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CONTENTS

Households' Attitudes and Preferences Towards Socially Responsible Investing

Rafał Buła [1]

Abstract

The rapid development of the market for Socially Responsible Investments (SRI) raises a question about the motives of investors purchasing socially responsible financial instruments. This study aims to determine whether households‘ investment choices reflected in the rate of return on their asset portfolios are influenced by respondents' values, general attitudes (beliefs) and personal norms towards environmental deterioration. In the study, the Value-Belief-Norm model was used to disentangle how Polish households‘ attitudes and preferences towards SRI shape their decisions. The conclusions drawn based on the online survey results, factor analysis, and estimated SEM-PLS model suggest that the influence of rising ecological awareness slightly lowers the required rate of return, but this impact can be treated as negligible and statistically insignificant.

Key words

Socially Responsible Investing, ESG, households‘ attitudes and preferences

JEL Classification: G41, G51, Q51

1. Introduction

Since the pioneering work of [Moskowitz, 1972], the problem of creating a portfolio meeting the additional criteria of nonfinancial character has been widely discussed by researchers and practitioners. As it is shown, e.g., by [Cochran and Wood, 1984], this debate is similar to the discussion dating back to the 1960s regarding the relation between social responsibility of enterprises and their financial outcomes (Corporate Social Performance, CSP vs. Corporate Financial Performance, CFP). Achieving a consent about necessity of taking into account nonfinancial aspects while assessing companies‘ performance required a long dispute and implementation of many legal acts [Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting]. However, this issue is still controversial and closely tied to the problem of determining the bundle of final corporate goals [Smith, 2003]. In reality, the problem whether there exists the co called „virtuous circle“ [Waddock and Graves, 1997] is unresolved as, e.g., [Zhao and Murrell, 2021] deny its existence based on the analysis covering a few hundreds of US companies or [Bussoli and Conte, 2018] in case of European banks. In some cases, a positive influence of CFP on CSP is found [Waddock and Graves, 1997], [Zhao and Murrell, 2016], while sometimes a negative one can be revealed [Bussoli and Conte, 2018]. But the real break of the „virtuous circle“ is a lack of confirmed impact of

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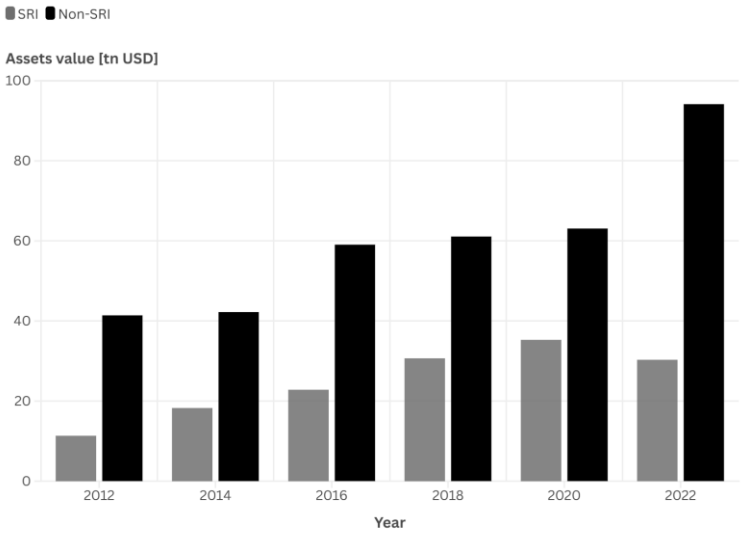
CSP on CFP [Zhao and Murrell, 2016, 2021]. As a result, it becomes doubtful whether investing in socially responsible companies can bring the investors the required financial outcome. As [Cornell and Damodaran, 2020] and [Hamilton et al., 1993] claim, considering nonfinancial aspects while creating an investment portfolio can be detrimental to its overall performance. [Cornell and Damodaran, 2020] following the reasoning of [Fama and French, 2007] argue that in the standard market equilibrium model existence of an above-average appetite on a specific type of assets (in this paper socially responsible ones) distorts asset pricing (compared to the situation when purely financial aspects are taken into account). As a result, elevated prices of socially responsible instruments lead to lower equilibrium returns accepted by the investors. As a consequence, the households‘ attitudes and preferences regarding environmental and social aspects of companies‘ activities are crucial to understanding their behaviour towards socially responsible assets. Identification of the influence of these attitudes and preferences (values, beliefs and norms) on the rate of return of households‘ portfolios is the main scientific aim of this study. To investigate the abovementioned issue, the Value-Belief-Norm model is used [Stern et al., 1999], as it is widely exploited to measure the support for social movements. The analysis is based on online survey results (2,000 adult respondents from Poland, representative by taking into account provinces, gender and age groups by using the quota sampling method).

The structure of the remaining part of the study is as follows. In the next section, a brief literature review discussing the idea of socially responsible investments and the attempts to analyse households‘ investment motives is presented. In the Data and Methodology section, the information about the sample and the methodology is provided. The Discussion offers a review of the main outcomes of the research, while the last part concludes.

2. Literature Review

The idea of socially responsible investing dates back to ancient times, being a product of religious norms. The modern history of SRI began in 1928 when the first ethical investment fund was created – the Pioneer Fund [Redins, 2006]. The SRI investing became more popular in the 1960s as a consequence of the US engagement in the Vietnam War [Beabout and Schmiesing, 2003] – in 1971, the World Pax Fund was created.

Figure 1: Value of SRI and non-SRI assets



Source: Own elaboration based on [GSIA, 2022].

An additional factor supporting the development of the SRI industry was the disinvestment strategy applied by many countries in opposition to apartheid in the Republic of South Africa [Grossman and Sharpe, 1986]. As of now, socially responsible investment is treated as "an investment approach that considers environmental, social and governance (ESG) factors in portfolio selection and management" [GSIA, 2022]. The rapid development of SRI is depicted in Figure 1.

Among the most crucial problems related to SRI is the problem of whether investing in this type of asset generates positive abnormal rates of return or not. [Statman and Glushkov, 2009] discussed three possible hypotheses concerning this issue:

1) *Doing good while doing well* implies that socially responsible companies provide the shareholders with excessive profits and rates of return.
2) *Doing good but not well* states that being socially responsible consumes shareholders' profits and depresses a company's performance.
3) *No effect* claims that socially responsible issues do not have any impact on a company's results.

[Cornell and Damodaran, 2020] claim that in the equilibrium, the *doing good but not well* hypothesis is the correct one, as justified by the theory of [Fama and French, 2007]. According to their idea, when a group of investors voluntarily resigns from including specific companies in their portfolio, only an increase in the expected rate of return encourages the remaining ones to hold them in equilibrium. As a result, the "sin stocks" must provide the investors with a positive abnormal rate of return, while the socially responsible assets generate negative alphas. As investing in socially responsible assets is not financially viable in this theory, the utility from holding them must be a result of satisfying needs other than the financial needs of the investors. Besides the financial motives, it is argued that the following motives exist [Doś and Foltyn-Zarychta, 2017]:

a) ethical,
b) individual investor preferences,
c) actions aimed at transforming the current socio-economic system,
d) image-related,
e) religious,
f) emotional and psychological.

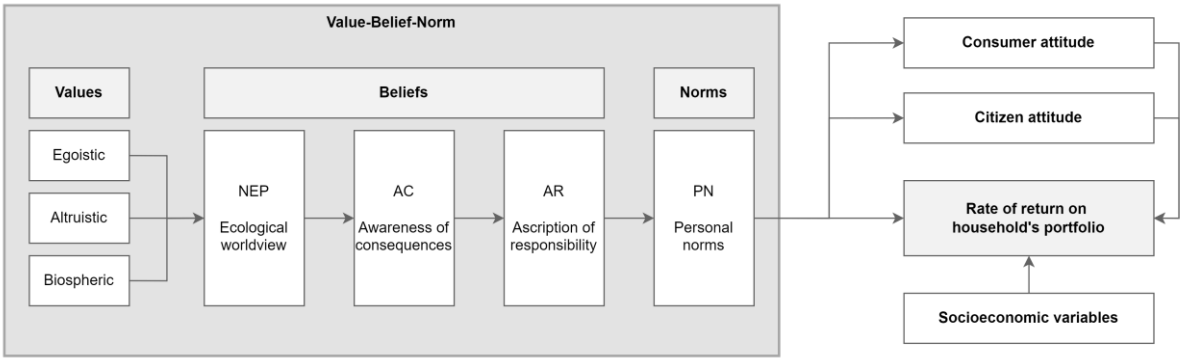
In the literature, many attempts were made to identify the most significant motives to invest in socially responsible assets using various theories and their influence on many distinct SRI characteristics.

[Nilsson, 2008] showed that among 528 private Swedish investors, the pro-social attitudes regarding the issues addressed in SRI positively influence investors' behaviour for SRI. [Doś et al., 2023] used the Contingent Valuation framework and Willingness-to-Pay (WTP) to investigate eagerness to sacrifice financial outcome while making SRIs among 521 millennials from Italy, Poland and Ukraine. They included in their study such values as ethicality, environmentalism, religiosity, collectivism and materialism while controlling for nationality and preparation to make SRI decisions. Using the Kruskal-Wallis test and multinomial ordered logit model, they find that environmentalism was the strongest factor among values influencing positively the WTP, while the remaining significant values were religiosity, ethics and collectivism. [Raut and Kumar, 2023] applied the SEM-PLS model and the Value-Attitude-Behaviour model to investigate the role of investors' values on their attitudes and intentions towards SRI. The analysis based on responses of 36 representatives of industry and academia proved a significant positive impact of Indian investors' attitudes on their intentions toward SRI. [Zhang, 2024] investigated 2824 US investors participating in the 2021 State-by-State Survey. Inspired by the Value-Belief-Norm model, he used the two-step hierarchical OLS to determine the influence of socially responsible motivation on the

importance investors placed on the ESG factor. The results clearly show that socially responsible motivation is positively and significantly impacting the ESG importance. [Shree and Pushpa, 2025] interviewed 100 investors from Bengaluru and analysed the correlation between the components of the VBN model and ethical investment behaviour, as application of this model was supported by [Abhayagunarathna and Gamage, 2023]. Using correlation analysis, they came to the conclusion that there is a strong and significant relationship between the constructs from the VBN model and ethical behaviour.

Having analysed the existing literature, it was noticed that the Value-Belief-Norm model of [Stern et al., 1999], despite its appealing features, is rarely used to analyse respondents' values influence on SRI. Thus, the author decided to exploit this model in disentangling the influence of pro-environmental values, beliefs and norms on the declared return rate on households' portfolios.

Figure 2: Value-Belief-Norm model impact on declared rate of return



Source: Own elaboration.

The VBN model combines components reflecting people's values, beliefs (worldview, awareness of consequences and consciousness of responsibility) and norms and tries to explain pro-environmental behaviour using a causal chain between the abovementioned constructs (Figure 2). Therefore, in this study, two hypotheses are tested:

H_1: The VBN model correctly reflects the pro-environmental attitude of the respondents.

H_2: The pro-environmental attitude of the respondents diminishes the declared rate of return on households' portfolio (the WTP for social responsibility is positive).

These hypotheses are tested in the following sections.

3. Data and Methodology

The empirical part of this analysis is based on 2000 surveys. Considering the time and cost of gathering the responses, an online survey was used. It was conducted by a market research company among residents of all regions of the Republic of Poland within the period 1-31 August 2024. The sample is representative, taking into account living place (at the level of provinces), gender and age groups as a result of the application of a quota sampling method. As in the study the dependent variable is the level of rate of return on households' portfolios, all respondents who declared that they do not save neither invest (in PLN) were excluded from the analysis (to maintain the coherence of results, the respondents saving or investing in other currencies only were also excluded). Finally, the sample consists of 907 respondents. The demographic characteristics of the sample and the subsample are presented in Table 1.

Table 1: Demographic characteristics of survey participants

	All	Savers
	Number	
Gender	$\chi^2 = 0.36$, p-value = 0.548	
Male	955	444
Female	1045	463
Age	$\chi^2 = 6.34$, p-value = 0.175	
18-29	299	132
30-39	360	178
40-49	397	208
50-59	301	124
60+	643	265
Education level	$\chi^2 = 57.98$, p-value = 0.000	
Primary school	21	6
Middle school	12	1
Vocational school	189	40
High school	621	227
Post-secondary school	187	71
Bachelor degree	234	116
Master's degree or higher	736	446
Household size	$\chi^2 = 8.10$, p-value = 0.324	
1 person	288	123
2 persons	594	297
3 persons	532	252
4 persons	390	167
5 persons	125	49
6 persons	50	14
7 persons	15	4
8 persons	6	1
Having children below 18	$\chi^2 = 1.51$, p-value = 0.220	
Yes	720	348
No	1280	559
Income level (in PLN)	$\chi^2 = 62.74$, p-value = 0.000	
Up to 1500	107	21
1501-3000	315	86
3001-4500	585	270
4501-6000	453	244
6001-7500	196	121
7501 or more	158	110
Prefer not to say	186	55
Living place	$\chi^2 = 3.65$, p-value = 0.056	
Rural area	532	211
Urban area	1468	696

Source: Own elaboration.

The subsample differs from the whole sample by the level of income and education. The remaining demographic characteristics are the same in both groups (the results of the chi-square homogeneity test are given in Table 1).

To create the structural model, many latent constructs reflecting the VBN model ideas were formed using the Likert scale of five points (from “fully disagree” to “fully agree”) as well as binary variables (“yes”, “no”). The scales were based on the items exploited by [Stern et al., 1999]. Before the structural model was created, a few initial analyses were conducted, including Mann-Whitney and Kruskal-Wallis tests for rate of return and socio-economic and demographic variables. Moreover, the Principal Component Analysis and Exploratory Factor Analysis methods were used. The last step was to create a SEM-PLS model described before. The outcomes are presented in the next section.

4. Results and Discussion

As the first step, the distribution of the declared rate of return of households' portfolios (in PLN) was analysed. Moreover, an initial assessment of potential ties to the socioeconomic and demographic variables was conducted using the nonparametric tests. The descriptive statistics of the return rate are shown in Table 2, while the distribution is shown in Figure 3.

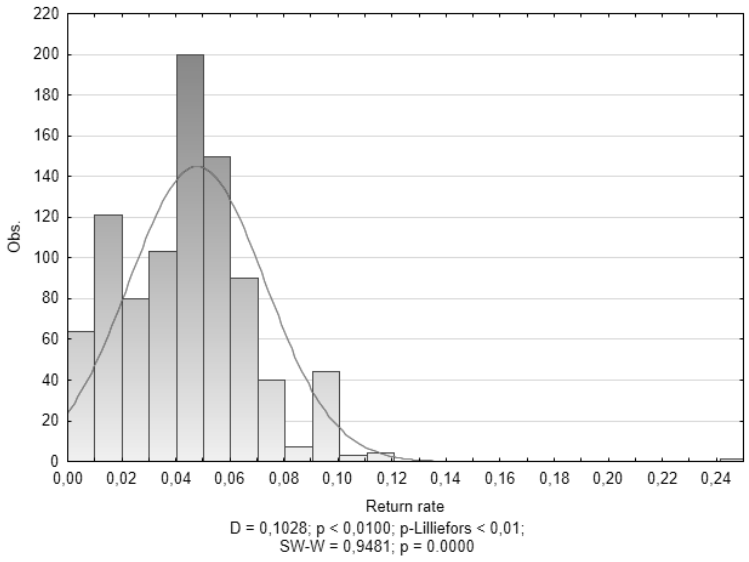
Table 2: Basic characteristics of the declared rate of return

	Return rate
Observations	907
Mean	0.0476
Confidence (-95%)	0.0460
Confidence (95%)	0.0493
Median	0.0500
Mode	0.0500
Frequency of Mode	169
Minimum	0.0000
Maximum	0.2515
Std.Dev.	0.0251
Coef.Var.	52.7622
Standard (Error)	0.0008
Skewness	0.7489
Kurtosis	4.3576

Source: Own elaboration.

The average declared rate of return equals 4.76% and is higher by 86 bp than the average rate of return on bank deposits at that time (3.90%) [NBP, 2025], close to the median and mode (5.00%). The distribution is right-skewed and leptokurtic (normality hypothesis rejected).

Figure 3: Declared rate of return distribution



Source: Own elaboration.

In the next step, the dependencies between various socio-economic and demographic factors were investigated as a step towards creating a PLS-SEM model. The results are included in Table 3.

Table 3: Nonparametric tests of rate of return by socioeconomic and demographic variables

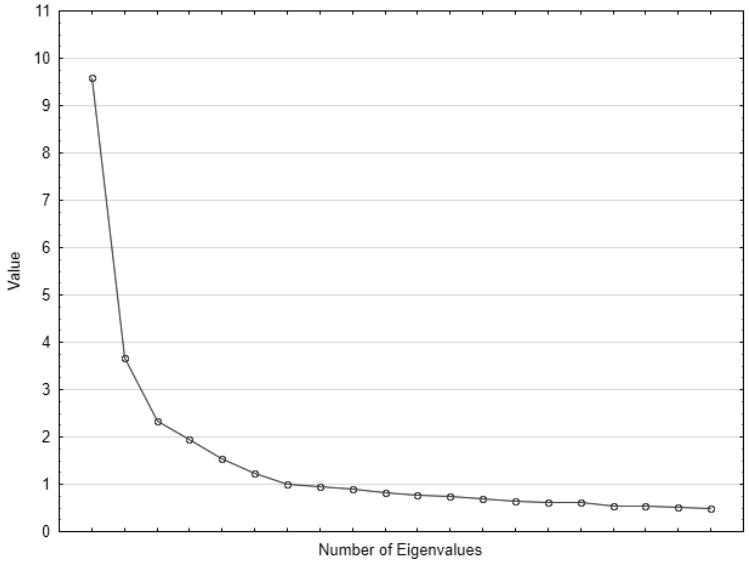
Variable	Test	p-value
Age	Kruskall-Wallis	0,381
Education level	Kruskall-Wallis	0,065
Household size	Kruskall-Wallis	0,000
Income level	Kruskall-Wallis	0,792
Living place	Mann-Whitney	0,341
Children below 18	Mann-Whitney	0,761
Gender	Mann-Whitney	0,017

Source: Own elaboration.

Only two variables are significantly correlated with return rate: household size and gender, and possibly education level. However, this analysis considers the factors separately, and the picture could be altered when all of them are analysed together.

To examine the constructs used in the article, the Principal Component Analysis and Exploratory Factor Analysis were applied. Based on the Kaiser criterion, we can identify 7 factors reflecting the latent constructs. The scree plot is shown as Figure 4, while the factor loadings (the normalised varimax criterion was used) are presented in Table 4.

Figure 4: Scree plot



Source: Own elaboration.

Two factors are the most important ones: Factor 1 reflecting the constructs related to Beliefs and Norms (17.4% of total variance) and Factor 3 reflecting respondents' biospheric and altruistic Values (10.8% of total variance). The remaining ones reflect egoistic values connected with power (Factor 6) or enjoying life (Factor 4), citizen and consumer perspective (Factor 7 and Factor 5). Next, the theoretical constructs are analysed using Cronbach's alpha as shown in Table 5.

Table 4: Factor loadings (EFA)

	Factor Loadings (Varimax normalised)						
Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Ego1	0.112	-0.027	0.095	**0.823**	-0.084	0.019	0.038
Ego2	0.065	0.074	0.301	**0.723**	-0.089	0.095	0.111
Ego3	0.027	-0.069	0.070	**0.716**	0.071	-0.268	-0.065
Ego4	0.057	-0.124	-0.086	0.314	0.142	**-0.757**	-0.007
Ego5	0.039	-0.199	-0.055	0.165	0.133	**-0.807**	0.038
Ego6	0.066	-0.084	-0.025	**0.537**	0.117	-0.318	-0.091
Alt1	0.104	0.016	**0.711**	0.079	0.070	-0.053	-0.165
Alt2	0.136	0.042	**0.721**	-0.014	0.139	-0.067	-0.031
Alt3	0.162	0.048	**0.720**	0.156	-0.003	0.126	-0.054
Bio1	0.379	0.095	**0.679**	0.108	0.185	0.146	0.021
Bio2	0.361	0.085	**0.709**	0.134	0.167	0.076	0.117
Bio3	0.317	0.036	**0.604**	0.087	0.154	0.043	0.134
NEP1	**0.507**	0.443	-0.008	-0.045	0.230	0.316	-0.174
NEP2	**0.766**	0.112	0.073	0.029	0.223	-0.042	-0.071
NEP3	**0.695**	0.033	0.177	0.095	0.089	0.174	0.006
AC1	0.156	**0.509**	-0.137	-0.032	0.153	0.293	-0.099
AC2	0.441	0.058	0.238	-0.074	0.072	-0.206	0.229
AC3	0.404	0.483	0.010	-0.040	0.138	0.405	-0.240
AC4	**0.806**	0.102	0.199	0.041	0.116	0.052	-0.093
AC5	**0.763**	0.091	0.135	0.041	0.072	-0.038	0.036
AC6	**0.738**	-0.022	0.041	0.072	0.152	-0.003	0.011
AR1	**0.562**	0.372	0.270	-0.019	-0.059	-0.157	0.190
AR2	0.142	**0.773**	0.167	-0.077	0.055	0.085	0.021
AR3	**0.583**	0.379	0.243	0.041	-0.015	-0.159	0.219
AR4	0.118	**0.789**	0.138	-0.026	0.015	0.102	-0.019
PN1	**0.695**	0.145	0.187	0.095	0.186	0.185	0.042
PN2	**0.545**	0.218	0.427	-0.045	0.164	-0.180	0.132
PN3	**0.562**	0.040	0.262	0.178	0.097	0.315	0.001
PN4	0.146	0.450	-0.034	0.129	0.149	**0.512**	-0.144
PN5	**0.590**	0.148	0.287	0.037	0.072	-0.103	0.101
Consumer1	0.163	0.132	0.275	-0.008	**0.651**	-0.095	0.005
Consumer2	0.081	0.033	0.285	-0.024	**0.623**	-0.120	0.118
Consumer3	0.174	0.053	-0.009	0.008	**0.696**	0.021	0.106
Citizen1	0.027	-0.222	-0.109	-0.042	0.175	-0.150	**0.727**
Citizen2	0.130	0.065	0.019	0.053	0.391	0.068	**0.652**
Citizen3	0.282	0.058	0.118	0.021	**0.609**	0.010	0.221

Source: Own elaboration.

The constructs seem to be reliable as Cronbach's alphas usually exceed 0.7 (except for constructs reflecting citizen and consumer attitudes, Table 5). Finally, the SEM-PLS model was estimated (Figure 5). The results are presented in Tables 6-9.

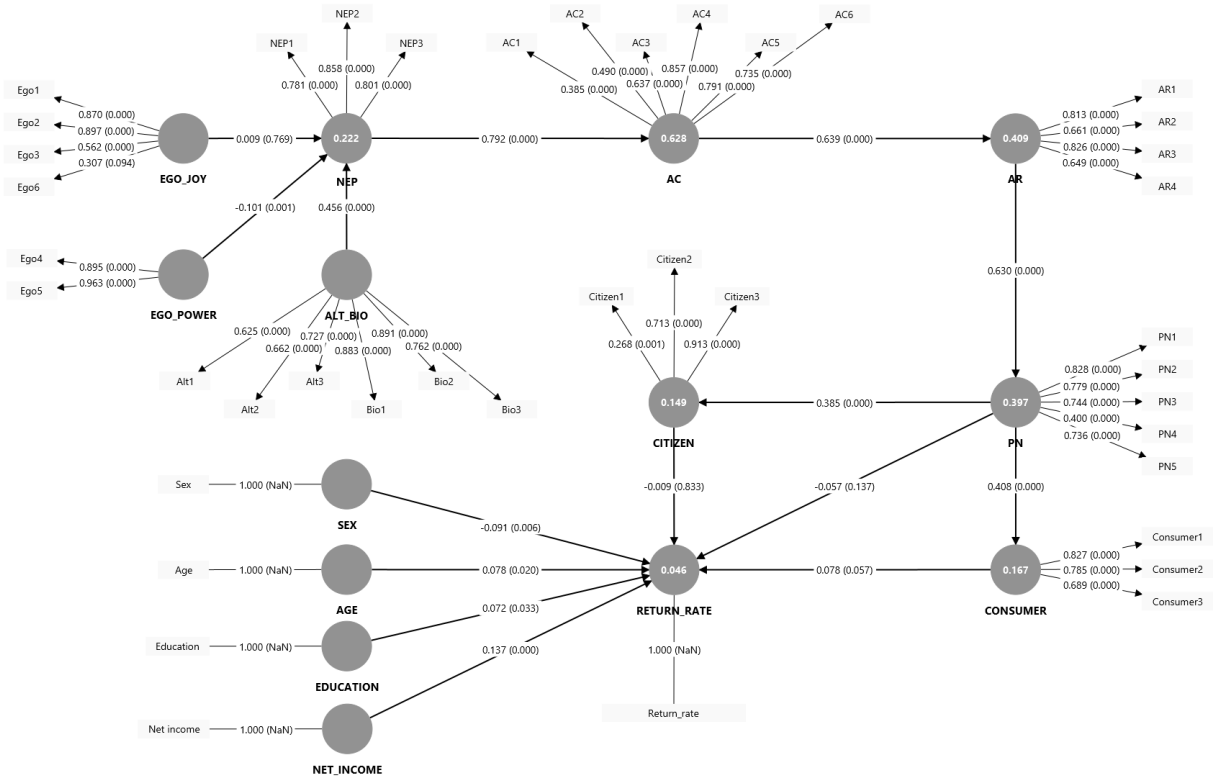
Table 5: Reflective measurement model assessment

Construct	Indicator	Loading	p-value	Cronbach's alpha	Composite reliability	Average variance extracted
AC	AC1	0.385	0.000	0.734	0.821	0.449
	AC2	0.490	0.000			
	AC3	0.637	0.000			
	AC4	0.857	0.000			
	AC5	0.791	0.000			
	AC6	0.735	0.000			
AR	AR1	0.813	0.000	0.733	0.828	0.550
	AR2	0.661	0.000			
	AR3	0.826	0.000			
	AR4	0.649	0.000			
BIO & ALT	Alt1	0.625	0.000	0.859	0.893	0.585
	Alt2	0.662	0.000			
	Alt3	0.727	0.000			
	Bio1	0.883	0.000			
	Bio2	0.891	0.000			
	Bio3	0.762	0.000			
CITIZEN	Citizen1	0.268	0.001	0.571	0.693	0.471
	Citizen2	0.713	0.000			
	Citizen3	0.913	0.000			
CONSUMER	Consumer1	0.827	0.000	0.658	0.812	0.592
	Consumer2	0.785	0.000			
	Consumer3	0.689	0.000			
EGO_JOY	Ego1	0.870	0.000	0.718	0.774	0.493
	Ego2	0.897	0.000			
	Ego3	0.562	0.000			
	Ego6	0.307	0.094			
EGO_POWER	Ego4	0.895	0.000	0.851	0.927	0.864
	Ego5	0.963	0.000			
NEP	NEP1	0.781	0.000	0.745	0.855	0.663
	NEP2	0.858	0.000			
	NEP3	0.801	0.000			
PN	PN1	0.828	0.000	0.748	0.832	0.510
	PN2	0.779	0.000			
	PN3	0.744	0.000			
	PN4	0.400	0.000			
	PN5	0.736	0.000			

Source: Own elaboration.

