Evaluation of the Macro- and Micro-Economic Factors Affecting the Financial Energy of Households

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Abstract: This paper is an evaluation of the common macro-economic, micro-economic, and social factors affecting households' financial situations. Moreover, the author's objective was to develop a fuzzy logic model for forecasting fluctuations in the number of nonperforming consumer loans in a country using the example of Poland. This study represents one of the first attempts in the global literature to develop such a forecasting model based on macro-economic factors. The findings confirm the usefulness of the proposed innovative approach to forecasting the volume of household insolvencies in a country.

Keywords: economics of family; personal finance; financial energy; forecasting; bankruptcy of households; financial health; consumer finance; consequences of COVID-19

1. Introduction

The paper is an attempt to contribute to evaluating the macro- and micro-economic factors affecting the financial energy of households. Conceptualizing the term "financial energy of households," the author of this research aimed to capture the broad aspects of households' financial standing and the factors directly and indirectly affecting consumers' solvency. The paper is an investigation of the links between the economic and social factors determining households' financial situations and their vulnerability to changes in the macro-economic situation of their country.

It is important to study the vulnerabilities of the household sector for at least two reasons. First, the household sector holds the largest share of wealth in developed economies. As wealth is one of the most important factors in determining a household's consumption patterns throughout its lifecycle, the consumption decisions of households are influenced by their degree of solvency, thereby impacting overall economic activity. Second, vulnerable households pose a threat to a country's financial stability due to their tenuous ties to financial institutions [1].

The financial crisis from 2007–2012 and the current global coronavirus pandemic have dramatically increased the risk of consumer insolvencies throughout the world. Many households are reporting financial distress and feel constrained by debt repayment obligations. Financial distress is a state in which an individual is unable to maintain their customary standard of living [2,3]. This means that anyone, regardless of wealth or level of education, can become financially vulnerable. While there are extensive studies on the effects of gender, level of education, age, and cultural background on consumers' financial decisions [4–10], households' level of financial distress and the factors affecting it have received little attention. Therefore, the author of this study formulated three research questions:

- What are the main macro- and micro-economic factors affecting households' risk of insolvency?
- What macro-economic factors can enable effective forecasting of the changes in the volume of nonperforming consumer loans in the country?

- Is fuzzy logic an effective technique to forecast the changes in the macro-economic risk of nonperforming household loans?

Thus, the contribution of this paper complements the existing literature in an important fourfold manner. First, it is an evaluation of the micro-economic, macro-economic, and social factors affecting households' risk of insolvency. Second, the four most common consumer profiles from the perspective of the factors determining financial vulnerability are identified. Third, the influence of specific macro-economic variables on the volume of personal bankruptcies within a country is identified. Fourth, a fuzzy logic model is proposed for forecasting changes in the macro-economic risk of nonperforming household loans.

This research should enable scholars to better situate the phenomenon of consumer bankruptcies within the literature. It should also result in a better understanding of the process of becoming insolvent, and it includes practical solutions for identifying the volume of household bankruptcies while considering the macro-economic, micro-economic, and social factors affecting the phenomenon.

Scientifically, the term "bankruptcy", which has a pejorative connotation, can be replaced by terms such as "insolvency" and "low financial energy." During the last two decades, personal bankruptcies have become increasingly central to debates on poverty, inequality, and quality of life. Consumption, income, and wealth are three main measures of a household's economic situation and reflect the stability and strength of its finances. The advantage of using the consumption measure is that it not only captures the objective aspects of a household's economic condition but also involves a social and comparative component, which accounts for deprivation that is disproportionate to resources [11]. In turn, consumers' income directly affects their purchasing power and determines their creditworthiness, which indirectly influences their consumption choices. For many individuals, taking out a bank loan may be the only way to afford a house, car, or other amenities that are vital for a person's welfare. Therefore, consumers' consumption decisions are influenced by their households' degree of solvency. Such a multidimensional understanding of the financial energy of households fully reflects the economic resources of income and wealth along with the resources available for consumption under specific cultural and socio-economic conditions.

Besides micro-economic variables, the macro-economic and social factors affecting households' financial energy and the overall scale of bankruptcies within a country's economy are examined. The macro-economic environment influences the availability of loans and their cost to households, the degree of prosperity of consumers, and the stability of the labor market, which affects consumers' earnings prospects. Therefore, in this research, variables such as the unemployment rate, inflation rate, growth rate of the GDP, and interest rates are identified. In the case of social factors, there are two dimensions—objective and subjective. Among the subjective factors, we can identify a consumer's level of awareness of their financial vulnerability, the degree to which they pay attention to their finances, their level of self-control, and their degree of impatience within the context of a materialistic culture. These factors can be used to predict a person's pursuit of possessions and material goods in the hope of reaching a desired state [12]. Materialists believe that the acquisition of material goods is a prime indicator of success and a key to self-definition, happiness, and the achievement of life goals [13]. Among the objective variables, we can identify one's level of education, the condition of one's health, and even the possession of retirement investments and plans as influential.

This paper consists of five sections. In the introduction, the author provides the basis for exploring the topic, the study's objectives, and the study's contributions and innovations to the literature. Section 2 is a literature review covering the causes of household insolvency in various countries, including the USA, Malaysia, the UK, Lithuania, the Czech Republic, Germany, and Chile. Section 3 is an introduction to this study's assumptions. In Section 4, the author presents the conceptual framework for evaluating the risk factors for insolvency, and a forecasting model is constructed. Section 5 is the conclusion, with implications for policy-making efforts and future research.

