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ATTITUDES TOWARDS ARTIFICIAL INTELLIGENCE IN THE AREA OF PERSONAL FINANCIAL PLANNING: A CASE STUDY OF SELECTED COUNTRIES *

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Abstract. The financial sector's focus on simplifying decision-making processes, maximally shortening procedures via cooperation with the fintech industry, robotisation and the use of artificial intelligence are a response to market needs and becoming an important element of how financial service groups compete on the market. The theory of consumer behaviour assumes that consumers have needs that they will hierarchise, and that they will make choices to maximise their own satisfaction. The purpose of the article is to diagnose the sociological and economic determinants underlying consumer satisfaction in terms of planning personal finances using modern technologies. Comparisons of international data were conducted via quantitative analysis of robo-advice using Mann-Whitney U tests, the Chi-square test and Spearman's rho correlation. The survey results show that the majority of socioeconomic characteristics of households are statistically significant when considering satisfaction with robo-advisory financial services and spending analysis, as well as with artificial intelligence suggesting improvements. This study is a contribution to the literature on consumer behaviour in the modern world.

Keywords: modern financial technologies; personal finance management; robo-advice; personal financial planning

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JEL classification: D12, G41, G53, O33

1. Introduction

The effectiveness of using artificial intelligence (Belanche et al. 2018) in various aspects of the economy has been a topic of discussion for many years now. The speed with which users implement and adapt new technological solutions depends on the level of sophistication offered by financial services in a given country. Each financial institution struggles with data overload and the problem of processing and selecting the most relevant. Thanks to technology, robotisation and artificial intelligence, it becomes possible to personalise customer service and switch to remote service channels.

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The application of modern financial solutions not only serves to minimise the costs associated with employment, but also to target action on the complex problems faced by customers. Robotics and artificial intelligence (Xie, 2019) both significantly influence the financial industry, as the technology used there is a key element in the strategy of banks and emerging financial entities (Baker & Dellaert 2017; Jung et al. 2018). Replacing traditional consultancy services with innovations, especially at the beginning, is not met with much enthusiasm, mainly due to the novelty factor, competition, fear and lack of knowledge (Belanche at al. 2018).

The global landscape of innovation is undergoing comprehensive transformation due to the growing importance of intangible investment. The fintech concept (Schueffel 2016; Gai et al. 2018; Das & Ali 2020) currently transcends electronic banking and consumer digitisation services and focuses on the development and implementation of innovative financial instruments to meet the financial requirements of the end-users. Digital technologies (Skinner 2018; Jagtiani & Kose 2018; Tanda & Schena 2019) and their impact on consumer decisions currently stand at the forefront of international consumer policy discourse (Zopounidis et al. 2018; Bhatia, 2019). The use of modern technologies presents a clear opportunity to accelerate the transformation of the banking sector and give users greater control over their finances and increase the value of their investments. Asset management support technologies may play a new and promising role in supporting financial decisions that involve analysing decisions in circumstances of uncertainty and a huge diversity of possible decisions. The impact of modern financial technologies on data transfer and security, consumer privacy, as well as the responsibility of financial service providers on online platforms and digital consumer education are just some of the hot topics of our times (Świecka et al. 2020; Thorun & Diels 2020).

One form of automated financial consulting is robo-advice – defined as an automated investment platform that uses quantitative algorithms to manage investors' portfolios and accessible to clients online. Robo-advisors differ from existing online investment platforms or online brokerage with respect to two different conceptual levels: customer assessment, and customer portfolio management (Beketov et al. 2018; Jung et al. 2018). The solution is based on advanced algorithms using artificial intelligence and tools for analysing large data sets. The robo-advisor (online software) provides vital financial advice to their clients in a cost-effective manner with moderate to minimal human interventions (Balwani et al. 2019). Emergence of financial technologies ecosystem was preceded by three waves of technological disruptive changes: electronic payments, blockchain and cryptocurrencies, and artificial intelligence. The concept of artificial intelligence in the financial sector centers on devices that can interpret and understand tasks and take action to complete those financial tasks. For example, the devices might be robo-advice, digital brokers, or assorted devices used in trading, tax management, and trade decision making. Artificial intelligence offers a high degree of automation and efficiency improvements, which are most apparent in investment platforms and portfolio management (Palmiéa et al., 2020).

Robo-advisors have emerged from the entwinement of two strands of history represented by investment theory and AI-technology during the latter part of the 20th century. The leading robo-advisory models founded in today's AI-driven technological environment are mostly based on Modern Portfolio theory (MPT), based on an optimal portfolio for a given investor's risk preference. Therefore, behavioural finance is considered as one of the most realistic representation of financial markets and investor behaviour, which might eventually replace MPT as the paradigm of choice. This shift to behavioural finance received a further boost in 2017, with recent developments in AI-based machine learning, which have built the momentum through the possible combination of two investment philosophies (Shanmuganathan 2020).

Research into the implementation of robo-advisory solutions in practice is limited (D'Acunto et al., 2019). Literature and reports predominantly focus on technical, legal and market forecasting issues (Jl, 2017; Mordor Intelligence 2017; Netscribes 2018; Glaser et al. 2019; EIBIS 2020), excluding the use of robo-advice in personal

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finance planning. The use of robo-advice has come under the microscope in the USA and China. Over one million Bank of America customers use the services of a chatbot (named Erica) to submit basic financial inquiries (Rosman, 2018). Another example of the practical use of modern technologies is the Bank of Tokyo (Marinova et al., 2017), where a banker-humanoid (named Nao) accompanies the client during a standard visit to the bank. Banks and entities from the fintech industry seek to popularise robo-advice services, claiming that they offer a competitive advantage. It is worth emphasising that the size of the market is expanding, and robo-advisers manage approximately USD 880,000 million of assets and have noted an annual increase of 30% (Statista.com 2019). Analyses conducted thus far (Lundahl et all 2009; Sabri 2011; Bhatnagar 2016; Iriobe & Oyinlola 2017) do not relate directly to an assessment regarding which socio-demographic traits – from a statistical point of view – may influence the level of satisfaction experienced by customers (Kim & Lim 2010) with the use of modern technologies in personal finance in terms of robo-advice and the monitoring of spending habits.

Progress in information technology (IT) and information systems (IS) provides firms with more options for replacing or supplementing personal service provision with self-service technologies (SST). Many of these technologies provide decision support to consumers either as their main purpose (apps, information terminals) or as a fringe benefit (self- scanning) (Djelassia et al., 2018). Robo-advice is an example of customer self-service technology (SST). SST is applicable, among others, in retail and financial services as a customer-centric strategy and fosters loyalty, trust, or word-of-mouth communication (Taillon & Huhmann 2017). One of the prominent benefits noted by customers is that self-service allows customers to have greater efficiency in a transaction and so they forego the full service option and purchase online (Collier & Barnes 2015).