The analysis of the estimated parameters leads to a conclusion that the model is reliable and valid (a few deviations in the case of outer loadings, average variance extracted, the crossloadings or meeting the Fornell-Larcker criterion seem to be of minor importance).

Figure 5: The estimated SEM-PLS model



Source: Own elaboration.

Table 6: Fornell-Larcker criterion check

	AC	ALT_ BIO	AR	CITI ZEN	CONSU MER	EGO_ JOY	EGO_ POWER	NEP	PN
AC	0.670								
ALT_BIO	0.489	0.765							
AR	0.639	0.467	0.742						
CITIZEN	0.357	0.318	0.281	0.686					
CONSUMER	0.337	0.380	0.317	0.503	0.769				
EGO_JOY	0.128	0.299	0.123	0.061	0.057	0.702			
EGO_POWER	-0.093	-0.023	-0.111	0.087	0.091	0.142	0.929		
NEP	0.792	0.461	0.573	0.379	0.320	0.131	-0.110	0.814	
PN	0.756	0.610	0.630	0.385	0.408	0.215	-0.054	0.680	0.714

Source: Own elaboration.

Analysis of the inner model leads to two main conclusions. The first of them states that the relations described in the VBN model are confirmed by the empirical data – all path coefficients related to the structure of the VBN model are significantly different from zero and of correct sign (except for the egoistic values connected with enjoying life, which are irrelevant). This observation confirms VBN model's validity and usefulness in measuring people's attitudes and preferences.

Table 7: Path statistics

Path	Original sample	Sample mean	Standard deviation	p-value
AC → AR	0.639	0.641	0.027	0.000
AGE → RETURN_RATE	0.078	0.078	0.033	0.020
ALT_BIO → NEP	0.456	0.455	0.029	0.000
AR → PN	0.630	0.632	0.023	0.000
CITIZEN → RETURN_RATE	-0.009	-0.009	0.040	0.833
CONSUMER → RETURN_RATE	0.078	0.079	0.041	0.057
EDUCATION → RETURN_RATE	0.072	0.072	0.034	0.033
EGO_JOY → NEP	0.009	0.018	0.030	0.769
EGO_POWER → NEP	-0.101	-0.104	0.029	0.001
NEP → AC	0.792	0.793	0.016	0.000
NET_INCOME → RETURN_RATE	0.137	0.137	0.033	0.000
PN → CITIZEN	0.385	0.388	0.024	0.000
PN → CONSUMER	0.408	0.410	0.029	0.000
PN → RETURN_RATE	-0.057	-0.058	0.038	0.137
SEX → RETURN_RATE	-0.091	-0.092	0.033	0.006

Source: Own elaboration.

The second conclusion relates to the influence of people's values, beliefs and norms on the declared rate of return on households' portfolios. The analysis of path coefficients and total effects reveals that the influence of ecological worldview reflected by the VBN constructs was negative, as expected (-0.028 for PN → RETURN_RATE path), but statistically insignificant (p-value 0.389).

Table 8: Total effect of constructs on return rate

Path	Original sample	Sample mean	Standard deviation	p-value
AC → RETURN_RATE	-0.011	-0.012	0.013	0.395
AGE → RETURN_RATE	0.078	0.078	0.033	0.020
ALT_BIO → RETURN_RATE	-0.004	-0.004	0.005	0.399
AR → RETURN_RATE	-0.018	-0.018	0.021	0.392
CITIZEN → RETURN_RATE	-0.009	-0.009	0.040	0.833
CONSUMER → RETURN_RATE	0.078	0.079	0.041	0.057
EDUCATION → RETURN_RATE	0.072	0.072	0.034	0.033
EGO_JOY → RETURN_RATE	0.000	0.000	0.000	0.861
EGO_POWER → RETURN_RATE	0.001	0.001	0.001	0.446
NEP → RETURN_RATE	-0.009	-0.009	0.011	0.396
NET_INCOME → RETURN_RATE	0.137	0.137	0.033	0.000
PN → RETURN_RATE	-0.028	-0.029	0.033	0.389
SEX → RETURN_RATE	-0.091	-0.092	0.033	0.006

Source: Own elaboration.

Analysing the socio-economic and demographic variables, finally only age, education, net income and gender were significantly different from zero. Women declared lower return rates on their portfolios (-0.091), possibly due to increased risk aversion [Buła and Wojtala, 2021; Siva, 2012; Fiserova & Anchor, 2012].

Table 9: f^2 statistics

Path	Original sample	Sample mean	Standard deviation	p-value
AGE → RETURN_RATE	0.006	0.007	0.005	0.273
CITIZEN → RETURN_RATE	0.000	0.001	0.002	0.976
CONSUMER → RETURN_RATE	0.004	0.006	0.005	0.381
EDUCATION → RETURN_RATE	0.005	0.006	0.005	0.305
NET_INCOME → RETURN_RATE	0.018	0.019	0.009	0.042
PN → RETURN_RATE	0.003	0.004	0.004	0.513
SEX → RETURN_RATE	0.008	0.009	0.006	0.187

Source: Own elaboration.

A single most powerful factor was net income (0.137), followed by age (0.078) and education (0.072). The remaining factors were insignificant. These conclusions are confirmed by the f^2 values (Table 9).

5. Conclusion

The results of the analyses provide mixed conclusions. On the one hand, the hypothesis H_1 was confirmed, proving the usefulness of the VBN model in measuring people's pro-environmental attitudes and preferences. This result is not new, as the VBN model was widely used in the research and proved its applicability. On the other hand, the hypothesis H_2 was rejected due to the lack of statistical significance of the results. The direction of influence was as predicted in the literature (reflecting the idea that socially responsible assets generate lower returns than the remaining financial instruments), but this impact was too small to be considered non-negligible. The main single variable influencing the rate of return was the level of net income, followed by age, education level and gender. Except for the study of [Zhang, 2024], this analysis is based on a sample larger than the remaining studies presented, creating a significant discrepancy between this study and the remaining ones. As a consequence, the issue must be analysed by expanding the sample or possibly reshaping the model. The author aims to tackle this problem in future studies.

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Cross-market Stock Asset Classification Structure Based on Complex Network Clustering

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Abstract

This study aims to uncover the latent topological structure of stock markets through complex network clustering. This framework constructs a correlation network based on the daily returns of international equities, transforming asset co-movements into a force-directed network layout. A rigorous benchmark is conducted across five community detection algorithms. Louvain, Girvan-Newman, Walktrap, Label Propagation, and Spectral Clustering to identify persistent asset clusters that transcend conventional industry classifications. By enforcing a uniform cluster cardinality across all models, we uncover a relatively stable correlation in stock relationships that differs from traditional categorizations based on industry. Quantitative topological metrics reveal that the detected clusters exhibit strong intra-community connectivity while maintaining inter-cluster bridges, suggesting the presence of cross-community investment opportunities. The findings offer new insights for enhancing portfolio diversification and assessing systemic risk.

Key words

Complex networks, community detection, stock market, clustering, asset classification structure

JEL Classification: C38, C45, G11, G17

1. Introduction

In recent years, the application of complex network theory in financial markets has garnered increasing attention, offering a novel modeling perspective for understanding the intricate interdependencies among financial assets. Compared to conventional classification approaches based on geographical markets or industry labels, this method captures the underlying dynamics of asset comovements more effectively (Isogai, 2017). By representing financial systems as graph structures where nodes denote assets and edges encode statistical relationships, such as return correlations, network-based frameworks uncover latent clustering patterns and systemic structures that may not align with traditional economic categorizations (Tse et al., 2010). This structural insight provides both theoretical and practical foundations for monitoring systemic risk and optimizing portfolios.

However, the temporal evolution of market structures poses a fundamental challenge for network construction. Most complex network models rely on static data, which often lags behind real-time market dynamics. Asset interdependencies are not static, especially under the influence of financial cycles, policy shifts, or external shocks. Consequently, capturing the evolving structure of asset networks in a statistically robust yet time-sensitive manner remains a critical research problem (Zhou et al., 2023). Other advances include the use of multifractal methods for constructing high-dimensional networks, aiming to enhance sensitivity and

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stability in structural identification (Zhang & Zhuang, 2019; Isogai, 2017), which provides a promising direction for financial network modeling.

Beyond normal market conditions, complex networks also prove highly effective in identifying pathways of crisis propagation and mechanisms of systemic contagion. Numerous empirical studies have demonstrated that during major financial events, such as the dot-com bubble and the 2008 global financial crisis, the topology of asset networks undergoes significant shifts, typically evolving from a decentralized to a more centralized configuration (Heiberger, 2014). Moreover, studies based on minimum-spanning trees reveal the existence of heterogeneous interaction channels between markets (Roy & Sarkar, 2011). At the same time, global network analyses further uncover regional structural asymmetries, such as the strong intra-European market connections in contrast to the weaker linkages among Asian markets (Lee & Nobi, 2018). These findings underscore the need for network-based frameworks to analyze cross-border financial systems.

Prior research has shown that, during financial crises or in their early stages, financial networks tend to evolve into highly clustered, large-scale communities, indicating a marked intensification of asset co-movement (Zhou et al., 2023). Within this context, the structural positioning of individual stocks—particularly as measured by centrality metrics—has been found to exhibit a significant association with asset returns. Building on long-term data from the Chinese stock market, Chen et al. (2015) further revealed that centrality not only captures the extent of interdependence among assets but also mirrors macroeconomic dynamics, such as GDP growth, thereby underscoring the explanatory power and practical relevance of network structural features for understanding market behavior and anticipating systemic risks.

To address this challenge, this study aims to examine whether data-driven community detection methods can uncover economically meaningful clusters of financial assets and assess the extent to which these clusters diverge from or provide complementary insights to traditional industry-based classifications. By constructing return correlation networks for the constituents of the Dow Jones Industrial Average (DJIA) and the German DAX index, this research applies and compares five prominent community detection algorithms—Louvain (Blondel et al., 2008), Girvan-Newman (Girvan & Newman, 2002), Walktrap (Pons & Latapy, 2005), Label Propagation (Raghavan et al., 2007), and Spectral Clustering (Ng et al., 2001) to identify latent intra-market and cross-market structures. The analysis is designed to evaluate the internal consistency and external separability of the resulting clusters using a suite of network-based structural metrics.

Building on the aforementioned motivation, these algorithms are applied to networks constructed from pairwise Pearson correlations of asset returns, with a focus on statistically significant and structurally relevant linkages. A fixed correlation threshold is employed to retain only meaningful edges, thereby isolating the core comovement structures within each market. The resulting networks are visualized using a force-directed layout, and the detected communities are analyzed in terms of size distribution, internal connectivity, and topological compactness.

The remainder of this paper is organized as follows. Section 2 introduces the core methodologies underlying the complex network-based clustering algorithms employed in this study. Section 3 presents the empirical results of applying these algorithms to the return networks of the DJIA and DAX constituents, comparing clustering outcomes and evaluating performance metrics. Section 4 concludes the paper with a summary of key findings.

2. Methodology

To capture the intrinsic interdependence structure among financial assets, we first construct an adjacency matrix based on the Pearson correlation coefficient. The Pearson correlation

coefficient is computed using the daily return time series of each stock. As a measure of linear association, it provides a symmetric and standardized indicator ranging from -1 to 1, reflecting both the strength and direction of the linear relationship between asset returns. The formulation is presented in Equation (1),

$$\rho_{ij} = \frac{\sum_{t=1}^{T} (r_{i,t} - \bar{r}_i)(r_{j,t} - \bar{r}_j)}{\sqrt{\sum_{t=1}^{T} (r_{i,t} - \bar{r}_i)^2} \sqrt{\sum_{t=1}^{T} (r_{j,t} - \bar{r}_j)^2}}, \quad (1)$$

where $r_{i,t}$ denotes the return of asset i at time t, and $\bar{r}_i$ represents the average return of asset i. In this study, we retain only statistically significant positive correlations exceeding a predetermined threshold to construct the adjacency matrix, thereby ensuring that the resulting network emphasizes structurally robust connections.

The Louvain algorithm operates through an iterative process consisting of two phases, aiming to achieve a global maximization of modularity. The modularity measure is defined in Equation (2),

$$Q = \frac{1}{2m} \sum_{ij} \left[A_{ij} - \frac{k_i k_j}{2m} \right] \cdot \delta(c_i, c_j), \quad (2)$$

where m is the total weight of all edges, A_{ij} represents the adjacency matrix, k_i is the weighted degree of node i, and $\delta(c_i, c_j)$ is the community indicator function. In the initial phase of the algorithm, each node is treated as an individual community. The algorithm iteratively traverses nodes, calculating the modularity gain to determine whether a node should remain in its current community or migrate to a neighboring one. This process leads to the formation of super-nodes and is repeated until no further improvement in modularity can be achieved.

The Girvan–Newman algorithm deconstructs the network structure from an opposing perspective, focusing on the identification of structurally vulnerable points. Its core mechanism lies in iteratively computing the edge betweenness centrality across the entire graph, which quantifies the extent to which an edge participates in shortest paths. The formal definition is presented in Equation (3),

$$B(e) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}, \quad (3)$$

where $\sigma_{st}(e)$ denotes the number of shortest paths from node s to node t that pass through node v, and σ_{st} represents the total number of shortest paths between s and t. At each iteration, the edge with the highest betweenness centrality is removed, triggering a progressive fragmentation of the network. This process is repeated until a predefined number of communities is achieved, thereby partitioning the graph into modular substructures.

The Walktrap algorithm leverages the principle that short random walks tend to remain within the same community, thereby capturing local clustering tendencies. It begins by computing the distance between nodes based on the probability distribution of short random walks. Subsequently, it applies an agglomerative hierarchical clustering process to merge the most similar communities iteratively. The distance metric is formally defined in Equation (4),

$$d(C_i, C_j) = \sqrt{\sum_{v \in V} \frac{(P_{iv}^t - P_{jv}^t)^2}{k_v}}, \quad (4)$$

where P_{iv}^t denotes the probability of reaching node v after t steps of a random walk starting from a representative node within community i, and k_v represents the degree of node v. This method is sensitive to local structural patterns and is effective in detecting tightly connected subgraphs. However, in networks with heterogeneous connectivity, its emphasis on local dynamics rather than global modularity may lead to fragmented community structures.

The Label Propagation Algorithm (LPA) is a fast and decentralized clustering method that assigns a unique initial label to each node. It then iteratively updates each node's label based on

the most frequent label among its neighbors. The label update rule is formally defined in Equation (5),

$$c_i^{(t+1)} = \arg\max_c \sum_{j \in N(i)} w_{ij} \cdot \delta(c_i^t, c_j^t), \tag{5}$$

where $c_i^{(t+1)}$ denotes the label assigned to node i after the $(t+1)th$ iteration, $N(i)$ represents the set of neighboring nodes of node i, and w_{ij} indicates the connection weight or similarity between node i and its neighbor j. This dynamic updating process continues until convergence, typically when label changes cease to occur. However, due to its non-deterministic nature, the algorithm may yield multiple valid solutions. Moreover, in the absence of an explicit optimization objective, community boundaries can become unstable under minor perturbations to the network structure.

Spectral clustering differs from the aforementioned graph-theoretic approaches by reformulating the clustering task as an eigenvalue decomposition problem. It constructs the Laplacian matrix and computes its leading eigenvectors, which are then used to embed the nodes into a low-dimensional space. The formal expression is given in Equation (6),

$$\mathcal{L} = D^{-\frac{1}{2}} \cdot (D - A) \cdot D^{-\frac{1}{2}}, \tag{6}$$

where A is the adjacency matrix and D is the degree matrix. In the resulting spectral space, conventional clustering algorithms, most commonly K-means, are applied to partition the nodes into communities. This method demonstrates strong separation capability in non-convex spaces; however, it is sensitive to initialization and often requires multiple resampling procedures to ensure robustness.

The node degree characterizes the macroscopic structure of the network and is defined as the number of direct connections associated with a given core node. The formal definition is provided in Equation (7),

$$K_i = \sum_{j=1}^{N} a_{ij} = \sum_{j=1}^{N} a_{ji}, \tag{7}$$

where a_{ij} denotes the connection status between nodes i and j. In weighted networks, the degree is generalized as the total sum of connection weights, reflecting the breadth of a node's influence. Nodes with high degrees, commonly referred to as hubs, represent assets that are highly integrated within the correlation structure.

The clustering coefficient measures the density of triadic closures within the network. It is defined as the average ratio of the number of actual triangle connections to the number of possible triangles within each node's neighborhood. The formal definition is provided in Equation (8),

$$\mathcal{LC}_i = \frac{2E_i}{k_i(k_i - 1)}, \tag{8}$$

where $\mathcal{LC}_i$ denotes the local clustering coefficient of node i, and E_i represents the number of actual edges among the neighbors of node i. This metric ranges from 0 to 1. Values approaching 1 indicate a strong community structure, while values near 0 suggest a chain-like or loosely connected configuration. In this study, the average clustering coefficient is computed within each community, enabling a comparison between internal cohesiveness and external connectivity density.

3. Empirical results

In this study, we utilize daily price data of constituent stocks from the DJIA and DAX 30 indices over the period from 2019 to 2024, with all prices denominated in U.S. dollars for consistency. The primary sector classifications of the constituent stocks are used as a

benchmark for evaluating clustering performance. Asset return series are used to capture co-movement, based on which correlation matrices are constructed. These matrices serve as the basis for building weighted, undirected networks, where nodes represent individual stocks and edges reflect statistically significant correlations in returns.

Figure 1: Quantile corridors of cumulative return distributions for index constituents across different markets

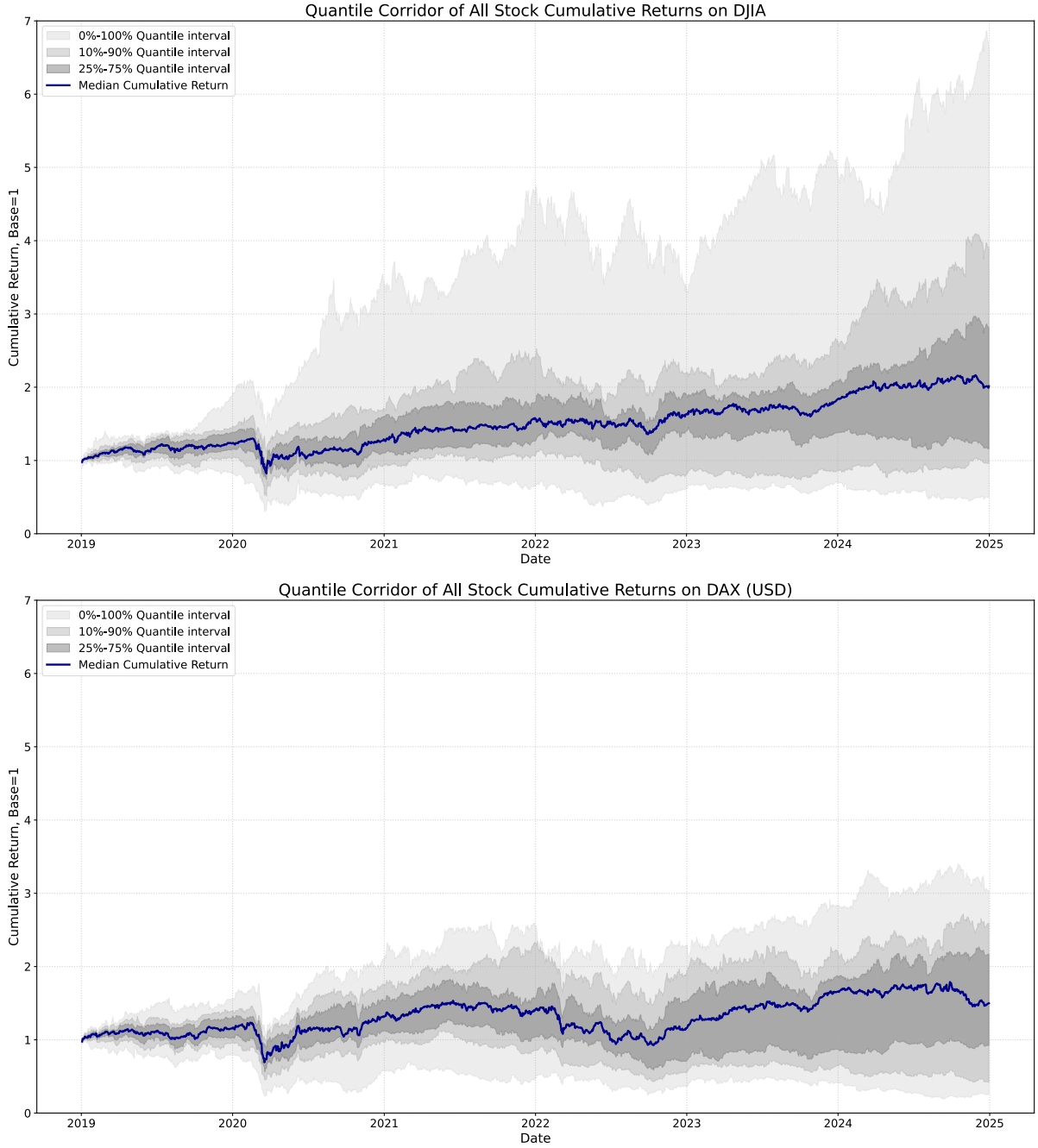

Figure 1 illustrates the quantile corridors of cumulative returns for the constituent stocks of two distinct equity indices, capturing the cross-sectional evolution of stock performance within two representative markets. The cumulative returns of DJIA constituents exhibit a pronounced upward trend, particularly during periods of market recovery or sustained bull markets. The noticeable expansion of the upper quantile boundary reflects the presence of significantly outperforming stocks, indicative of internal market leadership effects and structural return divergence. The broader dispersion band highlights higher levels of systematic volatility and

persistent spread among constituents, suggesting that individual stock performances diverge considerably even under an overall upward market trend.

In contrast, the DAX index exhibits more concentrated fluctuations, characterized by relatively narrow quantile corridors. The smaller spread between quantile bands indicates a more uniform distribution of cumulative returns among its constituents during the sample period. However, the index also demonstrates greater vulnerability to drawdown risks, as reflected in the comparatively larger fluctuations of the median return. The volatility of the corridor boundaries suggests that DAX stocks may be less exposed to external macroeconomic shocks or synchronized industry cycles, resulting in a more stable return pattern over time.

Figure 2: Complex network clustering results under force-directed layout (N=9)

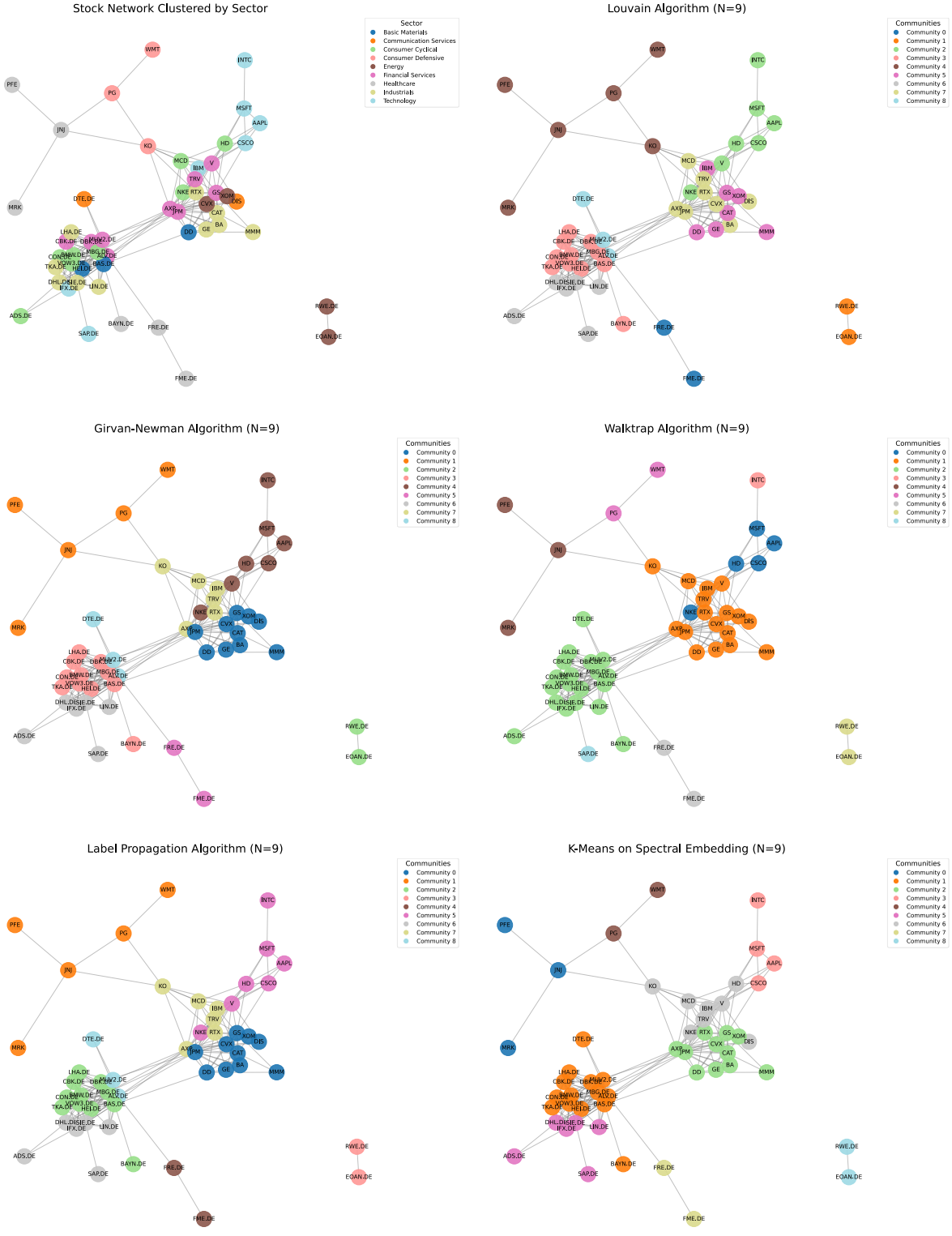

Figure 2 provides a systematic comparison between traditional primary industry classification and five complex network-based clustering methods in identifying stock communities. To ensure comparability, all clustering algorithms are constrained to detect exactly N = 9 communities, matching the number of first-level industry sectors represented in the sample. The networks are constructed using a force-directed layout, with constituents of the DJIA and the DAX index represented as nodes. Only statistically significant edges defined by a pairwise return correlation exceeding 0.5 are retained to emphasize structurally meaningful

comovement. Isolated nodes lacking any qualifying connections are excluded from the visualization to maintain focus on the core network topology.

Subfigure 1 presents the baseline network layout based on traditional industry classification, where stocks from the same primary sector are assigned identical colors. In contrast, all clustering algorithms exhibit pronounced spatial agglomeration, with the resulting communities being formed strictly within each market. While some sectors display partial local cohesion, the overall network remains relatively loose, with numerous adjacent nodes belonging to different industries. Notably, in both the Walktrap and Spectral Clustering methods, only one out of the five or six detected communities in each method typically corresponds to a single industry. The remaining communities show substantial cross-sectoral integration. The other three methods show even broader intermixing of industries across multiple communities.