2. Literature Review

The author of this paper studied the literature on the causes of financial distress in households in European, North and South American, and East Asian countries. The literature review showed that the causes of personal bankruptcy do not depend on the region where consumers are located. In Figure 1, a classification of causes that considers the influence of macro-economic, micro-economic, and social factors on personal bankruptcy risk is presented. The proposed classification considers the entire spectrum of factors leading to an increased risk of consumer bankruptcy as discussed in detail in literature review below.
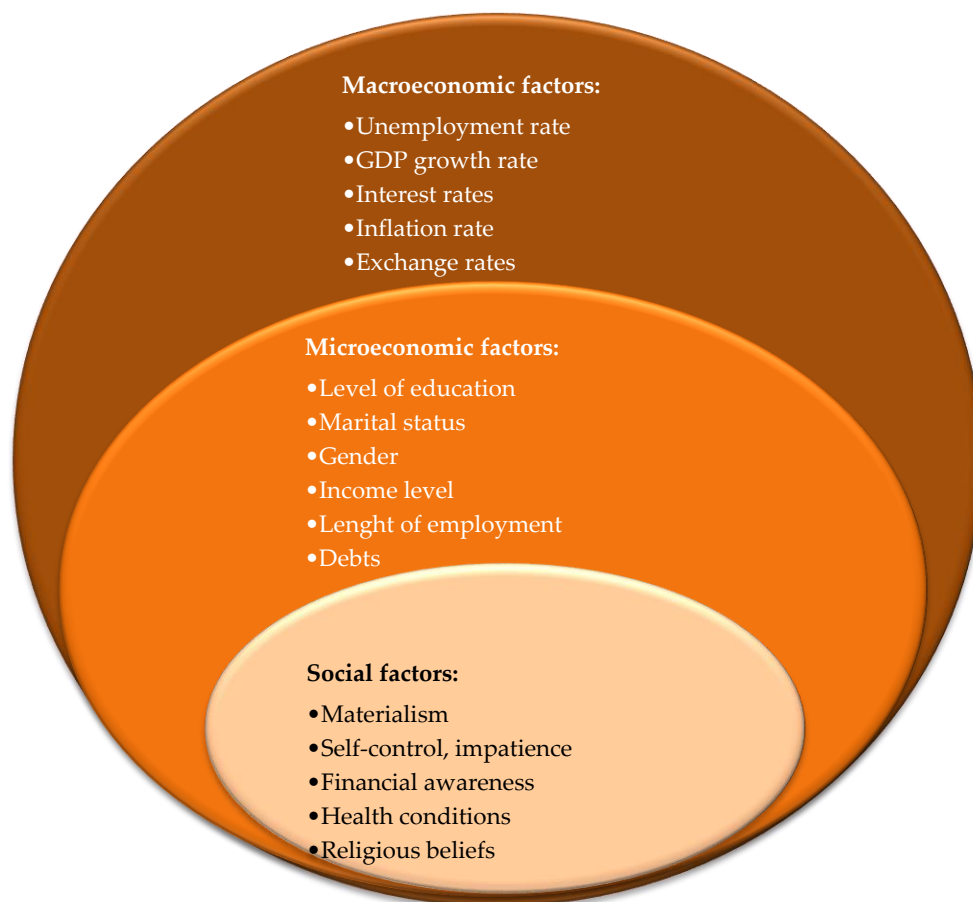

Macroeconomic factors:
- Unemployment rate
- GDP growth rate
- Interest rates
- Inflation rate
- Exchange rates

Microeconomic factors:
- Level of education
- Marital status
- Gender
- Income level
- Lenght of employment
- Debts

Social factors:
- Materialism
- Self-control, impatience
- Financial awareness
- Health conditions
- Religious beliefs

Figure 1. The classification of personal bankruptcy causes. Source: based on the author's own studies.

Generally, the causes of bankruptcy can be divided into two groups. The first consists of exogenous causes. These are the factors shaping the economic conditions affecting a country's households. Households do not have any influence over them and must adapt to the rules they are given for functioning within their country's economy. There is no doubt that the macro-economic situation directly affects the financial standing of consumers, as it influences the availability and cost of credit and the prospective income levels and wealth of households. The second group of causes of bankruptcies includes endogenous causes that can be divided into micro-economic and social factors. Both types of endogenous factors are shaped by the decisions of households, which is why it is important to identify them, as they can then be managed by consumers, leading to a reduced risk of insolvency. It is also important to note that both groups of risk factors overlap, as shown in Figure 1. The social factors are also overlapped by micro- and macro-economic factors, because in the majority of cases these factors are strongly influenced by the environment. The level of education of the consumer is correlated to financial awareness. The health condition of consumer can be shaped by such factors as age, gender, and to some extent even income

level. The level of debts can be affected by religious beliefs as proved in the literature review below.

The results of many studies (e.g., [14–18]) have confirmed the existence of a strong relationship between households' level of financial vulnerability and the unemployment rate, as increasing unemployment results in borrowers being unable to meet their repayment obligations. Shocks to the GDP are the second factor among the macro-economic variables affecting households' insolvency risk. They disrupt the sources of household income, which decreases households' ability to repay their debts. This condition gradually increases the probability of experiencing financial distress, causing foreclosures on the collateral used for securing bank credit, such as homes or cars [19–22]. The third macro-economic factor is the interest rate. When the lending rate increases, the cost of credit card payments, purchase loans, and personal loans also increases, becoming a significant financial burden for borrowers [21,23,24]. The inflation rate directly affects the interest rate, but by influencing the financial situation of enterprises, it can also affect the unemployment rate, as has been discussed [25,26]. The last, most common macro-economic variable affecting the global risk of personal bankruptcy is the exchange rate. The exchange rate clearly has a direct impact on the economic situation of enterprises (both exporters and importers), but it should also be noted that households are also under its influence, either directly (in case of, for example, incurring debts in foreign currencies) or indirectly (through increases in the cost of living in the case of countries dependent on imported goods, e.g., petrol or gas).

