \pi_e^-/\alpha$ . The short-run symmetry can be tested by a standard Wald test of joint null hypothesis  $\sum_{i=1}^{q-1} \psi_{ei}^+ = \sum_{i=1}^{q-1} \psi_{ei}^-$ .

The presence of co-integration is confirmed by the Wald F-Bounds and  $t$ -Bounds tests, which suggest the rejection of the null hypothesis of no co-integration for the ARDL and NARDL models in the first place (the results of the calculations are available upon request). If the output gap is included into the NARDL model, the  $t$ -Bounds test does not indicate co-integration for Czechia, Estonia, Latvia and

Slovakia, and shows rather weak evidence for co-integration in the case of Hungary and Poland. As there is rather weak evidence of co-integration for the NARDL with an output gap model, it is eliminated from further discussion. In order to preserve the comparability of the results across countries, the next section presents the estimates from the ARDL and NARDL models only.

## 5. Empirical results

As presented in Table 1, the estimates of the linear ARDL model are uniform in the sense that there is a significant incomplete long-term ERPT across all Eastern European countries, with the estimates ranging from 0.153 for Slovakia to 0.672 for Latvia. On the other hand, the estimates of the short-term ERPT are quite heterogeneous. A relatively high value of the short-term ERPT relates to Estonia and Slovenia, followed by Croatia, Lithuania and Poland. A counter-intuitive negative value of the short-term ERPT is obtained for Czechia and Slovakia. No relationship between the exchange rate and inflation is observed in Bulgaria, Hungary, Latvia and Romania. Ultimately, our results are in line with the international evidence that the ERPT is higher in the long run.

**Table 1.** Estimates of the ERPT (ARDL)

Country	$\beta$	Long-term	Short-term	$R^2$
Czechia .....	-0.309***	0.398***	-0.141*	0.52
Hungary .....	-0.205***	0.423***	-0.001	0.69
Poland .....	-0.415***	0.481***	0.023**	0.42
Romania .....	-0.251***	0.209***	—	0.71
Bulgaria .....	-0.326***	0.424***	—	0.75
Croatia .....	-0.349***	0.554***	0.189***	0.68
Slovakia .....	-0.397***	0.153***	-0.261**	0.69
Slovenia .....	-0.367***	0.218***	0.476***	0.85
Estonia .....	-0,078***	0.376**	0.367**	0.67
Latvia .....	-0.104***	0.672***	-0.028	0.71
Lithuania .....	-0.199***	0.560***	0.116*	0.49

Note. Czechia, Hungary, Poland and Romania practice a monetary regime of inflation targeting, while Bulgaria, Croatia, Slovakia, Slovenia, as well as the Baltic States are countries with a fixed exchange rate regime. Significance test results: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Source: authors' calculations.

The NARDL model, as defined in Eq. (3) is estimated for each country with a maximum lag length of four for both dependent and independent variables, with

all insignificant control variables removed from the model.<sup>5</sup> Table 2 presents the results of the Wald symmetry tests for exchange rate effects in both the long and short term. The null hypothesis of a long-term symmetric ERPT is rejected at a 5% level of statistical significance in eight out of 11 countries. Therefore, a long-term asymmetry is confirmed in most of the Eastern European countries, except Poland and Slovenia. No evidence of a short-term asymmetry is found only in Lithuania, but there are no results for symmetry tests for Bulgaria, Latvia, Romania and Slovenia.

**Table 2.** Results of symmetry tests (NARDL)

Country	Short-Term Tests (WST)	Long-Term Tests (WLT)	Country	Short-Term Tests (WST)	Long-Term Tests (WLT)
Czechia .....	3.17***	11.93***	Estonia .....	9.82***	16.23***
Hungary .....	14.29***	4.16**	Latvia .....	—	4.20**
Poland .....	9.10***	1.12	Lithuania .....	0.17	2.70*
Romania .....	—	2.51**			
Bulgaria .....	—	19.19***			
Croatia .....	4.92**	11.69***			
Slovakia .....	4.36**	6.39**			
Slovenia .....	—	0.62			

Note. \*\*\*, \*\*, \* – the null of symmetry is rejected at 1%, 5% and 10% significance levels, respectively.

Source: authors' calculations.

The long-term ERPT is significantly greater following appreciations in Bulgaria, Croatia, Latvia, Lithuania and Slovenia, i.e. in all countries with a fixed exchange rate regime, as well as in Poland, which practices a floating exchange rate of its currency (Table 3). According to the theoretical arguments, it means that product technology switching and pricing to market effects prevail over capacity constraints. The appreciation of the NEER is neutral in respect to CPI in Romania, while a counterintuitive inflationary effect of appreciation is observed in Slovakia.

<sup>5</sup> For all country-specific NARDL models, the Breusch–Godfrey LM and Breusch-Pagan-Godfrey tests report no residual serial correlation and no functional misspecification, respectively (the results of the tests are available upon request). The stability of the NARDL model estimates is verified with the Ramsey RESET test, as well as the CUSUM and CUSUM Square tests. The Ramsey RESET test shows the presence of homoscedasticity in all countries, except for Slovenia, for which the results show a somewhat lower than 10% statistical significance. Despite the slightly weaker results of one of the recursive tests in the case of Czechia and Poland, both CUSUM and CUSUM Square tests are also in favour of homoscedasticity; thus, heteroscedasticity is not a concern. Additionally, the model's residuals are normally distributed according to the Jarque-Bera test.



**Table 3.** Estimates of the ERPT (NARDL)

Country	$\beta$	Long-term		Short-term		$R^2$
		Appr (-)	Depr (+)	Appr (-)	Depr (+)	
Czechia .....	-0.252***	0.203***	0.291***	0.380**	-0.357**	0.64
Hungary .....	-0.275***	0.412***	0.448***	-0.409**	0.375***	0.77
Poland .....	-0.337***	0.711***	0.544***	-0.037**	0.016***	0.47
Romania .....	-0.701***	-0.036	0.329***	—	-0.392**	0.76
Bulgaria .....	-0.348***	0.871***	0.337***	—	-0.381**	0.77
Croatia .....	-0.358***	0.846***	0.340**	0.121	0.336**	0.68
Slovakia .....	-0.288***	-0.314***	0.479***	0.273***	-0.356**	0.66
Slovenia .....	-0.387***	0.887***	0.519***	0.566**	—	0.88
Estonia .....	-0.149***	0.513**	1.017***	0.549**	0.227**	0.73
Latvia .....	-0.169***	0.879***	0.648***	-0.165*	—	0.72
Lithuania .....	-0.179***	0.739***	0.150	0.217**	0.334**	0.55

Note. \*\*\*, \*\*, \* – the null of symmetry is rejected at 1%, 5% and 10% significance levels, respectively.

Source: authors' calculations.

Depreciations are inflationary in the long run for all countries except Lithuania. A positive association between depreciations and consumer prices, with an opposite price effect for appreciations is likely to reflect a dependency on imports in Eastern European countries. In addition to the above-mentioned theoretical argument on capacity constraints, a much stronger long-term ERPT for Estonia and Romania for depreciations can result from the fact that their monetary policy is focused much more on the reaction to a currency appreciation than to a depreciation. Among other countries with a monetary regime based on inflation targeting, a similar assumption can be relevant to Czechia and Hungary (to a lesser extent), but not for Poland, where the ERPT for appreciation is higher than the pass-through for a depreciation.

The pattern of short-term ERPT asymmetry varies across countries. First of all, inflationary pass-through is much weaker for appreciations in Croatia, Lithuania and Slovenia, and depreciations in Hungary and Poland. No effect of the former is observed in Bulgaria and Romania and of the latter in Latvia and Slovenia. Moreover, depreciations bring about a counterintuitive decrease in the CPI dynamics in Bulgaria, Czechia, Romania and Slovakia, while appreciations are associated with a short-term acceleration in the inflation rate in Hungary, Latvia and Poland (to a lesser extent). It is not possible to find any significant differences in both the magnitude and direction of the asymmetric ERPT between countries with floating and fixed exchange rate regimes.

Except for Czechia and Hungary, the estimates of the long-term asymmetric ERPT (Table 3) are higher in comparison to the symmetric ERPT (Table 1). It means

that the linear ARDL model underestimates the magnitude of the pass-through from NEER to consumer prices.

The estimates of the short-term asymmetric ERPT are consistent with those of the symmetric ERPT for Croatia, Estonia, Lithuania and Slovenia. For Bulgaria, Latvia and Slovakia, as well as for all countries with a floating exchange rate, comparisons are mixed. However, it is worth noting that the lack of any short-term relationship between the exchange rate and inflation in Bulgaria, Hungary, Latvia and Romania, as obtained in the linear specification, disappears if the nonlinearity in the exchange rate effects on inflation is allowed. For Czechia and Hungary, the estimates of the short-term asymmetric ERPT are much stronger when compared to the magnitude of a symmetric ERPT.

As revealed by coefficient of determination  $R^2$ , the explanatory power of the NARDL model is higher compared to the ARDL model for nine out of 11 countries, except for Croatia and Slovakia. On average, the long-term pass-through coefficients are larger in the asymmetric (nonlinear) model given by Eq. (3) than in the symmetric (linear) model shown in Eq. (2) for countries with a fixed exchange rate, especially in the Baltic States, whereas differences are much smaller (if any) for countries with a floating exchange rate. Causality running from the exchange rate to inflation over the short term seems to be country-specific and dependent on the choice of the specification of the model: linear or nonlinear.

Our results are in line with other studies that report asymmetries in the pass-through to consume prices for the Eastern European countries (Nasir et al., 2020; Przystupa & Wróbel, 2011; Stoian & Murarușu, 2015). Similarly to such Euro area members as Germany, Portugal and Spain (Colavecchio & Rubene, 2020), the ERPT is stronger for appreciations for most of the Eastern European countries with a fixed exchange rate regime, except for Estonia and Slovakia.

Evidence of a complete ERPT is found only for the long-term effect of depreciation in Estonia (Table 3). The long-term effects of appreciation are close to the complete ERPT in Bulgaria, Croatia, Latvia and Slovenia, as the value of the coefficient on  $e_t^-$  exceeds 0.8. Similarly to the results presented by Anderl and Caporale (2023), the long-term ERPTs for the inflation-targeting countries with exchange rate flexibility are far from zero pass-through.

On average, the long-term estimates of ERPT are higher for countries with a fixed exchange rate regime. The ERPT for appreciations is as high as 0.573 for fixers (it increases to 0.868 if Slovakia is not included) and 0.323 for floaters (it increases to 0.442 if Romania is not accounted for), with the corresponding values for depreciations standing at 0.419 and 0.403, respectively. As far as the Baltic States are concerned, the long-term ERPT for appreciations and depreciations are the highest and reach 0.710 and 0.605, respectively. If asymmetry is not accounted for, the Baltic States still have the highest ERPT (0.536), although the differences between countries with floating and fixed exchange rate regimes disappear, standing at 0.378 and 0.337,

respectively. Our results are in accordance with other studies asserting that the ERPT seems to be higher for countries that have adopted some form of a fixed exchange rate regime (Beirne & Bijsterbosch, 2009; Mirdala, 2014).