Unlike traditional classifications based on exogenous business attributes, network-based clustering methods infer endogenous structures from return comovements, thereby uncovering behaviorally-driven cross-sectoral asset interdependencies. For example, cross-industry groupings reveal deeper structural economic linkages: Louvain, Girvan-Newman, and LPA all form communities that include financial stocks alongside cyclical or industrial firms (e.g., CAT, GS and CON.DE, DBK.DE, CBK.DE), suggesting shared exposure to macroeconomic cycles and interest rate fluctuations. Walktrap and Spectral clustering identify communities that combine healthcare (e.g., JNJ, MRK) and defensive consumer stocks (e.g., PG, WMT), indicating their comovement during recessionary periods as risk-hedging assets.

Table 1: Clustering Structural Evaluation Indicators for Complex Stock Networks Across Markets

AL	N	M	m	AIE	AIND	ACC	AEE	AEND		CC
Louvain	9	11	2	12	4.15	0.5685	11	3.81		0.625
GN	9	11	2	12.44	4.31	0.5351	10.56	3.65		0.5167
Walktrap	9	19	1	20.44	7.36	0.2546	2.56	0.88		0.2708
LPA	9	11	2	12.44	4.31	0.5351	10.56	3.65		0.5167
Spectral	9	14	2	15	5.19	0.3943	8	2.77		0.4583

Note: AL is the algorithm, N is the number of communities, M/m is the max/min community size, AIE/AEE is the average internal/external edges per community, AIND/ AEND is the average internal node degree, ACC is the average clustering coefficient within communities, CC is the community connectivity (clustering coefficient of community).

Table 1 compares the performance of five complex network community detection algorithms applied to cross-market stock networks, using multidimensional structural metrics to assess clustering quality quantitatively. Although all algorithms partition the network into nine communities (N), they exhibit significant differences in terms of community size distribution, internal cohesion, and inter-community connectivity. It should be noted that GN and LPA divide the same community. In terms of community size, except for the Walktrap algorithm, which generates 19 communities (M) and includes a minimum community size (m) of 1, resulting in severe fragmentation, the remaining algorithms produce communities ranging from 2 to 10 nodes, demonstrating moderate control over community granularity. A comparison of key structural indicators, AIE and AEE, shows that Louvain, GN, and LPA achieve similar levels of intra-community link density (AIE $\approx$ 12-12.44). However, Louvain exhibits higher external isolation (AEE = 3.81), indicating more precise community boundaries.

The internal compactness of communities is verified by both AIND and ACC. Louvain yields the highest AIND (4.15) and ACC (0.5685), suggesting tightly interconnected communities with strong local transitivity. In contrast, Walktrap's fragmentation results in a high AIND (7.36) but a low ACC (0.2546), indicating that while its communities may contain a few highly connected nodes, they lack cohesive local clustering. Spectral's contrasting AIND (5.19) and ACC (0.3943) suggest the presence of a star-shaped connectivity pattern within communities, where central nodes dominate connections but lack sub-cluster structures. The

inter-community connectivity indicator CC further supports these conclusions: Louvain achieves a significantly higher CC value (0.625) compared to Walktrap (0.2708) and Spectral clustering (0.4583), indicating that its communities are not only internally cohesive but also maintain effective inter-community connections through critical nodes. This structure is consistent with the expected topology of financial networks, characterized by high intra-modular clustering and controllable inter-modular coupling.

4. Conclusion

This study introduces a network-based framework for classifying cross-border equity assets, leveraging daily return correlations among DJIA and DAX constituents to construct force-directed correlation networks. By applying five representative community detection algorithms under a unified clustering constraint, we systematically investigate the latent structural organization of international equity markets beyond traditional industry taxonomies. The results consistently indicate that the identified asset clusters often transcend conventional sectoral boundaries. Network-based clustering effectively captures latent interdependencies among assets, reflecting patterns of return co-movements that may not align with formal sector classifications.

Comparative structural analysis reveals that the Louvain algorithm yields the most coherent community partitions, characterized by strong internal cohesion, high clustering coefficients, and more apparent boundary separation, making it particularly effective for extracting economically meaningful asset groups. In contrast, algorithms such as Walktrap and Spectral display either excessive fragmentation or weak local clustering, indicating that the choice of detection algorithm significantly influences interpretability.

However, it is important to acknowledge a limitation of the current framework: the complex networks analyzed are constructed based on historical return data, rendering them essentially static representations whose validity hinges on relatively stable market conditions. In real-world financial markets, asset correlations exhibit pronounced time-varying behavior, particularly during periods of heightened volatility, systemic shocks, or major policy interventions. Relying on static structures may thus result in misleading associations with outdated relationships.

Overall, our findings suggest that complex network clustering offers a powerful alternative lens for understanding global equity interdependencies. This approach enhances the detection of hidden market regimes and structurally cohesive asset groups. Future work may extend this framework to dynamic networks and incorporate higher-frequency data or additional asset classes.

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Financial wellbeing of marginalized community

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Abstract

This article contributes to the research on financial wellbeing by analyzing the correlation between financial wellbeing and demographic factors of marginalized community in Slovakia. To this question, we use statistical data from the EU SILC MRC survey for 2020. By utilizing OLS regression, we aim to identify the specific demographic factors that significantly influence both objective and subjective financial wellbeing. The results show a significantly positive relationship between subjective and objective financial wellbeing and highlight the necessity of considering both subjectively and objectively expressed financial wellbeing when formulating policies aimed at improving it.

Key words

financial wellbeing, marginalized community, perceived financial situation

JEL Classification: G51, I31

1. Introduction

The literature on financial wellbeing defines it as the ability to maintain a desired standard of living both today and in the future, coupled with financial freedom (Brüggen et al., 2017). The importance of financial wellbeing is its direct influence on an individual's life satisfaction, its improvement of mental health, and its contribution to overall wellbeing. The concept of financial wellbeing is multidimensional (Netemeyer et al., 2018), as evidenced by the numerous factors that influence it. We have categorized these factors into aggregated groups: financial behavior, financial literacy, subjective and objective factors, and socio-demographic characteristics. Financial behavior can be divided into good and bad habits that positively or negatively affect financial wellbeing (Brenner et al., 2020). This includes monetary operations such as saving behavior (Dong et al., 2019; Joo & Grable, 2004; Shim et al., 2009), investment behavior (Chatterjee et al., 2019; Tenney & Kalenkoski, 2019), expenditure management (Shim et al., 2009; Strömbäck et al., 2017; Xue et al., 2020) and insurance protection (Dong et al., 2019). Financial behavior is shaped by financial literacy. Financially literate individuals can critically process information, update financial strategies, exhibit a higher rate of good consumption habits, and have greater protection against becoming victims of financial fraud (Drever et al., 2015; Fazli Sabri et al., 2012; Lapidos et al., 2018; Philippas & Avdoulas, 2020; Postmun et al., 2015). The basic classification of objective factors includes income, wealth, and the amount of debt and liabilities, while subjective factors are, for example, financial socialization, feelings, and emotions. Key demographic variables influencing financial wellbeing include age, gender, education, employment status, number of dependent children, and health status (Belbase et al., 2020; Niedzwiedz et al., 2015; Panisch et al., 2019; Prawitz et al., 2006).

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Current academic studies have primarily examined financial wellbeing among young adults and adolescents (Cwynar et al., 2019; Doherty Bea & Yi, 2019; Lanz et al., 2020; Rea et al., 2019; Shim et al., 2009; Sorgente et al., 2023; Sorgente & Lanz, 2019; Utkarsh et al., 2020) and retirees (Kim & Lyons, 2008; Tenney & Kalenkoski, 2019; Xue et al., 2020). When reviewing research on marginalized groups, we do not find direct definitions of its financial wellbeing, only financial inclusion as determinant of financial wellbeing (Kumar et al., 2024; Lal, 2021; Mishra et al., 2023; Sunitha, 2019). Conversely, there are many publications that examine marginalized groups in the context of poverty, which can be seen as the opposite of financial wellbeing (Klimovský et al., 2016; Rochovská & Horňák, 2008; Sirovátka & Mareš, 2006; Zelinsky, 2011).

The aim of this article is to expand existing scientific literature by identifying the financial wellbeing across demographic characteristics of the marginalized Roma community in Slovakia. Slovakia has a high proportion of marginalized Roma communities compared to other European Union countries (Holubová et al., 2021), and simultaneously, a low level of financial literacy persists across the entire society (Cupak et al., 2023). When analyzing financial wellbeing and its influencing factors using OLS regression, we consider the subjective expression of satisfaction with one's financial situation. For objective assessment, we look at the ability to cover basic obligations, the possibility of enjoying life through out-of-home holidays, and the ability to cope with unexpected expenses. This objective and subjective expression of financial wellbeing is achieved using data from survey on marginalized Roma communities in Slovakia. This survey was conducted as a specific part of the EU-SILC survey in 2020.

We found a positive relationship between objective and subjective financial wellbeing of marginalized community. Education and active participation in the labor market are significant factors that influence both objective and subjective financial wellbeing. Subjective financial wellbeing is also negatively affected by age. Our findings can help policymakers gain a deeper understanding of the overall wellbeing of marginalized groups. This understanding is crucial for developing truly effective and responsive aid policies.

The article is organized as follows. Part 2 contains a description of the data, variables and the methodology. In part 3, the results of the regression analysis are described. The last 4 section is the conclusion.

2. Data and methodology

In the following section, we introduce our database. This is a selective EU-SILC survey focusing on the marginalized Roma community, carried out in cooperation between the Office of the Plenipotentiary of the Government of the Slovak Republic for Roma Communities and the Statistical Office of the Slovak Republic. The survey was conducted in 2020. For the analysis, data is aggregated at the household level, and individual characteristics reflect information about the reference person who was responsible for completing the questionnaire for that household. The survey included 1,279 households. The proportion of households decreases as the age group increases, and in over 60% of households, the reference person is male. The largest group represented is unemployed individuals – 36.5%, followed by employed individuals (23.9%). Around 20% were pensioners. Self-employed individuals represented the smallest proportion, accounting for only 1.5%.

Typical characteristics of a marginalized group include social exclusion, discrimination, and limited access to education, employment opportunities, and career advancement. Due to these characteristics, they also face reduced access to healthcare or housing. Their exclusion from society can result from a combination of various factors, and these disparities can further widen. Insufficient access to education often leads to early school leaving and limited

opportunities in the labor market. With low education levels, average income decreases, as do opportunities for career growth and future prospects for improving financial and employment situations. A low level of education negatively impacts financial wellbeing both directly and indirectly. In this paper, we focus on a marginalized group defined by ethnic origin, specifically the Roma community living in Slovakia.

In this paper, we define financial wellbeing as the ability to maintain a desired standard of living (a subjective expression) and the ability to meet financial obligations (an objective expression), both in the present and in the future. This definition combines the subjective perspective of Brüggen et al. (2017) and the objective view of Kempson and Finney (2017). To analyze the financial wellbeing of marginalized groups, we use both objective and subjective measurements of financial wellbeing. The objective measure of financial wellbeing will consist of the following indicators: arrears on mortgage or rent payments, arrears on utility bills (heating, electricity, gas), arrears on other loan repayments, the ability to take a holiday away from home once a year, and the ability to face unexpected expenses. To measure subjective financial wellbeing, we used a direct question from the survey: "Please assess your overall satisfaction with your household's financial situation." Responses were collected using a Likert scale ranging from 0 (least satisfied) to 10 (completely satisfied).

In the article, we work with demographic characteristics such as economic status, gender, education, and age structure. The independent variables include: Employed, Self-employed (serving as indicators of an economically active individual), Male (a dummy variable coded as 1 if the respondent is male), education (where we observe the impact of Secondary and tertiary education – Degree), and age (specifically, an "Age over 35" dummy variable coded as 1 if the respondent is older than 35 years).

To thoroughly analyze the relationship between financial wellbeing and demographic characteristics, our article employs Ordinary Least Squares (OLS) regression. This statistical method allows us to model the linear relationship between our dependent variable, financial wellbeing, and a set of independent variables representing various demographic characteristics. We have operationalized financial wellbeing through both objective and subjective measures. The demographic characteristics, such as age, gender, economic status, and education level, are included in the regression models as independent variables.

By utilizing OLS regression, we aim to identify the specific demographic factors that significantly influence both objective and subjective financial wellbeing, quantifying the strength and direction of these relationships. This approach enables us to gain robust insights into how different demographic profiles correlate with varying levels of financial wellbeing within the observed marginalized groups.

3. Results

Descriptive analysis results for demographic variables are in Table 1. Respondents in the "Age over 35" category make up about 70% of the total sample. Roughly 60% of the analyzed households are headed by a male. The "employed" and "self-employed" categories comprise approximately 25.5% of households. About 18% of respondents have a secondary education, and only 0.8% hold a university degree.

Next, we examine the percentage distribution of households across various objective financial wellbeing categories (Table 2). In terms of arrears, households do not show significant problems: approximately 90% of households have no mortgage arrears, and about three-quarters of households do not suffer from arrears on utilities or other loans. This situation is not surprising, as only a small number of marginalized households can even obtain a mortgage, and they must meet the same criteria as other applicants. However, we observe significant shortcomings in the ability to finance a holiday away from home once a year or to

cope with unexpected expenses. Not even 10% of households can afford a holiday away from home at least once a year, and less than 15% of households are able to cover unexpected expenses. These results suggest that marginalized groups can generally cover their routine expenses with regular income but are unable to build reserves for unforeseen circumstances or allocate funds for leisure activities like holidays.

Table 1: Household characteristics

Household Characteristics			
Age Structure		Economic Status	
Under 35 years	29.8%	Employed	23.9%
35 to 45 years	24.8%	Self-employed	1.5%
45 to 55 years	20.6%	Pensioner	19.2%
55 to 65 years	15.0%	Unemployed	36.5%
65 to 75 years	8.6%	Other	18.9%
Over 75 years	1.2%	Education	
Gender		Primary	80.7%
Male	60.2%	Secondary	18.4%
Female	39.8%	Degree	0.8%

Source: EU SILC MRC 2020, own processing

Table 3: Share of Households in Individual Indicators of Objective Financial Wellbeing

Objective financial wellbeing 2020		**Had problem multiple times (1b)**	**Had problem once (2b)**	**No problem (3b)**
Arrears	**Mortgage / Rent**	7.15%	2.39%	90.45%
	Utilities	15.04%	9.82%	75.14%
	Other Loans	16.94%	6.75%	76.31%
		No (1b)	Yes (2b)	
Holiday away from home		91.16%	8.84%	
Ability to face unexpected expenses		85.68%	14.32%	

Source: Own processing based on MRK 2020 data.

The estimated coefficients from the regression analyses are presented in Table 3. Our analysis employs three distinct models: Model 1 investigates the drivers of objective financial wellbeing, while Model 2 and Model 3 focus on subjective financial wellbeing as the dependent variable, with Model 3 further incorporating objective financial wellbeing as a predictor.

Model 1, focusing on objective financial wellbeing, reveals several key determinants. We observe a statistically significant positive impact of both employment and self-employment, indicating that being economically active robustly contributes to improved objective financial standing. Male gender also exerts a statistically significant positive influence, suggesting a better objective financial position for men. Furthermore, attaining higher levels of education, specifically secondary or tertiary education, significantly and positively correlates with objective financial wellbeing when compared to individuals with only primary education.

Interestingly, the hypothesized negative impact of being in an older age group (Age over 35) on objective financial wellbeing did not reach statistical significance in this model.

Model 2 re-examines the role of demographic factors, this time with subjective financial wellbeing as the dependent variable. Model 3 extends Model 2 by explicitly assessing the incremental impact of objective financial wellbeing on subjective perceptions. In Model 2, we again confirm a statistically significant positive effect of employment or self-employment on subjective financial wellbeing, underscoring the importance of economic activity for perceived financial wellbeing. Consistent with Model 1, higher educational attainment also demonstrates a statistically significant positive relationship with subjective financial wellbeing relative to primary education. A notable finding in this model is the statistically significant negative impact of the older age group (Age over 35) on the subjective expression of financial wellbeing, suggesting that older individuals may perceive their financial situation less favorably, even after accounting for other demographic factors.

Finally, Model 3 highlights a statistically significant positive effect of objective financial wellbeing on subjective financial wellbeing, demonstrating that concrete financial security translates into a stronger sense of perceived financial wellbeing. Crucially, the demographic variables included in Model 3 maintain their statistical significance and direction of impact as observed in Model 2.

Table 3: Regression model

	(1)	(2)	(3)
VARIABLES	OFWB	SFWB	SFWB
OFWB			0.348***
			(0.0438)
Employee, Self-employee	0.346***	1.513***	1.401***
	(0.123)	(0.185)	(0.177)
Man	0.181*	0.151	0.0842
	(0.106)	(0.159)	(0.154)
Secondary	0.504***	0.934***	0.762***
	(0.138)	(0.203)	(0.195)
Degree	1.382***	1.035	0.555
	(0.522)	(0.731)	(0.747)
Age over 35	-0.115	-0.404**	-0.365**
	(0.110)	(0.170)	(0.166)
Constant	6.076***	4.252***	2.131***
	(0.102)	(0.163)	(0.312)
Observations	1,279	1,252	1,252
R-squared	0.035	0.098	0.147

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: EU SILC MRC 2020, own processing

4. Conclusion

The aim of this paper was to examine the financial wellbeing of a marginalized group in Slovakia thereby complementing the existing literature on financial wellbeing which has been

growing recently. A further contribution is the assessment of the financial situation of the marginalized group from a wellbeing perspective (both objectively and subjectively expressed) as previous literature concerning them has primarily focused on the analysis of poverty.

The results of the paper indicate a significantly positive relationship between subjective and objective financial wellbeing. Demographic factors influencing both the subjective and objective expressions of financial wellbeing are economic status (employee or self-employed) and education. Individuals with a university education have significantly higher also objective financial wellbeing. Subjective financial wellbeing statistically significantly decreases with increasing age.

Our research has a limitation: we relied on what people told us in survey. While this helps us understand their feelings, people might not always give exact financial details. They might worry about what others think (social desirability) or about their privacy. Also, it is hard to get real and official financial data. So, we had to create our own way to measure objective financial wellbeing using the information we had. This could make our results a bit less bias.

For future studies, we suggest using more direct financial information. This could be anonymous data from banks, like details about people's income, savings, debts, and how well they manage money. This kind of data would give us a clearer and more complete picture of financial wellbeing. Another good step for future research would be to study more countries. This would let us compare how financial wellbeing changes based on where people live and different government policies. Looking at multiple countries would show how various economies, welfare systems, and laws affect marginalized groups. This wider approach would make the findings much more useful for policy decisions.

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Amounts of income tax transferred to NGOs in the years 2010-2023 and tax changes in Poland, Czech Republic and Slovakia

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Abstract

Significant changes in tax regulations in recent times prompt us to examine the impact of these changes on certain trends in the economy and society. One of the positive phenomena in both the social and economic spheres is the possibility of transferring part of income tax by individuals to public benefit organizations. The aim of this paper is to examine the impact of recent changes in the tax sphere on the amount of money transferred to public benefit organizations and the number of taxpayers who declared their willingness to provide such support to third sector organizations. The change in the tax scale in income taxation in Poland, income thresholds in the period under review, the tax-free amount and the percentage of the transferred part of income tax (from 1.5% to 2%) could have contributed to changes in the amount of support transferred to public benefit organizations. The correlation and similar analysis were also prepared for Slovakia and Czech Republic. The paper uses elements of descriptive statistics.

Key words

Income tax, tax deduction, non govermental organizations

JEL Classification: H24, K34.

1. Introduction

Tax designations as a method of financing the non-profit sector is a concept that is typical for the countries of Central and Eastern Europe. Designations began to be introduced in the 1990s and at the beginning of the new millennium, Hungary was among the first countries to introduce designations. Designations is also introduced in Estonia, Italy, Lithuania, Poland, Romania, Slovakia, Slovenia and Spain, while the specific form of designations varies in individual countries. In addition to tax designations, it may be possible to deduct the value of a donation from the income tax base to further support the non-profit sector, which, for example, Italy has allowed since 2005, in addition to the introduced designations, for both natural and legal persons up to 2% of the tax base. (Smetanková and Krček, 2022)

The aim of this paper is to examine the impact of changes in the tax sphere on the amount of money transferred to public benefit organizations and the number of taxpayers who declared their willingness to provide such support to third sector organizations in Poland, Czech Republic and Slovakia. The hypothesis is as follows: the amount of transferred money to NGOs from tax returns in 2011-2023 increased with the number of taxpayers and tax

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changes could have influence on it. The methodology used in this study is literature and legal acts review in theoretical part of paper. In empirical part of paper the trend and dynamic analysis was used as well as correlation test.

2. Literature review

In democratic countries there are three sectors (areas) of individual and institutional activity:

- the first sector – activity aimed at generating profit, i.e. business, chich includes production, services and trade;
- the second sector – government sector – public activity of the government, including central and local administration;
- the third sector – social activity which is not aimed to generate financial profit.

A non-governmental (social, non-profit) organization (NGO) is an institution whose purpose is to satisfy people's needs and provide help wherever the two other sectors are unable to reach or when their work is ineffective (Dąbkowska-Dworniak, 2020). The end of the 20th century in Poland was a time of strong development of civil society. The Round Table talks gave rise to the transparency of social life and social participation. Today, the democratic state is a guarantor of the activity of active citizens, which manifests itself in many different forms of participation. Nevertheless, the third sector is a complementary activity for local government units (Tyborowska and Walat, 2022).

The Russian invasion of Ukraine in late February of 2022 caused a humanitarian refugee crisis on a scale unseen since World War II. As of the writing of this paper, 6.9 million Ukrainian refugees have entered Central European countries, including Poland, Hungary, Slovakia, and the Czech Republic. The scale and speed at which refugees surged into other European countries required significant resources to respond to this influx. However, scholars have found that governments struggle to adapt to turbulent, uncertain, and complex environments in forced migration events. Conversely, nongovernmental organisations (NGOs) respond quickly to provide needed humanitarian, social, and cultural assistance to incoming refugees. The responsiveness of NGOs is especially critical in the beginning days and weeks of crisis when the ability to respond quickly is most needed. Thus, the resilience of NGOs in providing needed services to refugees is a critical factor in any country's initial response to a crisis. Role of the third sector organization is very important and should be donated (Bryan, Lea and Hyanek, 2023).

The dependency of non-profit organisations only on state funding and the lack of alternative sources of revenues means that those organisations become "price-takers" because they have no negotiating power. Therefore, they are forced to accept a weaker market position and adapt to conditions of stronger market participants. They are also more susceptible to co-option with state agencies (Mikołajczak, 2019).

According to Art. 3. sec. 2 of the Act of 24 April 2003 on public benefit activities and volunteering in Poland, it states: "non-governmental organizations are legal entities or entities without legal personality established pursuant to the provisions of the Acts, including foundations and associations, which are not public finance sector entities within the meaning of the provisions of the Acts and do not operate for profit, established pursuant to the provisions of the Acts...". The most important issues related to the functioning of the so-called NGOs are indicated in the following Acts: the Law on Associations, the Act on Foundations and the Act on Benefits. There is no single legal act that would regulate all issues related to the functioning of non-governmental organizations. In addition to the "founding" foundations, small fragments of the Acts and regulations that regulate various aspects are important, e.g.:

- Act on Personal Income Tax – describes the issue of tax exemptions;

- Act on tax from goods and services – rules for paying this tax;
- Act on Public Finance– some details in the implementation of projects co-financed from public funds;
- Act on Copyright and intellectual property – rules, e.g. for concluding contracts for specific work with project authors or using photos, Labor Code – employment issues, etc.

Income tax is levied on a taxpayer's income. The income can include salary and wages, rental received, the proceeds of business operations, and the profit resulting from the increased value of assets or assets sold. The personal income tax is a relatively young tax that was used for the first time in the eighteenth century for the financial Napoleonic war. Personal income tax is currently widely used in tax systems due to its positive features such as progressivity of taxation; as a good macroeconomic stabilizer, it can influence changes in GDP, it does not cause price distortion, and it complies with the solvency principle (Široký, Krzikallová and Krajňák, 2020).

The most important tax changes in the period under analysis are (table 1):

- change in the tax scale in income taxation (12% and 32% from 2022),
- increase in the first tax threshold in the period under review (from PLN 85,528 to PLN 120,000 from 2022),
- increase in the tax-free amount (from PLN 8,000 to PLN 30,000 from 2022)
- change in the percentage of the income tax transferred to public benefit organizations (from 1% to 1.5% starting from the settlement for 2022).

Due to numerous changes in income tax in Poland during the period under review, the years were grouped according to periods in which the same rules applied.

Table 1: Tax law changes in income tax in Poland in years 2011-2023

Years	2010-2016	2017-2018	2019	2020-2021	2022	2023
Cost of obtaing income in PLN	1,335	1,335	1,751	3,000	3,000	3,000
Tax rates	18%/32%	18%/32%	17,75%/32%	17%/32%	12%/32%	12%/32%
Tax thresholds in PLN	85,528	85,528	85,528	85,528	120,000	120,000
Tax-free amount in PLN	556.02	1,440	1,440	1,360	3,600	3,600
Tax-free amount calculation	3,089*18%	8,000*18%	8,000*17,75%	8,000*17%	30,000*12%	30,000*12%

Source: Authors' own elaboration

Tax designations is not implemented in the Czech Republic. In the past, there have been some attempts to implement it. In 2001, there was a parliamentary bill, where the designations would amount to up to 7% of the annual income tax for the benefit of eligible recipients; the designations would be possible if the tax liability exceeded CZK 7,200; this proposal was rejected. In 2004, another initiative was launched, considering the designations of 1% of the tax, however, this initiative by non-profit entities ended without any concrete results. In 2005, an amendment to the Income Tax Act was submitted, it was 1% tax designations, this proposal was not adopted. In 2006, a consultation process was initiated by the Ministry of Finance of the Czech Republic with the professional public and social partners on the matter of tax designations; the plan to introduce the designations was ultimately abandoned. (Smetanková and Krček, 2022)

In the Czech Republic, as in Italy, taxpayers can deduct a donation for a specific purpose and to a specific entity from their income tax base. The Income Taxes Act allows individuals to claim a deduction for the value of a gratuitous performance if the total value of gratuitous performance in the tax period exceeds 2% of the tax base or is at least CZK 1,000. The

maximum deduction is 15% of the tax base. For the tax period of calendar years 2020 to 2026, a maximum of 30% of the tax base can be deducted; this increase in the limit is regulated for the years 2020 and 2021 by the Income Tax Act and for the years 2022 to 2026 by Act No. 128/2022 Coll., on measures in the field of taxes in connection with the armed conflict in the territory of Ukraine caused by the invasion of the troops of the Russian Federation.

The Income Taxes Act defines designated entities as primarily municipalities, regions, state organizational units, legal entities with their registered office in the Czech Republic and legal entities that are organizers of public collections under a special law. In order for funds to be deductible from the tax base, according to the Income Tax Act, they must be provided for the financing of science and education, research and development purposes, culture, education, the police, fire protection, support and protection of youth, protection of animals and their health, social, health and environmental, humanitarian, charitable, religious purposes for registered churches and religious societies, physical education and sports, and to political parties, political movements, European political parties or European political foundations for their activities.

The Slovak Republic is a civil law country with five primary forms of not-for-profit, non-governmental organizations (NGOs):

- Associations;
- Foundations;
- Non-Investment Funds (NI Funds);
- Not-for-Profit Organizations Providing Publicly Beneficial Services (NPOs); and
- Organizations with an International Element (OIEs).