The subject of Technology readiness (TR) of SSTs is also discussed in the literature, i.e. the customer's psychological willingness to accept new technologies. TR comprises four dimensions: innovativeness, optimism, discomfort and insecurity. Service providers introduce self-service technologies to increase productivity and efficiency and to offer customers access to services via new and convenient channels, thereby better meeting customer demands and boosting their satisfaction. The impact of TR on customers can be investigated by (1) attitude towards using SSTs, (2) adoption of SSTs, i.e. actual usage and (3) response to the firm in terms of perceived service quality, satisfaction and loyalty to an SST (Liljandera, Gillberg, Gummerus, Rie 2006). Other dimensions of TR are innovativeness and optimism and they have a positive impact on the customers' decisions to use self-service technologies while discomfort and insecurity have a negative impact (Gelderman et al. 2011). SST service quality can be measured by examining many dimensions including functionality, enjoyment, security, assurance, design, customisation and convenience. The quality of self-service technology in retail banking services consists of four elements – consistency, dependability, timeliness and technology – based on two popular dimensions, which are reliability and responsiveness and their influence on customer satisfaction (Iberahim, et al. 2016). The literature also discusses the positive relationship between a self-service technology investment and solid financial performance (Hung et al. 2012). Buyers' continued usage of SSTs depends on their acceptance of the technology and their satisfaction with service delivery based on two different lines of research: technology acceptance and service/relationship marketing. Buyers who are satisfied tend to continue their usage, whereas dissatisfied buyers withdraw (Erikkson & Nilson 2007). There are no studies on socio-economic factors affecting the satisfaction of using self-service services based on the example of robo-advice. This indicates the existence of a research gap, which the results of the study and their analysis presented in the article intend to fill.

One of the main theories related to the customer self-service process is that of resource matching (Anand & Sternthal 1999) and its further theoretical development within the field of efficiency (Collier & Kimes 2012; Zhu et al. 2007). This theory is a reference point for environments where performance is the key goal. Unfortunately, it cannot be fully applied to analyses regarding remote consumer service channels in the financial sector, as it is not

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appropriate for the dynamics of action and operations performed independently. The theory of consumption values focuses on efficiency (which better describes consumer behaviour in the digital financial services market), explaining why consumers decide to buy (Sheth et al. 1991). Financial service providers using remote applications strive towards increased efficiency, performance and diversification of communication channels (Liljander et al. 2006; Collier & Barnes 2015; Iberahim et al. 2015). Customer self-services enables a new service model to be created that bases its assumptions on the equal involvement of investors and bidders in the financial management process and can influence the establishment of long-term relationships between the parties involved (Djelassi et al. 2018). Most financial institutions do not take advantage of customer self-service potential because they base their assumptions on an incomplete business model in the area of remote service. Remote financial management support services are focused on the speed of response to reported needs, reducing service time, convenience for customers and lowering costs for the service provider (Boon-itt 2015). Innovation in finance may go hand in hand with consumer discomfort arising from lack of control over modern tools, uncertainty of their knowledge and skills, lack of confidence in technology and a sense of technological overwhelm (Parasurman 2000).

One of the objectives of using modern technologies is to support consumer decision-making processes and adapt modern financial services to evolving needs (Buettner 2017; Nitin et al. 2019). Robo-advice facilitates management by providing potential investors with investment guidelines regarding the benefits of investing. Implementing a new path of communication with the recipient requires in-depth research into consumer behaviour, knowledge of which is necessary not only when it comes to understanding purchasing decisions, but also in order to create tailor-made products and predict the future evolution of customers' decisions (Mazurek, Maz 2019). Analysis of consumer attitudes significantly affects preferences and further predictions based on the personality of the user (Blackwell et al. 2005). The assessment of alternatives in the financial decision making process (Beckett et al. 2000) is a multi-stage process, which consists of (a) forming opinions on possible methods of satisfying needs, (b) shaping attitudes towards them and (c) establishing a purchase. This scheme draws on previously accumulated information and experience. Therefore, the challenge is the diagnosis of which determinants may be significant to the consumer in order to shift financial management towards robo-advice. The implementation of modern technologies in the process of personal finance management offers a number of challenges in the area of data circulation and analysis, digitisation and the automation of manual processes, as well as big data architecture.

The purpose of the article is to diagnose the sociological and economic determinants underlying consumer satisfaction in terms of planning personal finances using modern technologies. The paper is organised as follows. At the beginning the article presents the research methodology, after which the authors outline the main results of their worldwide survey. Subsequently, the discussion of the results is shown, whereupon the authors conclude by listing limitations and offering future research options.

2. Methodology

The statistical material used in the article stems from the *ING International Survey – New Technologies 2019*. This online survey was carried out by Ipsos from 30 January to 11 February 2019. Sampling reflects gender ratios and age distribution, selecting from pools of possible respondents furnished by panel providers in each country. European consumer figures are expressed as an average, weighted to take the varying populations of the countries into account. 14,824 respondents from 15 countries (Austria, Belgium, Czech Republic, Germany, France, Italy, Luxembourg, Netherlands, Poland, Romania, Spain, Turkey, United Kingdom, USA, Australia) were involved in

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the survey. The article uses data for Poland made available directly by ING Bank Śląski economists for scientific purposes. 14,824 respondents were surveyed, whose descriptive statistics are presented in Table 1.

Table 1. Descriptive statistics of the studied population (N = 14,824)

Characteristics	Variants of the characteristics	Austria	Belgium	Czech Republic	Germany	France	Italy	Luxembourg	Netherlands	Poland	Romania	Spain	Turkey	United Kingdom	USA	Australia
		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Age	18-35	221	199	284	181	179	174	129	194	268	298	190	396	180	230	149
	36-45	257	266	341	277	283	310	197	275	245	381	332	358	299	247	240
	46-65	430	376	332	408	357	418	254	311	416	311	413	243	353	367	343
	Over 66	99	174	78	139	192	105	69	234	87	36	66	14	184	160	275
Gender	Female	516	516	521	523	517	504	312	519	537	524	507	513	500	510	504
	Male	491	499	514	482	494	503	337	495	479	502	494	498	516	494	503
Employment	Student	52	62	71	51	50	61	44	40	41	59	47	111	28	27	30
	Unemployed	100	219	104	151	99	212	41	198	93	152	203	80	197	193	190
	Employed	543	438	650	513	545	462	396	482	626	621	581	692	519	506	420
	Self-employed	58	33	59	39	43	115	29	57	74	79	55	46	58	62	66
	Retired	254	263	151	251	274	157	139	237	182	115	115	82	214	216	301
Household	1 person	235	230	134	222	295	106	92	262	94	81	83	41	217	190	223
	2 people	392	352	334	377	419	265	213	396	256	278	268	123	358	358	412
	3 people	197	226	274	201	153	293	145	174	263	316	304	293	194	189	186
	4 people	128	137	200	145	110	261	142	122	258	232	271	335	174	155	121
	5 people	40	46	64	44	25	72	44	43	103	78	59	163	53	64	40
	6 or more	15	24	29	16	9	10	13	17	42	41	16	56	20	48	25
Education	Primary	69	46	65	62	185	105	42	266	27	124	102	161	215	273	284
	Secondary	489	443	625	375	382	529	201	381	500	112	274	130	305	236	245
	Vocational	245	267	136	172	216	51	167	223	58	523	165	90	151	166	174
	BA	82	132	68	214	84	270	115	47	123	180	328	493	233	225	200
	MA	122	127	141	182	144	52	124	97	308	87	132	137	112	104	104
Income (euro)	0-249	13	9	15	17	7	10	2	6	39	77	8	23	18	22	20

