COMPUTER DATA ANALYSIS AIMED AT CONSTRUCTING A MODEL OF ESTABLISHING THE FACTORS WHICH DETERMINE HOUSEHOLD SAVINGS IN THE REPUBLIC OF CROATIA*

Darko Dukić, D.Sc.
Gordana Dukić, D.Sc.
ABACUS tuition, research and business consultancy, Osijek

Davorin Turkalj, B.Sc.
Faculty of Agriculture in Osijek

ABSTRACT

Examining the relationships between different economic variables has been significantly simplified through the usage of computer analysis. What used to be very complex procedures requiring considerable finances and amounts of time are now greatly reduced thanks to computer technology and adequate software applications. In addition, advances in communication and development of computer networks have provided universal interconnectedness, and thus also permanent accessibility of different data necessary for conducting economic analyses. In this way business entities and macroeconomic policy makers are able to react in a timely manner to changes in the environment, and thus make decisions based on relevant indicators. This paper intends to demonstrate how computer analysis can be applied to construct a model for establishing the factors which determine household savings in the Republic of Croatia. Time and savings deposits of households are an important economic category. They are the source of funds used for loans to both households and businesses. To establish the factors with the heaviest impact on household savings multiple regression analysis was used. In this paper special attention was given to the possibilities of the software package *STATISTICA 6.0* intended for solving various statistical problems.

Key words: computer data analysis, model, relevant variables, time and savings deposits of households, multiple regression analysis

---

1. INTRODUCTION

In economic theory, household (private) savings are defined as the difference between disposable income and consumption. In this context, disposable income can be simply determined as the difference between gross domestic product and taxes. Private savings are treated as one of the major model variables in macroeconomic research. Time and savings deposits of households are not only sources of funds for extending loans to individuals; they are also the basis for investment into the business sector. This indicates the dual role of household savings. In the short run, they aid the growth of gross domestic product through increases in private and investment spending, whereas in the long run it is clear that economic growth is possible only with investments, which are funded by savings.

Deposit business belongs to passive banking business. The banking sector's interest is to market the funds obtained through savings as loans, and to increase its profits by keeping the difference between interest rates on loans and deposits. One consequence of such endeavours is the increase in loans extended by the banks to finance unproductive spending. Excessive debt incurrence without economic justification can bring about negative cyclical movements and result in serious macroeconomic instabilities when a significant number of debtors are incapable of repaying their debts. One should also consider the fact that the credit activity of banks has a direct impact on money supply and the occurrence of inflationary pressures. A particular problem is the foreign debt increase stimulated by the banking sector. These tendencies are a result of money shortage on domestic financial markets, i.e. increased demand for credit. In conclusion, mobilization and concentration of free financial assets is a basis for developing the financial potential required for business expansion. On the other hand, uncontrolled credit expansion can have far-reaching consequences.

In the total supply of time and savings deposits the biggest share is accounted for by household savings. Their detailed interpretation is therefore necessary to fully understand overall economic processes. For a correct assessment of the character and dynamics of household savings macroeconomic policy makers need to determine the variables having the strongest influence in this area. Bank management also needs to identify the factors which determine household savings, and to establish to what extent a particular factor is influential. With this knowledge it will be possible to take timely measures to ensure sufficient supply of deposited funds required for normal functioning of an economy.

A proper analysis of the above issues would be very difficult without computers and appropriate software. They allow us to make a relatively simple assessment and evaluation of structural parameters, as well as to test the model for adequacy. The model formulated in this paper is founded on computer data analysis, and is thus the basis for a systematic and continuous examination of the factors which determine household savings.

2. TIME AND SAVINGS DEPOSITS WITH BANKS

In the framework of their passive business, banks mobilize free assets from other sectors functioning within a national economy. It is customary to make a distinction between kuna deposits and foreign currency deposits collected in this manner. It should be noted that foreign currency savings deposits are all foreign currency sight deposits and foreign currency payment instruments issued. Foreign currency time deposits also include foreign currency notice deposits.

Table 1 lists the data on time and savings deposits with banks in the Republic of Croatia, broken down by sectors, on 30 September 2006.

Table 1: Time and Savings Deposits with Banks in the Republic of Croatia by sectors on 30 September 2006

SECTOR	TIME AND SAVINGS DEPOSITS WITH BANKS (million kuna)			
	Kuna deposits	Foreign currency deposits	Total	Share (%)
1. Savings deposits	2877.02	23790.69	26667.71	20.31
1.1. Local governments	3.50	16.84	20.33	0.02
1.2. Enterprises	193.06	4861.86	5054.92	3.85
1.3. Households	2676.36	18527.27	21203.63	16.15
1.4. Other banking institutions	-	171.55	171.55	0.13
1.5. Non-banking financial institutions	4.11	213.17	217.28	0.17
2. Time and notice deposits	43278.78	61382.35	104661.13	79.69
2.1. Local governments	1008.94	1.98	1010.93	0.77
2.2. Enterprises	14708.81	6336.55	21045.36	16.02
2.3. Households	22049.90	53859.99	75909.90	57.80
2.4. Other banking institutions	1581.11	241.10	1822.21	1.39
2.5. Non-banking financial institutions	3930.02	942.73	4872.75	3.71
Total (1+2)	46155.80	85173.04	131328.84	100.00

Sources: *"Time and Savings Deposits with Banks", http://www.hnb.hr;*
                 "Foreign Currency Deposits with Banks ", http://www.hnb.hr.