Other forms of NGOs, which remain outside the focus of this Note due to their limited interactions with foreign grant makers, include religious organizations, political parties, political movements, trade unions, interest associations, and associations related to certain professions (chambers). An NGO's income from donations and inheritance is generally exempt from income tax. Other income from statutory activities, including membership fees, is also generally exempt. Grants covered by international agreements that are binding on the Slovak Republic are also exempt from income tax. Certain NGOs are generally exempt from donations tax, including those whose statutory activities relate to health care, humanitarian assistance, social care, the operation of schools and other educational activities, science, physical fitness and sports for children and youth, and the protection of the environment. Slovakia imposes a value-added tax (VAT), with a standard rate of 20 percent and a reduced rate of 10 percent for books, pharmaceuticals, medical supplies, and some other products serving handicapped persons or general health care. Certain transactions are exempt from VAT, including those related to culture, sports, educational and scientific services and goods, as well as health and social care services and goods. Also exempt from VAT are services and goods rendered to members of associations as compensation for paid membership fees. NGOs may request a return of the VAT paid for goods that are exported to countries outside the EU for the purpose of serving the NGO's statutory activities in those countries. Finally, although taxpayers generally cannot deduct their donations to NGOs, natural and legal persons may assign up to 2 percent of their income tax to certain NGOs engaging in publicly beneficial activities (https://cof.org/country-notes/nonprofit-law-slovakia).

In the tax regulations in Slovakia, only two changes in income tax were observed, which could affect the amount of deductions and the tax burden itself. In the years 2004-2012, a flat PIT rate of 19% was in force. In 2013, a progressive rate was introduced in income taxation. For income above 176.8 times the minimum subsistence level (approx. €34,402), a rate of 25% is applied. The second change concerns the tax-free amount. In the years 2010-2022, it was ~€3,830 per year, in 2023 it was increased to ~€4,922.82 (Senaj et al., 2016).

3. Methods and research

The variables selected for analysis are as follows:

- Number of taxpayers declaring a tax transfer to NGOs,
- Amount transferred to NGOs,
- Amount of donations,
- Number of tax returns,
- Number of donation items,
- Number of tax returns share with applied donations.

The data were chosen for an analysis for 3 researched neighbouring countries: Poland Czech Republic and Slovakia. Tables 2, 5 and 8 present data in nominal values (in persons or in national currency). Tables 3, 4, 6, 7, 9 and 10 ilustrate analysis of dynamics of each data, firstly changes in relation to the previous year and secondly to the first year of analyzed period. These values are expressed in %.

3.1. Poland

The correlation coefficient between the number of taxpayers in Poland who transfer part of their tax amount to NGOs and the amount transferred to these organizations (table 2, 3, 4) is 0.64897. A moderate positive linear correlation indicates that as the number of taxpayers declaring the transfer of tax amount to NGOs increases, the amounts transferred also increase.

Table 2: Number of tax payers and amount transfered to NGOs in Poland in 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of taxpayers w thous	8,624	10,135	11,166	11,537	12,034	12,457	13,178	13,614	14,131	14,499	14,794	15,337	15,943	12,652
Amount transferred to NGOs mln PLN	360.9	403.9	459.4	482.2	511	560	619.1	662.2	763.9	876.7	908	973	1115.1	1530.4

Source: *Authors' study based on* https://www.gov.pl/web/pozytek/wykaz-opp-15

Table 3: Number of tax payers and amount transfered to NGOs in Poland – dynamic to previous year

Dynamics to previous year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Number of taxpayers w thous	18%	10%	3%	4%	4%	6%	3%	4%	3%	2%	4%	4%	-21%
Amount transferred to NGOs mln PLN	12%	14%	5%	6%	10%	11%	7%	15%	15%	4%	7%	15%	37%

Source: *Authors' study based on* https://www.gov.pl/web/pozytek/wykaz-opp-15

Table 4: Number of tax payers and amount transfered to NGOs in Poland – dynamic to 2010

Dynamics to base year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Number of taxpayers w thous	18%	29%	34%	40%	44%	53%	58%	64%	68%	72%	78%	85%	47%
Amount transferred to NGOs mln PLN	12%	27%	34%	42%	55%	72%	83%	112%	143%	152%	170%	209%	324%

Source: *Authors' study based on* https://www.gov.pl/web/pozytek/wykaz-opp-15

We could see increasing value but the biggest increase we observed between 2022 and 2023. Maybe because of that the 2022 year was the first year with higher second threshold (from 85,528 to 120,000 PLN) and higher tax free amount. However, the number of taxpayers in the last year of the analysis broke the upward trend as it decreased in 2023 by 21% compared to 2022. We observed still increasing amount transferred to NGOs from tax returns in whole analyzed period.

3.2. Czech Republic

To determine the extent of donations claimed under personal income tax, data from the Financial Administration of the Czech Republic can be used. Information on the total number of personal income tax returns filed, the number of donation items claimed in these tax returns, and the total amount of donation deductions claimed are only available from 2011. The development of the values of these items in the period 2011 to 2023 is shown in the following table (table 5, 6, 7).

Table 5: Number of personal income tax returns, number of donation items and amount of donations in the total number of tax returns in the Czech Republic in 2011-2023

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of tax returns in thousand	1,926	1,946	2,168	2,150	2,136	2,188	2,239	2,279	2,285	2,297	2,236	2,264	2,213
Number of donation items in thousand	123	125	147	146	152	160	170	180	189	195	218	240	227
Amount of donations in million CZK	1,483	1,581	1,659	1,762	1,801	1,957	2,275	2,430	2,502	2,912	3,490	4,068	3,713

Source: Authors' processing according to the Financial Administration https://www.financnisprava.cz

The year-on-year development of the above items and the development as of 2011 is shown in the following tables.

Table 6: Number of personal income tax returns, number of donation items and amount of donations in the total number of tax returns in the Czech Republic – dynamic to previous years

Dynamic to previous year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Number of tax returns in thousand	1.0%	11.4%	-0.8%	-0.6%	2.4%	2.3%	1.8%	0.3%	0.5%	-2.7%	1.3%	-2.3%
Number of donation items in thousand	2.3%	16.8%	-0.1%	3.9%	5.0%	6.3%	5.9%	5.2%	3.2%	12.0%	9.9%	-5.4%
Amount of donations in million CZK	6.7%	4.9%	6.2%	2.2%	8.6%	16.3%	6.8%	3.0%	16.4%	19.9%	16.6%	-8.7%

Source: Authors' processing according to the Financial Administration https://www.financnisprava.cz

Table 7: Number of personal income tax returns, number of donation items and amount of donations in the total number of tax returns in the Czech Republic – dynamic to 2011

Dynamics to base year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Number of tax returns in thousand	1.0%	12.6%	11.6%	10.9%	13.6%	16.3%	18.4%	18.7%	19.3%	16.1%	17.6%	14.9%
Number of donation items in thousand	2.3%	19.6%	19.4%	24.1%	30.2%	38.4%	46.6%	54.2%	59.1%	78.2%	95.9%	85.3%
Amount of donations in million CZK	6.7%	11.9%	18.9%	21.5%	32.0%	53.4%	63.9%	68.7%	96.4%	135.4%	174.4%	150.4%

Source: Authors' processing according to the Financial Administration https://www.financnisprava.cz

From the values given, it is clear that there has been a gradual increase in the number of tax returns filed and also an increase in the number of tax returns in which the donation item was claimed. The highest number of tax returns filed was in 2020, the highest number of donation items claimed, and the highest donation amount claimed was in 2022.

Observing the dynamics of the amounts transferred to the base year, a constant increase in the monetary values supplying social organizations is clearly visible.

3.3. Slovakia

The third analyzed country neighbouring with Poland and Czech Republic is Slovakia. There is a result which we obtain for the data from Slovak Ministry of Finance.

Table 8: Number of tax payers and amount transfered to NGOs in Slovakia in 2010-2023

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of taxpayers thous	700	720	740	760	790	820	830	840	850	851	850	922	920	920
Amount transferred to NGOs mln EURO	50	53	55	58	60	63	65	67	68	53,4	68	87,2	106	106

Source: *Authors' study based on* https://www.financnasprava.sk/sk/elektronicke-sluzby/verejne-sluzby/zoznamy

Analysing the data for Slovakia we can see raising amount transferred money to NGOs and number of taxpayers. The correlation coefficient between the number of taxpayers in Slovakia who transfer part of their tax amount to NGOs and the amount transferred to these organizations (table 8, 9, 10) is 0.835692. A strong positive linear correlation indicates that as the number of taxpayers declaring the transfer of tax amount to NGOs increases, the amounts transferred also increase.

Table 9: Number of tax payers and amount transfered to NGOs in Slovakia – dynamic to previous year

Dynamics to previous year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Number of taxpayers thous	3.4%	3.0%	2.2%	3.8%	3.7%	1.3%	1.3%	1.3%	0.1%	-0.4%	8.8%	-0.5%	0.1%
Amount transferred to NGOs mln EURO	6.5%	3.5%	5.1%	4.0%	4.8%	2.9%	3.4%	1.3%	-21.5%	27.3%	28.2%	21.7%	-0.2%

Source: *Authors' study based on* https://www.financnasprava.sk/sk/elektronicke-sluzby/verejne-sluzby/zoznamy

Table 10: Number of tax payers and amount transfered to NGOs in Slovakia – dynamic to 2010

Dynamics to base year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Number of taxpayers thous	3.4%	6.5%	8.9%	13.1%	17.3%	18.8%	20.3%	21.8%	22.0%	21.5%	32.1%	31.5%	31.6%
Amount transferred to NGOs mln EURO	6.5%	10.2%	15.8%	20.5%	26.3%	29.9%	34.3%	36.1%	6.8%	36.1%	74.5%	112.3%	111.9%

Source: *Authors' study based on* https://www.financnasprava.sk/sk/elektronicke-sluzby/verejne-sluzby/zoznamy

In the relation to the previous year the biggest decrease in the amount transferred to NGOs was observed in 2019 (-21.5%). In the number of taxpayers slightly decreases were noticed in 2020 (-0.4%) and 2022 (-0.5%).

Discussion and conclusion

Initially, the increase in the number of NGOs was very sharp, however, in recent years the number of such organizations plateaued at approximately 8-8.5 thousand nationwide. The share of NGOs in the total number of non-profit organizations is not large and ranges between 8% and 10% (in Poland there are approx. 100 thousand registered NGOs). On the other hand, funds originating from the 1% scheme represent approximately 2-3% of revenues of all non-governmental organizations in Poland (Sikorski, 2018).

With regard to problems of lack of autonomy, government bodies not only decide which problem areas they want to devolve to NGOs, but they also set priorities and conditions for the NGOs. This lack of autonomy is closely related, for many NGOs, to an inability to pursue their own aims. For example, in the Czech Republic, Hungary, and Poland, many NGO representatives felt working with local governments was taking them away from their own views concerning the needs of their constituent groups. In Poland, governments were described as having a paternalistic attitude to NGOs and often using them to provide

nonspecialist basic services. A recurrent theme among Polish panel members was that they were “stuck in a vicious cycle”: NGOs did not win contracts for services because of their poor standards, but they were unable to improve their standards until they began contracting services (Cox, 2020).

NGOs are favored in many areas of the tax system of the Slovak Republic. NGOs may be able to stabilize their income from tax assignation by changes to the tax laws. But doing so requires long-term effort, and the results are volatile; a new government may disregard the previous government’s promises to the NGOs. Then there are the other possibilities of cooperation between NGOs and corporations (networking, CSR, shared marketing) which help to build long-term partnerships. In our opinion, these partnerships are more effective than tax assignment. However, NGOs also have to make an effort if they want to be involved in the mechanism of tax assignation; they must comply with the administrative regulations (register for the tax assignation at a notary), and they have to persuade corporations and individuals to assign the 2% of their taxes, e.g., by proving their reputation, transparency and credibility (Svidronová and Kuviková, 2014).

The ideas of assignment mechanism in the Slovak Republic are dated back to 1997. This process is mainly supported by the representatives of the third sector as it is the opportunity for long-term financing. The original proposal of the mechanism contained the opportunity of assignment only for individuals, who could assign 1 % of paid income tax. However, the assignment mechanism which could be used only by individual for the first two years of its existence was put in practice only in 2002. It has gone through several changes during a 15-year-period, but it has preserved its position within tax policy until now. As we have already mentioned, the mechanism could have been applied only by natural persons from 2002 to 2003. In 2004 the tax reform cancelled deductible items for legal entities in the form of donations. However, the pressure of non-profit organisations in Slovakia enabled the implementation of a new system, concretely the system of tax assignment by legal entities in the amount of 2 % of their tax liability. Therefore, the support of public sector was extended to legal entities in 2004. The Slovak Republic became the only European country with such a right given to legal entities. A legal entity can assign the tax to several non-profit organisations. However, the minimal amount of assigned income tax for one organisation is defined in legislation (legal entities can assign at least 8 EURO for one receiver). The total corporate tax revenue reached 1 billion EURO in 2004. The theoretical maximum value of 2 % of corporate tax represented 20.3 million EURO. The actual assigned tax reached 18.9 million EURO. It represented 92.7 % usage of the tax assignment mechanism by legal entities in the first year of the existence of the assignment mechanism (Kusnirova, 2018).

Tax designations is the possibility of allocating part of the income tax for a selected purpose, i.e. it is a tax redistribution of tax to a specific organization. The concept of tax designations originates in Spain and Italy, where it was a means of redistributing income to the Catholic Church. Tax designations are partly similar to subsidies, but the taxpayers themselves decide on the use of financial resources, not state representatives, and the state's tax revenue is therefore lower in the case of using the designations. [(Smetanková and Krček, 2022), (Marková, 2022)].

Results of research shows that this is a very important part of public sector and private persons would like to support the activity of non-governmental organization. The state could offer taxpayers some attractive incentives that encourage citizens to pass the part of their income tax to NGO’s. In this analysis is it showed that public government have some instruments to improve the financial situation of organizations from the third sector. The number of taxpayers is correlated with the amount of money transferred to NGOs from tax returns. Thus the hypothesis was positively verified.

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Insurance demand forecasting: possibilities of using alternative data when applying statistical and artificial neural network-based methods

Andrea Kolková [1] Martina Borovcová [2]

Abstract

The aim of the paper is to apply ETS, ARIMA, artificial neural networks, and hybrid models for forecasting demand in the insurance industry, using Google Trends data. The selected models are applied to the search for head terms in the insurance sector in selected Central European countries (the Czech Republic, Slovakia, Poland, and Hungary). The article analyzes 16 time series. According to the results, demand growth can be predicted based on the search for travel insurance in Hungary. Further demand growth can be expected for vehicle insurance in all selected countries. Searches for the term insurance are generally growing in the Czech Republic and Poland, while according to the prediction it will decrease in Hungary and Slovakia. Based on the results of the calculations of the accuracy rate of the models, it can be stated that artificial neural networks were the most accurate model 6 times, the hybrid model 5 times, ARIMA models 3 times, and ETS models 2 times.

Key words

Insurance, Demand forecasting, ETS, ARIMA, neural networks, hybrid model

JEL Classification: G17, G22, C4, C53

1. Introduction

The aim of the paper is to apply Exponential Smoothing (ETS), Auto Regressive Integrated Moving Average (ARIMA), artificial neural networks and hybrid models for forecasting demand in the insurance industry using Google Trends (hereinafter referred to as GT) data. The selected methods were applied to search for head terms in the insurance sector in selected Central European countries (the Czech Republic, Slovakia, Poland, Hungary).

Using alternative data in insurance demand forecasting can significantly increase the accuracy and timeliness of predictions by capturing new patterns of client behaviour that are not apparent from traditional data sources. Data from online searches can reveal current trends, changes in consumer preferences, or reactions to economic and legislative changes in real time. This could allow insurance companies to better tailor products, target marketing, or optimize risk models, leading to greater competitiveness and more efficient portfolio management.

Recently, it has been shown that the use of classical statistical methods, such as exponential smoothing, may be insufficient for some time series. Therefore, new methods are being developed. Methods based on artificial neural networks are already being supplemented by hybrid models (Smyl, 2020). Comparing statistical methods is also a subject of research (Spiliotis et all, 2022; Ning et all, 2022; Kolková, Ključnikov, 2022).

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2. Methodology

2.1 Data analysis

This paper used the following general keywords: insurance, life insurance, travel insurance, car insurance. These general keywords were analysed in the former selected Central Europe countries (Czech Republic, Poland, Hungary, Slovakia). A total of 16 time series of search terms were analysed. The time series was collected from 1.1.2011 to 1.5.2025, with monthly data. Search data represents the relative interest in searches relative to the highest point of the graph for a given area and time. A value of 100 represents the highest popularity of the term. A value of 50 means that the term was half as popular. A score of 0 means that not enough data was collected for the term. Table 1 shows the descriptive characteristics of the data examined.

Table 1: Data Description

		Min.	Q1.25 %	Median	Mean	Q3.75 %	Max.
Travel insurance	Czech Republic	0	27	40	40.1953	51	100
	Hungary	2	14	21	27.0414	36	100
	Poland	0	9	17	23.6568	31	100
	Slovak Republic	0	10	17	23.7337	30	100
Keyword insurance	Czech Republic	43	53	60	61.7041	68	100
	Hungary	32	39	43	45.6036	51	100
	Poland	57	70	75	75.4911	80	100
	Slovak Republic	31	37	40	43.3609	47	100
Vehicle insurance	Czech Republic	13	45	56	57.5917	73	100
	Poland	12	44	58	54.5503	68	100
	Slovak Republic	0	0	26	22.2249	34	100
	Hungary	0	3	5	7.7574	11	100
Life insurance	Czech Republic	0	31	39	42.2130	52	100
	Hungary	18	27	37	38.9941	47	100
	Poland	51	62	67	68.8402	75	100
	Slovak Republic	26	48	53	54.2367	61	100

Source: own processing

GT data has been collected since 2004, however, since that year the number of Google search users has increased significantly, therefore the relative search intensity for most categories is decreasing and such analyses would not correspond to reality and provide distorted results. To eliminate this deficiency, the work uses data from 2011, when it can be said that the user base is approximately similar.

From the results in Table 2, it is evident that the Hurst exponent in all monitored time series has a value greater than 0.5, which means that the time series has a trend (persistent) structure. It is therefore clear that past developments influence the future, and their predictability is confirmed.

Table 2: Data analysis

		Variance	SD	Skewness	Kurtosis	Hurst exponent
Travel insurance	Czech Republic	413.1581	20.3263	0.4326	3.4261	0.6197
	Hungary	376.4923	19.4034	1.4312	4.8606	0.6405
	Poland	418.0363	20.4459	1.5593	5.3392	0.7551
	Slovak Republic	484.3394	22.0077	1.3926	4.3738	0.6262
Keyword insurance	Czech Republic	137.1500	11.7111	0.8075	3.5005	0.7869
	Hungary	100.6812	10.0340	1.8458	8.3954	0.7992
	Poland	66.2395	8.1388	0.3371	3.3709	0.7024
	Slovak Republic	92.2797	9.6062	2.4208	12.0943	0.7854
Vehicle insurance	Czech Republic	364.7430	19.0982	0.0562	2.3808	0.8081
	Poland	363.6180	19.0688	-0.5458	2.9792	0.7466
	Slovak Republic	446.3182	21.1262	0.7081	3.4513	0.6735
	Hungary	106.5658	10.3231	5.1070	41.5137	0.7663
Life insurance	Czech Republic	278.5139	16.6887	0.6022	4.1340	0.5791
	Hungary	207.1488	14.3927	0.9599	4.4831	0.8044
	Poland	97.5279	9.8756	0.7420	3.3804	0.7124
	Slovak Republic	116.0627	10.7732	0.7057	4.8000	0.6702

Source: own processing

2.2 Models used

In this work, 4 groups of models will be used. ETS models form a group of Exponential smoothing models. These models are selected including the distinction between models with additive and multiplicative errors. The following models are analysed within the ETS (M,N,N) models: Simple Exponential Smoothing with Multiplicative Errors ETS (A,N,N), Simple Exponential Smoothing with Additive Errors ETS (A,A,N), Holt's Linear Method with Additive Errors ETS (M,A,N), Holt's Linear Method with Multiplicative Errors ETS (M,M,N), where the first letter in parentheses expresses the error (A-additive or M-multiplicative), the second letter expresses the trend (A-additive, M-multiplicative or N-none) and the third letter expresses seasonality (A-additive, M-multiplicative or N-none).

. From these models, the one that describes it more accurately will be selected for each time series. This will then be compared with the other models. The calculation will be performed using the automatic ETS algorithm, in the forecast package, in the R program.

Another statistical approach to forecasting time series is ARIMA (Auto Regressive Integrated Moving Average) models. We write ARIMA models similarly to ETS using letters in parentheses, i.e. ARIMA (p,d,q), where p represents the degree of the autoregressive part, d is the degree of differentiation and q is the degree of the moving average part. The calculation will again be performed using the automatic algorithm auto.arima, in the forecast package, in the R program.

Exponential smoothing pairs and ARIMA models are the most widely used approaches to predicting time series (Hyndman & Athanasopoulos, 2021).

These models will be compared with models based on artificial neural networks. In this work, feed-forward neural networks with a single hidden layer and lagged inputs for forecasting univariate time series will be used. The calculation will again be performed using the NNETAR function in the forecast package, in the R program.

The last model used will be forecastHybrid (Shaub & Ellis, 2018), published in (Shaub, 2020). It is a hybrid model that combines three predictive approaches: an automatically

configured ARIMA model, an exponential smoothing model (*ETS*), and a neural network for time series modelling (*NNETAR*) and minimizing the root mean square error (RMSE). This hybrid structure allows for the use of complementary strengths of the individual models, linear dynamics (ARIMA), seasonal components (ETS), and nonlinear relationships (NNETAR), and thus ensures more robust and accurate time series forecasting. All components of the hybrid model come from the forecast package (Hyndman & Khandakar, 2008). The resulting for forecastHybrid is then given by,

$$f(i) = \sum_{m=1}^{n} w_m \cdot f_m(i), \quad (1)$$

where w_m are the weights assigned to each calculation method, f_m is the result of the given method.

The data will be divided into training and testing in a ratio of 80:20. The appropriate model will be created on the training data and the most suitable model parameters will be selected, and the accuracy of the given model will be calculated on the testing data. The accuracy will be calculated according to the RMSE criterion. As previous studies have shown (Kolková, 2018), there is no point in using multiple criteria to evaluate accuracy, they will usually provide the same result.

3. Results

3.1 Selecting the most accurate prediction models

The input time series (x) contains 169 observations with a defined frequency for all models, and two exogenous variables were used. In Table 3, we see the accuracy of the models according to the RMSE criterion, applied to the test data.

Table 3: Accuracy of test data

		ETS	ARIMA	NNETAR	HYBRID
Travel insurance	Czech Republic	20.763962	23.839368	21.896058	**19.414938**
	Hungary	40.063726	29.492194	26.141194	**21.995538**
	Poland	39.896968	35.661672	**31.850871**	34.945908
	Slovak Republic	32.669018	**31.529027**	37.590781	32.650292
Keyword insurance	Czech Republic	14.302824	10.545681	10.138786	**10.004031**
	Hungary	7.518862	11.520796	**6.583066**	8.092895
	Poland	7.852262	8.597342	10.473934	**6.496196**
	Slovak Republic	3.736589	5.180161	3.297998	**2.714769**
Vehicle insurance	Czech Republic	17.967304	**11.094304**	24.423239	15.943471
	Poland	24.394021	24.393828	**24.183179**	24.309503
	Slovak Republic	**16.227346**	16.22789	16.283464	16.324915
	Hungary	20.128137	20.819806	**18.236771**	19.631662
Life insurance	Czech Republic	24.684917	**16.489132**	18.827044	18.283494
	Hungary	10.794535	16.973646	**10.405088**	12.300309
	Poland	10.154177	10.454908	**7.284488**	10.381825
	Slovak Republic	**9.455111**	9.473107	9.508504	9.46934

Source: own processing

For the search for travel insurance in the Czech Republic and Hungary, a hybrid model minimizing the root mean square error (RMSE) value was chosen as the optimal one. The hybrid model used partial prediction models, the results of which are represented by objects with different numbers of components: auto.arima (18), ETS (19) and NNETAR (15). Specifically, the auto.arima model contains 18 elements, including, among other things, information about the selected model order, estimated parameters, residuals and forecast values. The ETS model has 19 components, which reflects its more complex structure based on exponential smoothing with parameters for level, trend and seasonality. On the other hand, the NNETAR model, built on neural networks, contains 15 parts, including the specification of the network architecture, neuron weights, activated lags and forecasts.

For Poland, the most accurate model is NNETAR with seasonality parameters (1,1,1) and 2 scales. 13 lags were used in this model. The model structure (model) consists of 20 components defining the architecture and weights of the neural network. For Slovakia, the most accurate forecast was calculated using the Arima model (1,0,2) with non-zero mean.

For the search for the keyword insurance in the Czech Republic, Poland and Slovak Republic, the most suitable hybrid model was with parameters for the Czech Republic auto.arima (19), ETS (19) and NNETAR (15), for Poland auto.arima (18), ETS (19) and NNETAR (15), for Slovakia auto.arima (19), ETS (19) and NNETAR (15). In Hungary, the most accurate model for the search for the keyword insurance was the artificial neural network model with seasonality parameters (1,1,1). 15 lags were used for this model.

When searching for the term vehicle insurance in the Czech Republic, the most accurate model was ARIMA (1,1,1). In Poland, it was an artificial neural network model with seasonality parameters (1,1,1) and 1 lag. For vehicle insurance in Slovakia, the most accurate model was ETS(A,N,N) with smoothing parameters 0.3746 and initial states 6.0149. In Hungary, the most accurate model was artificial neural network model with seasonality parameters (1,1,1) and 2 lags.

Life insurance in the Czech Republic was forecasted using the ARIMA(1,0,0) model. In Hungary, the most inaccurate model for life insurance was the artificial neural network model with seasonality parameters (1,1,1) and 17 lags. In Poland, the most accurate model for Slovakia for life insurance was the ETS(M,N,N) model with smoothing parameters 0.1199 and initial states 67.7543.

Based on the results of the calculations of the accuracy rates of the models, it can be stated that artificial neural networks were the most accurate model 6 times, the hybrid model 5 times, ARIMA models 3 times, and ETS models 2 times.

3.2 Summary of results

Table 4 summarizes the prediction results. We can see that most searches in the field of insurance terms show a decreasing trend. The trend of stagnation did not appear for any of the examined search terms. We can observe growth in the search for travel insurance in Hungary. Further growth can be seen in vehicle insurance in all selected countries. Searches for the term insurance are generally growing in the Czech Republic and Poland. All other search terms will show a decrease in the next 12 months. Therefore, a decrease in demand can be expected, especially for life insurance, which shows a decrease in searches in all countries. This is probably also related to the stabilizing economic situation and, therefore, a smaller need to take out insurance.

In a search for the term vehicle insurance in Hungary, a higher kurtosis was found based on the data analysis (Table 2). This finding may have affected the relevance of the results. However, non-linear models were used for this country, which are more robust to high kurtosis. Therefore, no further statistical analysis is necessary. And these results can be considered relevant.