Social scientists have long been interested in the determinants of individuals' financial well-being [27]. Most studies have highlighted the following six factors, which are believed to have the biggest influence on an individual's risk of personal bankruptcy [28–33]: level of education, marital status, gender, income level, length of employment, and degree of indebtedness. Caputo [34] studied the influence of marital status and gender on households' risk of financial distress in the USA. He found that formerly married persons (i.e., those who had separated or divorced) were 3.6 times as likely to declare bankruptcy as married persons and that single persons were 4.4 times less likely to declare bankruptcy than married persons. In his study, it was also proven that women were more likely than men to declare personal bankruptcy between 1986 and 2004 in the USA. Traditionally, a person's level of education, income level, and degree of indebtedness have been studied in the literature, with there being clear evidence to support the influence of these factors on an individual's probability of declaring insolvency [35].

Financial vulnerability may also be driven by factors other than macro- and micro-economic ones, including materialism and lifestyle behaviors that may be induced by irresponsibility or short-sightedness on the part of consumers. These may, in turn, dramatically increase the risk of consumers declaring personal bankruptcy. Household attitudes and behavioral characteristics are known to be related to debt-related decisions (e.g., the likelihood of carrying debt and the amount of debt) [36]. For example, spending behaviors, compulsive shopping, saving for a goal, expectations about future income and the economy (e.g., the interest and inflation rates), and credit-related attitudes are commonly reported to be associated with debt-related decisions [36–38]. Among the social factors that may cause personal bankruptcy are health issues, as consumers are sometimes unable to cover huge medical expenses, forcing them to mortgage their homes [11]. Several studies have also been focused on specifically analyzing the relationship between religion and risk-taking attitudes. One of the latest studies conducted in Germany showed that religiously affiliated individuals were, in general, more risk-averse than non-religious people. Furthermore, it was proven that Muslims in Germany exhibited fewer risk-taking behaviors in general than Catholics and Protestants [39].

Nowadays, households encounter an environment characterized by a high level of financial complexity, which requires not only financial knowledge but also appropriate consumption decisions depending on both the macro-economic situation and the consumer's predisposition to make decisions that do not increase their risk of insolvency. Figure 2 presents the common profiles of consumers' financial risk behaviors. This classification

considers a broad spectrum of factors, from level of education, income, and marital status to impatience, snobbery, and financial literacy. Based on consumers' demographic resources (low vs. high) and consumption behaviors, such as self-control and financial awareness (low vs. high), four quadrants to classify the risk-taking behaviors of households were identified.
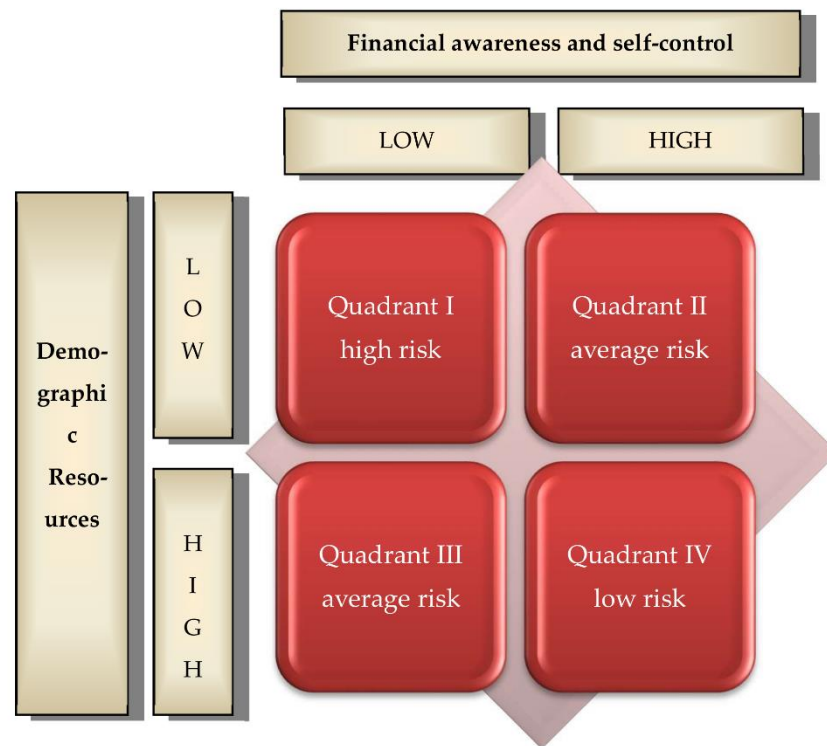

Figure 2. The common profiles of consumers' financial risk behaviors. Source: based on [17].

The first quadrant (Figure 2) represents the consumers burdened with high-risk behaviors. Such households are characterized, on the one hand, by low levels of financial awareness and self-control, and, on the other hand, by the availability of few demographic resources (e.g., poor education, low income, undesirable jobs, etc.). Thus, quadrant I represents the worst situation for consumers. The opposite of quadrant I is quadrant IV, which represents the group of households that is the least financially vulnerable. The consumers in this group are well-educated, high-income persons with good financial knowledge and reasonable, controlled attitudes toward consumerism.