As regards the adjustment speed of consumer prices toward long-term equilibrium prices, it is slightly higher in the asymmetric specification of the NARDL as compared to the linear specification of the ARDL, where the asymmetries are neglected. If ERPT asymmetries are taken into account, the highest level of the coefficient of adjustment speed of  $-0.701$  is found in Romania. On the other hand, a relatively slow speed of adjustment is obtained for the Baltic States, with coefficient  $\beta$  reaching the value between  $-0.149$  and  $-0.179$ .

The estimates of other determinants of consumer prices are presented in Table 4. As expected, there is a strong long-term relationship between the money supply and CPI for all countries except for Slovakia, where the coefficient on  $m_t$  is smaller and statistically significant at a 1% level. Concerning the short-term impact, our findings reveal that the money supply changes lack any inflationary effects (only in Bulgaria and Croatia positive coefficients on  $m_t$  are statistically significant at a 10% and 5% level, respectively).

Similarly to the money supply effects, the long-term reaction of consumer prices to the world crude oil prices is quite uniform, which implies an increase in the level of prices in response to oil price hikes, but the short-term effects are quite heterogeneous. In the case of higher oil prices, an acceleration in inflation is observed in five countries, with the opposite outcome in Romania and neutrality in five other countries.

**Table 4.** Other consumer price determinants (NARDL)

Country	Money supply		Crude oil price		Index of economic freedom	
	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term
Czechia .....	0.336***	-0.085**	0.067***	0.010**	0.001	—
Hungary .....	0.190***	-0.429**	0.034***	0.038**	-0.271*	-0.141**
Poland .....	0.326***	—	0.093***	0.010**	-0.302**	0.103*
Romania .....	0.160***	-0.139**	0.084***	-0.112**	-0.032	-0.290**
Bulgaria .....	0.368***	0.063*	0.045***	0.001**	-0.192**	-0.690***
Croatia .....	0.201***	-0.148**	0.040***	—	-0.300***	-0.007
Slovakia .....	0.034*	0.010	0.055***	0.005	-0.240**	-0.022**
Slovenia .....	0.153***	-0.023**	0.035***	—	-0.029	-0.178**
Estonia .....	0.170***	-0.011**	0.169***	0.031**	0.678***	—
Latvia .....	0.169***	-0.048**	0.059***	—	-0.093	—
Lithuania .....	0.439***	-0.087**	0.097***	—	-1.210***	0.013

Note. \*\*\*, \*\*, \* – the null of symmetry is rejected at 1%, 5% and 10% significance levels, respectively.

Source: authors' calculations.

The liberalisation of the economy, as characterised by the IEF from the Heritage Foundation, has a predominantly anti-inflationary impact both in the long and short run. In a more liberal environment, a long-term decrease in the consumer price level is observed at a statistically significant level in six countries, while the short-term inverse relationship between the IEF and inflation is statistically significant in five countries. Evidence of an increase in the price level is found only for Estonia over the long run and for Poland in the short run. No price effects of economic freedom are found for Czechia and Latvia.

It is worth noting that in the absence of IEF control the estimates of the ERPT for appreciations and depreciations become very similar for Czechia, Latvia, Poland, Romania, Slovakia and Slovenia, while for Hungary they are lower (the results of the calculations are available upon request). Among other findings, a counterintuitive inverse relationship between depreciation and the consumer price level emerges for Bulgaria. The ERPT is lost for appreciation in Estonia and depreciation in Croatia. On the other hand, the ERPT becomes exaggerated for appreciation in Lithuania. The estimates of the short-term asymmetric ERPT are similar with and without the IEF control only for Croatia, Czechia and Hungary. Empirical estimates become less similar if there is no control from the IEF and crude oil prices. However, in this case the cointegration between exchange rates and consumer prices is not observed for Czechia, Estonia, Hungary, Poland and Romania. In conclusion, the control of economic freedom and crude oil prices appear to be justified due to better cointegration properties and the consistency with the theoretical arguments.

## 6. Conclusions

It has been found that both appreciations and depreciations of the NEER have significant long-term effects on consumer prices. Appreciations are stronger in countries with a fixed exchange rate regime, especially in Bulgaria, Croatia, Lithuania and Poland. Regarding the estimates of short-term ERPT, comparisons are mixed between linear and nonlinear specifications for countries with both fixed and floating exchange rate regimes. The ERPT is stronger in the long run, but it is incomplete in most of the countries, except for depreciation in Estonia. However, the long-term effects of appreciation are close to the complete ERPT in Bulgaria, Croatia, Latvia and Slovenia. On average, the long-term estimates of ERPT are higher for countries with a fixed exchange rate regime. For short-term estimates of ERPT, it is not possible to find any significant differences in both the magnitude and direction of the asymmetric ERPT between countries with floating and fixed exchange rate regimes.

The observed statistically significant asymmetric effects of exchange rates on consumer prices, both in the long and short run suggest that underestimating the impact of exchange rate appreciations could result in a biased conclusion with regard to the appropriate disinflationary policy to be implemented. The question whether prices respond differently depending on the magnitude of the exchange rate variation remains yet to be answered. In terms of the modelling strategy, this might be examined by allowing the threshold to be different from zero. This is a topic for future studies, along with the estimation of the pass-through asymmetries to import prices. The aim of future research could be to explain the significant differences in the results relating to the direction and magnitude of the ERPT across countries, providing a list of the likely explanations (structural changes, capital flows, forward or retrospective expectations, policy interventions, household preferences, etc.). For this purpose, the estimation of the ERPT for disaggregated consumer prices time series could be informative. Moreover, our findings must be interpreted with caution due to a relatively short sample covering the 2002–2021 period. As longer time series become available in the future, it should enhance the quality of the analysis as well, lowering the risk of small sample biases in the estimates.

Furthermore, our findings show a strong long-term correlation between consumer prices and both the money supply and crude oil prices in all Eastern European countries. However, a counterintuitive inverse relationship between changes in the money supply and inflation prevails in the short run, while higher crude oil prices are inflationary in half of the studied countries. More economic freedom is predominantly associated with a long-term decline in the consumer prices and a short-term disinflation.

## References

- Anderl, C., & Caporale, G. M. (2023). Nonlinearities in the exchange rate pass-through: The role of inflation expectations. *International Economics*, 173, 86–101. <https://doi.org/10.1016/j.inteco.2022.10.003>.
- Aron, J., Macdonald, R., & Muellbauer, J. (2014). Exchange Rate Pass-Through in Developing and Emerging Markets: A Survey of Conceptual, Methodological and Policy Issues, and Selected Empirical Findings. *Journal of Development Studies*, 50(1), 101–143. <https://doi.org/10.1080/00220388.2013.847180>.
- Baharumshah, A. Z., Soon, S-V., & Wohar, M. E. (2017). Markov-switching analysis of exchange rate pass-through: Perspective from Asian countries. *International Review of Economics and Finance*, 51, 245–257. <http://dx.doi.org/10.1016/j.iref.2017.05.009>.
- Beirne, J., & Bijsterbosch, M. (2009). *Exchange rate pass-through in Central and Eastern European member states* (ECB Working Paper Series No. 1120). <https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1120.pdf>.

- Ben Cheikh, N. (2012). Asymmetric Exchange Rate Pass-Through in the Euro Area: New Evidence from Smooth Transition Models. *Economics*, 6(1), 1–29. <http://dx.doi.org/10.5018/economics-ejournal.ja.2012-39>.
- Bussière, M. (2013). Exchange rate pass-through to trade prices: the role of nonlinearities and asymmetries. *Oxford Bulletin of Economic and Statistics*, 75(5), 731–758. <https://doi.org/10.1111/j.1468-0084.2012.00711.x>.
- Caselli, F. G., & Roitman, A. (2016). *Non-Linear Exchange Rate Pass-Through in Emerging Markets* (IMF Working Paper No. WP/16/1). <https://www.imf.org/external/pubs/ft/wp/2016/wp1601.pdf>.
- Choi, S., Furceri, D., Loungani, P., Mishra, S., & Poplawski-Ribeiro, M. (2018). Oil prices and inflation dynamics: Evidence from advanced and developing economies. *Journal of International Money and Finance*, 82, 71–96. <https://doi.org/10.1016/j.jimonfin.2017.12.004>.
- Choudhri, E. U., & Hakura, D. S. (2001). *Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?* (IMF Working Paper No. WP/01/191). <https://www.imf.org/en/Publications/WP/Issues/2016/12/30/Exchange-Rate-Pass-Through-to-Domestic-Prices-Does-the-Inflationary-Environment-Matter-15496>.
- Colavecchio, R., & Rubene, I. (2020). *Non-linear exchange rate pass-through to euro area inflation: a local projection approach* (ECB Working Paper No. 2362). <https://doi.org/10.2866/997922>.
- Corsetti, G., Dedola, L., & Leduc, S. (2008). High exchange-rate volatility and low pass-through. *Journal of Monetary Economics*, 55(6), 1113–1128. <https://doi.org/10.1016/j.jmoneco.2008.05.013>.
- Delatte, A-L., & López-Villavicencio, A. (2012). Asymmetric exchange rate pass-through: Evidence from major countries. *Journal of Macroeconomics*, 34(3), 833–844. <http://dx.doi.org/10.1016/j.jmacro.2012.03.003>.
- Eklund, J. E., & Lappi, E. (2019). Persistence of profits in the EU: how competitive are EU member countries?. *Empirica*, 46(2), 327–351. <https://doi.org/10.1007/s10663-018-9399-5>.
- Frankel, J., Parsley, D., & Wei, S-J. (2012). Slow pass-through around the world: A new import for developing countries?. *Open Economies Review*, 23(2), 213–251. <https://doi.org/10.1007/s11079-011-9210-8>.
- Ghosh, A. (2013). Exchange rate pass through, macro fundamentals and regime choice in Latin America. *Journal of Macroeconomics*, 35, 163–171. <https://doi.org/10.1016/j.jmacro.2012.09.001>.
- Goldfajn, I., & Werlang, S. R. C. (2000). The pass-through from depreciation to inflation: a panel study (BCB Working Papers Series No. 5). <http://dx.doi.org/10.2139/ssrn.224277>.
- Gust, C., Leduc, S., & Vigfusson, R. (2010). Trade integration, competition, and the decline in exchange-rate pass-through. *Journal of Monetary Economics*, 57(3), 309–324. <https://doi.org/10.1016/j.jmoneco.2010.02.001>.
- Kripfganz, S., & Schneider, D. C. (2022). *ardl: Estimating autoregressive distributed lag and equilibrium correction models* (TUPD Discussion Papers No. 2022-006). <https://www2.econ.tohoku.ac.jp/~PDesign/dp/TUPD-2022-006.pdf>.
- María-Dolores, R. (2010). Exchange rate pass-through in New Member States and candidate countries of the EU. *International Review of Economics & Finance*, 19(1), 23–35. <https://doi.org/10.1016/j.iref.2009.02.009>.