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	250-499	13	10	58	20	22	20	3	17	83	202	20	20	39	24	30
	500-999	55	32	231	57	79	64	7	36	285	314	85	120	84	82	94
	1000-1499	128	122	304	119	129	145	5	119	263	174	190	120	162	106	135
	1500-1999	117	145	170	146	120	162	7	131	131	77	187	151	114	81	88
	2000-2499	125	142	77	126	145	130	16	151	78	36	130	102	93	94	98
	2500-2999	108	99	34	111	127	103	27	100	21	13	107	88	88	74	76
	3000-3499	77	103	6	102	81	77	39	88	11	4	69	88	71	64	70
	3500-3999	89	61	5	68	83	52	40	66	5	2	49	59	54	73	50
	4000-4999	53	58	4	81	62	43	66	48	2	6	42	51	79	77	64
	5000-5999	28	29	2	32	27	17	75	14	0	5	12	39	41	59	42
	6000-6999	11	10	2	13	10	8	70	5	5	2	9	33	27	44	26
	7000+	15	7	4	18	11	14	152	12	8	9	3	53	30	90	48

Source: ING International Survey – New Technologies (2019).

Regarding the use of modern technologies in personal financial management, the respondents were presented with two statements to evaluate their level of satisfaction:

1) I would be happy for a computer program to make investment decisions on my behalf.
2) I would be happy for a computer program to analyse my spending habits and recommend improvements.

The respondents responded to these statements on a 5-point Likert scale: 1 – totally disagree, 2 – disagree, 3 – difficult to say, 4 –agree, 5 – totally agree.

In order to analyse the date, the following statistical methods were employed:

1) The Chi-square test for independence: a nonparametric method for testing the relationship between two variables expressed on a qualitative scale. These were socio-demographic variables with 2 questions on a 5-point scale.
2) The Mann-Whitney U test: a nonparametric test for studying the differences between 2 groups. In this case, Poland is compared with each country in turn, and the average acceptance value of robo-advice in terms of qualitative sociodemographic variables (gender, work) was compared in different countries.
3) Spearman's rho correlation coefficient: a nonparametric test used to examine the relationship between two variables expressed on the ordinal scale. Applied to the relationship between the survey and socio-demographic questions that were graded (rated on a scale from the lowest to the highest).

The following research hypotheses were formulated:

H1: There are statistically significant differences between Poland and the other countries analysed (apart from Italy and Spain) in terms of the acceptance of robo-advice for making investment decisions as well as for a computer program to analyse expenditure and suggest improvements.

H2: In most of the countries studied, age is associated with a lower acceptance for a computer program to make investment decisions, analyse expenditure and recommend improvements.

H3: In most countries, the willingness to allow a computer program to make investment decisions – along with the willingness for a computer program to analyse spending habits and recommend improvements – is proportional to the number of people in the household.

H4: Acceptance for a computer to make investment decisions, analyse expenditure and recommend improvements is inversely proportional to age.

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H5: Most countries feature statistically significant differences between men and women in terms of accepting robo-advice for investment and there is no difference in terms of accepting a computer program to make expenditure analysis and recommend improvements (apart from Germany, the Netherlands and Turkey).

H6: In most countries there are differences between working and non-working people in terms of accepting robo-advice for investment or as a means of analysing expenses and suggesting improvements.

3. Research background

Table 2 presents the most significant robo-advisor parameters in Europe. Assets under management in Europe amounts to USD 49,471m in 2020 in the robo-advisor segment. Assets under management are expected to show an annual growth rate (CAGR 2020-2023) of 35.2% resulting in a total amount of USD 122,312 million by 2023. In the robo-advisor segment, the number of users is expected to amount to 4,005.1 thousand by 2023 from 2,173 thousand in 2020. The average assets under management per user in the robo-advisor segment amounts to USD 22,767 in 2020 and is expected to grow to USD 30,539.

Table 2. Robo-advisors in Europe

Key characteristics	2017	2018	2019	2020	2021	2022	2023
Assets under Management (in million USD)	7 365,0	15 925,0	30 052,0	49 471,0	72 689,0	97 626,0	122 312,0
Assets under Management Growth (in percentages)	-	116,20	88,70	64,60	46,90	34,30	25,30
Users in thousands	562,90	962,50	1 509,10	2 173,00	2 891,30	3 506,20	4 005,10
Penetration Rate (in percentages)	0,10	0,10	0,20	0,30	0,30	0,40	0,50
Assets under Management per User in USD	13 085,0	16 546,0	19 914,0	22 767,0	25 141,0	27 844,0	30 539,0

Source: Statista.com (2020).
Note: penetration rate is the share of active paying customers (or accounts) from the total population of the selected market (market segment, region) for each year.

Taking into account only the 15 countries studied, assets under management by robo-advisors are presented in Fig. 1. According to data for 2020, the total value of these assets amounted to USD 43,032.0 million projected to rise by 2023 to a level of 106,590.0 million USD. The largest markets were Germany and the United Kingdom, accounting for 32% and 52% of assets under management respectively of all the countries surveyed.