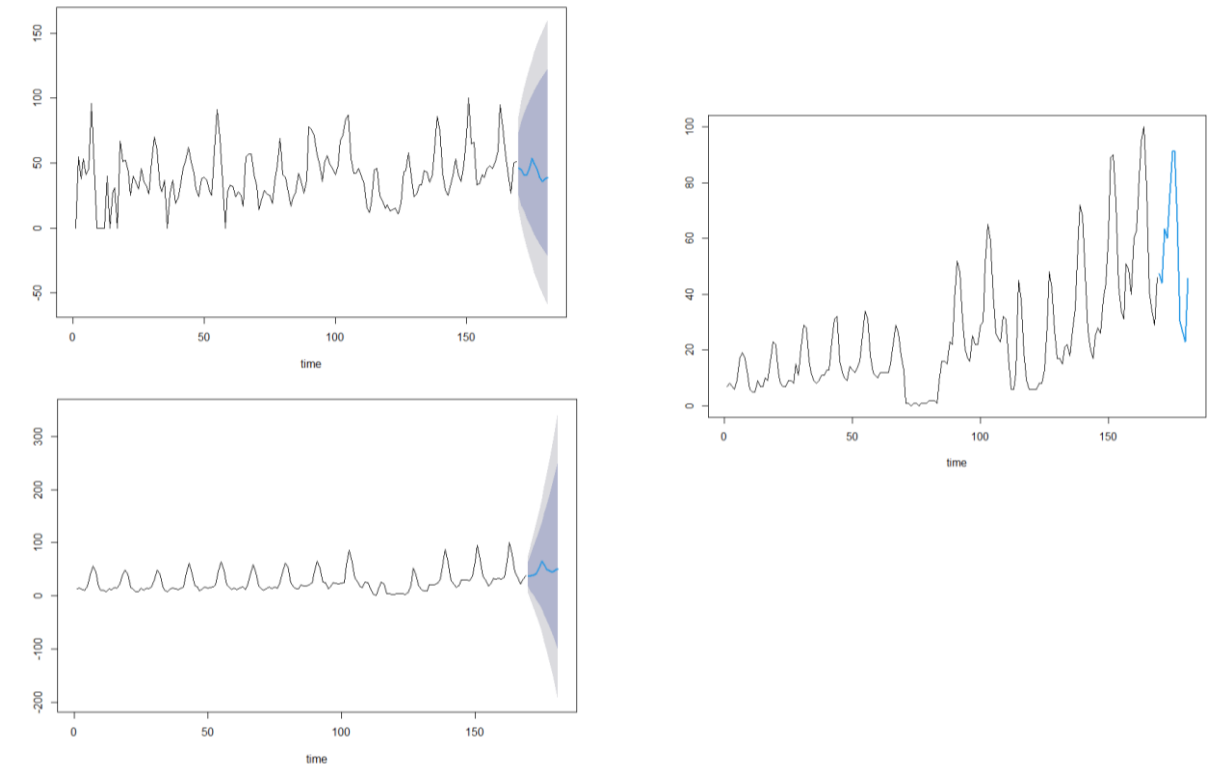
Table 4: Forecast results

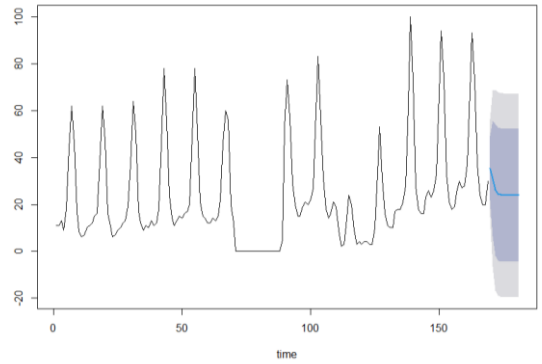
		Model	Trend
Travel insurance	Czech Republic	hybridModel	decline
	Hungary	hybridModel	growth
	Poland	NNETAR	decline
	Slovak Republic	auto.arima	decline
Keyword insurance	Czech Republic	hybridModel	growth
	Hungary	NNETAR	decline
	Poland	hybridModel	growth
	Slovak Republic	hybridModel	decline
Vehicle insurance	Czech Republic	auto.arima	growth
	Poland	NNETAR	growth
	Slovak Republic	ETS	growth
	Hungary	NNETAR	growth
Life insurance	Czech Republic	auto.arima	decline
	Hungary	NNETAR	decline
	Poland	NNETAR	decline
	Slovak Republic	ETS	decline

Source: own processing

In the following graphs, we will look at the resulting trends in more detail. In Figure 1, we see searches for the term travel insurance, and although the overall average of forecast values is lower than the last value, it can be seen that the forecast values in all countries follow the previous trends. In Hungary, there is an increasing trend and a slight increase.

Figure 1: Forecast for searching for the term travel insurance in Czech Republic, Poland, Hungary, Slovakia

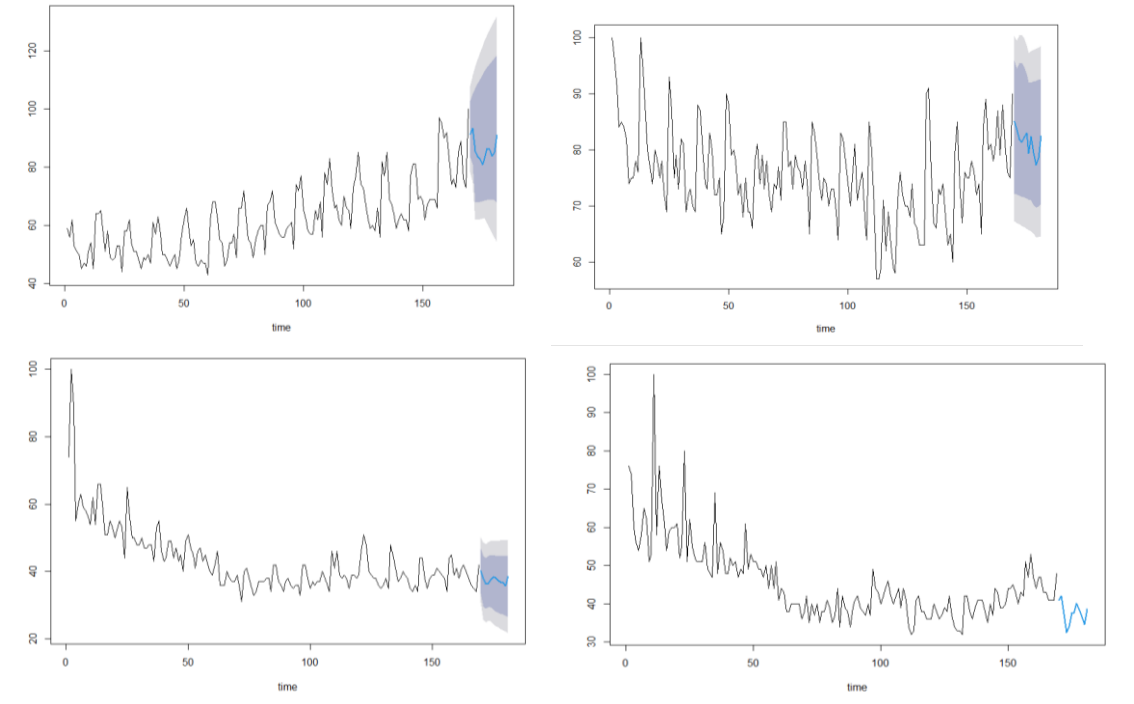




Source: own processing

In Figure 2 we see the forecast for searching for the term insurance in Czech Republic, Poland, Hungary, Slovakia. In the Czech Republic and Poland we can see a slight increase, which is given by the previously started trend and especially in the Czech Republic there is a permanent increase in interest in searching for the term insurance. On the contrary, in Slovakia and Hungary there is a permanent decrease in interest in searching for this term and this trend is predicted to continue.

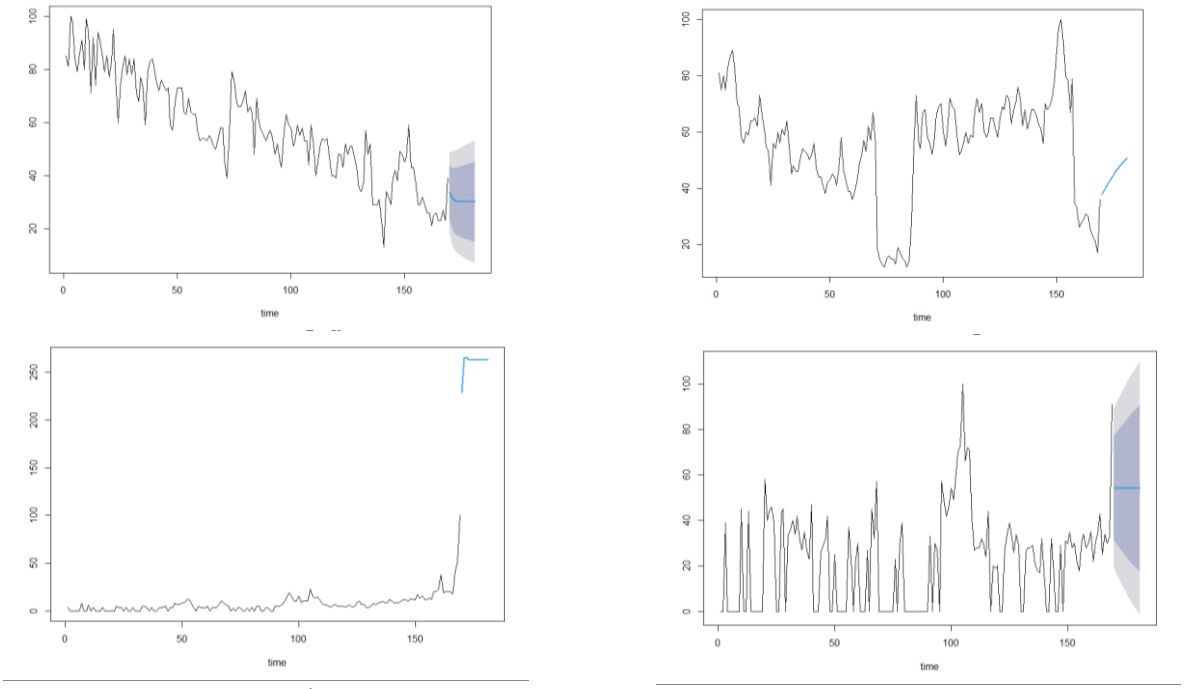
Figure 2: Forecast for searching for the term insurance in the Czech Republic, Poland, Hungary, Slovakia



Source: own processing

When searching for the term insurance by search term vehicle, we can expect an increase compared to the previous year. In the Czech Republic and Slovakia, this is only a slight increase compared to the previous 12 search values, but in Poland and Hungary we can expect a higher demand for vehicle insurance. In Hungary, the forecast has a non-standard shape, which is due to a sudden increase in interest in searching for this term in the last months of the monitored interval.

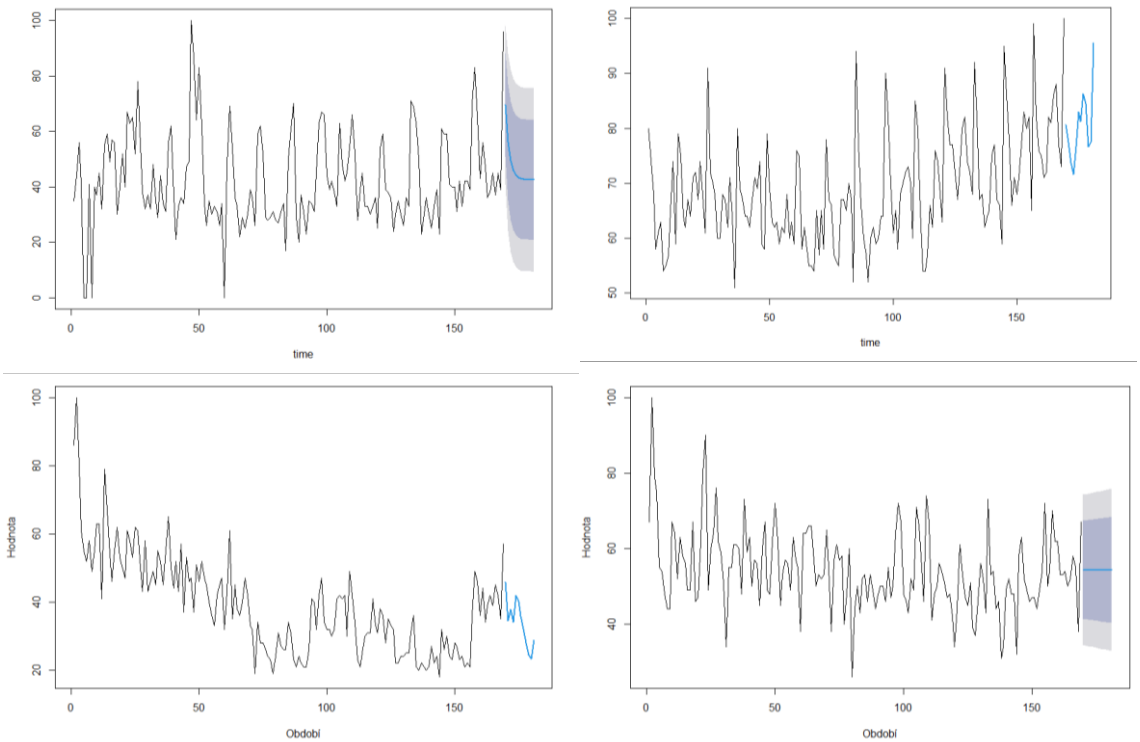
Figure 3: Forecast for searching for the term vehicle insurance in the Czech Republic, Poland, Hungary, Slovakia



Source: own processing

There is a decrease in searches for the term life insurance compared to the previous 12 values in all countries. In Poland, the trend of growth in searches can be seen to end. In Slovakia, a decrease can be predicted, which will be followed by year-round stagnation. In the Czech Republic and Hungary, we observe a clear decrease in interest in this topic.

Figure 4: Forecast for searching for the term life insurance in the Czech Republic, Poland, Hungary, Slovakia



Source: own processing

4. Conclusion

The aim of the paper was to apply ETS, ARIMA, artificial neural networks and hybrid models for forecasting demand in the insurance industry, using Google Trends data. The use of this data can significantly increase the timeliness of predictions.

According to the results, demand growth can be predicted based on searches for travel insurance in Hungary. Further demand growth can be expected for vehicle insurance in all selected countries. Searches for the term insurance are generally growing in the Czech Republic and Poland, while, according to the prediction, they will decrease in Hungary and Slovakia. Based on the results of the model accuracy calculations, it can be stated that artificial neural networks were the most accurate model 6 times, the hybrid model 5 times, ARIMA models 3 times and ETS models 2 times.

In further research, it would be appropriate to focus on the selection of searched keywords. Furthermore, the use of not only head terms, but also long-tail, possibly branded keywords and query and information words (so-called FAQ style). To determine the accuracy of the created models, the subject of research could also be measuring the degree of accuracy ex post with the actual demand of selected insurance companies.

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Consumer price trends with a focus on food and non-alcoholic beverage prices in the Czech Republic between years 2000 and 2024

Aleš Kresta, Karolina Lisztwanová, Iveta Ratmanová [1]

Abstract

The paper focuses on capturing changes in month-on-month inflation in the Czech Republic between years 2000 and 2024. The starting point is the monthly values of the total consumer price index, i.e., data presented by the Czech Statistical Office. The development of this index was graphically captured using the same month of the previous year and the immediately preceding month as the starting period. Periods with the highest mean value and highest variability were identified. The months associated with the highest change expressed in percentage points of this index were identified. The same was determined for month-on-month changes in this index for food and non-alcoholic beverages. The month-to-month development of prices for selected foods for end consumers between 2015 and 2024 was also assessed. Among selected food types, those with the highest change in average price and the highest variability were identified.

Key words

consumer price index, food prices, inflation, price level

JEL Classification: E31

1. Introduction

The European economy has had to deal with many shocks in the last five years. The most important ones are probably the coronavirus pandemic, the war in Ukraine, the climate changes and last but not least, the risks of the EU introducing regulatory measures in the area of environmental protection policy. However, after the COVID wave subsided, economies struggled with persistent problems in global supply and production chains for a surprisingly long time. This had an impact on production and delayed deliveries to the consumer market and increasing of price level. Also, what cannot be forgotten is the fact that the beginning of the war in Europe also contributed significantly to the price increase of natural gas, electricity, and fuel. On the other hand, households gradually dissolved part of the previously created savings from the pandemic waves as soon as it was possible under the circumstances. In the case of the Czech Republic, the situation was even more specific in that the super-gross wage taxation system was abandoned in 2021, and it brought an additional almost one hundred billion Czech crowns to the economy.

The following Figure 1 concerns the situation of the Czech Republic during the period between the years 2000 and 2024. Data shows that changes in the price level in the last five years were different compared to the data from the rest of observed period. The highest annual

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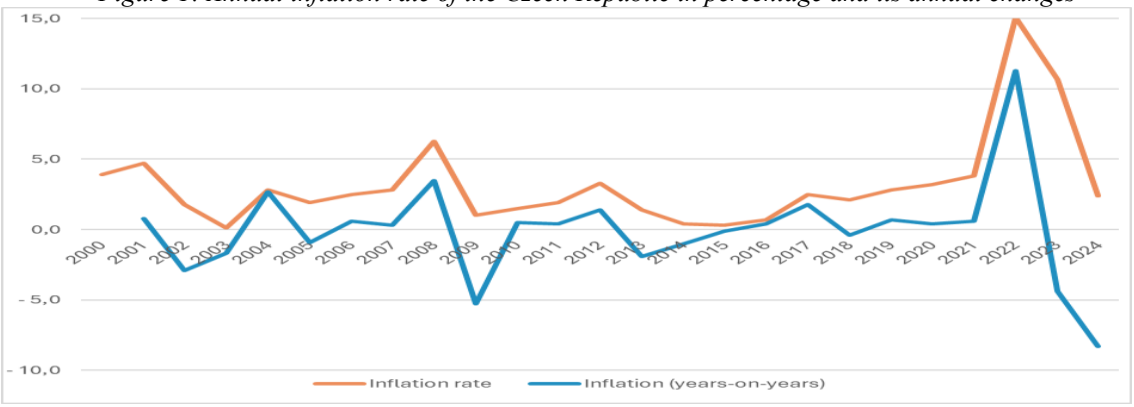
inflation rate was reached just in the year 2022. This means that in 2022, the prices of goods and services consumed by the average Czech household were on average 15.1 % higher compared to 2021.

Figure 1: Annual inflation rate of the Czech Republic in percentage and its annual changes



Source: Authors' processing according to the Czech Statistical Office

The average year-on-year rate of inflation can also be described by expressing the value of its year-on-year changes. That is, the amount of the year-on-year difference between values of annual inflation rates. Regarding year-on-year changes of average annual inflation rate, the most significant year-on-year increase was associated with the years 2022 and 2021, and the most significant decline in the inflation rate occurred between years 2023 and 2022. According to the data for the observed period, it can be stated that the largest changes in the average annual inflation rate occurred during the last five years.

In addition to year-on-year changes, the development of price level changes can also be stated through month-on-month changes. With regard to the study (Komárek, Polák, 2024), it can be observed within the framework of month-on-month changes, according to Eurozone data, that the revaluation towards higher prices occurs most often in March. However, the situation in individual countries may differ. With regard to the above-mentioned findings and respecting selected time period, it seems interesting to verify the development of month-on-month changes in the price level in the conditions of the Czech Republic.

The aim of the paper is to determine and evaluate the monthly development of consumer prices based on input data, which are the values of the consumer price index in the selected period between years 2000 and 2024 in the conditions of the Czech Republic. Moreover, the same facts will be determined and assessed in the case of consumer prices of food and non-alcoholic beverages. In addition, the variability of consumer prices of food and non-alcoholic beverages will be determined and assessed within partial five-year intervals of the selected period, and at the very end, the variability of selected types of food in two selected five-year intervals between 2015 and 2024 will be identified.

2. Literature review

In connection with high inflation in recent years, there was a need to assess the development of food prices in the Czech Republic. Food has indeed been one of the significant components of consumer price growth recently, and in the fall of 2022, its prices rose the fastest. (Brůha, Šnobl, Sutóris, Tomanová, 2023) The disadvantage of increasing food prices is their more intense societal perception by individual economic entities, who are confronted with food prices almost daily. Socially vulnerable groups of the population thus face a more intense increase in price levels and, in some cases, face the impossibility of replacing some foods with cheaper alternatives. The analysis (Hait, Janský, 2013) shows that lower-income households (i.e., the bottom 40% of households) spend a larger share of their expenses on food and a smaller share

on household furnishings or other goods and services. In households of pensioners, a larger share of expenses is on food, health, housing, and energy, and a smaller share is on clothing and accommodation.

According to Bošková, Mrhálková, and Dolanová (2023), the prices of domestic agricultural producers and also the prices of domestic food depend on the development of the price level of food inputs outside the territory of the Czech Republic. The prices of agricultural input costs and the production prices of agricultural commodities began to increase during 2021. The increase in global food prices at that time was primarily driven by long-standing global demand, which was driven by economic and population-expanding developing countries, particularly in Southeast Asia. The supply side and prices in 2020–2021 were also more affected than ever by extreme weather fluctuations worldwide. (Brůha, Šnobl, Sutóris, Tomanová, 2023) The impacts of the war in Ukraine were partially eliminated by the strengthening of the national currency exchange rate in 2022. However, the following increase in energy prices had a negative impact, and according to Brůha, Šnobl, Sutóris, and Tomanová (2023), the intensity of growth in production and consumer prices in the Czech Republic was higher than the European average.

Food prices also respond to changes in demand. The fundamental aspects include relatively high purchasing power resulting from previous COVID years, not accompanied by corresponding production growth, followed by a reduction in the tax burden due to the abolition of super-gross wage taxation, and the impact of inflationary expectations in the food industry. (Doucha, Mrhálková, 2024) The income situation of Czech households has so far allowed traders and service providers to reflect the increase in their costs in prices and partially compensate for losses or lost profits. A significant demand factor was neighbouring countries' different approaches to value-added tax changes. Lower or zero rates of this tax impacted so-called arbitrage purchases in the border areas of the Czech Republic.

3. Methods and research

With regard to the aim of the paper, it is necessary to mention the details of the input data and used methods. The values of consumer price index presented by the Czech Statistical Office were used as input data. Consumer price index is the price development indicator in the system of price indexes calculated in the Czech Republic. The index measures changes of final consumer prices (including all taxes) of goods and services paid by the population and is used for the measurement of rate of inflation in the Czech Republic. More precisely, month-on-month changes in the consumer price index publicly available were used as input data. Month-on-month changes are determined either in relation to the immediately preceding month (as a base period) or in relation to the same month of the previous year (as a base period). The detail form of the consumer price index, the selection of price representatives, the methods of determining consumer prices, including the method of calculating the indices, is presented in the document Consumer Price Indices of the Czech Statistical Office. The calculation of consumer price index is carried out on constant weights according to the Laspeyres formula:

$$I = \frac{\sum \frac{p_1}{p_0} \cdot p_0 \cdot q_0}{\sum p_0 \cdot q_0} \cdot 100, \tag{3.1}$$

where p_1 is price of goods in the current period p_0 is price of goods in base period and $p_0.q_0$ is household expenditures on goods (services) in the base period.

From the available value of monthly changes in the consumer price index, its variability was determined by determining the mean value and standard deviations for individual periods. The following formula applies to determine the mean value:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}, \tag{3.2}$$

where x_i are the values found and n is number of observations. To calculate the standard deviation, the following applies:

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x - \bar{x})^2}, \tag{3.3}$$

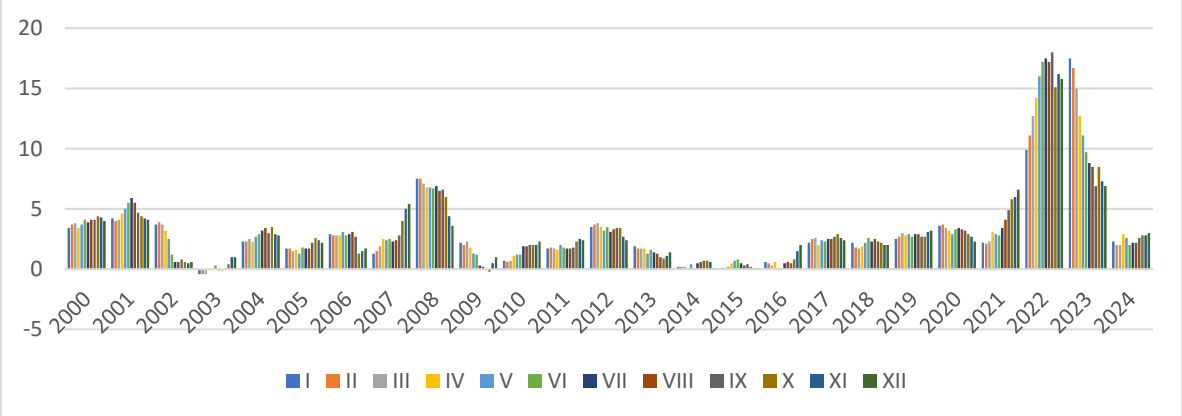
where x_i are the values found and n is number of observations.

As it was mentioned, publicly available data about consumer price index (CPI) and its month-on-month changes was used respecting the selected period from the year 2000 to the year 2024, so as to capture and assess their development. The treatment of this issue was therefore divided into two separate parts. The first part is dedicated to capturing and describing the development of the overall (total) consumer price index. The second part is focused on capturing and describing the development of the consumer price index in the case of food and non-alcoholic beverages.

As for the total consumer price index, firstly, data about changes of consumer price index for the same month in the previous year is graphically presented. Later, monthly data about changes of the consumer price index compared to the previous month are graphically presented as well. In the case of capturing changes in the food and non-alcoholic beverage price index the attention is paid to month-on-month changes with an emphasis on changes in this index in relation to the current previous month.

As for the development of the total consumer price index, its details are clear from Figure 2. Figure 2, covering the Czech Statistical Office data, provides a more detail graphic description of the development in price level during observed period and describes the changes of the inflation rate expressed as the increase or decrease of the all-consumer price compared to the same month of the previous year. It represents the percentage change in the price level in the month of the given year, compared to the same month of the immediately preceding year. The values of these changes are clear from the y-axis. The x-axis contains observed years broken down by individual months, which are expressed in Roman numerals. As it is clear from the data, the highest changes came in the last five years, and they are not comparable to anything from previous data in the observed period. The highest percentage of month change was reached between September 2022 and September 2021, and moreover, it is clear that the changes detected between years 2022 and 2021 were the highest.

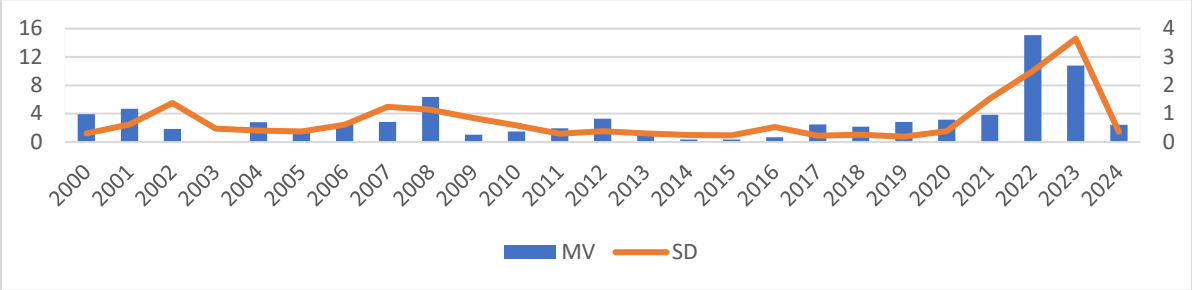
Figure 2: Percentage change in the price level in the reported month of given year compared to the same month of previous year



Source: Authors' processing according to the Czech Statistical Office

Figure 3 is based on the same input data as Figure 2, but depicts the mean value (MV) of these changes (y-axis) and the identified value of standard deviation (SD) (z-axis). As data declares, the highest month-to-month changes were identified in the year 2022. However, the highest fluctuations in the data were observed in the year 2023.