Although the consumers who fall into quadrants II and III are not as risk-prone as those in quadrant I, these households are also of key interest for risk analysts because of the disconnect between their levels of financial literacy and demographic resources, which leads to moderately risky behaviors. For example, the consumers who fall into quadrant III lack financial awareness, which can present an increased risk of experiencing financial hardships regardless of their demographic status (e.g., level of education or income) because they have a low degree of self-control in the context of consumerism. In turn, the households classified as belonging to quadrant II may have an abundance of demographic resources, but they may still be subject to the risk of insolvency when they lack financial awareness of their uncontrolled consumption.

3. Research Assumptions and Forecasting Method

The objective of this research was to develop a model for forecasting changes in the volume of nonperforming consumer loans in the specific country studied. The analyzed country was Poland. The forecasting horizon spanned twenty years: from 2000 to 2020. The main limitation of this research was the prevalence of changes in personal bankruptcy

laws. In Poland, consumer bankruptcy legislation was only introduced in 2014. Thus, the definition of bankruptcy in this research was broadened to include so-called nonperforming loans. In banking, commercial loans are considered nonperforming if a borrower's payment is 90 days past due. Nonperforming loans are also a good measure of household insolvencies. Such a broad definition is often used in studies of countries where personal bankruptcy laws have recently been introduced.

To address the complexity of the households' insolvency phenomenon, in forecasting the financial risk of consumers, the methodology of fuzzy logic was chosen for the model's development.

Most of the methodologies in use nowadays, in all areas, must have advanced decision-rendering capabilities (e.g., engineering, finance, law, etc.). They must have the ability to provide an answer to a complex question. Some of them are based on classical (conventional) logic, which will always correspond to either affirmative or non-affirmative answers such as "white" or "black," "no" or "yes," "high" or "low," etc. These sets of answers are considered sets of truth values {0, 1} [40]. The idea behind the fuzzy logic theory is to replace the set of truth values {0, 1} with the entire interval (0, 1) as a practical approach to addressing a complex problem.

The fuzzy set of universe X is represented by a membership function that maps each element according to its degree of membership within the interval (0, 1). The membership function is a generalized form of the characteristic function, and it is associated with fuzzy logic. Considering the "high"/"low" example, a sentence in this universe according to the classical logic theory can have two possible values, but, using the fuzzy logic theory, the provided answer may have any of a large number of values, which are evaluated in the following manner: "how high/low regarding the highest/lowest value." The fuzzy sets, therefore, solve the problem of quantifying vague linguistic terms.

Membership functions can be present in any form and may be arbitrarily determined by the analyst. In the literature, the most common functions take one of three forms: triangular, trapezoidal, or Gaussian.

The general issues to be taken into consideration before designing a forecasting model based on fuzzy logic are as follows [40]:

- an expert is always needed in the design phase;
- using fewer rules makes it easier to understand the model's behavior;
- it is unnecessary to implement all the possible rules;
- the model may be fine-tuned by modifying the membership functions.

The developed model is based on five different entry variables and it forecasts the number of non-performing loans with the use of macro-economic factors. For each entry variable in the model, the author identified three fuzzy sets (which are subsets of a set of values of the entry variable) and their corresponding membership functions. The fuzzy sets and the thresholds for all the membership functions are presented in Table 1. It is important to note that the author developed the model using the entry variables in the dynamic form (the rate of change), not in the static form (the value of a variable during a specific period). There are two advantages to employing such a research approach. First, it increases the usefulness of the proposed model when discussing various countries. Most countries are characterized by varied combinations of economic conditions and of economic variables. Implementing the rate of change instead of using the static form of economic data increases the universality of the model. Second, the volume of personal bankruptcies is determined within a dynamic system. It is difficult to define a reference state that has been influenced by the static values of other economic variables. For example, the value of the interest rate itself at a specific moment may not influence changes in the volume of nonperforming loans, but an increase/decrease in interest rates can increase/decrease the macro-economic risk of consumer insolvencies. Thus, it is more reliable and representative of the actual situation to explore and forecast this phenomenon from a dynamic perspective. Figure 3 presents an example of fuzzy sets defined with membership functions for the growth rate of the GDP (variable "X4" in the model).

Table 1. The entry variables in the forecasting model. Source: based on the author's own studies.