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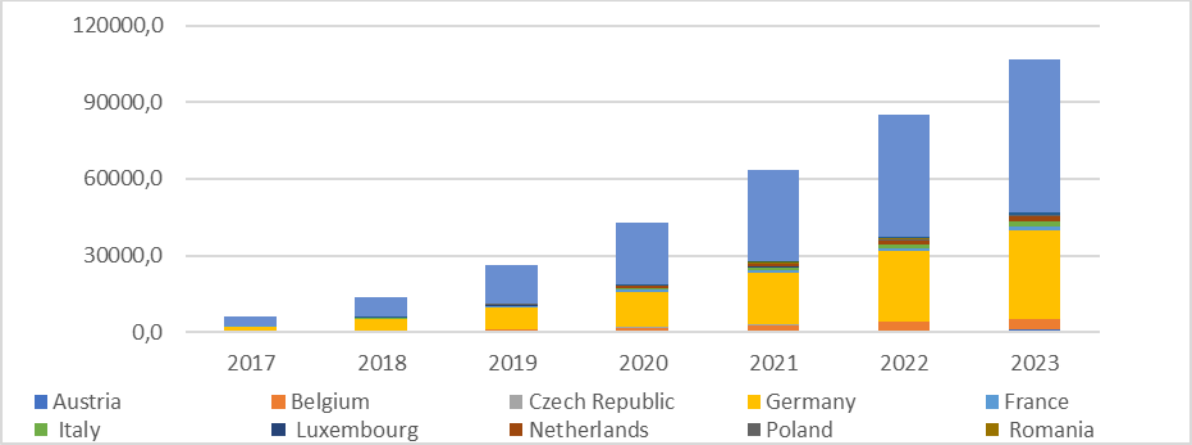

Fig. 1. Assets under Management of robo-advisors in million USD in selected European countries
Source: Statista.com (2020)

Taking into account the users of robo-advisors in the 15 European countries surveyed (Fig. 2), in 2020 there were 1635.00 thousand projected to rise by 2023 to 2867.3 thousand. Most users of this service are in Germany and the United Kingdom, accounting for 27% and 46% respectively of all users among the countries surveyed.

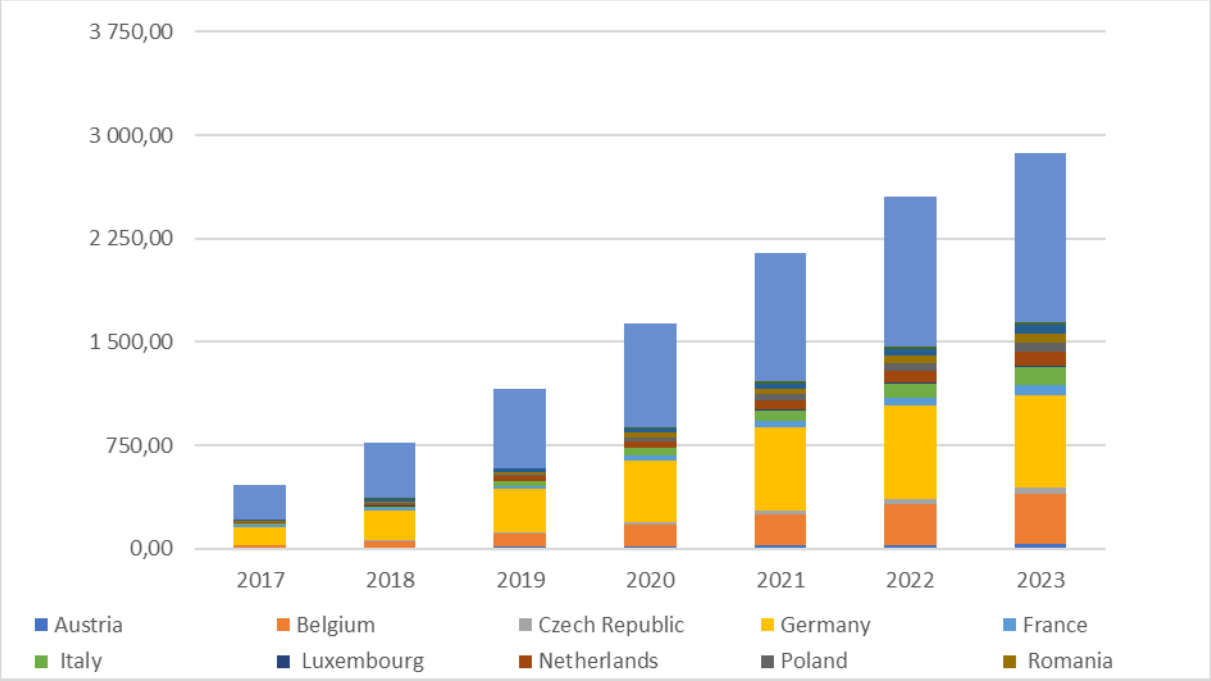

Fig. 2. Users of robo-advisors in thousands in selected European countries
Source: Statista.com (2020)

Fig. 3 and 4 present the structure of answers to 2 questions presented to the respondents. The first question concerned financial robo-advice supporting investment decisions. In the case of the European countries studied, the average of the responses was 18% agree, 21% neither agree or disagree and 61% disagree. Countries with the greatest levels of satisfaction with financial robo-advice include Turkey (30%), Romania (21%), Czech Republic

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(20%), UK (19%), Poland (18%) as well as Spain and Italy (17%). For the USA, 22% responded 'agree'. The second question concerned satisfaction a computer program analysing spending habits and suggesting improvements (Fig. 2). For the second question, the percentage of those satisfied was higher than the first. The average 'agree' response for the European countries studied was 38%, and the highest level of satisfaction was indicated by respondents from Turkey (65%), Romania (53%), Poland (45%), Czech Republic (42%), Spain (41%), Luxembourg (35%) and the UK (34%). In the case of the USA, the percentage of respondents indicating satisfaction was the same as the European countries studied and amounted to 38%.

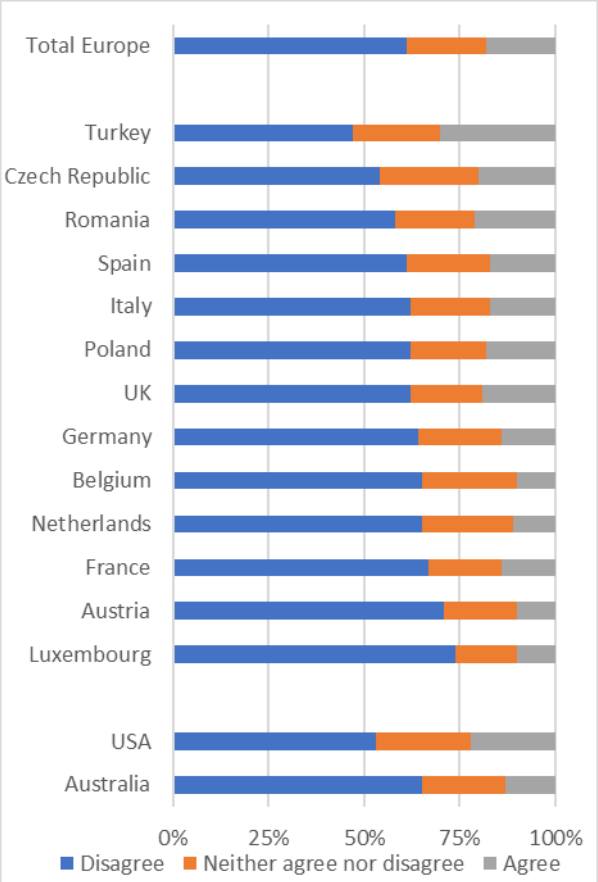

Fig. 3. I would be happy for a computer program to make investment decisions on my behalf
Source: ING International Survey – New Technologies (2019); Note: The 'disagree' category includes 'totally disagree' and 'disagree', and the 'agree' category includes 'totally agree' and 'agree'.