- de Melo Modenesi, A., Luporini, V., & Pimentel, D. (2017). Asymmetric Exchange Rate Pass-Through: Evidence, Inflation Dynamics and Policy Implications for Brazil (1999–2016). In P. Arestis, C. Troncoso Baltar, & D. Magalhães Prates (Eds.), *The Brazilian Economy since the Great Financial Crisis of 2007/2008* (pp. 69–99). Palgrave Macmillan. [https://doi.org/10.1007/978-3-319-64885-9\\_4](https://doi.org/10.1007/978-3-319-64885-9_4).
- Mirdala, R. (2014). *Exchange Rate Pass-Through to Domestic Prices under Different Exchange Rate Regimes* (WDI Working Paper No. 1070). <https://deepblue.lib.umich.edu/bitstream/handle/2027.42/132969/wp1070.pdf?sequence=1>.
- Nasir, M. A., Duc Huynh, T. L., & Vo, X. V. (2020). Exchange rate pass-through & management of inflation expectations in a small open inflation targeting economy. *International Review of Economics & Finance*, 69, 178–188. <https://doi.org/10.1016/j.iref.2020.04.010>.
- Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, 94(446), 621–634. <https://doi.org/10.1080/01621459.1999.10474156>.
- Poghosyan, T. (2020). *Exchange Rate Pass-Through in the Caucasus and Central Asia* (IMF Working Paper No. WP/20/154). <https://www.imf.org/en/Publications/WP/Issues/2020/08/07/Exchange-Rate-Pass-Through-in-the-Caucasus-and-Central-Asia-49617>.
- Pollard, P. S., & Coughlin C. C. (2004). *Size Matters: Asymmetric Exchange Rate Pass-Through at The Industry Level* (Federal Reserve Bank of St. Louis Working Paper No. 2003-029C). <https://doi.org/10.20955/wp.2003.029>.
- Przystupa, J., & Wróbel, E. (2011). Asymmetry of the Exchange Rate Pass-Through: An Exercise on the Polish Data. *Eastern European Economics*, 49(1), 30–51. <https://doi.org/10.2753/EEE0012-8775490103>.
- Shevchuk, V. (2022). Price and output effects of long-term exchange rate changes: Central and Eastern European countries in 2002–2019. *Entrepreneurial Business and Economics Review*, 10(3), 37–50. <https://doi.org/10.15678/EBER.2022.100303>.
- Stoian, A., & Murarușu, B. (2015). *On the exchange rate pass-through in Romania* (NBR Occasional Papers No. 18). <https://www.bnr.ro/PublicationDocuments.aspx?icid=6899>.
- Takhtamanova, Y. (2008). *Understanding Changes in Exchange Rate Pass-Through* (FRBSF Working Paper No. 2008-13). <https://www.frbsf.org/wp-content/uploads/sites/4/wp08-13bk.pdf>.

# Analysis of the impact of socio-economic factors on the number of suicide cases in European countries

Aleksandra Katarzyna Duchalska<sup>a</sup>

**Abstract.** Suicide rates in Europe have in the recent years reached a disturbingly high level, sparking frequent discussions on the topic of mental health and suicide prevention, which significantly affect not only individuals but also their environment. The aim of this paper was to analyse the impact of the socio-economic situation on suicide rates using panel data analysis. The study presents an overview of the related literature and the definitions of essential terms concerning suicide, as well as the socio-economic factors determining suicide rates. The parameters of a fixed effects model were estimated, interpreted and compared with the results of earlier research. The analysis of the selected dataset showed that GDP *per capita* and the Gini coefficient have a negative and statistically insignificant impact on suicide rates. On the other hand, the conducted research showed that high divorce and unemployment rates, risk of poverty, social exclusion and excessive alcohol consumption proved to be statistically significant, thus increasing suicide rates.

**Keywords:** suicide, panel data analysis, socio-economic situation, fixed effects model

**JEL:** C33, I12, I14, I15

## 1. Introduction

Suicide is the worst possible outcome of a mental illness, thus suicide rates were chosen as an indicator of mental health problems. Mental health, similarly to physical health, is a broad topic which requires a large number of indicators to be taken into consideration when assessing the condition of the mental state of an individual. Many variables are either hidden and difficult to observe or can be exposed only when one's mental condition deteriorates. In addition, since the identification of both the symptoms of a mental illness and the boundaries between mentally stable and mentally ill varies among specialists, the word 'illness' raises doubts and tends to be replaced in psychology with the word 'disorder'. In extreme cases, patients require hospitalisation and can be treated without their consent, although a hospital stay is not always necessary, as psychotherapy and pharmacotherapy may be a more efficient form of treatment (Pużyński, 2007). Death resulting from an individual's conscious decision to end their life is referred to as

---

<sup>a</sup> Krakow University of Economics, College of Economics, Finance, and Law, Institute of Quantitative Methods in Social Sciences, ul. Rakowicka 27, 31-510 Kraków, Poland, e-mail: [aleksandr Duchalska@gmail.com](mailto:aleksandr Duchalska@gmail.com),  
ORCID: <https://orcid.org/0009-0006-2850-3285>.



suicide. The most common methods of taking one's life include hanging, poisoning and jumping from a height. A phenomenon occurring more often than suicide is a suicide attempt (Pieszczachowicz, 1997, p. 61).

The reasons for taking one's own life are extremely difficult to determine; however, it is possible to distinguish the factors that contribute to the decision. These include unexpected situations that have a significant impact on daily life, causing overwhelming stress and the feeling of helplessness, which makes death seem as the best and only solution. Examples of such situations can be the sudden loss of a job, a traumatic experience or an unexpected deterioration in interpersonal relationships, for instance a divorce. There are also long-term factors whose negative impact on the well-being of an individual is often unapparent, and noticeable only after a suicide attempt. A toxic environment at work, school or home lowers self-esteem and destroys interpersonal relationships (Woźniak, 2020).

It is important to note that the scale of the problems associated with mental health disorders is larger than it seems. The actual number of people who experience mental health issues is much higher than the cases recorded in official statistics. Gas or carbon monoxide poisoning, car accidents and many other dangerous situations that seem like a mishap are not always recorded as suicide attempts. There are instances when the members of the close family request that the suicide is recorded under a different name in fear of the negative reaction of their environment. It is important to note that datasets usually focus on the records of deaths, not attempts, according to Woźniak (2020), the number of suicide attempts among adults are estimated to be 10 times higher, and among teenagers from 100 to 200 times higher than the number of suicides (Woźniak, 2020). According to Rosa (2012), official data are unreliable, as the goal of each institution collecting data on suicides is different. It is assumed that suicide attempts occur from 10 to 20 times more often than suicides (Rosa, 2012). For instance, data collected by police officers are only a small part of the real number of suicides. Police officers prioritise determining the cause of death at the scene and their classification of the given death highly depends on the questioned individuals, like the family members or friends of the deceased. Also, police officers' beliefs have an impact on their decision regarding the classification of death as suicide or e.g. an unfortunate accident (Rosa, 2012). A fitting example of the influence of authorities' beliefs on suicide rates is illustrated by the difference between the number of the recorded suicides in protestant parishes and catholic parishes. A study performed by Lincoln Day based on datasets from late 19th century and early 20th century from Switzerland, Prussia and the Netherlands shows that protestant parishes recorded much more suicides than catholic parishes, while the latter recorded much more deaths of an unknown cause. The reason for that may be the fact that for Catholics suicide is a sin, people who die of suicide could not be

buried in the cemetery, which causes enormous distress to the families (Rosa, 2012). It is important to note that suicide is more than just another death in the statistics as it leaves a mark on other people in the immediate environment. In addition, publicising a story about a suicide might result in the Werther effect, which happens when a group of imitators are inspired by such a story. The opposite is the Papageno effect occurring when a person living with suicidal thoughts, influenced by certain information, finds another way out of the crisis, which can lead to a reduction in the number of suicide attempts.

It should also be mentioned that society also suffers through the growing problem of suicide, as it bears the cost of productivity loss and the expense in the form of medical bills from psychiatric hospitals or prevention campaigns or workshops. High suicide rates indicate the disintegration of society. Moreover, despite the growing number of suicide deaths, which are the most common cause of death worldwide, the problem remains a much-downplayed area of public health (Woźniak, 2020).

## **2. Literature review**

The unemployment rate is one of the most important subjects of macroeconomic research, essential to describing the state of a country's economy. It is associated with unused productive resources, which affect economic growth. Numerous scientific papers indicate a link between suicide rates and unemployment rates; its impact was described in the works of Andrés (2005), Córdoba-Doña et al. (2014), Fountoulakis et al. (2014), Inagaki (2010) and Murali and Oyeboode (2004). Unemployment is associated with the loss of financial independence and increased stress. Losing a job entails a loss of relationships with co-workers, which play a key role in a person's social life and has a negative impact on their social status, which, in turn, affects their self-esteem. Increased stress and the sudden loss of a livelihood is also the source of strained family relationships, particularly when the main income earner in a household becomes unemployed. Such a situation increases the risk of suicide (Prete, 2003). According to an article by Murali and Oyeboode (2004), economic inequalities result in psychosocial stress, which can lead to poorer mental health and higher mortality rates. Research confirms that there is a direct link between poverty, emotional disorders and disparities in access to medical facilities or treatments. The differences in access to healthcare services are the main source of this correlation. Many studies point to the relevance of social status in understanding mental illness and disability. Moreover, epidemiological studies from around the world confirm the existence of a negative correlation between social status and mental illness. Mental disorders are most common among lower social classes. Murali and Oyeboode

(2004) mention findings presented in the study by Gunnell et al. (1995), which show that suicide and murder are most common in poor, densely populated areas, which according to them, is confirmed by a study by Crawford and Prince (1999), who noted rising suicide rates among a group of young, unemployed men living in extreme poverty (Murali & Oyebode, 2004).

The Gini coefficient of equivalised disposable income, i.e. per household member, was included in the work of Andrés (2005), but did not show statistical significance, while it was significant in the work of Inagaki (2010). Some theories indicate that suicide rates can be affected by social inequalities which are a source of social stress and result in higher criminal activity observed among the lowest-income groups. Other theories emphasise the importance of the feeling of inferiority and limited access to health services common among poor social groups. Inequalities contribute to reduced social integration and increased mortality. They have a negative impact on the general health of the population (Andrés, 2005). Inagaki (2010) points out that most research papers do not include Japan even though for a long time Japan had the highest suicide rates in the world. In his work, he distinguishes two types of approaches found in the literature. The first type is characterised by an individual-based approach, in which it is proven that people tend to compare their earnings to others, and individuals are likely to feel dissatisfaction when their neighbours earn more than them. The second type of literature focuses on correlations in collective data which show a positive relationship between income inequality and suicide rates, but which are often statistically insignificant. Inagaki's (2010) research assumes that individual perceptions of self-worth are closely related to suicidal tendencies. His research confirms that in Japan there is a statistically significant positive correlation between unequal income distribution and suicide rates.