| Symbol	Description of Variable	Thresholds for Individual Membership Functions
X1	The percentage change of interest rate	Membership functions and its values: -"Decrease"—Sigmoidal function: less than 0% (values less than −10% belong to the fuzzy subset "decrease" with the degree of membership of 1, values from −10% to 0% belong to both fuzzy subsets "decrease" and "steady"); -"Steady"—Gaussian function: from −10% to +10% (values from −10% to 0% belong to both fuzzy subsets "decrease" and "steady"; and values from 0% to 10% belong to fuzzy subsets "steady" and "increase"); -"Increase"—Sigmoidal function: more than 0% (values greater than +10% belong to the fuzzy subset "increase" with the degree of membership of 1, values from 0% to +10% belong to both fuzzy subsets "steady" and "increase")
X2	The percentage change of inflation rate	Membership functions and its values: -"Decrease"—Sigmoidal function: less than 0% (values less than −20% belong to the fuzzy subset "decrease" with the degree of membership of 1, values from −20% to 0% belong to both fuzzy subsets "decrease" and "steady"); -"Steady"—Gaussian function: from −20% to +20% (values from −20% to 0% belong to both fuzzy subsets "decrease" and "steady"; and values from 0% to +20% belong to fuzzy subsets "steady" and "increase"); -"Increase"—Sigmoidal function: more than 0% (values greater than +20% belong to the fuzzy subset "increase" with the degree of membership of 1, values from 0% to +20% belong to both fuzzy subsets "steady" and "increase").
X3	The percentage change of unemployment rate	Membership functions and its values: -"Decrease"—Sigmoidal function: less than 0% (values less than −10% belong to the fuzzy subset "decrease" with the degree of membership of 1, values from −10% to 0% belong to both fuzzy subsets "decrease" and "steady"); -"Steady"—Gaussian function: from −10% to +10% (values from −10% to 0% belong to both fuzzy subsets "decrease" and "steady"; and values from 0% to +10% belong to fuzzy subsets "steady" and "increase"); -"Increase"—Sigmoidal function: more than 0% (values greater than +10% belong to the fuzzy subset "increase" with the degree of membership of 1, values from 0% to +10% belong to both fuzzy subsets "steady" and "increase").
X4	GDP growth rate	Membership functions and its values: -"Decrease"—Sigmoidal function: less than 0% (values less than −2.4% belong to the fuzzy subset "decrease" with the degree of membership of 1, values from −2.4% to 0% belong to both fuzzy subsets "decrease" and "steady"); -"Steady"—Gaussian function: from −2.4% to +2.4% (values from −2.4% to 0% belong to both fuzzy subsets "decrease" and "steady"; and values from 0% to +2.4% belong to fuzzy subsets "steady" and "increase"); -"Increase"—Sigmoidal function: more than 0% (values greater than +2.4% belong to the fuzzy subset "increase" with the degree of membership of 1, values from 0% to +2.4% belong to both fuzzy subsets "steady" and "increase").
X5	The percentage change of exchange rate PLN/EUR	Membership functions and its values: -"Depreciation"—Sigmoidal function: less than 0% (values less than −15% belong to the fuzzy subset "decrease" with the degree of membership of 1, values from −15% to 0% belong to both fuzzy subsets "decrease" and "steady"); -"Steady"—Gaussian function: from −15% to +15% (values from −15% to 0% belong to both fuzzy subsets "decrease" and "steady"; and values from 0% to +15% belong to fuzzy subsets "steady" and "increase"); -"Appreciation"—Sigmoidal function: more than 0% (values greater than +15% belong to the fuzzy subset "increase" with the degree of membership of 1, values from 0% to +15% belong to both fuzzy subsets "steady" and "increase").
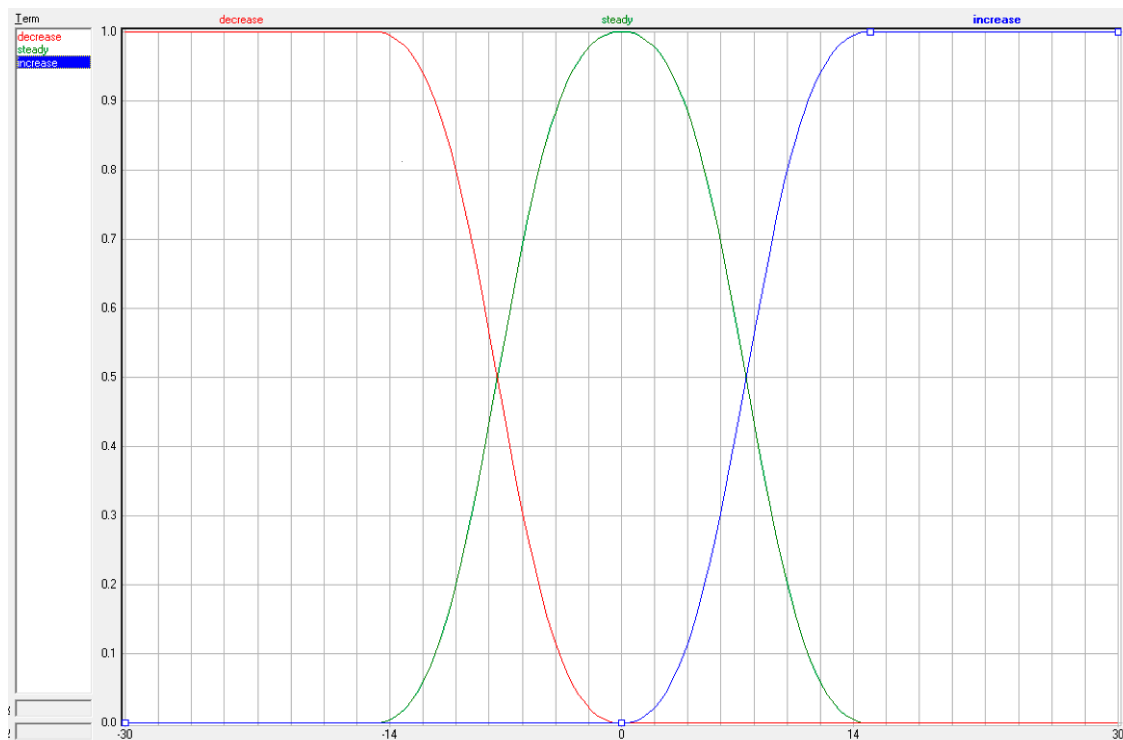
Figure 3. Fuzzy sets for the variable "X4"—the growth rate of the GDP with membership functions. Source: based on the author's own studies.

With such defined subsets, the boundary between the values believed to have a positive or negative effect on the volume of nonperforming loans is fuzzified—specific variable values are "partially positive" and "partially negative." There is no such possibility in the case of classical logic, which is bivalent.