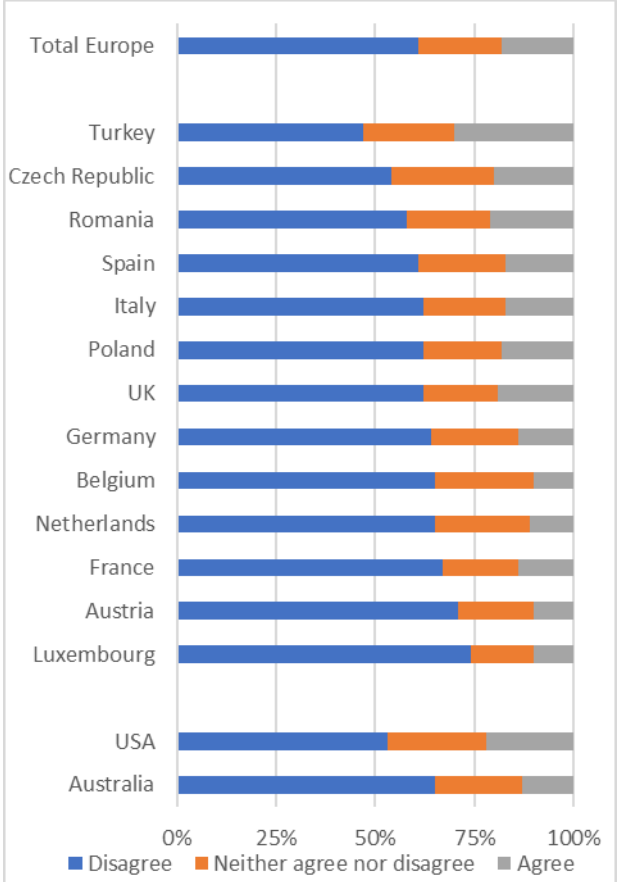

Fig. 4. I would be happy for a computer program to analyse my spending habits and recommend improvements
Source: ING International Survey – New Technologies (2019).

Subsequently, in the first stage of the study, the Poles' opinion on financial robo-advice was compared with the opinion of residents of other countries in this respect. Comparative analyses were performed using a series of Mann-Whitney U tests. Table 3 presents the results of the comparative analyses together with descriptive statistics for opinions on financial robo-advice for making investment decisions by country.

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Table 3. Descriptive statistics for opinions on financial robo-advice for making investment decisions by country and the results of comparative analyses via Mann-Whitney U tests

I would be happy for a computer program to make investment decisions on my behalf	*M*	*SD*	*Z*	*p*	*r*
Poland	2,35	1,16		-	
Australia	2,11	1,11	4,69	***	0,10
Austria	1,93	1,09	8,87	***	0,20
Belgium	2,11	1,08	4,52	***	0,10
Czech Republic	2,50	1,10	3,54	***	0,08
France	2,09	1,17	5,63	***	0,13
Germany	2,11	1,20	5,20	***	0,12
Italy	2,28	1,18	1,53	0,126n.s.	0,03
Luxembourg	2,01	1,03	5,83	***	0,14
Netherlands	2,12	1,08	4,21	***	0,09
Romania	2,49	1,24	2,35	*	0,05
Spain	2,29	1,19	1,43	0,152n.s.	0,03
Turkey	2,78	1,31	7,43	***	0,17
UK	2,23	1,25	3,21	**	0,07
USA	2,48	1,25	2,11	*	0,05

M – mean, SD – standard deviation, Me – median, Z – U Mann-Whitney statistic, p – level of statistical significance, r – strength of effects, **p*<0,05, ***p*<0,01, ****p*<0,001, n.s. – statistically insignificant

The results of the Mann-Whitney U tests proved to be statistically significant, which means that there were differences between Poland and the other countries in terms of acceptance of robo-advice for making investment decisions. Only statistically significant differences between Poland and Italy were not indicated Z = 1.53; p = 0.126; V = 0.03 and Spain Z = 1.11; p = 0.265; V = 0.03.

Countries featuring a higher level of acceptance of investment advice for investments included Turkey, the Czech Republic, Romania and the USA. Other countries indicated a lower rate of acceptance of this advisory function, and the lowest value was found for Austria and Luxembourg. Based on the r strength of effect ratio, it can be concluded that the differences were most marked between Poland and Australia and Luxembourg.

Similarly, by means of a series of multiple comparisons via Mann-Whitney U tests, a study was conducted into whether and how Poles differed from other nationalities in terms of robo-advice given by a computer program for analysing expenses and suggesting improvements.

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Table 4. Descriptive statistics for opinions on financial robo-advice in terms of analysing habits related to expenditure by country and the results of comparative analyses via Mann-Whitney U tests

I would be happy for a computer program to analyse my spending habits and recommend improvements	*M*	*SD*	*Z*	*p*	*r*
Poland	3,23	1,14		-	
Australia	2,66	1,19	10,49	***	0,23
Austria	2,55	1,29	11,97	***	0,27
Belgium	2,71	1,17	9,77	***	0,22
Czech Republic	3,11	1,16	2,19	*	0,05
France	2,71	1,30	9,15	***	0,20
Germany	2,55	1,30	11,93	***	0,26
Italy	2,98	1,17	4,62	***	0,10
Luxembourg	2,82	1,26	6,49	***	0,16
Netherlands	2,66	1,12	10,93	***	0,24
Romania	3,44	1,23	4,40	***	0,10
Spain	3,09	1,24	2,39	*	0,05
Turkey	3,80	1,15	11,43	***	0,25
UK	2,77	1,28	8,10	***	0,18
USA	2,99	1,28	4,12	***	0,09

M – mean, SD – standard deviation, Me – median, Z – U Mann-Whitney statistic, p – level of statistical significance, r – strength effects, **p*<0,05, ***p*<0,01, ****p*<0,001, n.s. – statistically insignificant

All results of the Mann-Whitney U analyses turned out to be statistically significant p <0.001. Therefore, citizens of different nationalities differed in their willingness for a computer to analyse their expenditure. Turkey and Romania featured a higher level of acceptance of robo-advice for spending analysis than Poland. The greatest reluctance to have a computer program give financial advice was expressed by the inhabitants of Austria and Germany.