Various models and approaches can be found in the academic work on suicide and its relationship to the economy, and the results are sometimes contradictory. For example, Andrés (2005) points out in his paper that existing economic and suicidological theories are inconsistent in terms of the impact of unemployment and economic growth on suicide rates. Furthermore, there are studies indicating an increasing effect of income on this phenomenon, while others show an opposite relationship. The impact of GDP or inflation is also debatable. Fountoulakis et al. (2014) point to the existence of trends and relationships that differ among European countries. A study using data from 29 European countries evaluated the impact of socio-economic factors on suicide rates during the 2000–2011 period. The authors point out that GDP *per capita* is erroneously used as a measure of living standards and that economic growth benefits all citizens, while the unequal distribution of income in society and investment in institutions closely related to quality of life, such as the healthcare system, are often overlooked. The reason for including this

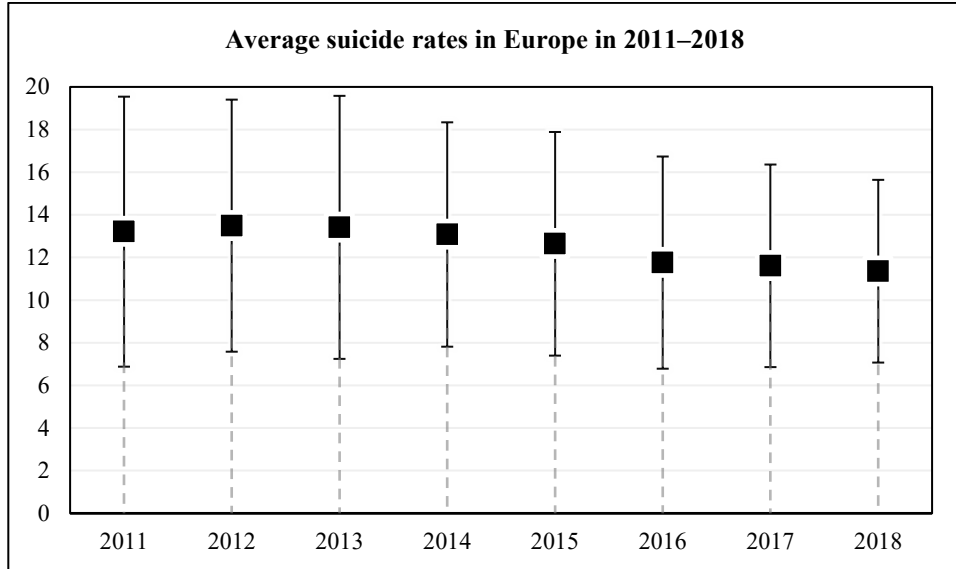
variable to the model was to examine its impact on the number of deaths caused by suicides and compare the results with those obtained by different authors. When it comes to demographic variables, in the work of Andrés (2005), pure alcohol consumed by the average person aged 15 and over measured in litres is found to have a significant impact on suicide rates. The crude divorce rate was also included in Andrés' research as, similarly to unemployment, it is a life-changing event and can be a source of overwhelming stress.

### **3. Data overview and methodology**

An analysis of panel data was conducted to investigate the relationship between suicide rates and selected economic and social variables. The analysis concerned 30 European countries and the years 2011–2018. The data were obtained from Eurostat and the Global Health Observatory (GHO) of the WHO. In order to keep the panel balanced, the research included only those countries for which the data were available in full, i.e.: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom. The explanatory variable that represents mental health is the standardised suicide rates, i.e. the weighted average of the raw suicide rates of each age group, with the weights represented by the size of the group.

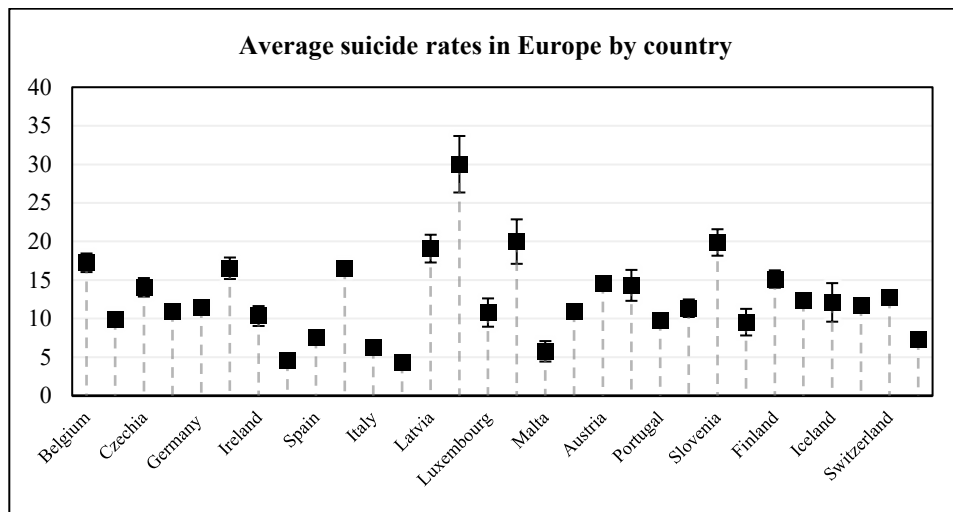
Figure 1 shows the average suicide rates from 2011 to 2018. During the period of 2012–2013, the average reached the highest values and later it slowly decreased from year to year. Moreover, during the 2011–2014 period, the maximum was reached by 27 countries, the exceptions being Luxembourg reaching the maximum in 2015, and Norway and the UK in 2018. This suggests that during those years, certain phenomena occurred that had a negative impact on mental health in Europe.

**Figure 1.** Average suicide rates in Europe from 2011 to 2018



Source: author's work.

Figure 2 shows a comparison of average suicide rates in selected European countries. From all the countries, Lithuania stood out due to its remarkably high average suicide rates reaching the highest value of 36.12 in 2013, followed by a decrease reaching a minimum of 23.98 in 2018. Other countries characterised by high rates were Hungary, Latvia and Slovenia, with an average of no less than 19. The lowest suicide rates were noted in the UK and the Mediterranean countries: Cyprus, Greece, Italy, Malta and Spain, with an average of no more than eight. The rest of the average rates were between 10 and 17.

**Figure 2.** Average suicide rates in Europe from 2011 to 2018 by country

Source: author's work.

Six explanatory variables were selected for the estimation:

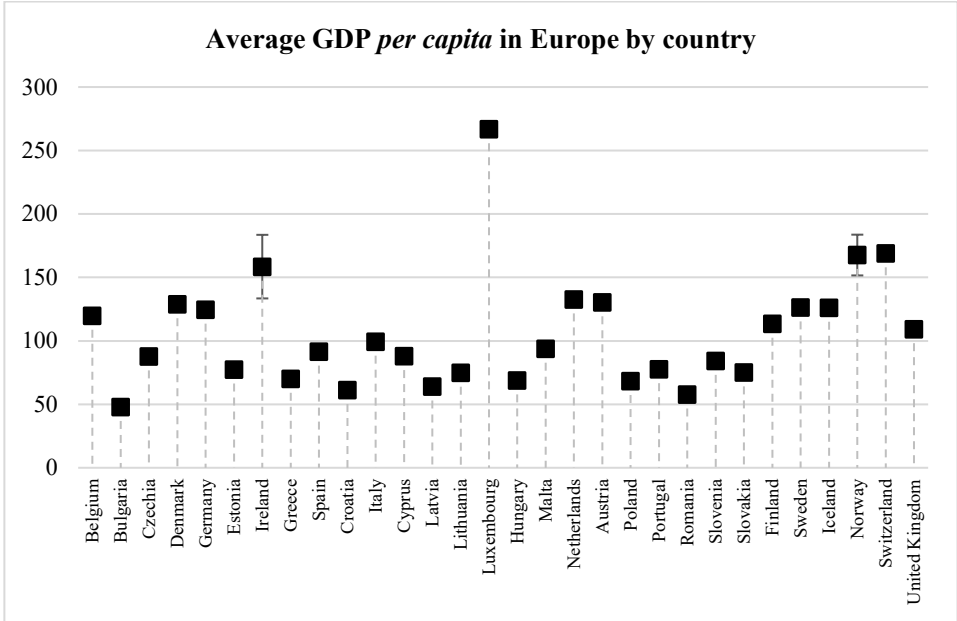
- Real GDP *per capita* expressed in PPS, Eurostat's notional currency, which takes into consideration the purchasing power of national currencies. It was included in the work of Andrés (2005), Fountoulakis et al. (2014) and Yin et al. (2016) to represent the condition of the economy,
- The Gini coefficient of equivalised disposable income, i.e. per household member, included in Andrés' (2005) work, although it did not show statistical significance; however, it was significant in Inagaki's (2010) work,
- The percentage of people at risk of poverty or social exclusion, as stated in the article by Murali and Oyeboode (2004); these factors can cause mental disorders,
- Pure alcohol consumed by the average person aged 15 years and over measured in litres. According to the work of Andrés (2005), alcohol consumption has a significant impact on suicide rates.

These variables were selected based on the literature and not to negatively affect the balance of the panels. Additional variables included later in the paper are:

- The crude divorce rate, included in the work of Andrés (2005); the crude divorce rate is the ratio of the number of divorces each year to the average population in that year, multiplied by 1,000,
- The unemployment rate, included in the work of Andrés (2005), Córdoba-Doña et al. (2014), Fountoulakis et al. (2014), Inagaki (2010) and Murali and Oyeboode (2004).

Figure 3 shows the average values of GDP *per capita* from 2011 to 2018 in 30 European countries. The smallest value was achieved by Bulgaria, which was not significantly different from the rest of the countries, most of which were between 50 PPS and 150 PPS. Countries whose average GDP *per capita* was higher than 150 PPS, but lower than 170 PPS, were Ireland, Norway and Switzerland; moreover, the standard deviation of Ireland and Norway was large, indicating the high variability of GDP *per capita* of these countries at that time. Luxembourg far exceeded the other countries, with an average GDP *per capita* of as much as 267 PPS. There was no significant difference between the countries with the highest and the lowest suicide rates. The average GDP *per capita* of these countries was between 50 PPS and 100 PPS, except for the UK, whose average GDP *per capita* was 109 PPS.