The output of the model is a variable representing the forecast of trends in the volume of nonperforming loans (consumer insolvencies) in the country studied. This variable has a value from −30% to +30%, and it is represented by three membership functions (Figure 4):

- "Decrease"—sigmoidal function: under 0% (values under −15% belong to the fuzzy subset "decrease" with a degree of membership of 1; values from −15% to 0% belong to both the fuzzy subsets "decrease" and "steady");
- "Steady"—Gaussian function: from −15% to +15% (values from −15% to 0% belong to both the fuzzy subsets "decrease" and "steady"; values from 0% to +15% belong to both the fuzzy subsets "steady" and "increase");
- "Increase"—sigmoidal function: above 0% (values greater than +15% belong to the fuzzy subset "increase" with a degree of membership of 1; values from 0% to +15% belong to both the fuzzy subsets "steady" and "increase").

In other words, the function "increase" represents a worsening situation for the credit market, showing an increase in nonperforming consumer loans within a country. The function "steady" indicates the stabilization of the credit market, with a more-or-less stable risk of customer insolvencies. The function "decrease" represents an improvement in a country's situation from the perspective of the number of nonperforming loans and households at risk of bankruptcy.
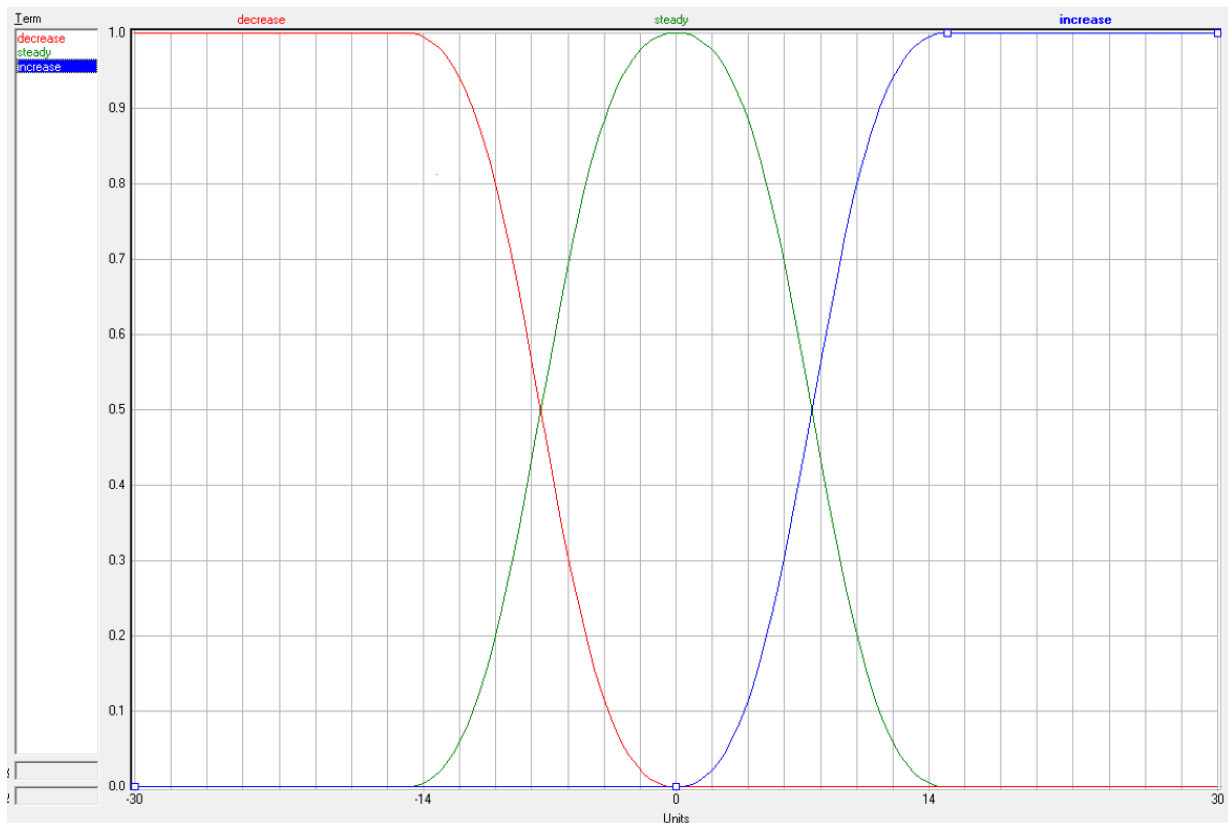
Figure 4. Defined membership functions for the variable "output" representing the forecast of the trends in the volume of nonperforming loans. Source: based on the author's own studies.

4. Results and Discussion

To conduct this study, the author programmed the fuzzy logic model with the structure presented in Figure 5. The model consisted of five inputs (the variables presented in Table 1) and one rule block where the set of decision rules was stored. The model's output was a variable representing a forecast of the fluctuations in the volume of nonperforming household loans within the country studied. The model was based on a set of rules written by the author in the form of "IF—THEN," in which expert knowledge was encapsulated. As there were five entry variables (X1, X2, X3, X4, and X5) with three possible states ("decrease," "steady," and "increase"), and there was a set of 243 possible decision rules. Due to space constraints, only the 30 most important decision rules are presented in Table 2.
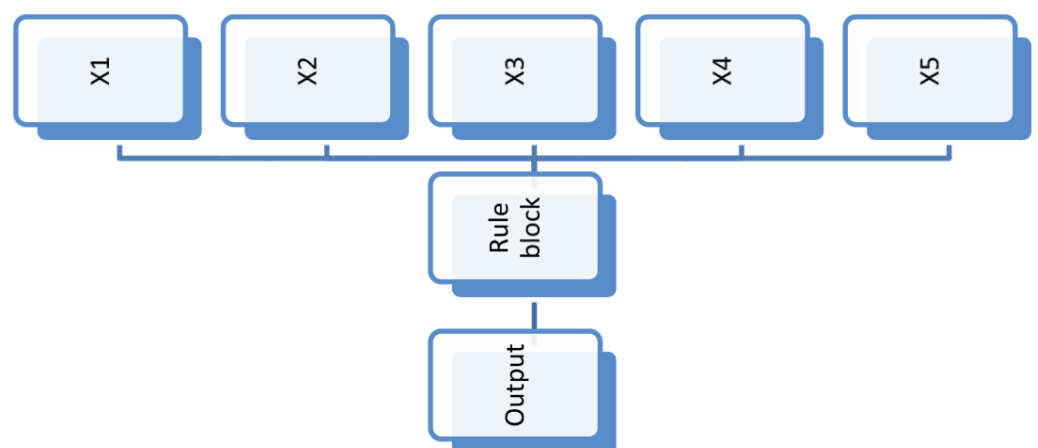