Next, a study was conducted as to whether acceptance of robo-advice was related in different degrees to sociodemographic variables in Poland and other countries. Spearman's rho correlation analysis was used for variables measured on the ordinal scale. Table 5 presents the results of correlation analyses for the relationship between sociodemographic variables and the acceptance of financial robo-advice for making investment decisions by country.

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Table 5. Results of Spearman's rho correlation analysis for the relationship between sociodemographic variables and acceptance of financial robo-advice for making investment decisions by country

I would be happy for a computer program to make investment decisions on my behalf	Age	Qualification	Number of people in the household	Income
Poland	-0,03	-0,02	0,07*	-0,03
Australia	-0,34***	0,09**	0,15***	0,04
Austria	-0,10***	0,05	0,11***	-0,07*
Belgium	-0,18***	-0,04	0,12***	-0,03
Czech Republic	0,00	-0,02	0,04	-0,01
France	-0,21***	0,07*	0,14***	0,01
Germany	-0,23***	0,11***	0,12***	0,06
Italy	-0,10**	0,08*	0,10**	0,08*
Luxembourg	-0,13***	-0,05	0,05	-0,09*
Netherlands	-0,19***	0,14***	0,16***	0,15***
Romania	-0,08**	-0,13***	0,03	-0,09**
Spain	-0,11***	0,12***	0,11***	0,04
Turkey	0,05	0,13***	0,07*	0,17***
UK	-0,36***	0,06	0,19***	0,06
USA	-0,34***	-0,01	0,13***	-0,02

*p<0,05, **p<0,01, ***p<0,001

The results of correlation analyses demonstrate that in most countries age was associated with a decrease in acceptance for a computer program to make investment decisions. In the United Kingdom, the strongest relationship in this respect was $\rho = -0.36$; $p < 0.001$, then the USA $\rho = -0.34$; $p < 0.001$ and Australia $\rho = -0.34$; $p < 0.001$. Furthermore, in most countries, the willingness for a computer program to make investment decisions was proportional to the number of people in the household. In the United Kingdom, the strongest relationship in this respect was $\rho = 0.19$; $p < 0.001$.

In the case of countries such as Italy, the Netherlands and Turkey, high acceptance for a computer program to make investment decisions was demonstrated to be associated with higher levels of education and income. It is interesting that the exact opposite relationship occurred in the case of Romania.

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Table 6. Results of Spearman's rho correlation analysis for the relationship between sociodemographic variables and acceptance of financial robo-advice in analysing spending habits by country

I would be happy for a computer program to analyse my spending habits and recommend improvements	Age	Qualification	Number of people in the household	Income
Poland	-0,24***	-0,02	0,11***	-0,04
Australia	-0,32***	0,08*	0,14***	0,06
Austria	-0,15***	-0,033	0,13***	-0,02
Belgium	-0,18***	-0,07*	0,08*	-0,01
Czech Republic	-0,13***	-0,06*	0,06	0,02
France	-0,21***	-0,015	0,15***	0,00
Germany	-0,23***	0,08**	0,12***	0,07*
Italy	-0,19***	0,06	0,14***	0,07*
Luxembourg	-0,17***	-0,04	0,10**	-0,10*
Netherlands	-0,20***	0,13***	0,17***	0,15***
Romania	-0,12***	-0,12***	0,04	-0,11**
Spain	-0,22***	0,07*	0,13***	0,06
Turkey	-0,10**	0,17***	0,13***	0,20**
UK	-0,37***	0,07*	0,19***	0,10**
USA	-0,31***	-0,01	0,20***	-0,01

*p<0,05, **p<0,01, ***p<0,001

For all the countries studied, correlation analyses revealed that as age increased, the acceptance of a computer analysing expenses and recommending improvements decreased. The strongest relationships in this area were also shown by the United Kingdom $\rho = -0.37$; $p < 0.001$, then the USA $\rho = -0.31$; $p < 0.001$ and Australia $\rho = -0.32$; $p < 0.001$, with Turkey having the weakest $\rho = -0.10$; $p < 0.01$. Also in most countries, the number of people in the household proved to be proportional to the willingness for a computer program to analyse spending habits and recommend improvements. This relationship was also the strongest in the United Kingdom $\rho = 0.19$; $p < 0.001$ and the USA $\rho = 0.20$; $p < 0.001$.

Further analysis indicated that for countries such as Germany, the Netherlands, Turkey and the United Kingdom, high acceptance for a computer program to analyse expenditure was associated with higher education and income levels. Romania is the only case where people with a university degree and higher earnings are less willing to have a computer analyse expenses and recommend improvements.

A study was also conducted as to which countries featured a differentiated level of acceptance of financial advice by gender. For this purpose, comparative analyses were carried out using Mann-Whitney U tests.

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Table 7. Descriptive statistics for opinions on financial robo-advice in terms of making investment decisions by country and gender as well as the results of comparative analyses via Mann-Whitney U tests

I would be happy for a computer program to make investment decisions on my behalf	Women		Men		*Z*	*p*	*r*
	M	*SD*	*M*	*SD*			
Poland	2,34	1,15	2,36	1,17	0,28	0,780n.s.	0,01
Australia	2,03	1,04	2,20	1,17	1,97	*	0,06
Austria	1,78	0,96	2,08	1,19	3,66	***	0,12
Belgium	2,02	1,03	2,21	1,13	2,57	*	0,08
Czech Republic	2,46	1,05	2,53	1,16	0,91	0,363n.s.	0,03
France	2,00	1,14	2,19	1,21	2,47	*	0,08
Germany	1,91	1,06	2,33	1,30	5,10	***	0,16
Italy	2,15	1,12	2,41	1,22	3,32	**	0,10
Luxembourg	1,91	1,02	2,11	1,04	2,77	**	0,11
Netherlands	1,98	1,01	2,28	1,13	4,28	***	0,13
Romania	2,41	1,17	2,57	1,31	1,66	0,097n.s.	0,05
Spain	2,23	1,16	2,34	1,21	1,28	0,199n.s.	0,04
Turkey	2,79	1,31	2,78	1,32	0,10	0,924n.s.	0,00
UK	2,09	1,19	2,36	1,30	3,32	**	0,10
USA	2,35	1,23	2,61	1,26	3,33	**	0,11

M – mean, SD – standard deviation, Me – median, Z – U Mann-Whitney statistic, p – level of statistical significance, r – strength effects, *p<0,05, **p<0,01, ***p<0,001, n.s. – statistically insignificant

The results of the Mann-Whitney U tests proved to be significant, which means that the countries analysed do feature differences between men and women in terms of accepting robo-advice for investment. No such gender differences were found in Poland Z = 0.28; p = 0.780; r = 0.01, the Czech Republic Z = 0.91; p = 0.363; r = 0.03, Romania Z = 1.66; p = 0.097; r = 0.05, Spain Z = 1.28; p = 0.199; r = 0.04 or Turkey with Z = 0.10; p = 0.924; r = 0.00. In all other countries, men were more willing than women to have a computer make investment decisions for them, and the largest gender differences were found among the inhabitants of Germany and Austria.