**Figure 3.** Average GDP *per capita* in Europe from 2011 to 2018 by country

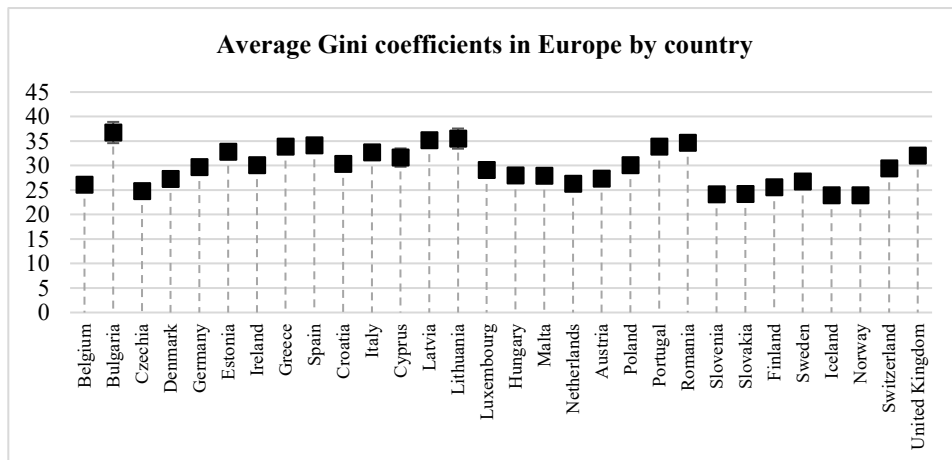


Source: author’s work.

A Gini coefficient lower than 30 indicates low-income stratification, and higher than 45 high income stratification (Raczkowska, 2017). Figure 4 shows the average values of the Gini coefficients from 2011 to 2018 in Europe. The highest average Gini coefficient was in Bulgaria, and the lowest in Iceland, Norway, Slovakia and Slovenia. The countries with the lowest average suicide rates were characterised by average income stratification. The exception was Malta, where the average stratification was low. The Gini coefficients of the countries with the highest average

suicide rates were diverse, as the coefficients of Lithuania and Latvia had the second and third highest values, respectively, while Slovenia had the smallest coefficient, and Hungary's coefficient was 28.

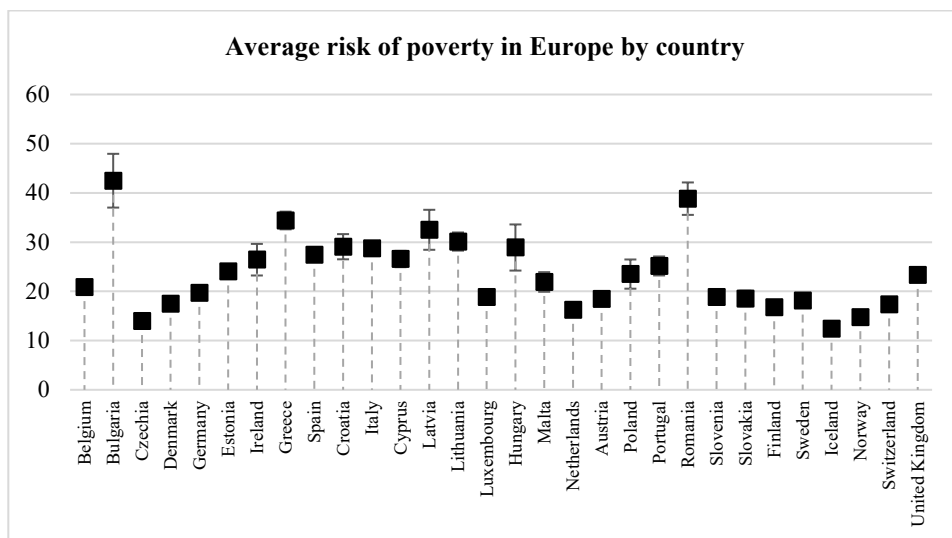
**Figure 4.** Average Gini coefficients in Europe from 2011 to 2018 by country



Source: author's work.

Figure 5 shows the average poverty risk from 2011 to 2018 in Europe. The highest average poverty risk of 42% was in Bulgaria, while the lowest in Iceland reaching 12%.

**Figure 5.** Average risk of poverty in Europe from 2011 to 2018 by country

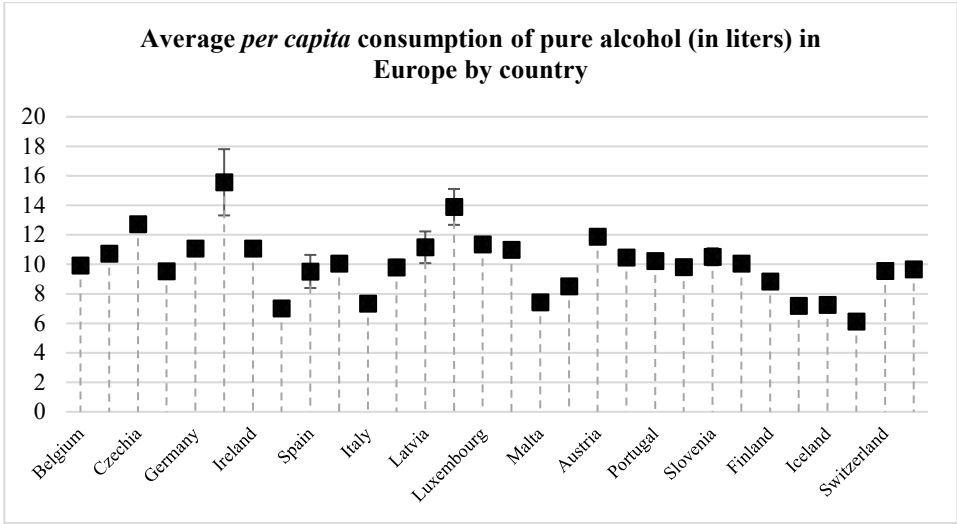


Source: author's work.



Figure 6 shows average alcohol consumption from 2011 to 2018 in Europe. Estonia had the highest variability and the highest average alcohol consumption. The average Estonian drank an average of 16 litres of pure alcohol during the period studied. Lithuania had the second highest average, with its average suicide rates well above the average of the other countries. Its standard deviation, as in the case of Spain and Latvia, was large. The lowest average alcohol consumption, equal to six litres, was recorded in Norway. An average citizen of Greece, Iceland, Italy, Malta and Sweden drank seven litres of pure alcohol during the studied period.

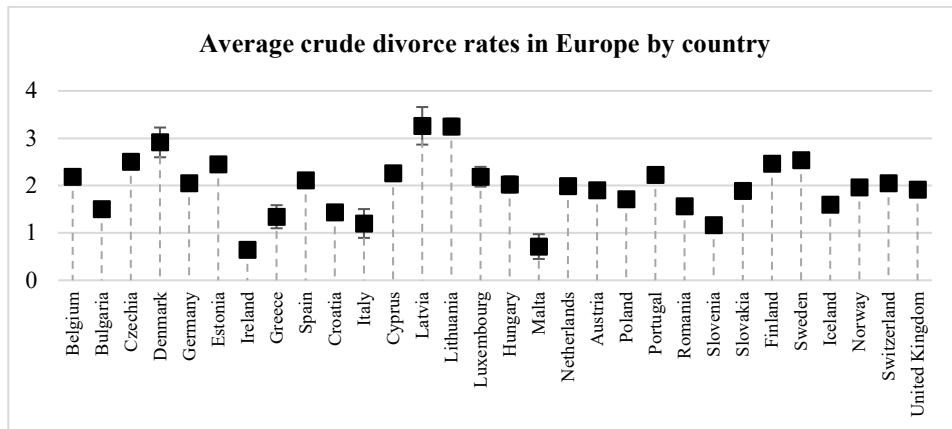
**Figure 6.** Average consumption *per capita* of pure alcohol (in litres) in Europe from 2011 to 2018 by country.



Source: author's work.

Figure 7 shows the average divorce rates from 2011 to 2018 in Europe. The highest average rates were in Lithuania and Latvia, while the lowest in Ireland and Malta. The average suicide rates in these countries also happened to be among the lowest. Moreover, Denmark, Italy, Latvia and Malta were characterised by high variability in the rates during the period under review. The figure shows a considerable variation in the values of average divorce rates among the studied countries. Some observations were missing from the divorce data: for Ireland and Greece for 2018, for the UK for 2017 and 2018, while for Iceland, only data for 2011 were available.

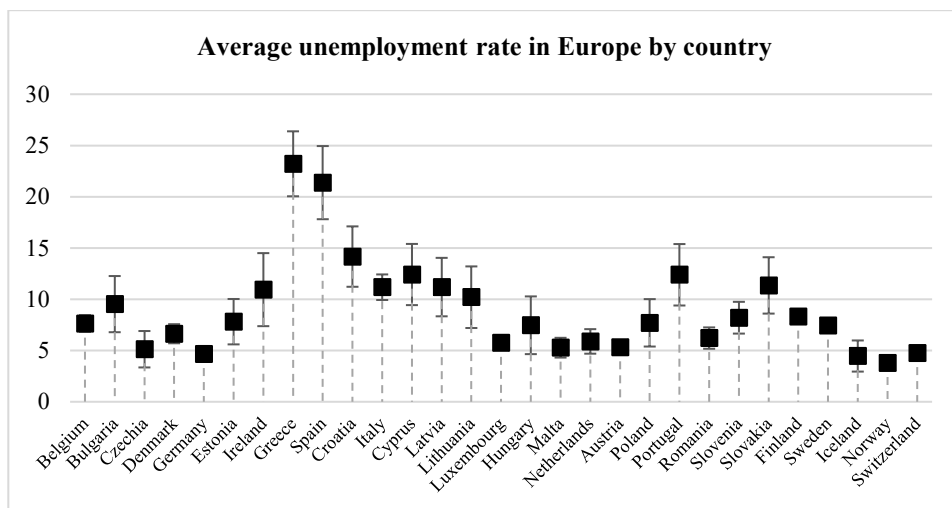
**Figure 7.** Average crude divorce rates in Europe from 2011 to 2018 by country



Source: author's work.

Figure 8 shows the average unemployment rates from 2011 to 2018 in Europe. The UK was omitted due to missing observations over the entire period studied. Greece and Spain had the highest average unemployment rates, equal to 23.2% and 21.4%, respectively. The lowest average unemployment rates of less than 5% were observed in Germany, Iceland, Norway and Switzerland, whose average was 3.8%. The average of most countries was between 5% and 15%. Half of the countries are characterised by a significant variation in the average.

**Figure 8.** Average unemployment rate in Europe from 2011 to 2018 by country



Source: author's work.

**4. Empirical results**

In this research, six variables were studied: the unemployment rate, the percentage of people at risk of poverty or social exclusion, the Gini coefficient of equivalised disposable income, the crude divorce rate, pure alcohol consumption and real GDP *per capita*. To examine the dependencies between the endogenous variables and the exogeneous variable, the parameters of a fixed effects model were estimated. While working in the RStudio environment, the variables were coded as follows: *gini* stands for the Gini coefficient, *alcohol* stands for alcohol consumption, *poverty* stands for the percentage of the population at risk of poverty, *GDP* stands for GDP *per capita*. The parameters of the fixed effects model take the values presented in Table 1.