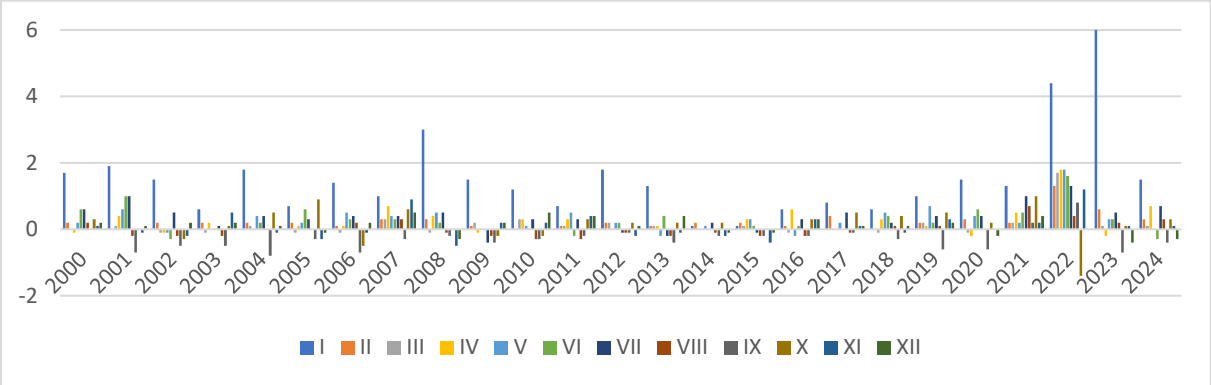
Figure 3: Mean value and standard deviation of values of change in the CPI compared to the same month of the previous year



Source: Authors' processing according to the Czech Statistical Office

Figure 4 shows the inflation rate, expressed as the changes in the total consumer price index compared to the previous month, expresses the percentage change in the price level of the monitored month compared to the previous month.

Figure 4: Percentage change in the price level in the reported month of given year compared to the previous month

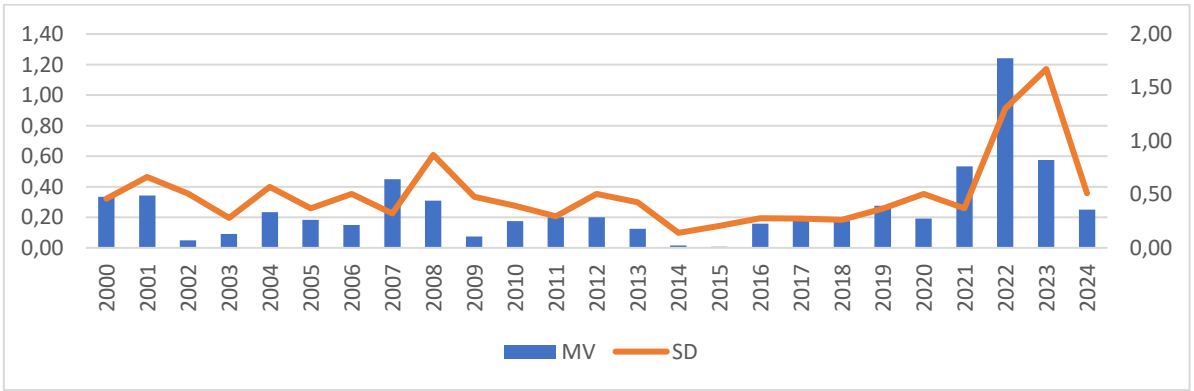


Source: Authors' processing according to the Czech Statistical Office

Figure 4 shows that changes were declared over the period under review, with the significant monthly movements occurring in the year 2008 and in the years 2021, 2022, and 2023. The highest month-on-month price increase was recorded between January 2023 and December 2022 (6%) and January 2022 and December 2021 (4.4%). The most significant value of the month decrease was observed between February and January 2023 (-1.4 %).

Figure 5 is based on the same input data as Figure 4, but depicts the mean value (MV) of these changes (y-axis) and the identified value of standard deviation (SD) (z-axis). As data declares, the highest month-to-month changes were identified in the year 2022. However, the highest fluctuations in the data were observed in 2023.

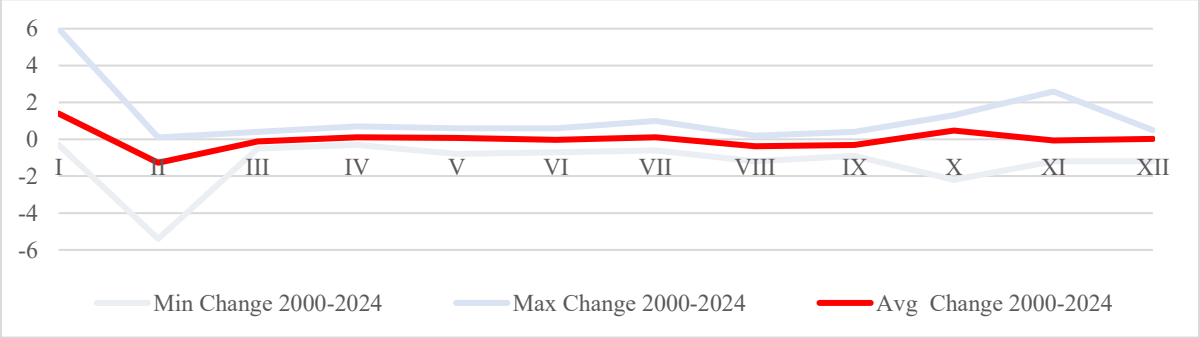
Figure 5: Mean value and standard deviation of values of change in the CPI compared to the previous month



Source: Authors' processing according to the Czech Statistical Office

A different approach to assessing changes in the inflation rate over the observed period was used to construct Figure 6. The input data is monthly consumer price indices in relation to the previous month. However, the values in Figure 6 express the increase or decrease of these changes. For example, if the value of the month-on-month inflation rate in February 2000 was 0.2 and in January 2000 was 1.7, then the value of this change is a decrease of 1.5 percentage points. Figure 6 thus expresses the values of month-on-month changes of the inflation rates with respect to the intensity of these month-on-month changes. According to the data can be declared (respecting observed period) the most significant movement occurred between January and December (increase of 6 percentage points). More exactly, this value was observed between January 2023 and December 2022. The most significant monthly decrease was observed between February and January respecting data of the observed period (decrease by 5.4 percentage points). More specifically, this value was observed between February and January 2023. If the average values of these changes are considered, the most significant price decreases occurred between February and January and the highest average increases in the month-on-month inflation rate occur at the beginning of the year, i.e., in connection with the annual revaluation between January and December. From data is clear that the autumn price increase from September to October is also significant, followed by a price decrease in November.

Figure 6: Changes in the total consumer price index on a monthly basis



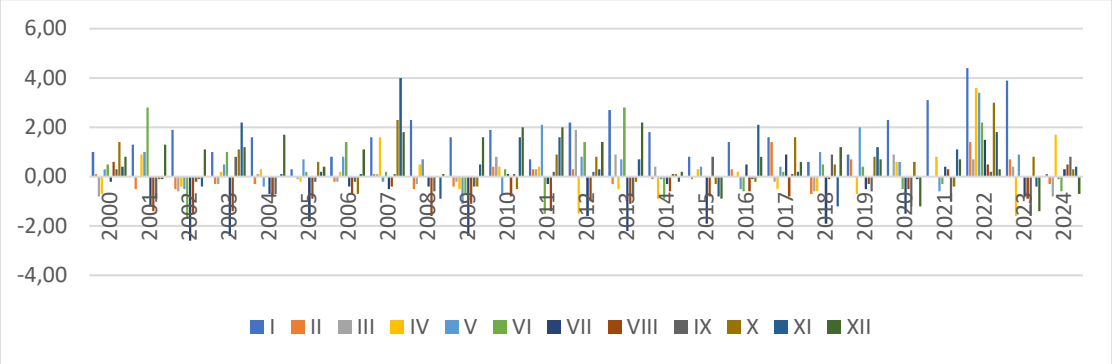
Source: Authors' processing according to the Czech Statistical Office

From the above-mentioned observations, respecting month-to-month movements in the price level, it is clear that although the average intensity of these month-to-month changes did not exceed 1.5 percentage points it ultimately contributed to changes in the price level during the observed period. These findings also declare that specific periods were consistently associated with growth or decline of month-on-month consumer price indices, However, the overall average values of these differences range from 1.4 to minus 0.4 percentage points.

3.1 Development of the month-on-month consumer price index for food and non-alcoholic beverages

As it was mentioned, data on changes in the consumer price index for food and non-alcoholic beverages are also examined. Figure 7 depicts the development in the inflation rate expressed as the change of the consumer price index of food and non-alcoholic beverages compared month data with the data of the previous month. The values of these changes are clear from the y-axis. The x-axis contains observed years broken down by individual months, which are expressed in Roman numerals. According to the data it is clear that the price level was not stable.

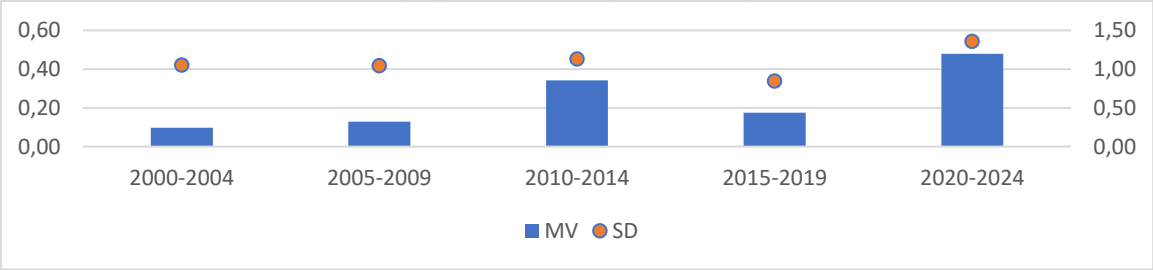
Figure 7: Percentage change in the price level in the reported month of given year compared to the previous month in the case of food and non-alcoholic beverages



Source: Authors' processing according to the Czech Statistical Office

The maximum month-on-month inflation rate for food and non-alcoholic beverages was reached between January 2022 and December 2021 (4.4 %). The lowest percentage change in the price level of the monitored month compared to the previous month is evident from the data for July 2002 (-2.6 %). It was also found that only the January month-on-month inflation rate always reaches values greater than zero. As for the month-on-month inflation rate itself, its negative value was most often observed in August, then in July and in September. On the contrary, month-on-month inflation the most often increases in December, then in November and in June. It can also be noted that in almost 57 % of observations of the month-on-month inflation rate, its value was higher than zero.

Figure 8: Standard deviation and mean value in month-to-month changes of food and non-alcoholic beverages prices according to selected periods



Source: Authors' processing according to the Czech Statistical Office

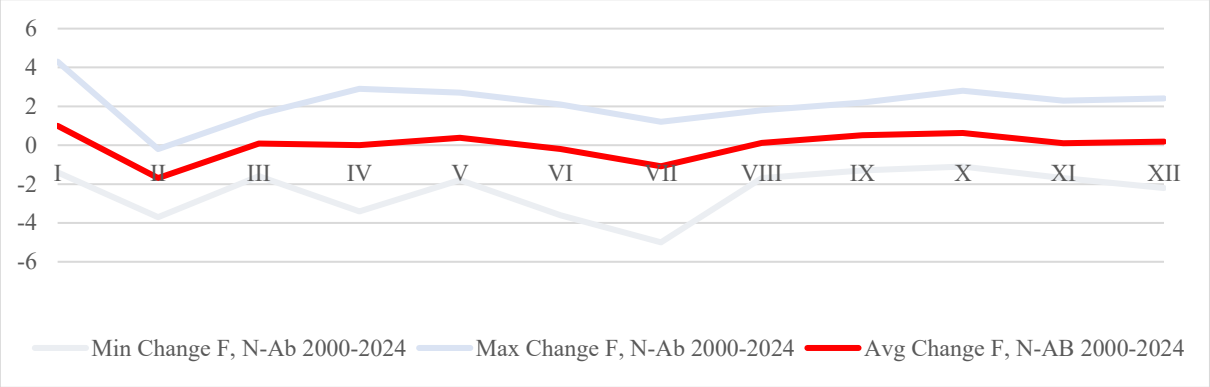
According to Benecká (2025), food and non-alcoholic beverages prices are traditionally among the most volatile items in the consumer basket. To assess the variability of changes in this kind of prices, the mean value and standard deviation were subsequently determined for individual five-year sub-periods between 2000 and 2024. More precisely, the following Figure 8 expresses the variability of the consumer price index within the monitored month compared to the previous month. The mean values of month-to-month changes are plotted on the y-axis, and the standard deviation values are plotted on the z-axis. The x-axis captures individual five-year periods defined with respect to the overall observed period.

Figure 8 shows that the percentage values of month-on-month changes in the price level were highest in the last period, i.e. between years 2020 and 2024, when its mean value was 0.48 %. This fact can also be stated in the case of the standard deviation. Again, its highest value is associated with the 2020-2024 period.

When it comes to Figure 9, the input data is monthly changes of consumer price indices of food (F) and non-alcoholic beverage (N-Ab) in relation to the previous month. Simply said, Figure 9 expresses the values of month-on-month changes of the inflation rates with respect to the intensity of these month-on-month changes (the differences between the monthly price

indices). In this way, the intensity of the development of this indicator is captured respecting month data of total observed period.

Figure 9: Changes in the total consumer price index of food and non-alcoholic beverages on a monthly basis



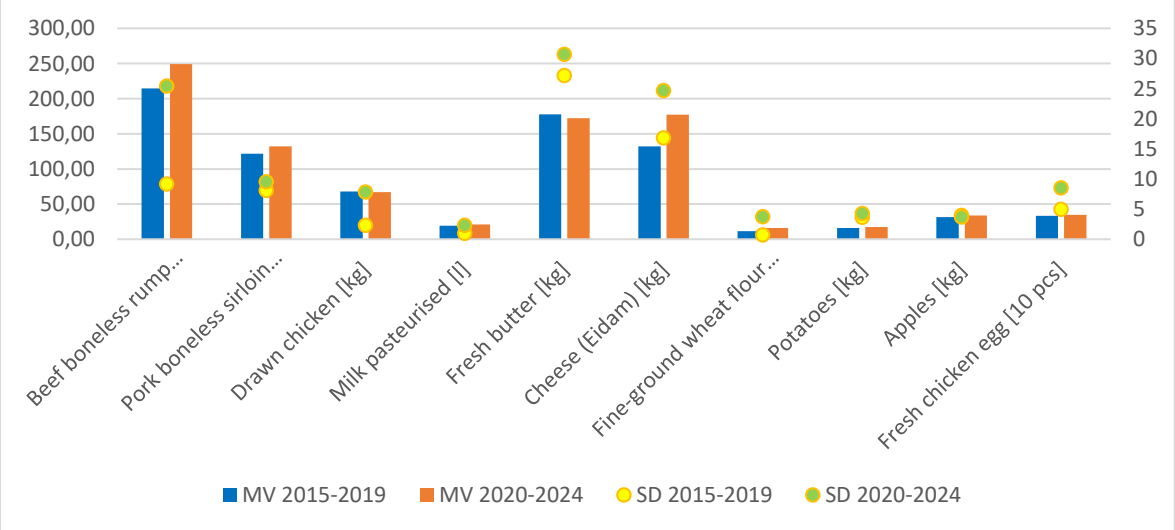
Source: Authors' processing according to the Czech Statistical Office

The highest value (the line Max F, N-Ab) was recorded in January (month-on-month growth of 4.3 percentage points). The lowest observation value was found for the July data (the line Min F, N-Ab), namely 5 percentage points. It means that if the difference between the monthly value of the consumer price index between July and June was found, its value was equal to a decrease of 5 percentage points. Specifically, the month-on-month price index in June 2013 reached the value 102.8 % and in July 2013 reached the value 97.8 %. In the case of average values, the highest difference between monthly price indices was identified in January (increase in 1 percentage point) and the lowest in February (decrease in 1.7 percentage point). In other words, the overall average values of these differences range from 1.0 to minus 1.7 percentage points.

3.1.1 Development of consumer prices of the selected kind of foods

The last part of the observation focused on the month-on-month changes in prices of selected kind of foods for the period defined as 2015 to 2019, as the first period, and the second selected period starting in January 2020 and ending in December 2024. The selected food types were meat and milk products, flour, eggs, and one representative fruit and vegetable in specific units. The description of data on price developments for selected food products is not currently linked to determining the causes of these developments, but rather to their general identification and assessment using parameters such as the mean value and standard deviation.

Figure 10: Standard deviation and mean value of prices of selected foods in the selected periods



Source: Authors' processing according to the Czech Statistical Office

Figure 10 illustrates the notable differences in price variability among selected types of food based on the calculated mean values (MV) and standard deviations. The y-axis shows the prices of selected products and the z-axis shows the standard deviation values. The findings confirm that the average prices of these selected food types increased during the observed period. In terms of their average prices in selected periods, the highest increase was recorded for flour (38%), cheese (35%) and beef (16.35%). Conversely, the smallest price increases were observed for eggs and potatoes. In the case of butter, there has even been a decline in average price based on the input data. As regards the price variability of these selected foods, in all cases higher variability was confirmed in the second period under review, i.e. between the years 2020 and 2024. The highest variability was found in the case of butter in both periods monitored and lowest variability in the case of milk.

4 Discussion and conclusion

Based on the processing of input data from the Czech Statistical Office, the following facts were established respecting selected period. First, the month-to-month change in the inflation rate was determined based on the consumer price index. According to month-to month data using the same month of the previous year as the base period, it was found, that the highest month-to-month mean value of changes was identified in the year 2022 and the highest fluctuation in the year 2023. The highest month-on-month change occurred between September 2022 and September 2021.The month-on-month change in the consumer price index was also assessed, with the data of the previous month as the base period. The highest month-to-month changes were identified in the year 2022 and the highest fluctuations in the data were observed in the year 2023. The highest value of month-on-month change increasing occurred between January 2023 and December 2022. The lowest month-on-month change was recorded between February 2023 and January 2023.

In this observation, the highest, lowest, and average values of differences between consumer price index values were also determined. As input data the month-on-month change in the consumer price index respecting the data of the previous month as the base period was used. It was found that the largest increases in this indicator occur between months January and December, and the largest decreases between months February and January. The average value of these changes ranged from 1.4 percentage points to minus 0.4 percentage points.

Month-on-month changes in the consumer price index were also determined for food and non-alcoholic beverages. The description of price developments for this kind of products intended for consumption by final consumers is not currently linked to the causes of these developments in this paper, but rather to their general identification and assessment using selected parameters such as mean value and standard deviation. The highest value of month-on-month CPI changes was observed in the five-year periods between 2020 and 2024. The greatest variability in input data was also detected during this period.

In terms of more detailed expression of month-on-month changes, the highest increase in percentage points for these types of products was recorded in January, and the largest decline in July. The average value of these changes ranged from 1.0 percentage points to minus 1.7 percentage points.

With regard to findings in the case of selected kind of foods, the findings confirm that the average prices of the selected food types increased during the observed period. In terms of their average prices in selected periods (the first period focused on the years between 2015 and 2019, and the second period on the years between 2020 and 2024) the highest increase was recorded for flour and the smallest price increase was observed for eggs. The highest variability was found in the case butter in both periods monitored and lowest variability in the case of milk.

Further research will focus on capturing the development of other selected food types in the chosen period, identifying the causes of their development based on data from the Czech Statistical Office and other publicly available information using advanced statistical processing methods.

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A Union of Contrasts: Disparities in Household Wealth, Consumption, and Savings[1]

Patrícia Krupová [2]

Abstract

This paper investigates the persistent disparities in household financial well-being between Central and Eastern European (CEE) and Western & Southern European countries. Using household-level data from the fourth wave of the Household Finance and Consumption Survey (HFCS), the study compares net wealth, nondurable consumption, and savings. Non-parametric Wilcoxon-Mann-Whitney tests are employed, implemented via survey-adjusted rank-based regression to account for the complex data structure. The findings reveal highly statistically significant differences across all three dimensions ($p < 0.001$), with households in CEE countries consistently exhibiting lower levels of wealth, consumption, and savings. These results challenge the narrative of macroeconomic convergence at the household level and highlight the heightened financial vulnerability of CEE households to economic shocks.

Key words

Wealth, Consumption, Savings, Country Comparison, CEE, Survey Data

JEL Classification: D14, G5

1. Introduction

Central and Eastern Europe (CEE) offers a unique space for examining household wealth, consumption and savings. The economic integration of Central and Eastern European (CEE) countries into the European Union has spurred significant growth, yet it also casts a spotlight on the persistent disparities in household financial well-being compared to Western Europe. While economic convergence is often measured at the macroeconomic level, the reality for households—reflected in their wealth, consumption, and savings—presents a more complex picture. This paper examines these three core dimensions, focusing on the CEE region as a unique space where post-socialist legacies and modern economic pressures intersect, creating distinct financial landscapes compared to the founding EU member states.

The most striking disparity is evident in net household wealth. According to the latest findings from the European Central Bank's Household Finance and Consumption Survey (HFCS), the gap remains immense. For instance, the median net wealth in countries like Germany or France is several times higher than in CEE nations, including Slovakia and its neighbors (ECB, 2023). As shown in the paper by Arrondel *et al.* (2016), substantial differences exist in the composition of real and financial wealth. CEE countries can be characterized by an extremely high rate of primary home ownership and very low participation in risk financial markets. In contrast, Western European households are less likely to own their main residence but significantly more likely to invest in risky financial

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assets. Furthermore, Southern European households distinguish themselves with high participation in other real estate and self-employment businesses.

This wealth gap is intrinsically linked to savings behavior. The average household savings rate in the CEE region has lagged the levels observed in Western Europe. Recent data shows that net savings as a share of disposable income remain low and, in some cases, negative, as seen in Slovakia in 2022 (OECD, 2023). This trend results in a heightened vulnerability to economic shocks. While the Visegrad Four (V4) countries recorded an average savings rate of approximately 12.01%, this still falls short of the 15.5% average in the founding EU member states, underscoring a reduced capacity for wealth generation through savings (Eurostat, 2023). The paper by Le Blanc *et al.* (2016) highlights differences between CEE countries and other European countries in how households finance negative saving. CEE respondents reported a significantly lower ability to obtain financial assistance from relatives and friends. Only 38–39% stated they could receive €5,000 in support, compared to 70% in Portugal and 61% in Belgium.

Substantial differences in consumption also persist across the Union. Data from Eurostat indicates significant consumption inequality, where the expenditures of the richest 20% of the population are often more than double those of the poorest 20% in half of the EU member states (Eurostat, 2020). Interestingly, Slovakia and the Czech Republic exhibit significantly lower levels of consumption inequality compared to Austria. Moreover, countries such as Malta, Cyprus, and Greece, consumption appears to be more inequally distributed (Eurostat, 2020).

By examining the interconnected dynamics of wealth, savings, and consumption, this study provides a granular, comparative analysis of the financial realities facing households in the CEE versus Western & Southern Europe. Understanding these differences is critical for policymakers aiming to foster genuine economic convergence and enhance financial stability across the entire European Union.

This paper aims to address the following question: How do the financial profiles of households in the CEE region, specifically concerning net wealth, savings, and consumption, statistically compare to those in Western & Southern Europe, and what is the magnitude and significance of these differences?

The remainder of this paper is organized as follows. Section 2 describes the data source and outlines the methodology, including the non-parametric testing strategy. Section 3 presents the main empirical findings of the comparative analysis. Section 4 discusses the implications of these results and concludes.

2. Data and Methodology

2.1 Data

We use household level data from the fourth wave of the Household Finance and Consumption Survey (HFCS) conducted under European Central Bank. This dataset provides insights into household finances and consumption behavior across Eurozone as well as non-Eurozone countries. Our sample includes the following countries:

Table 1: Sample of countries used

Central and Eastern Europe (8)	**Western and Southern Europe (12)**
Czech Republic (CZ)	Austria (AT)
Estonia (EE)	Belgium (BE)
Croatia (HR)	Cyprus (CY)
Hungary (HU)	Germany (DE)
Lithuania (LT)	Spain (ES)
Latvia (LV)	France (FR)
Slovenia (SI)	Greece (GR)
Slovakia (SK)	Ireland (IE)
	Italy (IT)
	Malta (MT)
	Netherlands (NL)
	Portugal (PT)

Source: Own elaboration based on *EuroVoc – EU's multilingual thesaurus*

We dropped countries for which information on variables of interest was not available. Furthermore, Luxembourg was dropped as well because of its highly outlier values.

Net household wealth in this analysis is defined as the difference between total household assets and total liabilities. Assets include both real and financial components. Real assets consist primarily of the main residence, other properties, automobiles, other vehicles, and valuables (e.g., jewelry or artwork). Financial assets include balances in checking and savings accounts, investments in mutual funds, bonds, publicly traded stocks, and other managed financial products. In addition, business assets, loans extended to other households, and other financial assets are included. On the liabilities side, the analysis captures all household debts. The most significant are mortgages on the main residence, loans for other properties, and unsecured debts such as credit card balances, overdrafts, personal loans, and consumer credit. Net wealth thus equals the value of all assets minus total liabilities.

Nondurable consumption is expressed monthly and includes expenditures such as food and housing-related services (e.g., utilities, telephone), but excludes durable goods (e.g., cars, appliances), rent, loan repayments, insurance, and renovations. These definitions of wealth and nondurable consumption are consistent with definitions by the European Central Bank (2020). *Savings* are represented by the current balance of households' savings accounts, which is consistent with the terminology used by the OECD (n.d.).

2.2 Methodology

The analytical strategy for this study was conducted in two sequential stages. The first stage consisted of a descriptive analysis to provide a graphical comparison of the means for the variables of interest. Coefficient plots were generated to visualize the differences in the mean estimates for the CEE and the Western & Southern European regions. Austria was selected as the reference country from among the Western and Southern European countries for comparisons of average net wealth, consumption, and savings. Accordingly, the values presented in the figures 1, 2 and 3 reflect relative differences in euros with respect to Austria.

Austria serves as a useful benchmark—it is neither the wealthiest nor the most consumption-intensive country but represents a higher European standard to which other nations may be compared (ECB, 2023). Each figure is split into two sections: the left side shows coefficients for CEE countries (black dots), while the right side displays coefficients for Western and Southern Europe (black diamonds). Values around zero indicate proximity to the Austrian average in terms of wealth, consumption, or savings; positive values indicate higher levels, and negative values denote lower levels.

The findings from this descriptive stage guided the second stage: inferential statistical testing. The distributional properties of the variables were examined prior to formal testing. Visual inspection of histograms revealed that all three variables were non-normally distributed and exhibited significant positive skew.

Given the violation of the normality assumption required for parametric t-tests, a non-parametric approach was chosen to compare the distributions between the CEE and the Western & Southern European regions. Specifically, the Wilcoxon-Mann-Whitney (WMW) rank-sum test was selected for this purpose.