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Table 8. Descriptive statistics for opinions on financial robo-advice in terms of analysing spending habits by country and gender as well as the results of comparative analyses via Mann-Whitney U tests

I would be happy for a computer program to analyse my spending habits and recommend improvements	Women		Men		*Z*	*p*	*r*
	M	*SD*	*M*	*SD*			
Poland	3,28	1,13	3,16	1,15	1,52	0,128n.s.	0,05
Australia	2,64	1,20	2,68	1,19	0,42	0,673n.s.	0,01
Austria	2,50	1,26	2,60	1,32	1,04	0,296n.s.	0,03
Belgium	2,70	1,17	2,72	1,18	0,37	0,712n.s.	0,01
Czech Republic	3,06	1,13	3,16	1,18	1,63	0,104n.s.	0,05
France	2,69	1,29	2,72	1,31	0,25	0,804n.s.	0,01
Germany	2,38	1,21	2,72	1,37	3,80	***	0,12
Italy	2,95	1,18	3,01	1,17	0,89	0,373n.s.	0,03
Luxembourg	2,76	1,28	2,87	1,25	1,06	0,289n.s.	0,04
Netherlands	2,54	1,13	2,78	1,10	3,59	***	0,11
Romania	3,45	1,21	3,43	1,26	0,04	0,968n.s.	0,00
Spain	3,09	1,25	3,08	1,24	0,23	0,819	0,01
Turkey	3,94	1,07	3,64	1,22	3,79	***	0,12
UK	2,70	1,26	2,83	1,31	1,59	0,111n.s.	0,05
USA	2,95	1,27	3,03	1,29	1,08	0,278n.s.	0,03

M – mean, SD – standard deviation, Me – median, Z – U Mann-Whitney statistic, p – level of statistical significance, r – strength effects, **p*<0,05, ***p*<0,01, ****p*<0,001, n.s. – statistically insignificant

The results of the Mann-Whitney U test were mostly insignificant, which means that there were no differences between men and women in the analysed countries in terms of acceptance of robo-advice for analysing expenses and recommending improvements. Such differences were only demonstrated for Germany Z = 3.80; p <0.001; r = 0.12, the Netherlands Z = 3.59; p <0.001; r = 0.11 and Turkey Z = 3.79; p <0.001; r = 0.12. In the case of Germany and the Netherlands, men were more likely to have a computer analyse their expenses, while in the case of Turkey, women were more likely to do so. People working (employed or self-employed) were also compared with those not working (at school/at university/retired/unemployed) in terms of their evaluation of financial robo-advice by country.

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Table 9. Descriptive statistics for opinions on financial robo-advice in terms of making investment decisions by country and employment as well as the results of comparative analyses via Mann-Whitney U tests

I would be happy for a computer program to make investment decisions on my behalf	Working people		Non-working people		*Z*	*p*	*r*
	M	*SD*	*M*	*SD*			
Poland	2,34	1,03	2,35	1,21	0,71	0,477n.s.	0,02
Australia	1,87	0,98	2,37	1,19	6,89	***	0,22
Austria	1,90	1,07	1,95	1,10	0,68	0,495n.s.	0,02
Belgium	2,01	1,04	2,22	1,12	2,98	**	0,09
Czech Republic	2,45	1,04	2,52	1,13	0,57	0,569n.s.	0,02
France	1,86	0,97	2,28	1,28	4,71	***	0,15
Germany	1,92	1,10	2,25	1,25	4,12	***	0,13
Italy	2,07	1,09	2,43	1,21	4,79	***	0,15
Luxembourg	1,90	0,94	2,07	1,07	1,70	0,089n.s.	0,07
Netherlands	1,92	0,98	2,30	1,13	5,38	***	0,17
Romania	2,39	1,18	2,54	1,26	1,61	0,107n.s.	0,05
Spain	2,11	1,12	2,39	1,21	3,51	***	0,11
Turkey	2,45	1,19	2,91	1,34	4,84	***	0,15
UK	1,86	1,10	2,51	1,29	8,45	***	0,26
USA	2,21	1,14	2,68	1,30	5,73	***	0,18

M – mean, SD – standard deviation, Me – median, Z – U Mann-Whitney statistic, p – level of statistical significance, r – strength effects, **p*<0,05, ***p*<0,01, ****p*<0,001, n.s. – statistically insignificant

The results of the Mann-Whitney U tests proved to be significant for the most part, which means that the countries analysed do feature differences between working and non-working people in terms of their acceptance of robo-advice advice for investment. No such differences were found for Poland Z = 0.71; p = 0.477; r = 0.02, Austria Z = 0.68; p = 0.495; r = 0.02, Czechs Z = 0.57; p = 0.569; r = 0.02, Luxembourg Z = 1.70; p = 0.089; r = 0.07 or Romania Z = 1.61; p = 0.107; r = 0.05. In the remaining countries, it was shown that working people were more favourably inclined to robo-advice for investment and the widest differences were found in the case of the United Kingdom.

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Table 10. Descriptive statistics for opinions on financial robo-advice in terms of analysing spending habits by country and employment as well as the results of comparative analyses via Mann-Whitney U tests

I would be happy for a computer program to analyse my spending habits and recommend improvements	Non-Working people		Working people		*Z*	*p*	*r*
	M	*SD*	*M*	*SD*			
Poland	3,19	1,10	3,24	1,16	0,94	0,350n.s.	0,03
Australia	2,42	1,16	2,91	1,18	6,41	***	0,20
Austria	2,50	1,24	2,59	1,32	1,02	0,309n.s.	0,03
Belgium	2,62	1,17	2,81	1,17	2,78	***	0,09
Czech Republic	3,10	1,13	3,12	1,17	0,31	0,754n.s.	0,01
France	2,53	1,25	2,85	1,32	3,96	***	0,12
Germany	2,33	1,25	2,70	1,32	4,44	***	0,14
Italy	2,82	1,18	3,10	1,16	3,79	***	0,12
Luxembourg	2,59	1,18	2,94	1,29	3,29	**	0,13
Netherlands	2,48	1,11	2,81	1,11	4,78	***	0,15
Romania	3,45	1,25	3,43	1,23	0,42	0,677n.s.	0,01
Spain	2,92	1,28	3,18	1,21	3,26	**	0,10
Turkey	3,48	1,22	3,91	1,11	5,14	***	0,16
UK	2,40	1,25	3,05	1,24	8,04	***	0,25
USA	2,76	1,25	3,17	1,27	5,05	***	0,16

*M – mean, SD – standard deviation, Me – median, Z – U Mann-Whitney statistic, p – level of statistical significance, r – strength effects, *p<0,05, **p<0,01, ***p<0,001, n.s. – statistically insignificant*

The results of the Mann-Whitney U tests again proved to be largely significant, which means that in the countries analysed there were differences between working and non-working people in terms of their acceptance of robo-advice for spending analysis. Such differences were not found in Poland Z = 0.94; p = 0.350; r = 0.03, Austria Z = 1.02; p = 0.309; r = 0.03, Czechs Z = 0.31; p = 0.754; r = 0.01 or Romania Z = 0.42; p = 0.677; r = 0.01. In other countries, working people would be more likely to use robo-advice for spending analysis and recommendations for improvement than non-working people. Here too, the most extreme differences were observed in the United Kingdom.