Table 1 shows the estimation of the model parameters with dummy variables. The impact of the Gini coefficient is statistically significant at the level of 10%, which may result from the fact that the average Gini coefficients among European countries are remarkably close to one another. Poverty risk and alcohol consumption are statistically significant at the level of 0.1%. The impact of GDP *per capita* is not significant. The coefficient of determination is 33%.

**Table 1.** Fixed-effects model estimation for a panel of 30 European countries from 2011 to 2018

	Estimate	Std. Error	t-value	Pr(>  t )	
Gini .....	-0.16	0.08	-1.90	5.90E-02	.
alcohol .....	0.57	0.13	4.37	1.93E-05	***
poverty .....	0.36	0.04	8.50	3.85E-15	***
GDP .....	-0.01	0.01	-0.63	0.52759	
R-Squared:	0.33				

Note. The *Estimate* column – estimated parameter values, *Std. Error* – standard error, *t-value* – value of the statistic, *Pr(> |t|)* – p-value, where \*\*\* – significance at a 0.1% level, \*\* – significance at a 1% level, \* – significance at a 5% level, . – significance at a 10% level, the *R-Squared* row – value of the R<sup>2</sup> coefficient of determination.

Source: summary of the results generated in the RStudio.

Table 2 shows the values of the estimated fixed-effects model with two additional variables. The *divorce* variable denotes raw divorce rates, and *unemployment* denotes the unemployment rate. There are missing observations in both datasets, so the UK was not included in this model. Adding the two additional variables had a positive effect on the coefficient of determination, as it increased it to 49%. The unemployment rate, poverty risk and alcohol consumption have a statistically significant impact at a 0.1% level, the divorce rate has a significant impact at a 1% level, the Gini coefficient has a significant impact at a 10% level, while the impact of GDP *per capita* is not statistically significant. The impact of GDP *per capita* is close to zero, but removing it from the model results in a slight reduction in the coefficient of

determination and entails minor changes in the values of the model parameters. As in the earlier models, the Gini coefficient and GDP *per capita* have a negative impact on suicide rates, while the other variables, along with the additional variables have a positive impact.

**Table 2.** Estimation of a fixed effects model with additional variables for a panel of 29 European countries from 2011 to 2018

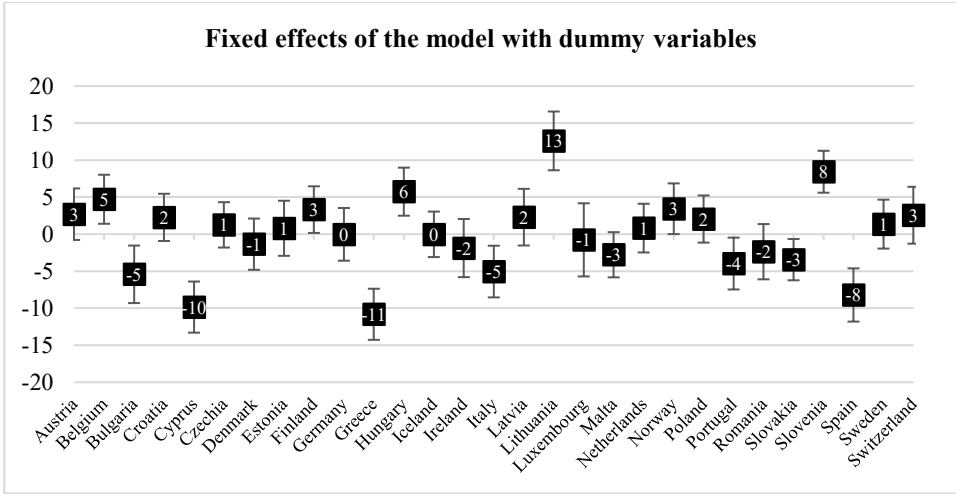
	Estimate	Std. Error	t-value	Pr(>  t )	
gini .....	-0.13	0.07	-1.78	7.69E-02	.
alcohol .....	0.52	0.11	4.57	8.67E-06	***
poverty .....	0.19	0.05	3.91	1.31E-04	***
GDP .....	-0.003	0.01	-0.24	0.812699	
divorce .....	1.47	0.46	3.17	1.78E-03	**
unemployment .....	0.23	0.05	4.61	7.34E-06	***
R-Squared:	0.49				

Note. As in Table 1.

Source: summary of the results generated in the RStudio.

Figure 9 shows the fixed effects of the model with dummy variables. Lithuania, whose average suicide rates from the years 2011–2018 were the highest among all countries, had the largest group effect. Slovenia had the second highest group effect, followed by Hungary, whose average suicide rates also ranked among the highest. The group effect of Latvia, whose average suicide rates were among the highest, was not high, but close to zero. Cyprus Greece and Spain, whose average suicide rates were among the lowest, had the lowest and negative group effects, while the group effects of Italy and Malta, whose average rates were among the lowest, were negative, but close to zero. The group effects of the remaining countries ranged from -5 to 5.

**Figure 9.** Fixed effects of the model with dummy variables for 29 European countries from 2011 to 2018



Source: results obtained in the RStudio; graph developed in Excel.

### 5. Results interpretation

In the estimated model, the impact of the Gini coefficient was negative and, at a significance level of 5%, statistically insignificant. In all models estimated by Inagaki (2010), the parameters determining the impact of the Gini coefficient on suicide rates in Japan are positive and statistically significant. In an article by Andrés (2005), who studied the effect of unemployment and social inequality on suicide rates in 15 European countries the Gini coefficient is also statistically insignificant, but its effect is negative only among women, while positive among men. The breakdown by age also yields inconsistent results. An article written by Kołodziej-Sarzyńska et al. in 2019 mentions a study whose results were contradictory to the results of Andrés (2005) and indicated that the effect of Gini coefficients on female suicide rates is positive. In the literature, the effect of income inequality on suicide rates was interpreted as the effect of less affluent individuals comparing themselves to their wealthier counterparts. In other words, the pressure associated with one’s financial situation is closely related to the wealth of their neighbourhood. As a result, individuals living in richer areas and whose financial situation is clearly worse than that of other residents are more likely to resort to suicide (Kołodziej-Sarzyńska et al., 2019). The reason behind the negative value of the estimation of the Gini coefficient parameter presented in Table 1 may be that its variation among countries was small during the studied period. In Andrés’ (2005) article, the direction of influence of the Gini coefficient parameter on suicide rates differed among age groups and between

men and women. It is likely that countries are too large geographic areas to study the impact of income inequality on suicide rates; therefore, examining these relationships in smaller areas, such as cities or towns and even neighbourhoods of given cities, would provide more accurate and statistically significant results.

Similarly to the Gini coefficient, the impact of GDP *per capita* on suicide rates is negative and statistically insignificant, which is consistent with the results of Andrés (2005) and Fountoulakis et al. (2014). The interpretation of the impact of GDP *per capita* is not related to its effect on individual financial status, but rather to the benefit of the society in the form of financial support distributed in the area of medical care, social care or education. The higher the GDP *per capita*, the more financial aid can be allocated towards measures that directly or indirectly prevent the deterioration of individual mental health (Kołodziej-Sarzyńska et al., 2019).

If the crude divorce rate for a country and a given year had been one unit higher between 2011 and 2018, the suicide rate would have been 1.47 units higher. According to Table 2, the crude divorce rate has a positive and statistically significant parameter, although its significance is lower than that of the other variables. In the model estimated by Andrés (2005), the divorce coefficient has a positive but insignificant impact, which may be caused by individual-specific factors whose influence is suppressed in the aggregated data. On an individual level, divorce entails a major change in a person's life, affecting its every aspect. Firstly, it shatters family relations, as it involves the emergence of negative feelings between the former spouses and a reduction in the contact of one of the parents with the children. The financial situation may deteriorate, in case when the duty of supporting the family rests on the shoulders of only one parent. What is more the perception of a divorcee by their environment also changes, as divorce is often viewed in a negative way. All this can take a toll on mental health. According to a study mentioned in the work of Kołodziej-Sarzyńska et al. (2019), depression and suicidal tendencies are more common among divorced people, especially in the first months after the process is finalised, than among people whose marital status has not changed (Kołodziej-Sarzyńska et al., 2019).

If the unemployment rate for a given year and a given country had been one percentage point higher between 2011 and 2018, suicide rates would have been 0.23 units higher. The unemployment rate is one of the most studied economic factors in the area of suicide. In most models, its effect has a positive direction, while the results are inconsistent regarding its statistical significance. In models estimated by Córdoba-Doña et al. (2014), Fountoulakis et al. (2014) and Inagaki (2010), the unemployment rate has a statistically significant effect, while in the work of Andrés (2005), its effect is significant at a 10% level only in the group of men aged 45 to 64. An individual's occupational status is closely related to their sense of worth and

sense of security, both of which are closely connected with mental health, so abrupt changes in these areas increase the risk of suicide.

If the poverty risk had been one percentage point higher in a country and a year between 2011 and 2018, suicide rates would have been 0.19 units higher. The impact of poverty risk on suicide rates is positive and statistically significant. According to a study described in an article by Murali and Oyebode (2004), members of the lowest and poorest social classes are the most vulnerable to mental illnesses, and suicides occur most commonly in these groups. This is because financial hardship is associated with tremendous social stress. In addition to the threat of not being able to meet one's needs, poverty is associated with social exclusion, which further limits an individual's opportunities to improve their situation (Murali & Oyebode, 2004).

The impact of alcohol consumption on suicide rates is positive and statistically significant. If the average citizen of a European country had drunk one litre of pure alcohol more each year between 2011 and 2018, suicide rates would have been 0.52 units higher. In the work of Andrés (2005), excessive alcohol consumption has a positive and significant effect on suicide rates. Murali and Oyebode (2004) note that high alcohol consumption is most prevalent among the poorest social groups, especially those including people working physically. Alcoholism is associated with the loss of employment and family breakdown; moreover, the risk of aggressive and self-aggressive behaviour increases under the influence of alcohol. The number of suicide-related deaths resulting from excessive alcohol consumption varies strongly from country to country, depending on the cultural attitudes toward alcohol consumption and the type of alcohol consumed (Kołodziej-Sarzyńska et al., 2019).

The highest average suicide rates from among the countries studied for all exogenous variables, except GDP *per capita*, are observed in Lithuania. The Gini coefficient, risk of poverty and social exclusion, the unemployment rate, alcohol consumption and divorce rates reach some of the highest values in this country, while the GDP *per capita* remains one of the lowest. Cyprus, on the other hand, whose average suicide rate reaches the lowest value of 4.3, has a slightly lower Gini coefficient, lower poverty risk, lower alcohol consumption and lower divorce rates compared to Lithuania, while the unemployment rate is higher, as is the GDP *per capita*. It should be noted, however, that Cyprus is among the smaller countries analysed.