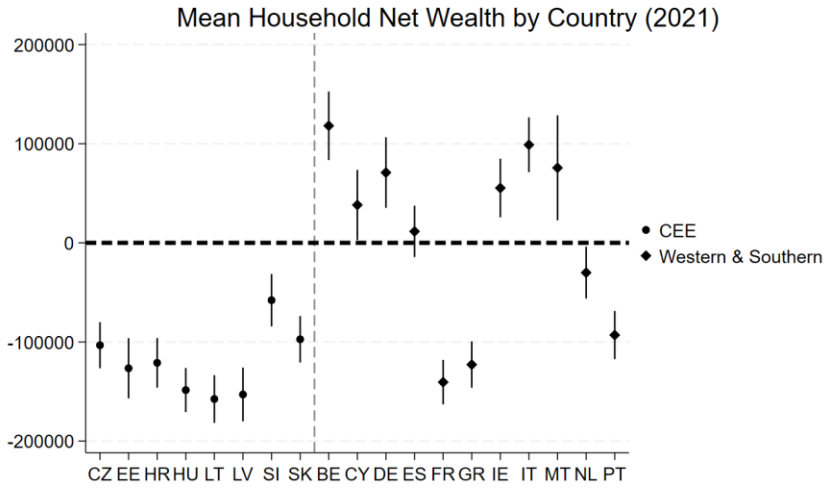
To implement this test within the multiply imputed and complex survey data structure, a standard rank-based regression procedure was employed. For each variable, a new variable containing its ranks was generated across the full sample. Subsequently, a survey-adjusted linear regression was estimated using this rank variable as the dependent variable and the region indicator as the primary independent variable. This approach is statistically equivalent to the WMW test and correctly incorporates the survey design features while pooling results using Rubin's Rules. A statistically significant p-value for the region predictor was interpreted as a significant difference in the distributions between the two groups.

3. Results

All Central and Eastern European countries (indicated by black dots) report lower average net wealth than the reference country Austria, often with negative deviations exceeding 100000 euros (Figure 1). This visual contrast underscores the persistent wealth disparities between the “old” and “new” EU member states. While some Western & Southern European countries (indicated by black diamonds), e.g. Belgium, Cyprus, Ireland or Italy, fall within the positive range in terms of household wealth, the CEE region lags by tens or even hundreds of thousands of euros. The reference value for net wealth in Austria is 216779 euros (zero axis).

The statistical analysis of household net wealth confirmed this trend. The Wilcoxon-Mann-Whitney test indicated a significant difference between the regions ($t = 19.62$, $p < 0.001$), with the Western & Southern European group showing significantly higher ranks compared to the CEE group.

Figure 1: Mean Household Net Wealth by Country (2021)



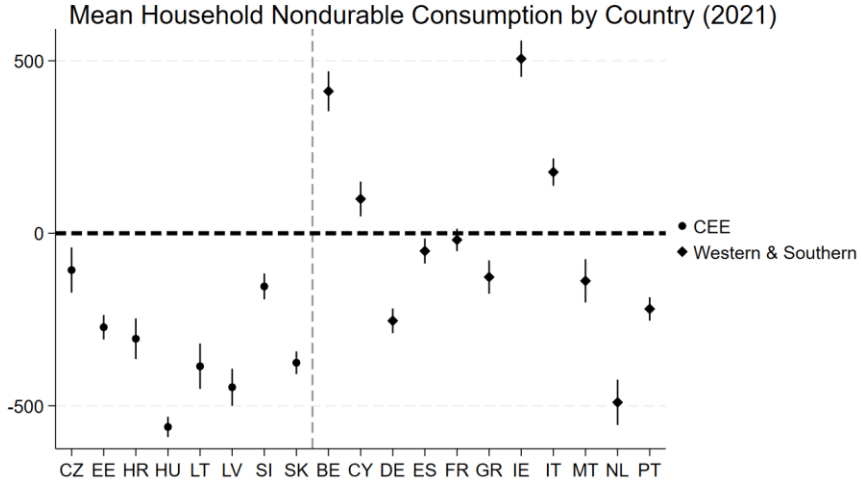
Source: ECB - HFCS (2021)

All countries in Central and Eastern Europe also report lower average nondurable consumption, in some cases by more than 500 euros (e.g., Hungary; Figure 2). Higher monthly consumption in Western countries may reflect not only higher income levels but also

different consumer behavior patterns and higher living costs. The reference value for monthly nondurable consumption in Austria is 1082 euros (zero axis).

The Wilcoxon-Mann-Whitney test revealed a statistically significant difference in the distribution of nondurable consumption between the CEE and the Western & Southern European regions ($t = 35.34$, $p < 0.001$). The positive coefficient indicates that the ranks of consumption were significantly higher in the Western & Southern group compared to the CEE group, suggesting higher overall levels of consumption in that region.

Figure 2: Mean Household Nondurable Consumtpion by Country (2021)



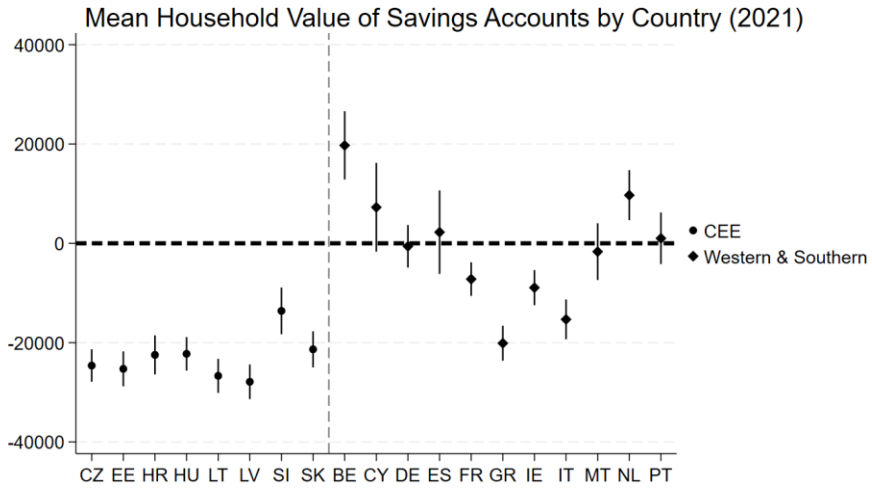
Source: ECB - HFCS (2021)

Again, significant regional differences are observable in household savings – Central and Eastern European countries show deeply subpar savings levels (e.g., Lithuania and Latvia lag Austria by almost 30000 euros; Figure 3). Slovenia is an exception, with savings levels approaching those of Western countries. The low level of average savings in CEE countries may stem from lower income levels, but also from cultural attitudes toward saving, lower trust in the financial system, or limited financial literacy. The reference value for savings in Astria is 31511 euros (zero axis).

Similarly, the analysis of the amount held in savings accounts also indicated a statistically significant difference between the two regions. The Wilcoxon-Mann-Whitney test showed that households in the Western & Southern European group had significantly higher ranks in savings account holdings compared to households in the CEE group ($t = 27.34$, $p < 0.001$).

These results together point to consistent regional differences—households in Central and Eastern Europe possess lower net wealth, lower nondurable consumption, and lower savings when compared with households in Western and Southern Europe.

Figure 3: Mean Household Value of Saving Accounts by Country (2021)



Source: ECB - HFCS (2021)

4. Discussion and concluding remarks

The results of this paper paint a clear and interconnected picture of persistent financial disparity between the two European regions. The statistically significant differences are not isolated; they reveal a cycle where lower net wealth in Central and Eastern European (CEE) countries constrains the capacity for savings, which in turn limits both consumption smoothing and future wealth accumulation. This finding challenges a "convergence paradox": while CEE economies have shown notable macroeconomic growth since their integration into the EU (ECB, 2018), this has not yet translated into a corresponding convergence of financial well-being at the household level. Several factors likely contribute to this gap, including the historical legacy of a near-zero private wealth base post-1989, structural differences in wealth composition—namely, a heavy reliance on real estate over more diversified financial assets (Arrondel et al., 2016) —and persistent income disparities that fundamentally limit the ability of CEE households to save and invest at a pace comparable to their Western European counterparts. It is worth noting that low levels of financial literacy often contribute to lower saving rates and, more broadly, to suboptimal financial decision-making. For example, the 2021 HFCS survey indicated that households in Slovakia exhibit low financial literacy (Cupák et al., 2023). This lack of financial knowledge hampers their capacity to make sound retirement plans and other important financial decisions (Fornero et al., 2010).

A primary implication of these findings relates to household financial vulnerability. The significantly lower levels of savings and liquid net wealth mean that CEE households are systemically more exposed to economic shocks, such as the recent inflationary pressures or unexpected income loss. From a policy perspective, fostering genuine economic convergence may require interventions that go beyond broad economic targets to specifically promote household wealth accumulation, for instance by enhancing financial literacy and creating incentives for long-term investment. While this study provides a robust cross-sectional snapshot, its limitations point to clear avenues for future research. A longitudinal analysis tracking wealth dynamic overtime or studies that formally model the specific drivers of the wealth gap would be invaluable for designing effective, evidence-based policies to bridge Europe's household wealth divide.

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Modern Perspectives on Portfolio Optimization

Valentina Piantoni[1], Sergio Ortobelli Lozza[2]

Abstract

This article examines portfolio optimization strategies that address both financial and ESG risks. First, portfolios are optimized to minimize financial risk using Conditional Value-at-Risk (CVaR), Mean Variance (MV) and Gini tools, that is a coherent risk measure that captures extreme market losses. After identifying portfolios with reduced financial risk, a second optimization is applied to further lower ESG risks, ensuring alignment with sustainability goals. By integrating both financial and ESG considerations, the approach produces portfolios that offer strong financial performance while meeting responsible investing criteria. Results show that ESG-coherent portfolios not only meet sustainability objectives but also exhibit competitive, resilient financial outcomes. This dual optimization process provides investors with portfolios that balance risk management with ethical investment principles.

Key words

Portfolio Selection, Risk Analysis, Sustainability, Investment Decision Making, Ethical Challenges.

JEL Classification: G11, G17, Q56, M14.

1. Introduction

Investors today are increasingly incorporating environmental, social, and governance (ESG) factors into their portfolio management strategies, driven by growing concerns over sustainability and the financial risks posed by environmental challenges. As the importance of addressing ESG risks becomes more evident, there is a pressing need to integrate these factors into traditional financial analysis. To achieve this, advanced risk measures, such as Conditional Value-at-Risk (CVaR), offer a more comprehensive approach by capturing both financial and ESG-related risks.

This article explores how ESG-consistent risk measures, particularly CVaR, can be applied to optimize portfolio selection, balancing financial risk with ESG risks like climate change, social responsibility, and governance issues. The study follows a two-step optimization process: first, portfolios are optimized to minimize financial risk using CVaR, and then, the focus shifts to further reducing ESG-related risks, ensuring that portfolios align with sustainability objectives. This dual optimization approach not only reduces financial risk but also integrates high ESG standards, resulting in portfolios that deliver both strong financial returns and positive sustainability outcomes. Garcia-Bernabeu et al. (2021) propose a multi-objective approach to minimize both ESG and financial risks, providing a robust framework for this dual optimization.

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The results of this study demonstrate that portfolios optimized with ESG-consistent risk measures not only align with investors' sustainability goals but also maintain competitive financial performance. The findings offer a valuable comparison to Torri et al. (2023), who also explore the integration of ESG factors using coherent risk measures. While their approach centers on the integration of ESG risks into a unified financial risk measure, this study provides a more detailed, two-step methodology that first addresses financial risk before focusing on ESG factors, offering a refined framework for sustainable investment optimization.

2. The two-steps portfolio optimization

The objective of this study is to perform a two-step optimization on various portfolios from the S&P 500 index. The aim is to minimize market risk, followed by ESG (Environmental, Social, and Governance) risk, using a linear Conditional Value-at-Risk (CVaR) approach. This approach is intended to identify portfolios that demonstrate both strong risk-adjusted returns and high ESG standards.

For this study, we collected historical daily price data for each asset in the S&P 500 index, covering a period from April 21, 2011, to December 30, 2021. This dataset provides a comprehensive view of each asset's performance and volatility over a 10-year timeframe. The data was sourced from Refinitiv and exported to Excel for subsequent processing in MATLAB. In addition to price data, we gathered daily ESG (Environmental, Social, and Governance) scores for each asset in the S&P 500 index, corresponding to the same 10-year period. These scores were divided into the three ESG pillars: Environmental, Social, and Governance, with each pillar scored individually for every underlying asset. This granularity allows for an in-depth analysis of ESG attributes over time. To consolidate the ESG data, we calculated the average of the three pillars (Environmental, Social, and Governance) for each asset, resulting in a composite ESG score. This composite score provides a single metric representing the overall ESG performance of each asset, making it suitable for use in the optimization process.

Step 1: First Optimization – Minimizing Market Risk

The first optimization phase focuses on minimizing market risk for portfolios derived from the S&P 500 index. This step adheres to the principles of Modern Portfolio Theory, leveraging Conditional Value-at-Risk (CVaR) to account for extreme market downturns beyond what traditional risk measures capture. By combining classical optimization with CVaR, this approach aims to construct portfolios that minimize exposure to both average market volatility and tail risks. Markowitz's Modern Portfolio Theory (1952) introduced the concept, demonstrating that diversification portfolio risk by selecting assets that behave differently. The portfolio selection involves minimizing risk (represented by the variance) and optimizing the reward (represented by the mean of returns). These two metrics serve as the foundation for constructing portfolios that balance risk and return. Risk measures are essential tools in portfolio management, providing a way to assess and manage financial risks. Traditional measures, however, may not fully capture the complexity of modern investment portfolios, particularly when incorporating ESG (Environmental, Social, and Governance) factors. One such measure that is both coherent and widely used is Conditional Value-at-Risk (CVaR), introduced by Rockafellar and Uryasev (2000). Morelli (2023) reinforces the importance of CVaR in ESG optimization, highlighting its effectiveness in balancing financial and environmental goals. Unlike Value-at-Risk (VaR), which focuses on the maximum expected loss within a confidence interval, CVaR captures the average loss during extreme events beyond the VaR threshold, thus providing a more complete view of tail risks.

In our study, we use CVaR to evaluate portfolios that account for both financial and ESG risks. The formula for CVaR is:

$$CVaR_{\alpha}(L) = \min_{v}\left\{v + \frac{1}{1-\alpha}\, E[(L-v)^{+}]\right\} \quad (1)$$

where v is an auxiliary variable representing an estimate of the CVaR, $(L-v)^{+}$is the positive part $L-v$, representing the losses beyond the level v, $E[(L-v)^{+}]$ is the expected value of the losses that exceed the threshold v, $\propto$is the confidence level of the VaR.

This formulation optimizes the CVaR by minimizing the auxiliary variable ν, which acts as a cutoff for losses exceeding the VaR, thus capturing the expected extreme losses beyond that point. This approach is commonly used in optimization models to calculate the risk conditioned on extreme events. The CVaR function used in this study is linear and the portfolio is rebalanced daily, with the recalibration of 40 strategies occurring every trading day. This dynamic adjustment employs the most recent daily return data to capture evolving market conditions. The CVaR optimization is performed at three distinct confidence levels: 1%, 3%, and 5%, representing varying degrees of risk tolerance. For each of these levels, portfolios are optimized across 40 different average returns, from the global minimum CVaR till the maximum average return (resulting in 120 portfolios per day). The optimization problem is formulated as (for any given α):

$$\begin{gathered} Minimize:\ CVaR_{\alpha}(R_p) \\ s.t.\, E[R_p] \geq R_{target,k}, \\ \sum_{i=1}^{n} w_i = 1,\ w_i \geq 0; i = 1,\dots,n; k = 1,\dots,40 \end{gathered} \quad (2)$$

where $w = [w_1,\dots,w_n]'$ is the vector of the weights, $R = [R_1,\dots,R_n]'$ is the vector of returns, thus, $R_p = w'R$ is the portfolio of returns and $E[R_p]$ is the total expected return of the portfolio. This ensures that the portfolio meets a minimum target return $R_{target,k}$, varying for each of the 40 strategies, and it maintains full investment ($\sum_{i=1}^{n} w_i = 1$), and only holds long positions ($w_i \geq 0$). Thus, every day, for each alpha (1%, 3%, and 5%,), we fit the mean- $CVaR_{\alpha}$ efficient frontier and we compute the ex-post wealth for each of the 40 strategies. We implicitly assume that any investor has a position on the efficient frontier obtained on that day corresponding to the target return. For any optimal portfolio we also consider the ex-post ESG of the portfolio given by $ESG_p = w'ESG$ where w is the vector of optimal weights while $ESG = [ESG_1,\dots,ESG_n]'$ is the vector of ex-post assets' ESG. The ex-post ESG portfolios will be used as the second step of optimization in order to minimize the ESG risk in the optimal choices.

Step 2: Second Optimization – Minimizing ESG Risk

Recently, ESG (Environmental, Social, and Governance) factors have gained prominence in portfolio selection due to their positive correlation with stable financial performance, as highlighted by studies like Friede et al. (2015). The integration of ESG considerations reflects the growing demand for responsible investment, balancing financial returns with environmental sustainability, social responsibility, and sound corporate governance. Advanced techniques such as machine learning and big data analytics, discussed by Chong et al. (2020), further enhance the ability to optimize portfolios beyond traditional models like the Capital Asset Pricing Model (CAPM) (see Sharpe (1964)). These advancements represent a shift toward holistic strategies that incorporate both financial metrics and ESG principles. The second optimization phase refines the portfolios obtained in the first phase by focusing on enhancing their ESG performance. This step ensures alignment with responsible investing principles while preserving the market risk minimization. In this phase we propose a reward-risk analysis where our reward measure is represented by the ESG portfolio scores, and the

risk is a coherent measure applied to ESG returns. We use the previous ex-post ESG scores we obtain by the 40 optimal strategies of step 1. On these scores we evaluate returns for each strategy, and we evaluate different ESG-CVaR strategies. The idea is to take portfolios of the optimal strategies of step 1 in order to reduce the ESG risk. Thus, as for step 1, we fit the ESG-CVaR efficient frontier at any recalibration considering 40 optimal portfolios and we repeat the optimization till we have finished all data. Unlike the first step, where the objective was to minimize CVaR under average return constraints, here the CVaR levels (1%, 3%, and 5%) are optimized with respect to ESG returns and instead of the average returns we fit the portfolio ESG (from the ESG of the global minimum CVaR, till maximum ESG). This results in nine combinations:

- CVaR 1% with ESG 1%, 3%, and 5%.
- CVaR 3% with ESG 1%, 3%, and 5%.
- CVaR 5% with ESG 1%, 3%, and 5%.

Mathematically, the optimization problem for this phase can be represented as:

$$\begin{gathered} Minimize:\ CVaR_{\alpha}(R_{ESG,p}) \\ s.t.\, ESG_p \geq ESG_{target,k}, \\ \sum_{i=1}^{n} w_i = 1,\, w_i \geq 0; i = 1, \dots, n; k = 1, \dots, 40 \end{gathered} \tag{3}$$

where $R_{ESG,p}$ is the portfolio return of the ESG w is the vector of weights in the portfolio and ESG_p is the portfolio's ESG score, calculated as the weighted average of the ESG scores of the individual optimal portfolio we get from step 1. The objective of this phase is to minimize the ESG risk valued as the CVaR of the ESG returns requiring that the obtained portfolio maintain an ESG greater than a ESG target $(ESG_{target,k})$ ensuring that the portfolio reflects strong environmental, social, and governance standards. The key point of this optimization is that it works exclusively on portfolios that have already been optimized in the first phase to minimize market risk through CVaR. Therefore, the risk profile of the portfolio, which addresses market volatility and extreme market events, is not altered in this phase. The focus is entirely on adjusting asset weights to minimize the ESG risk. Thus, the optimal portfolio that comes from this optimization minimizes the ESG risk of portfolios that minimize the market risk. The resulting analysis gives ex-post strategies with lower market risk and ESG risk. This optimization helps to identify those portfolios that consider both risk typologies reflecting dual commitment: they are not only resilient to market risk but also aligned with responsible investing practices, addressing ESG-related risks such as environmental impact, social responsibility, and governance issues.

3. Empirical results

The two steps empirical analysis have been applied to the components presented on the 30th of December 2021 in the S&P500. The results of this analysis have been reported in Figures 1 and 2 and in Table 1.

Figure 1: Ex-post wealth optimal mean-CVaR$_{1\%}$ portfolios.

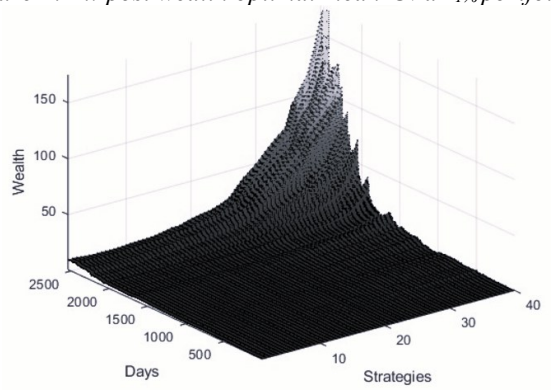

Figure 1 illustrates the three-dimensional representation of wealth evolution over almost 10-year period for the 40 strategies considered in our study, focusing on daily wealth growth with a Conditional Value-at-Risk (CVaR) of 1%. The graph highlights how wealth can grow up to 160 times the initial value by the end of the observed period. However, we use the components of the S&P500 present on the 30th of December 2021 and we do not change the components according to the quarterly changes of S&P500 components. Since the selected assets reflect the composition of the S&P 500 index at the final observation date, this approach did not involve rebalancing the S&P composition every three months. In addition, we observe that assets such as Netflix, Amazon, Tesla and many others which experienced extraordinary growth in the last decade, heavily influenced the outcomes. Some of these assets were not part of the S&P 500 at the start of the study but were included later. Their inclusion in the selection process, performed ex post (based on hindsight) rather than ex ante (forward-looking), led to an exaggerated and impractical wealth growth outcome. The use of CVaR at 1% indicates a higher level of risk aversion compared to 3% or 5%. Consequently, wealth outcomes for CVaR levels at 3% and 5% are even higher due to less conservative risk constraints. With larger alpha values (lower risk aversion), the average wealth values tend to increase significantly, along with more pronounced jumps in performance. When rotating the graph to analyze different periods, the effects of significant financial crises, such as the covid crisis, become evident. Riskier strategies show sharper declines in wealth during such events. Conversely, less risky strategies result in smaller losses, showcasing the trade-off between risk exposure and wealth preservation.

Figure 1: Ex-post wealth optimal ESG-CVaR$_{1\%}$ portfolios.

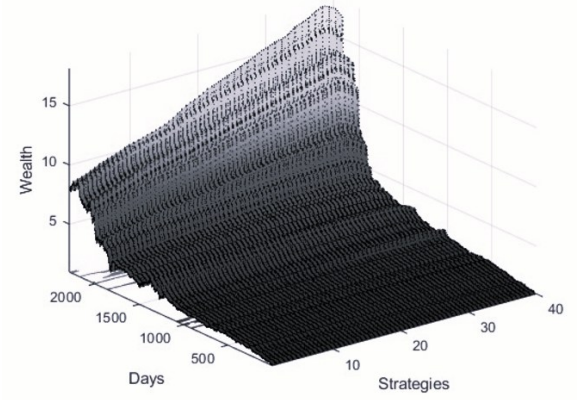

Figure 2 illustrates the evolution of wealth over almost 9 years depending on the investment strategy chosen, where 40 different strategies are analyzed. In this second step of

the analysis, the CVaR (Conditional Value at Risk) with a 1% threshold is already selected, and instead of fixing the mean return, the ESG score (Environmental, Social, and Governance) is used as the determining factor. The strategies now vary according to their ESG scores. Figure 2 demonstrates that selecting strategies with higher ESG scores minimizes risk and achieves substantial wealth. It indicates that starting with a strong ESG focus can lead to good wealth outcomes while maintaining a low-risk profile for both Market risk and ESG risk. Strategy 1 represents the global minimum CVaR strategy, which is the least risky as it minimizes overall ESG-related risk. This approach does not aim to maximize returns but chooses intermediate strategies that still minimize two sources of risk while achieving good wealth levels. Looking at the graph, we can observe that the maximum wealth attainable is approximately 16 times greater than the initial wealth. This result is achieved using Strategy 40, which corresponds to the highest ESG score strategy. In this analysis, the CVaR 1% threshold has been selected. The graph represents the pairwise 1%-1% strategy, meaning that CVaR at 1% was also chosen during the second step of optimization to produce this visualization. The first line in the graph corresponds to the global minimum CVaR, which does not prioritize ESG factors. In contrast, the last strategy focuses exclusively on one asset with the highest ESG score, which is inherently riskier but has the maximum ESG compliance. At the extreme end of the ESG optimization, only a single asset aligns with the highest ESG score, resulting in limited diversification but maximum alignment with ESG values. This visualization underscores the trade-offs between ESG prioritization, risk minimization, and wealth generation in long-term investment strategies. We summarize the results of step 2 in Table 1. Table 1 provides a detailed comparison of the performance metrics for two portfolio optimization strategies: one that focuses on minimizing Conditional Value-at-Risk (CVaR) and another that aims to maximize Environmental, Social, and Governance (ESG) scores. The results highlight key differences in portfolio outcomes across various combinations of CVaR and ESG thresholds, with particular attention to wealth, mean returns, and standard deviations (SD).

Table 1: Performance Metrics for Risk-Adjusted and ESG-Optimized Portfolios.

	Wealth		Sharpe Ratio		Standard Dev.	
	GM CVaR	Max ESG	GM CVaR	Max ESG	GM CVaR	Max ESG
1%,1%	8.08	15.08	0.0723	0.0759	0.014	0.0177
1%,3%	8.16	15.95	0.0733	0.0775	0.0138	0.0177
1%,5%	8.16	15.91	0.0733	0.0777	0.0138	0.0176
3%,1%	7.22	9.54	0.0700	0.0636	0.0137	0.0181
3%,3%	7.61	9.88	0.0713	0.0643	0.0138	0.0182
3%,5%	7.61	9.91	0.0713	0.0646	0.0138	0.0181
5%,1%	8.11	10.94	0.0722	0.0673	0.014	0.0179
5%,3%	7.86	11.21	0.0717	0.0683	0.0139	0.0178
5%,5%	7.86	11.18	0.0717	0.0684	0.0139	0.0178

Table 1 provides a detailed comparison of portfolio performance metrics under two optimization strategies: Global Minimum CVaR (GM CVaR) and Maximum ESG (Max ESG). Among these metrics, the Sharpe ratio plays a central role in evaluating the risk-adjusted returns of the portfolios. This ratio is calculated as:

$$Sharpe\ Ratio = \frac{R_p - R_f}{\sigma_p} \quad (4)$$

where R_p represents the portfolio return, R_f is the risk-free rate, and σ_p is the portfolio's standard deviation (volatility). The Sharpe ratio measures how much excess return a portfolio generates per unit of risk, with higher values indicating more efficient risk-adjusted performance. The results reveal a nuanced performance of Max ESG and GM CVaR portfolios across various combinations of CVaR (risk tolerance) and ESG thresholds. Max ESG portfolios achieve higher Sharpe ratios than GM CVaR portfolios only under the most risk-averse scenarios (CVaR at 1%), specifically for the pairs (1%,1%), (1%,3%), and (1%,5%). For instance, at the (1%,1%) threshold, Max ESG achieves a Sharpe ratio of 0.0759, exceeding the GM CVaR value of 0.0723. Similar trends are observed for (1%,3%) and (1%,5%), where the Max ESG Sharpe ratios are 0.0777 and 0.0776, compared to GM CVaR's 0.0733 and 0.0733, respectively. This advantage reflects the ability of ESG-compliant portfolios to balance financial returns with sustainability goals. By emphasizing investments in assets with strong ESG scores, Max ESG portfolios potentially reduce exposure to long-term systemic risks such as environmental or governance controversies. These risks, often overlooked in traditional financial optimization, could contribute to market stability and enhance the portfolio's overall resilience in the long term.