Figure 5. The structure of the fuzzy logic model. Source: based on the author's own studies.

Table 2. The exemplary set of decision rules of the fuzzy logic model. Source: based on the author's own studies.

No.	IF X1 Is	IF X2 Is	IF X3 Is	IF X4 Is	IF X5 Is	THEN Output Is
1	Increase	Increase	Increase	Decrease	Appreciation	Increase
2	Increase	Increase	Decrease	Increase	Depreciation	Decrease
3	Steady	Increase	Decrease	Increase	Steady	Decrease
4	Increase	Increase	Steady	Steady	Appreciation	Increase
5	Steady	Increase	Increase	Decrease	Appreciation	Increase
6	Steady	Steady	Increase	Decrease	Appreciation	Increase
7	Increase	Increase	Increase	Steady	Steady	Increase
8	Decrease	Decrease	Decrease	Increase	Steady	Decrease
9	Decrease	Decrease	Decrease	Steady	Steady	Decrease
10	Steady	Decrease	Steady	Increase	Depreciation	Decrease
11	Steady	Steady	Decrease	Steady	Steady	Steady
12	Steady	Steady	Steady	Steady	Depreciation	Steady
13	Steady	Steady	Steady	Increase	Appreciation	Steady
14	Steady	Steady	Steady	Steady	Appreciation	Steady
15	Increase	Steady	Decrease	Increase	Appreciation	Steady
16	Increase	Increase	Increase	Steady	Appreciation	Increase
17	Increase	Increase	Increase	Decrease	Depreciation	Increase
18	Increase	Increase	Steady	Decrease	Depreciation	Increase
19	Increase	Increase	Steady	Decrease	Appreciation	Increase
20	Increase	Steady	Increase	Steady	Appreciation	Increase
21	Decrease	Decrease	Decrease	Increase	Depreciation	Decrease
22	Decrease	Decrease	Decrease	Steady	Depreciation	Decrease
23	Steady	Decrease	Decrease	Increase	Steady	Decrease
24	Decrease	Decrease	Steady	Steady	Depreciation	Decrease
25	Decrease	Decrease	Steady	Increase	Steady	Decrease
26	Decrease	Steady	Steady	Decrease	Steady	Steady
27	Increase	Steady	Steady	Increase	Appreciation	Steady
28	Steady	Steady	Increase	Steady	Steady	Steady
29	Steady	Steady	Increase	Steady	Depreciation	Steady
30	Increase	Steady	Decrease	Steady	Deprecation	Steady

Based on the set of decision rules, the model was used to evaluate the country's macro-economic situation, which had a direct influence on households' credit-related decisions. There are five variables analyzed in the rule block, and the rules are constructed in consideration of the specific influence that each variable has on the risk of consumer insolvencies. An increase in the interest rate (variable X1) has a negative influence on consumers' degree of solvency. The bigger the increase in the interest rate is, the greater its negative influence on the volume of nonperforming consumer loans is (causing an increase in the number of such loans). In the same negative way, an increase in the inflation rate (variable X2) affects the output of a rule block. We must also remember that these two variables are very strictly dependent on each other. The third factor, changes in the unemployment rate (variable X3), negatively influences the financial situation of households as it increases. This variable often is negatively correlated with the fourth variable, which is the growth rate of the GDP. Variable X4 is believed to have a positive influence on the creditworthiness of households (the higher the increase in the GDP, the better). The last factor affecting the volume of nonperforming consumer loans in the country examined was fluctuations in the exchange rate. In this model, the fluctuation of PLN against EUR was represented. It was assumed that the appreciation of EUR against PLN would cause a higher risk of consumer insolvencies, as it could be expected to lead to an increase in the cost of living and is also often positively correlated with CHF. In Poland, there is a large group of consumers holding credits denominated in CHF, which has a direct, negative influence on their creditworthiness.