## 6. Conclusions

The aim of this study was to examine the impact of socioeconomic variables on suicide rates in European countries. For this purpose, a panel analysis was performed using a fixed effects model. From the dataset examined, the only variables that reduce suicide rates are GDP *per capita* and the Gini coefficient, but their

impact is statistically insignificant at a 5% level. The remaining variables are statistically significant at a 5% significance level and increase suicide rates. The growing effect of divorce on suicide rates is related to the overwhelming stress experienced by the divorcee, resulting from the sudden change in the family situation, greater financial burden, limited contact with the children and a culturally determined bias towards divorced people. Both unemployment and the risk of poverty are related to the financial situation of an individual, affecting one's sense of security. The lack of work, especially an abrupt change in the occupational status, reduces an individual's sense of worth and agency over their fate. The risk of poverty and social exclusion is associated with long-term financial and social hardship, which results in a feeling of hopelessness. Consumption of pure alcohol has an increasing and significant impact on suicide, which can be the result of problems stemming from alcohol addiction.

Two groups of countries with the highest and lowest suicide rates emerged based on the estimated group fixed effects. The fixed effects from 2011 to 2018 were the highest in Lithuania and Slovenia and the lowest in Cyprus, Greece and Spain. The fixed effects model suggests the existence of unmeasured factors specific to each country, which also significantly affect the level of suicide rates. These factors include e.g. the country's latitude, which determines the level of sunshine, amount of rainfall or the temperature in a country. Another factor could be related to the perception of suicide in terms of a country's culture or dominant religion, e.g. Christianity sees suicide as a sin, while in Japanese culture suicide is of a ritualistic nature.

Based on the results obtained from the model and information in the literature, it is safe to say that certain economic and social factors significantly shape the mental health of the residents of a country. Determining which of these factors have a significant impact and which do not is difficult. In some cases, the trend is dependent on the studied period, the population or distribution with respect to gender and age groups. The impact of GDP *per capita*, unemployment and the Gini coefficient are characterised by a high degree of inconsistency among studies in terms of both their statistical significance and direction of change. On the other hand, divorce rates, poverty risk and alcohol consumption produce consistent results, so it can be assumed that their impact should be given special consideration when planning suicide prevention policies.

Divorce is a sensitive topic that involves many negative emotions and difficult situations, for instance cheating, fighting or even violence. For this reason, reducing their impact on mental health is exceedingly difficult, as it requires an individual approach to each case, possible only during couples' therapy, which, for several reasons, not everyone wants to undergo. The fight against excessive and unhealthy alcohol consumption is possible primarily by making the public aware of the



negative effects of alcoholism, which affect not only the person with the disease, but also their closest family. The threat of poverty can be reduced through social benefits and creating opportunities for a better life, for instance detailed assistance with finding a job that includes not only finding work offers, but also preparing for interviews and future employment.

In summary, the phenomenon of suicide is an overly complex disease process that takes a different course in each case. Suicides do not occur suddenly from nowhere but are preceded by suicidal thoughts which eventually escalate to suicidal behaviour. They are influenced by many internal factors, specific to each individual, which are challenging in analysis due to their complexity and difficulty of detection. There are also external factors whose impact is observable, thus enabling prevention. Although collective data may not fully indicate a significant in individual suicide cases impact of economic or demographic events, their analysis is essential to suicide prevention, as it highlights which areas should be the focus of legislators.

It is also vital to spread awareness and to promote mental health care. Struggling individuals should be provided with easy access to specialists and facilities. Mental health is key to an individual's effective functioning in a society, thus more attention should be directed towards the provision of mental health treatment and suicide prevention.

## References

- Andrés, A. R. (2005). Income inequality, unemployment, and suicide: a panel data analysis of 15 European countries. *Applied Economics*, 37(4), 439–451. <https://doi.org/10.1080/0003684042000295304>.
- Córdoba-Doña, J. A., San Sebastián, M., Escolar-Pujolar, A., Martínez-Faure, J. E., & Gustafsson, P. E. (2014). Economic crisis and suicidal behavior: the role of unemployment, sex and age in Andalusia, Southern Spain. *International Journal for Equity in Health*, 13(1), 1–10. <https://doi.org/10.1186/1475-9276-13-55>.
- Crawford, M. J. & Prince, M. (1999). Increasing rates of suicide in young men in England during the 1980s: the importance of social context. *Social Science and Medicine*, 49(10), 1419–1423. [https://doi.org/10.1016/S0277-9536\(99\)00213-0](https://doi.org/10.1016/S0277-9536(99)00213-0).
- Fountoulakis, K. N., Kawohl, W., Theodorakis, P. N., Kerkhof, A. J. F. M., Navickas, A., Höschl, C., Lecic-Tosevski, D., Sorel, E., Rancans, E., Palova, E., Juckel, G., Isacson, G., Korosec Jagodic, H., Botezat-Antonescu, I., Warnke, I., Rybakowski, J., Azorin, J. M., Cookson, J., Waddington, J., Pregelj, P., Demyttenaere, K., Hranov, L. G., Injac Stevovic, L., Pezawas, L., Adida, M., Figuera, M. L., Pompili, M., Jakovljević, M., Vichi, M., Perugi, G., Andreassen, O., Vukovic, O., Mavrogiorgou, P., Varnik, P., Bech, P., Dome, P., Winkler, P., Salokangas, R. K. R., From, T., Danileviciute, V., Gonda, X., Rihmer, Z., Forsman Benhalima, J., Grady, A., Kloster Leadholm, A. K., Soendergaard, S., Nordt, C., & Lopez-Ibor, J. (2014). Relationship of suicide rates to economic variables in Europe: 2000–2011. *The British Journal of Psychiatry*, 205(6), 486–496. <https://doi.org/10.1192/bjp.bp.114.147454>.

- Gunnell, D. J., Peters, T. J., Kammerling, R. M., & J. Brooks (1995). Relation between parasuicide, suicide, psychiatric admissions, and socioeconomic deprivation. *BMJ*, 311(6999), 226–230. <https://doi.org/10.1136/bmj.311.6999.226>.
- Inagaki, K. (2010). Income Inequality and the Suicide Rate in Japan: Evidence from Cointegration and La-Var. *Journal of Applied Economics*, 13(1), 113–133. [https://doi.org/10.1016/S1514-0326\(10\)60006-2](https://doi.org/10.1016/S1514-0326(10)60006-2).
- Kołodziej-Sarzyńska, M., Majewska, M., Juchnowicz, D., & Karakuła-Juchnowicz, H. (2019). Czynniki ryzyka samobójstwa w kontekście teorii integracji społecznej według Émile'a Durkheima. *Psychiatria Polska*, 53(4), 865–881. <https://doi.org/10.12740/PP/92217>.
- Murali, V., & Oyeboode, F. (2004). Poverty, social inequality and mental health. *Advances in Psychiatric Treatment*, 10(3), 216–224. <https://doi.org/10.1192/apt.10.3.216>.
- Pieszczachowicz, J. (Ed.). (1997). Psychiatria. Psychika. Psychologia. In *Popularna encyklopedia powszechna* (t. 14). Fogra.
- Preti, A. (2003). Unemployment and suicide. *Journal of Epidemiology & Community Health*, 57(8), 557–558. <https://doi.org/10.1136/jech.57.8.557>.
- Pużyński, S. (2007). Choroba psychiczna – problemy z definicją oraz miejscem w diagnostyce i regulacjach prawnych. *Psychiatria Polska*, 41(3), 299–308. [https://www.psychiatriapolska.pl/pdf-154113-78667?filename=Choroba%20psychiczna%20\\_.pdf](https://www.psychiatriapolska.pl/pdf-154113-78667?filename=Choroba%20psychiczna%20_.pdf).
- Raczkowska, M. (2017). Nierówności dochodowe w kontekście jakości życia w krajach Unii Europejskiej. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, (498), 273–283.
- Rosa, K. (2012). (Nie)wiarygodność danych statystycznych dotyczących zachowań samobójczych. Perspektywa teoretyczna i praktyka społeczna. *Przegląd Socjologiczny*, 61(2), 265–290.
- Woźniak, M. (2020). Zachowania suicydalne jako problem społeczny XXI wieku – charakterystyka zjawiska z uwzględnieniem przyczyn oraz metod zapobiegawczych. In N. Laurisz, *Wyzwania i problemy społeczne początku XXI wieku* (pp. 108–119). Fundacja Gospodarki i Administracji Publicznej.
- Yin, H., Xu, L., Shao, Y., Li, L., & Wan, C. (2016). Relationship between suicide rate and economic growth and stock market in the People's republic of China: 2004–2013. *Neuropsychiatric Disease and Treatment*, (12), 3119–3128. <https://doi.org/10.2147/NDT.S116148>.

## Report from the 32nd Scientific Conference of the Classification and Data Analysis Section of the Polish Statistical Association

Krzysztof Jajuga,<sup>a</sup> Dominik Krężolek,<sup>b</sup> Marek Walesiak<sup>c</sup>

The 32nd Scientific Conference of the Classification and Data Analysis Section of the Polish Statistical Association was held on 19–20 September 2023, in Katowice, Poland. The conference was organised by the Classification and Data Analysis Section (Pol. Sekcja Klasyfikacji i Analizy Danych – SKAD) of the Polish Statistical Association (PSA), and by the Department of Demography and Economic Statistics, and the Department of Economic and Financial Analysis of the University of Economics in Katowice. Basic information about the conference is available at: <https://skad2023.ue.katowice.pl/>.

The Organising Committee was chaired by Dominik Krężolek, PhD, DSc, professor at the University of Economics in Katowice, while Alicja Ganczarek-Gamrot, PhD, DSc, professor at the University of Economics in Katowice, Justyna Majewska, PhD, Joanna Trzęsiok, PhD, and Jakub Kubiczek, MSc, were the members of the committee.

The following topics were addressed during the conference:

- theoretical aspects (taxonomy, graphical methods, discriminant analysis, linear ordering methods, multivariate statistical analysis, methods of analysing continuous and discrete variables, symbolic data analysis, machine learning methods);
- applications (financial data analysis, marketing data analysis, spatial data analysis, computer application of statistical methods, other areas of data analysis application – medicine, psychology, archaeology, etc.).

---

<sup>a</sup> Wrocław University of Economics and Business, Faculty of Economics and Finance, Department of Financial Investments and Risk Management, ul. Komandorska 118/120, 53-345 Wrocław, Poland, e-mail: [krzysztof.jajuga@ue.wroc.pl](mailto:krzysztof.jajuga@ue.wroc.pl), ORCID: <https://orcid.org/0000-0002-5624-6929>.