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4. Discussion

Analyses on robo-advice have thus far focused on technical and legal issues, while also attempting to forecast the growth of the robo-advice market (Jl, 2017; Mordor Intelligence 2017; Netscribes 2018; Glaser et al. 2019; EIBIS 2020). This study supplements the research approach with an analysis of how socioeconomic factors impact the use of modern technologies in the process of personal finance management. The study determines the statistical significance and strength of the relationship between the individual socio-demographic characteristics presented by the respondents – such as age, gender, employment, number of people in the household, education, income – and their satisfaction with using modern robo-advice technologies in personal finance and a computer program to monitor spending habits and suggest improvements.

In the authors's opinion, interesting conclusions can be drawn from analysis on the impact of psychological and cultural factors on the use of modern technologies to manage personal finances. For the issue in question, this represents a gap in research.

The study gives the following contribution to the literature on the subject: satisfaction with the use of modern technologies in planning personal finances on the example of robo-advice and home budget control depends on socio-demographic variables - age, (except for the control of the home budget by a computer program), income in the household, education, number of people in the household, forms of professional activity.

The direction that further research needs to take is to diagnose why consumers are more satisfied with the use of a computer program to analyse expenditure than with making investment decisions. The study has provided a rationale for analysing the relationship between personality, temperament, risk aversion, sense of security and style of spending.

5. Conclusion

Based on the empirical material collected, the International Survey – New Technologies 2019 found that the percentage of respondents indicating their satisfaction with using a computer program to analyse spending habits was higher than in the case of responses about the use of a computer program to make investment decisions on behalf of the consumer.

The analysis results of the Mann-Whitney U tests proved to be statistically significant, which means that there were indeed differences between Poland and the other countries in terms of accepting robo-advice to make investment decisions. Only between Poland, Italy and Spain were statistically significant differences not demonstrated. Countries with a higher level of acceptance for robo-advice given for investments included Turkey, the Czech Republic, Romania and the USA. The remaining countries had a lower acceptance rate for this robo-advice feature, with Austria and Luxembourg having the lowest. Based on the r strength of effect ratio, it can be stated that the strongest differences were observed between Poland, Australia and Luxembourg. All the analysis results yielded by the Mann-Whitney U tests proved statistically significant. Citizens of different nationalities differed in their willingness to let a computer analyse their expenditure. Turkey and Romania feature a higher level of acceptance than Poland of robo-advice for expenditure analysis. The inhabitants of Austria and Germany expressed the most reluctance to have a computer program give financial advice. H1 was confirmed.

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The results of correlation analyses showed that in most countries age was associated with less acceptance for a computer program to make investment decisions. The strongest relationship in this regard was in the case of the United Kingdom, followed by the USA and Australia. Also in most countries, the willingness for a computer program to make investment decisions was proportional to the number of people in the household, with the United Kingdom featuring the strongest relationship in this regard. For all analysed countries, correlation analyses showed that age is inversely proportional to the acceptance of a computer for analysing expenses and recommending improvements. The strongest relationships in this regard were also demonstrated in the United Kingdom, followed by the USA and Australia, with Turkey having the weakest correlation. Furthermore, in most countries, the higher the number of people in the household, the greater the willingness for a computer program to analyse spending habits and recommend improvements. This relationship was also the strongest in the case of the United Kingdom and the USA. H2 was found to be true.

Also in most countries, more people in the household translated into a greater willingness for a computer program to make investment decisions, with the United Kingdom featuring the strongest correlation in this regard. Additionally, in most countries the number of people in the household was proportional to the willingness for a computer program to analyse spending habits and recommend improvements. This relationship was also found to be the strongest in the case of the United Kingdom and the USA. H2 and H3 were confirmed.

The results of correlation analyses indicated that in most countries age was associated with less acceptance for a computer program to make investment decisions. The strongest relationship in this regard was found in the United Kingdom, followed by the USA and Australia. For all analysed countries, correlation analyses showed that as age increased, acceptance for a computer to analyse expenses and recommend improvements fell. The strongest correlations in this respect were also demonstrated for the United Kingdom, followed by Australia, with Turkey having the weakest. H4 was confirmed to be accurate.

The results of the Mann-Whitney U tests proved to be significant, which means the countries analysed featured differences between men and women in terms of their acceptance of robo-advice for investment. Such gender differences were not demonstrated in the case of Poland, the Czech Republic, Romania, Spain and Turkey. In all the remaining countries, men were more willing than women for a computer to make investment decisions on their behalf, with Germany and Austria having the largest gender divide. The results of the Mann-Whitney U tests were mostly irrelevant, which means that there were no differences between men and women in the analysed countries in terms of their acceptance of robo-advice for analysing expenses and recommending improvements. Such differences were only shown to apply to Germany, the Netherlands and Turkey. In the case of Germany and the Netherlands, men were more likely to have a computer analyse their expenses, while in the case of Turkey, women were more likely to do so. H5 was confirmed to be accurate.

The results of the Mann-Whitney U tests proved to be significant for the most part, meaning that the countries analysed featured differences between working and non-working people in terms of their acceptance of robo-advice for investment. Such differences were not found in the case of Poland, Austria, the Czech Republic, Luxembourg and Romania. In the remaining countries, it was demonstrated that working people were more favourably inclined towards robo-advice for investment while the largest differences were found in the United Kingdom. The results of the Mann-Whitney U tests in terms of robo-advice acceptance in the field of expenditure analysis again proved to be significant, which means that in the countries analysed there were differences between working and non-working people. Such differences were not revealed in the case of Poland, Austria, the Czech Republic and Romania. In the remaining countries, working people would be more likely to use robo-advice to

analyse spending and recommend improvement than non-working people. The greatest differences were also found in the United Kingdom. H6 was confirmed.

The research issues presented here are new, and the research results have practical significance and application value for entities offering automatic financial advice and household budget monitoring.

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