However, as the CVaR thresholds increase to 3% and 5% (indicating reduced risk aversion), the Sharpe ratios of Max ESG portfolios either converge with or fall below those of GM CVaR portfolios. For example, at the (3%,3%) level, the Sharpe ratio for Max ESG is 0.0646, compared to 0.0713 for GM CVaR. A similar trend is observed at (5%,3%) and (5%,5%), where the Sharpe ratio for Max ESG remains marginally lower than GM CVaR, reflecting a shift in the relative performance. This divergence at higher CVaR levels can be attributed to the underlying risk-return dynamics of ESG-compliant assets. At stricter CVaR thresholds, portfolios inherently restrict risk exposure, which may enhance the relative contribution of ESG-aligned assets to performance. However, as risk tolerance increases, the portfolio's diversification broadens, incorporating a wider set of assets that may dilute the incremental benefits of ESG optimization. Furthermore, ESG-focused portfolios often concentrate on sectors or companies with distinct risk-return profiles, leading to higher volatility (as evidenced by the higher standard deviations in Max ESG portfolios across all configurations).

The relationship between Sharpe ratios and CVaR levels also underscores a broader trend: both GM CVaR and Max ESG portfolios exhibit declining Sharpe ratios as CVaR thresholds increase. This reflects the nature of risk-adjusted performance, where portfolios optimized under lower CVaR levels are inherently designed to minimize extreme losses, leading to higher efficiency in generating returns per unit of risk. As CVaR thresholds rise, the relaxation of risk constraints allows for more aggressive allocation strategies, which may result in lower risk-adjusted returns despite higher absolute returns or wealth.

In conclusion, the Sharpe ratio analysis highlights the strengths and limitations of ESG integration in portfolio optimization. Max ESG portfolios deliver superior risk-adjusted returns under stringent risk constraints, demonstrating their potential to align financial performance with sustainability objectives. However, the diminishing advantage at higher CVaR levels points to the need for careful calibration of ESG considerations, particularly for investors with lower risk aversion. These findings illustrate that while ESG strategies can enhance long-term performance, they also require a nuanced understanding of the trade-offs between risk, return, and sustainability goals. For investors, this analysis provides valuable insights into constructing portfolios that balance financial resilience with responsible investment practices.

4. Conclusions

This study underscores the potential and challenges of integrating financial risk and ESG (Environmental, Social, and Governance) factors into portfolio optimization. Using a two-step methodology, the research demonstrates how minimizing financial risk via Conditional Value-at-Risk (CVaR) can be effectively combined with maximizing ESG scores to construct portfolios that align with both sustainability and financial performance objectives. The analysis also integrates key findings on wealth, Sharpe Ratios, and risk profiles from empirical results and visualizations.

The findings reveal that portfolios optimized for ESG factors consistently achieve superior wealth compared to those focused solely on minimizing CVaR. ESG-focused strategies exhibit higher Sharpe Ratios than GM CVaR portfolios. These results suggest that portfolios prioritizing ESG factors not only align with ethical standards but also enhance risk-adjusted financial performance, mitigating long-term systemic risks.

However, ESG-focused portfolios display higher levels of risk, as indicated by their increased standard deviations. This finding highlights a trade-off where investors must accept higher portfolio volatility to achieve enhanced ESG alignment and financial rewards. Graphical analyses illustrate distinct trade-offs between minimizing market risk and maximizing ESG alignment. The transition from GM CVaR to Max ESG strategies involves moving toward less diversified portfolios with greater ESG compliance but heightened exposure to specific assets. The results underscore the importance of tailoring portfolio strategies to varying risk tolerances. Investors with higher risk aversion may prefer GM CVaR strategies for more stable risk-adjusted returns. In contrast, those with a higher tolerance for volatility may benefit from ESG-maximized strategies, which yield higher returns despite their risk profile.

The dual optimization analysis demonstrates that ESG integration enhances portfolio resilience and risk-adjusted performance, while offering practical insights into navigating the trade-offs between financial risks, return potential, and ESG compliance. These findings contribute to the growing field of sustainable finance by demonstrating that ESG integration is not merely an ethical choice but also a financially sound strategy. The outperformance of ESG-optimized portfolios confirms the viability of combining financial and ESG objectives in portfolio management.

The integration of financial and ESG risks through dual optimization represents a forward-looking approach to investment management. By balancing risk, return, and sustainability, this methodology delivers not only resilient portfolios but also a commitment to ethical investment practices. These strategies pave the way for a more sustainable financial future, catering to the growing demand for responsible investing.

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CBDC – a revolution in payments or an inflated bubble?

Ilja Skaunic [1]

Abstract

The payments landscape in many countries has undergone rapid digitalisation, leading to a steady decline in the role of cash in national economies. This trend raises important questions: Are truly cashless societies likely to emerge in the foreseeable future? And if so, what will replace physical currency? Some experts point to cryptocurrencies as a possible alternative. However, this idea has not been fully embraced by central banks. In response, many central banks have proposed the development of their own digital currencies, known as Central Bank Digital Currency (hereinafter referred to as CBDC). To date, over 130 central banks are actively exploring or developing CBDC. While a few have already launched such currencies, others have discontinued their projects. This article aims to provide a brief analysis of the current state and future prospects of CBDC within the broader context of digital payment systems.

Key words

Central bank digital currencies, CBDC, digital innovation, financial stability, inclusion, cash, cybercrime

JEL Classification: G21, G28, E42, E58, F65, O33

1 Introduction

The global financial landscape is in a state of continual transformation. In the past, the phrase “Cash is King” encapsulated the central role of physical currency in economic life. However, what may have been accurate 30 or 40 years ago no longer reflects current realities. The importance of cash is steadily diminishing, both in absolute terms and as a share of the overall money supply. This ongoing trend prompts key questions: Are we on the verge of truly cashless societies? And if so, what will serve as the primary medium of exchange in these new systems?

One possibility is the adoption of cryptocurrencies (either in their pure form or as stablecoins) which operate largely outside the regulatory frameworks of central banks. In response to such developments, central banks around the world have begun exploring the issuance of their own digital currencies, commonly referred to as CBDC. By mid-2023, 130 countries representing approximately 98% of global GDP (up from just 35 countries in 2020) had initiated projects aimed at developing a CBDC in some form. Three countries have already implemented operational CBDC systems for retail payments.

However, offering even a brief global overview of ongoing developments exceeds the scope of a single conference presentation. This article therefore aims to provide a concise overview of the current state of CBDC initiatives worldwide. It compares the diverse approaches adopted by national governments and their central banks — starting with the first actual users, through countries currently engaged in pilot projects, to those still in the exploratory or deliberative phase without committing to a clear course of action, including

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those that presently see no immediate need to introduce a CBDC. At the same time, the article proceeds to briefly examine several of the challenges associated with CBDC implementation.

2 Definition of the CBDC

CBDC is generally defined as a new form of digital money, denominated in the national unit of account, which constitutes a direct liability of the central bank (Di Iorio at al., 2024). When intended for use by households and businesses for everyday transactions, it is referred to as a retail CBDC. Retail CBDCs differ from existing cashless payment instruments (such as credit transfers, direct debits, card payments, or e-money) in a key respect: they represent a direct claim on the central bank, as opposed to being liabilities of private financial institutions. By contrast, wholesale CBDCs are designed for a different user base, namely financial institutions. These CBDCs are intended for interbank transactions and other operations between banks, central banks, and other regulated financial entities. In this sense, wholesale CBDCs function similarly to current reserve balances or settlement accounts held at central banks (Di Iorio at al., 2024).

Krištoufek (2024) offers a similar definition, describing CBDCs as digital representations of a nation's fiat currency issued by the central bank. They are considered legal tender and typically operate on blockchain or distributed ledger technology (DLT). He classifies CBDC into two main types: retail CBDC, which are available to the general public for everyday use and function analogously to cash or digital wallets; and wholesale CBDC, which are limited to financial institutions for purposes such as interbank settlement, clearing, and other large-value financial transactions. Table 1 presents the key advantages and dangers of CBDC.

Table 1: Advantages and dangers of the CBDC

Advantages	Dangers
Central Bank Backing	Financial Stability Risks
Legal Tender Status	Privacy Concerns
Price Stability	Cybersecurity Vulnerabilities
Regulatory Oversight	Operational Risks
Interoperability	Monetary Policy Challenges
Financial Inclusion	Financial Inclusion Barriers
Monetary Policy Tools	Dependency on Technology Providers
Privacy and Security	

Source: Krištoufek (2024)

3 Literature review

In an increasingly digitalised society, it is hardly surprising that central banks are actively considering the introduction of digital forms of money issued directly to the general public. The concept of a CBDC is not new; it was originally proposed decades ago by Nobel laureate James Tobin (Auer et al., 2023). Nevertheless, the discourse surrounding CBDC has intensified significantly since 2016, both within central banks and among national governments. This heightened attention has been partly driven by the rapid expansion of private digital currencies (particularly stablecoins) whose values are typically anchored to fiat currencies such as the U.S. dollar. (Lloyd, 2023).

One of the most prominent drivers of interest in retail CBDCs is the decline in cash usage, particularly in developed economies and some emerging markets. As noted by the Bank for International Settlements (BIS), in jurisdictions where access to cash is diminishing, there is a growing risk that households and businesses will no longer have access to risk-free central

bank money. Some central banks view the continued provision of such access as a fundamental obligation, critical for maintaining confidence in the national currency. A CBDC could serve as a form of "digital banknote," fulfilling this public mandate (Chen et al., 2022).

The modern monetary system is characterised by a dual structure, comprising public money (i.e., physical cash) and private money issued by commercial banks. Although commercial bank money constitutes over 85% of the euro area's narrow money supply (M1), public money—being a central bank liability—remains the most secure form of currency and continues to anchor the system's credibility (Panetta, 2021; Brunnemeier and Landau, 2022).

Consumers typically treat commercial bank deposits as equivalent to public money, a perception reinforced by regulatory safeguards, deposit insurance schemes, and the central bank's role as a lender of last resort. These institutional mechanisms uphold the convertibility of private money into public money at par. However, the steady decline in cash usage threatens this equilibrium. As the practical relevance of convertibility fades, so too does the stabilising function of public money. In this context, a retail CBDC is viewed as a necessary innovation to preserve the integrity of the two-tier monetary architecture.

The growth of digital currencies also raises concerns about monetary sovereignty. Large digital platforms may integrate proprietary payment systems into their ecosystems, potentially issuing their own private currencies. If such currencies gain widespread acceptance, they could emerge as de facto units of account within contractual arrangements, undermining the monetary authority of central banks (Brunnemeier and Landau, 2022; Ahnert et al., 2024). A CBDC could serve as a countermeasure, ensuring that public money remains in active use and continues to function as the primary unit of account.

From a monetary policy standpoint, the potential impact of retail CBDCs depends heavily on their design and the broader macroeconomic context. CBDCs could strengthen monetary transmission channels by enhancing competition in the banking sector, promoting financial inclusion, and reducing reliance on foreign currencies. While their influence may be modest under stable conditions, their significance could increase during periods of low interest rates or financial stress. Over time, retail CBDCs may also help maintain trust in the monetary system as physical cash becomes increasingly marginalised (Das et al., 2023).

However, the introduction of retail CBDCs could also have disruptive effects on commercial banking. As potential substitutes for bank deposits, CBDC may lead to higher deposit interest rates, reduced bank market share, increased dependence on central bank liquidity, and declining profitability. These dynamics may result in greater market concentration and reduce the effectiveness of CBDC remuneration policies, particularly during liquidity crises (Hemingway, 2023).

Globally, the pace and scope of CBDC development are shaped by domestic economic structures and institutional factors. Auer et al. (2023) have developed a CBDC project index that reveals a pattern: retail CBDCs are more prevalent in countries with large informal economies, while wholesale CBDCs tend to be more advanced in financially developed jurisdictions. Despite contextual differences, common design principles have emerged, such as complementing rather than replacing cash, and involving the private sector in retail payment distribution. Cross-country cooperation and knowledge-sharing are increasingly seen as essential for informed and effective CBDC policymaking.

In emerging and low-income economies, CBDCs and other forms of digital money have the potential to significantly enhance financial inclusion—particularly for the estimated 1.7 billion unbanked adults worldwide. Initiatives such as Kenya's M-Pesa illustrate the transformative power of digital financial services. Nevertheless, these innovations come with risks, including digital exclusion, currency substitution, regulatory loopholes, and diminished monetary policy control. To mitigate these risks, governments must invest in robust digital

infrastructure and develop comprehensive regulatory frameworks that strike a balance between privacy, competition, and innovation (Adrian and Mancini, 2021).

Finally, the successful implementation of CBDCs will depend not only on technological capacity but also on legal preparedness. Legal clarity regarding the ownership, custody, and transfer of CBDCs is particularly important for token-based retail models. Ensuring that users retain a direct claim on the central bank—even when intermediated by private entities—is a fundamental legal requirement. Although implementation strategies will vary across jurisdictions, a coherent legal framework is necessary to ensure certainty in the treatment of digital assets on a global scale (Bechara et al. 2025).

4 Recent developments and trends in the implementation of CBDC

4.1 Results of Bank for International Settlements survey

The Bank for International Settlements (BIS) has conducted surveys among central banks from both advanced economies (AEs) and emerging market and developing economies (EMDEs), providing valuable insights into the global trajectory of CBDC. (Di Iorio et al., 2024). As of late 2023, 94% of the 86 central banks surveyed reported being engaged in some form of CBDC exploration. What initially began as a predominantly theoretical exercise has increasingly transitioned into tangible experimentation: more than half of the participating central banks are currently working on conceptual designs, and approximately one-third have initiated pilot projects.

Although retail CBDCs have historically dominated the discourse, there is growing interest in wholesale CBDCs, particularly among advanced economies. According to the survey, wholesale CBDCs are now more likely to be issued within the next six years than their retail counterparts. Central banks are actively engaging with stakeholders to shape the design and functionality of CBDCs, although many critical design elements (such as infrastructure choices, user access models, and privacy features) remain undecided.

In terms of functionality, most planned retail CBDC are expected to incorporate features such as holding limits, offline capabilities, interoperability with existing payment systems, and non-interest-bearing characteristics. For wholesale CBDC, interoperability and programmability are viewed as central design goals. A key motivation across jurisdictions is the need to preserve the role of central bank money in an increasingly digitalised monetary landscape, especially in the face of competition from private digital currencies.

Importantly, national contexts and institutional frameworks heavily influence CBDC design choices, making international cooperation and knowledge exchange all the more essential. While the formulation of CBDC policy remains a sovereign matter, global coordination is critical to ensuring the safety, efficiency, and interoperability of future cross-border payment systems. In this respect, embracing diversity in approach—while fostering collaboration—represents the most effective path forward (Di Iorio at al., 2024).

4.2 Survey done by Atlantic Council

The Atlantic Council is a nonpartisan, nonprofit think tank headquartered in Washington, D.C., with a primary focus on international affairs. Its mission is to promote constructive leadership and foster cooperation in addressing global challenges, including those related to economic development and financial innovation. The Council collaborates closely with governments, international organizations, and private sector actors (particularly within the transatlantic space) linking the United States and Europe. It is widely recognized for producing policy-relevant research and analyses.

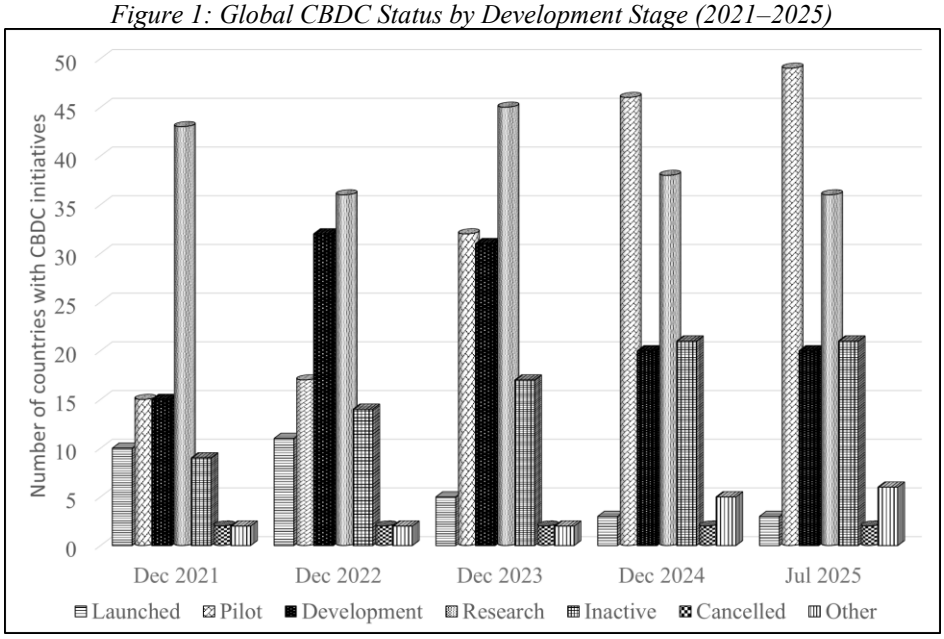
In recent years, the Atlantic Council has dedicated one of its key research initiatives to the topic of CBDC. This initiative has resulted in the creation of the *Central Bank Digital*

Currency Tracker, one of the most comprehensive and widely cited databases in the field. The tracker monitors the status of CBDC development efforts in jurisdictions around the world, offering both current and historical data on national projects spanning the last five years.

The Atlantic Council classifies CBDC-related activities into seven distinct categories: **Launched** – CBDCs that are fully operational. **Pilot** – projects undergoing live testing in limited environments. **Development** – projects that have moved beyond research but are not yet piloting. **Research** – exploratory or feasibility assessments without implementation. **Inactive** – paused or indefinitely delayed projects. **Cancelled** – projects that have been formally discontinued. **Other** – cases that do not clearly fall into the aforementioned categories.

As of July 2025, the Atlantic Council's dataset includes information from 137 countries. Among these, 3 countries have officially launched a CBDC, 49 are conducting pilot projects, and 20 are actively developing CBDC solutions without having entered the pilot phase. In addition, 36 countries are still in the research stage, 21 have suspended their initiatives, two have cancelled their projects outright, and in six cases, the project status does not clearly align with any defined category. These findings are visualized in *Figure 1*, which depicts the progression of global CBDC initiatives across five key points in time, from December 2021 to July 2025. The figure illustrates the increasing institutional engagement with CBDC projects and highlights the dynamic and evolving nature of central banks' approaches to digital currency issuance.

Figure 1: Global CBDC Status by Development Stage (2021–2025)



Source: Atlantic Council CBDC Tracker, July 2025.

Over the period from December 2021 to July 2025, several key shifts can be observed in the global landscape of CBDC development. The number of countries in the Pilot stage has seen the most dramatic growth, increasing from 15 in 2021 to 49 in July 2025, suggesting a strong global move from research and theoretical exploration toward real-world experimentation. This sharp rise reflects growing institutional confidence and political will to test CBDC in controlled environments. Conversely, the Development category peaked in December 2022 (32 countries) but has since declined to 20 countries, indicating that several projects have either transitioned to pilot implementation or have slowed their pace. The Research stage, which initially led in absolute numbers (43 countries in 2021), has fluctuated

slightly and now stabilizes at 36 countries, possibly indicating a maturing understanding of CBDC or a shift in priorities toward other phases. The Launched category remains surprisingly low and stagnant: after reaching 11 countries in 2022, the figure dropped to 3 and remained unchanged through July 2025. This trend suggests that, despite widespread interest, fully operational CBDCs remain rare, with most jurisdictions either postponing full rollouts or encountering obstacles. Of particular interest is the Inactive category, which has more than doubled from 9 countries in 2021 to 21 in 2025, signaling a growing number of paused or deprioritized initiatives—potentially due to technical, political, or economic constraints. Meanwhile, the Cancelled category remains static at 2 countries, and the other classification has modestly increased, possibly reflecting novel or hybrid approaches that do not fit standard development frameworks.

While the Atlantic Council's CBDC Tracker is widely used and methodologically robust, it is not without limitations. First, it omits certain countries of regional relevance, such as Slovakia or Finland. In cases where data for these countries are incomplete or unavailable, it is necessary to supplement them using alternative data sources. Second, it treats countries within each category as homogeneous, without accounting for variation in the intensity or scope of CBDC activity. For example, some countries listed as having "launched" a CBDC show minimal circulation, while others in the "pilot" phase are actively issuing and testing significant digital currency volumes. These nuances are important for interpreting the true state of CBDC implementation.

4.3 Examples of the approach to CBDC in specific countries

The following concise overview presents the current status of CBDC initiatives in 17 selected countries, as reported by the Atlantic Council (2025). These countries were chosen to represent all stages of CBDC development, encompass all continents, and reflect a diverse range of economic development levels.

Nigeria (launched). Nigeria launched the e-Naira in 2021. Despite relatively low adoption rates, the Central Bank of Nigeria has issued 3 billion e-Naira, of which 2.1 billion have been distributed to financial institutions. As of March 2024, the central bank is collaborating with a private company to enhance the e-Naira's technological infrastructure and promote wider adoption.

The Bahamas (launched). In 2024, the Central Bank of the Bahamas reported that the amount of Sand Dollars in circulation was approximately BSD 2.1 million. There were roughly 120,000 consumer wallets in active use.

China (pilot). The People's Bank of China (PBoC) has been a global leader in the development of both domestic and cross-border digital payment systems. China initiated its e-CNY pilot program in 2019, which currently includes around 260 million wallet users across 17 provincial-level jurisdictions. By June 2024, transactions using the digital yuan had reached a cumulative value of 7 trillion yuan (approximately USD 982 billion).

India (pilot). In 2024, the Reserve Bank of India (RBI) continued to experiment with wholesale and retail digital rupee pilot projects. By March 2025, the digital rupee in circulation reached 10.15 billion rupees (USD 122 million), with participation from 17 banks and over six million users.

Euro Area (pilot). European Central Bank (ECB) is currently in a two-year preparatory phase for its CBDC initiative. This phase focuses on establishing a regulatory framework, selecting technology providers for platform development, and conducting comprehensive testing and experimentation. As of July 2025, the ECB has published a progress report on this phase, refined its draft rulebook, and launched an Innovation Platform involving 70 private-sector partners to test use cases and technical integration.

Türkiye (pilot).
In December 2022, the Central Bank of the Republic of Türkiye (CBRT) announced the successful execution of its first payment transactions using the digital lira. The CBRT is currently in the second phase of its pilot program, with no formal decision on issuance made to date.
Sweden (pilot). Sweden has been a pioneer in CBDC development since 2017. The Swedish central bank, the Riksbank, completed the fourth phase of its pilot in March 2024. Concurrently, Sweden's Ministry of Finance launched an inquiry into whether the e-krona should be introduced. The inquiry concluded that there is currently no clear need for issuance and recommended further study.
Mexico (development). In April 2022, the Central Bank of Mexico (Banxico) announced revised plans to finalize the development of its retail CBDC, the digital peso. However, by 2023, Banxico reported that the project remained at an initial stage, with the timeline for a full-scale launch still uncertain.
Taiwan (development). In December 2023, the Bank of Taiwan (BoT) completed a feasibility and technological study on a wholesale CBDC. The BoT plans to focus on gathering stakeholder feedback throughout 2025 while refining the design. Wholesale CBDC trials are anticipated to begin in 2025.
Poland (research). The National Bank of Poland has adopted a cautious, research-driven approach toward CBDCs, with no official pilot or issuance as of mid-2025.
Czechia (research). In 2021, the Czech National Bank established an internal working group to evaluate CBDC trends. A 2022 BIS report noted that the bank currently sees no compelling reason to issue a CBDC in the Czech Republic.
Argentina (research). A 2022 BIS paper indicated that the Banco Central de la República Argentina (BCRA) does not prioritize CBDC issuance but will continue to study the subject. In October 2023, Juan Agustín D'Attellis Noguera, director of the BCRA, announced ongoing legislative work aimed at introducing a digital peso.
Bangladesh (research). In a July 2022 budget speech, the Finance Minister announced that Bangladesh Bank would begin feasibility studies on a CBDC. However, in 2023, the central bank expressed hesitation toward introducing a CBDC, citing insufficient successful international examples and limited digital literacy within the country.
Denmark (inactive). In 2022, Danmarks Nationalbank reported that its existing digitized payment system reduced the need for a retail CBDC. The bank's governor reiterated in March 2023 that despite declining cash usage, there is currently no justification for launching a retail CBDC.
Iceland (inactive). The Central Bank of Iceland published an interim research report in 2018 regarding the potential issuance of a CBDC, named Rafkróna. The report recommended against introducing the Rafkróna at that time, stating that further stakeholder consultation and comprehensive analysis are necessary.
Ecuador (cancelled). The Ecuadorian Central Bank launched its digital currency, the Sistema de Dinero Electrónico (SDE), in 2014. Due to low public trust in the central bank, the project was unsuccessful and discontinued in 2017.
United States (special situation). In January 2025, the U.S. administration issued an executive order aimed at reinforcing U.S. leadership in digital financial technologies. Subsequently, on July 17, 2025, the U.S. House of Representatives passed the Anti-CBDC Surveillance State Act (H.R. 1919). This legislation prohibits the Federal Reserve and other federal agencies from establishing, issuing, promoting, or utilizing any CBDC without explicit congressional authorization, effectively banning a U.S. CBDC unless specific legislation is enacted. The United States is currently the only country to have officially banned a CBDC.

5 Conclusion

The global landscape of CBDC is rapidly evolving, reflecting significant shifts in monetary policy, technological innovation, and financial inclusion strategies. As this overview demonstrates, countries are at diverse stages of CBDC development, ranging from early research and pilot testing to full-scale implementation. While only a few nations have launched operational CBDC, the growing number of pilot projects underscores an increasing institutional commitment to exploring the potential benefits and challenges of digital currencies.

Emerging economies often view CBDC as a tool to enhance financial inclusion and modernize payment systems, whereas advanced economies tend to focus on preserving monetary sovereignty, improving payment efficiency, and addressing declining cash usage. The contrasting approaches highlight the complexity of CBDC design, which must carefully balance innovation, security, legal frameworks, and user trust.

The findings also reveal that despite rapid technological progress, significant hurdles remain. Technical complexities, regulatory uncertainty, privacy concerns, and political considerations have contributed to the slow pace of full deployment. Additionally, some countries have paused or cancelled projects, reflecting the challenges in aligning CBDC initiatives with broader economic and societal goals. In this dynamic context, international cooperation, knowledge-sharing, and flexible regulatory frameworks will be crucial to ensure that CBDCs can effectively complement existing financial infrastructures without undermining stability or inclusivity. Ultimately, the continued experimentation and research documented here will inform future decisions on how best to integrate CBDCs into the global monetary system, potentially reshaping the role of central banks and redefining the nature of money in the digital age.

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