<sup>b</sup> University of Economics in Katowice, Faculty of Informatics and Communication, Department of Demography and Economic Statistics, ul. 1 Maja 50, 40-287 Katowice, Poland, e-mail: [dominik.krezolek@ue.katowice.pl](mailto:dominik.krezolek@ue.katowice.pl), ORCID: <https://orcid.org/0000-0002-4333-9405>.

<sup>c</sup> Wrocław University of Economics and Business, Faculty of Economics and Finance, Department of Econometrics and Computer Science, ul. Komandorska 118/120, 53-345 Wrocław, Poland, e-mail: [marek.walesiak@ue.wroc.pl](mailto:marek.walesiak@ue.wroc.pl), ORCID: <https://orcid.org/0000-0003-0922-2323>.

The main objective of the SKAD conference was to present the current research and create a platform for the exchange of ideas relating to theoretical and applied aspects of classification and data analysis. This annually held forum provides an opportunity for the presentation and promotion of state-of-the-art research and indicates possible development directions.

The conference featured 48 participants who are faculty members and doctoral students of the following universities and institutions: Mazovian Academy in Płock, Statistics Poland, Gdańsk University of Technology, Silesian University of Technology, Warsaw University of Life Sciences, SGH Warsaw School of Economics, Universidade do Porto, University of Essex, University of Economics in Katowice, Cracow University of Economics, Poznań University of Economics and Business, Wrocław University of Economics and Business, University of Gdańsk, Adam Mickiewicz University in Poznań, Lodz University, Poznań University of Life Sciences, University of Szczecin, the Statistical Office in Poznań.

39 presentations introducing research results relating to the theory and application of classification and data analysis were presented during four plenary and five parallel sessions. The sessions were chaired by Grażyna Trzpiot, Krzysztof Jajuga, Paweł Lula, Marek Walesiak, Elżbieta Gołata, Joanna Landmesser-Rusek, Andrzej Dudek, Jacek Batóg, Krzysztof Najman, Grażyna Dehnel, Iwona Foryś, Jerzy Korzeniewski, Kamila Migdał-Najman, and Eugeniusz Gatnar.

Below is a list of all papers presented during the conference:

- Krzysztof Jajuga, Józef Pocięcha, Marek Walesiak, *Wrocław and Cracow scientific centers and our Masters: Professor Zdzisław Hellwig and Professor Kazimierz Zajac – contribution to the development of the classification and data analysis methods*;
- Berthold Lausen, *Data Science Challenges for Explainable Artificial Intelligence (AI)*;
- Andrzej Dudek, *Forecasting volatility in time series with deep neural networks – an overview of methods and algorithms*;
- Grażyna Trzpiot, Zuzanna Krysiak, *Application of the cluster analysis to describe the climatic phenomenon of internal migration for selected countries*;
- Katarzyna Stapor, *Reliable Evaluation of Classification Models*;
- Marta Kuc-Czarnecka, Andrea Saltelli, *Ranking the rankers. An analysis of the science-wide author databases of standardized citation indicators*;
- Eugeniusz Gatnar, *Methods of measuring the costs of using dwellings by owners in the measurement of inflation*;
- Iwona Foryś, Jacek Batóg, *Factors influencing the prices of land for residential development in areas of increased noise: a statistical analysis*;

- Ewa Putek-Szeląg, Anna Gdakowicz, *The time of exposure of the property on the market and the features influencing its sale*;
- Jacek Batóg, Barbara Batóg, *Analysis of the long-term relationship between the size of the city and the level of development*;
- Marek Walesiak, Grażyna Dehnel, *Assessment of the implementation of the SDG 7 goal in EU countries in the perspective of the target year 2030 with the application of dynamic relative taxonomy and cluster analysis*;
- Jarosław Lira, Feliks Wysocki, *The use of the relative taxonomy method in the analysis of the economic activity of EU countries*;
- Justyna Majewska, *Analysing patterns of changes in mortality using functional data clustering*;
- Agnieszka Orwat-Acedańska, *Classification of small area populations according to mortality forecast errors resulting from relational models*;
- Kamila Migdał-Najman, Krzysztof Najman, *The image of the Tri-City Agglomeration through the eyes of Twitter users*;
- Paweł Lula, *Spatial, Temporal and thematic diversity of publication activity in Poland in the field of economics, finance and management based on the OpenAlex database*;
- Mirosław Krzyśko, Marcin Szymkowiak, Waldemar Wołyński, *Tourist attractiveness of counties in Poland in the light of functional Principal Component Analysis*;
- Marcin Salamaga, *Study of the impact of socio-economic factors on the diffusion of mobile technologies in spatial terms in Poland*;
- Janusz Wywiiał, Tomasz Szkutnik, *Bootstrap tests for unbiasedness of predictors*;
- Paweł Kaczmarczyk, *The effectiveness analysis of econometric modelling of the compound cyclicity of hourly demand for telecommunications services with the use of selected orders of autoregression*;
- Stanisław Jaworski, *The Optimal Sample Size in Triangular Model for Sensitive Questions*;
- Jerzy Korzeniewski, *Two-stage algorithm for establishing the sentiment of text documents*;
- Joanna Landmesser-Rusek, *Influence of the measure used to calculate the distance between time series for exchange rates on the topological structure of the currency network*;
- Anna Zamojska, *Examination of the durability of indicators for assessing the effectiveness of investment portfolio management in the short and long-term*;
- Marcin Pelka, *Symbolic Data Analysis in Payment Card Fraud Detection*;

- Jakub Kubiczek, Marek Leśkiewicz, *Specificity of distributions and possibilities of tax data analysis*;
- Elżbieta Gołata, *Reflections after NSP 2021 – the quality of the census*;
- Wioletta Grzenda, *Working life expectancy in Poland and periods of unemployment – longitudinal analysis based on SHARE data*;
- Grażyna Trzpiot, *Redefinitions of demographic burden measures*;
- Marcin Pelka, Aneta Rybicka, *Analysis of preferences and behaviours during online shopping*;
- Aneta Ptak-Chmielewska, Małgorzata Grzywińska-Rąpca, *Consumer Confidence Index (CCI) for European countries – link to the objective situation of households*;
- Andrzej Bąk, Tomasz Bartłomowicz, *Measuring consumer preferences using conjoint and radiant.multivariate packages of the R program*;
- Dominik Krężołek, *Semiparametric optimization of the investment portfolio in the metals and energy commodities market*;
- Dominik Krężołek, *Semiparametric Quantile Regression – Extreme Risk Analysis in the Metals Market*;
- Katarzyna Frodyma, *The DEA Method in Energy Efficiency Analysis*;
- Joanna Trzęsiok, *How do you colour black boxes? Comparison of selected solutions in the field of interpretability of nonparametric regression and discrimination models*;
- Michał Pietrzak, *The Idea of Economic Distance in the Potential Ratio Model*;
- Sylwia Filas-Przybył, Tomasz Klimanek, *Pupils' commuting to school – an analysis of selected aspects of mobility*;
- Dominik Rozkrut, *Ethical principles and data processing*.

The members of SKAD held an annual meeting on the first day of the conference. The meeting was chaired by Andrzej Dudek, President of SKAD, and its agenda included the following items:

- report on the SKAD activities;
- information on the planned domestic and international conferences;
- organisation of SKAD conferences in 2024 and 2025;
- elections of the representatives of SKAD to the International Federation of Classification Societies (IFCS) Council;
- other issues.

The Chairman of SKAD, Andrzej Dudek, PhD, DSc, Associate Professor, opened the meeting and reported on the activities of SKAD. He announced that SKAD currently has 235 members and is under review for information sharing resulting from the GDPR. He reminded the participants of the meeting that the SKAD website

features regulations and a membership declaration. Then, a minute of silence was observed in memory of the members of SKAD who passed away in the last period.

Issue 3/2022 of *Przegląd Statystyczny. Statistical Review* contains a report from the conference held at the Warsaw University of Life Sciences: Jajuga K., Landmesser-Rusek J., Walesiak M. (2022), *Report from the 31st Scientific Conference of the Classification and Data Analysis Section of the Polish Statistical Association*, (Vol. 69, no. 3, pp. 63–67).

Prof. Andrzej Dudek announced that Prof. Krzysztof Jajuga has been elected President of the IFCS for the period of 2025–2026. From 2023 to 2024, he will serve as President-elect and from 2027 to 2028 as Past President. In addition, Dr Marcin Pełka has been elected member of the Election Committee of the IFCS (until 31 March 2027).

Prof. Andrzej Dudek announced that the participants from Poland presented in Polish three papers during the DSSV-ECDA 2023 Conference (5–7 July 2023). During the CLADAG 2023 conference (11–13 September 2023, Salerno), Prof. Barbara Pawełek was member of the Scientific Committee, and Prof. Paweł Lula, Prof. Barbara Pawełek, Prof. Agnieszka Wałęga, Prof. Paweł Ulman were the organisers of the invited scientific sessions. Participants from Poland presented eight papers during the conference.

In the years 2023–2025, the following conferences are planned: the 41st International Scientific Conference from the Multivariate Statistical Analysis (MSA 2023) series (6–8 November 2023, Łódź), the 17th International Scientific Conference on Modelling and Forecasting of Socio-Economic Phenomena (13–16 May 2024, Zakopane), ECDA 2023 (9–11 September 2024, University of Gdańsk, Sopot), German-Polish Seminar on Data Analysis and Applications (11 September 2024, University of Gdańsk, Sopot), IFCS 2024 (15–19 July 2024, San Jose, Costa Rica), and CLADAG (2025, Sardinia).

The next item on the agenda was the organisation of the subsequent SKAD conferences. Prof. Paweł Lula made a declaration that the conference will be held at the Cracow University of Economics in 2024. The conference will be part of the programme celebrating the 100th anniversary of the establishment of the Cracow University of Economics.

In the next part of the meeting, the representatives of SKAD were elected to the IFCS Council. Two vacancies became available due to the end of the term of office of Prof. Andrzej Sokołowski and Prof. Krzysztof Jajuga's election as the IFCS president. Prof. Eugeniusz Gatnar (Chairman) and Dr Marcin Pełka (member) were appointed to the Returning Committee. Prof. Eugeniusz Gatnar asked the participants of the conference to propose candidates. Prof. Józef Pociecha proposed the candidacy of Paweł Lula (term of office until 2027) and Prof. Krzysztof Jajuga proposed the

candidacy of Andrzej Dudek (term of office until 2025). The candidates confirmed their consent to stand as candidates. Subsequently, a motion was voted on to close the list of candidates, which was unanimously accepted. The Returning Committee held a secret ballot. 27 members of SKAD took part in the voting (27 valid votes were cast). The results of the votes were 27 and 26 in favour, respectively, which ultimately confirmed the election of the above-mentioned candidates.

At the end of the second day of the conference, the SKAD Chairman, Prof. Andrzej Dudek, thanked the organisers and participants of the conference and invited them to the next SKAD conference to be held in Kraków.