The author tested the developed fuzzy logic model using the data representing the fluctuations in the number of nonperforming household loans in Poland from 2000–2020. To evaluate the effectiveness of the model, two measures were considered—the mean absolute error (MAE) and mean absolute percentage error (MAPE). In Figure 6, the real and forecasted yearly fluctuations in the volume of nonperforming loans are presented. Based on the obtained data (Figure 6), the first measure (MAE) was 8.29%, and the second (MAPE) was 33.01%. The idea of using such a fuzzy logic model for predicting the macro-economic risk of consumer insolvencies in a country is a new development in the literature. Thus, the author could not find any data to compare with the obtained results; however, looking at Figure 6, it can clearly be seen that, during the entire analyzed period, the real and forecasted lines representing the percentage change in the number of nonperforming loans always conformed to the same positive/negative trend. This finding indicates that the model correctly predicted the trends in the volume of such loans in the country for all years. The observed MAE and MAPE values also made it possible to draw the conclusion that the errors generated were small and acceptable.
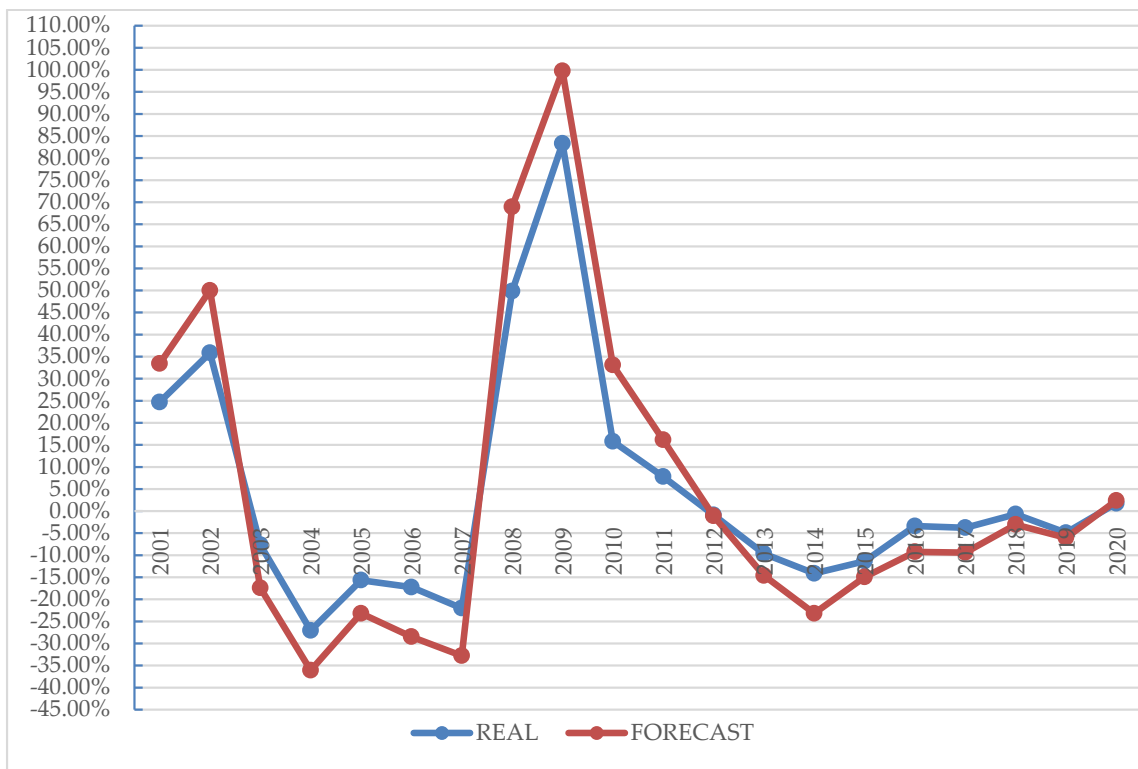

Figure 6. Yearly fluctuations in the volume of nonperforming loans in Poland (real versus forecasted). Source: based on the author's own calculations.

It is also worth underlining a few unique features of the proposed fuzzy logic model:

- it presents explicit knowledge;
- it has the ability to explain how to solve the problem (as opposed to the artificial neural network model that operates on a "black box" principle);
- it has the ability to solve problems not based on an algorithm written explicitly but using different methods of inference (reasoning); and it has the ability to use mainly the processing of symbols and, to a lesser degree, of numerical calculations.

Concluding the results and discussion, in the presented study there are three types of scientific deliberations that constitute direct contribution to the literature:

- theoretical discussion—the author presented an assessment of the main macro- and microeconomic factors affecting the risk of consumer insolvency and explained the

phenomenon of overlapping social factors. Based on these theoretical considerations, four common profiles of consumer behavior related to financial risk have also been proposed.

- methodological considerations—the author developed a forecasting model using fuzzy logic with explicit knowledge in the form of IF-THEN rules and the described membership functions for all used variables. The study also includes the identification of the most predictive macroeconomic factors.
- application considerations—as a final result of this study, the presented model can be used by managers, bankers, financial analysts, researchers, students, etc. The presented study allows readers to freely use the model in other countries.

5. Conclusions

In this paper, a novel approach to evaluating the macro-economic, micro-economic, and social factors affecting the financial situations of households worldwide was presented. Based on a review of the literature, the study's author identified the common factors affecting consumers' risk of insolvency and proposed that there were four common profiles of consumers' financial risk behaviors.

Moreover, in the present study, the author developed a fuzzy logic model that could be used for forecasting the fluctuations in the number of nonperforming loans in a specific country, using the example of Poland. It is worth highlighting that the forecasting methodology of fuzzy logic that was used was employed in an open application form that allows users to modify the model according to their needs; for example, the model could be used for a different country while taking into account various fluctuations in exchange rates or while adding a new variable that could influence the macro-economic risk of household insolvencies.

This study is one of the first attempts in the literature to forecast this phenomenon from the macro-economic perspective. The main limitation of the research is the prevalence of changes to consumer bankruptcy laws, which have made it impossible to thoroughly analyze the number of bankruptcies, as such data tend to be strongly affected by legal modifications. This limitation presents a complication when attempting to construct forecasts for this phenomenon. The author is going to continue the research towards the use of macro- and micro-economic factors combined into one early warning system. Such system will enable the prediction of not only the effect, namely the risk of bankruptcies of households (in annual terms), but also the reasons affecting the number of bankruptcies of consumers (for example, level of unemployment, exchange rates in the case of borrowers with debts in foreign currencies, etc.).

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