The presented data indicate that time and savings deposits of households accounted for as much as 73.95% of total assets mobilized by banks in this form on the domestic financial market. The household sector is followed by companies which account for a 19.87% share. All the other sectors held only 6.18% of the total amount of time and savings deposits. All this makes it clear that household savings are essential for normal functioning of an economy.

3. FORMULATING A MODEL FOR ESTABLISHING THE FACTORS WHICH DETERMINE HOUSEHOLD SAVINGS IN THE REPUBLIC OF CROATIA

In formulating a model for establishing macroeconomic variables with the greatest influence on household savings in Croatia it is possible to identify several basic phases. These phases are given in the diagram below.

Figure 1: Phases in constructing a model for establishing the factors which determine household savings in the Republic of Croatia
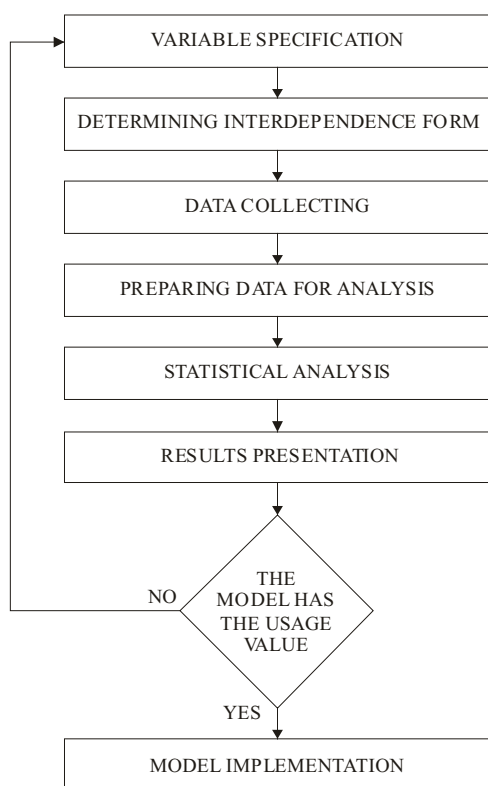
In the first phase of model construction we need to specify all the variables which are relevant in examining the factors of household savings. Here we need to make a distinction between the dependent (response) variable and independent (predictor) variables.

In the second phase it is necessary to establish the interdependence patterns connecting

the variables included in the model. Taking into account that the dependent variable varies with respect to the changes in values of independent variables, such interdependence in this analysis can be defined as stochastic, although the deterministic component is an integral part of the model. It will furthermore be assumed that the relation obtaining between the dependent variable and independent ones has a linear character.

Once the interdependence forms have been established, we begin with data collection. The data required for our analysis can be extracted from the publications produced by some state institutions, in particular the Croatian National Bank, the Central Bureau of Statistics and the Ministry of Finance. Thanks to the development of information and communication technologies all this information has in recent years become available through the Internet as well. Nevertheless, it should be pointed out that the lack of certain indicators which might be relevant for examining the present economic issue requires further investments into improvements of both methodology and data collection system.

The next step in formulating the model is preparing the data for analysis. In this phase it is crucial to align chronologically the values of all the variables included in the model, and, where necessary, to make the calculations required to obtain data which are suitable for analysis. This kind of data organization has been significantly improved and accelerated through appropriate software applications.

Statistical analysis of data in this paper includes correlation analysis and multiple regression analysis. Possibilities of the software package *STATISTICA 6.0* in the assessment and testing of significance of unknown parameters will be emphasized below.

The obtained research results need to be presented in an appropriate form, and then be used to conclude whether the model has a usage value. If the model turns out to be inadequate in any way, it has to be modified. On the other hand, an appropriate model can become the basis for permanent examination of the factors which determine household savings in the Republic of Croatia.

The facts stated above lead us to the conclusion that computer analysis of data is an essential element in the process of constructing and implementing the proposed model. Without computer analysis it would be impossible to ensure permanent monitoring and evaluation of macroeconomic variables assumed to have an impact on household savings.

4. RESULTS OF THE ANALYSIS

The first step in the model construction is to identify all the relevant variables assumed to have an impact on time and savings deposits of households, which is the dependent variable (DV). In this paper we have analyzed the position of time and savings deposits,

expressed in millions of kuna, at the end of every month under observation.

On the basis of the available data, this research has identified 5 independent variables:

- geometric mean of weighted averages of monthly banks' interest rates on kuna and foreign currency household deposits, in percentage on annual basis (*IV1*);
- average monthly net wages in current prices, in kuna (*IV2*);
- month-on-month rate of change of retail price indices, i.e. consumer price indices, in percentage (*IV3*);
- midpoint exchange rates HRK/EUR of the Croatian National Bank - monthly average (*IV4*);
- primary liquidity ratio, in percentage (*IV5*).

In determining the geometric mean of weighted averages of monthly interest rates, their relative significances determined for the last report period were used as ponders. Because of the lack of adequate data, the relative significance determined for one period was projected on interest rate values for all the months included in the research.

It should be noted that in the analysis for the period until December 1997 we used the data referring to retail price indices, whereas afterwards consumer price indices were used.

The variable which denotes the primary liquidity ratio of banks was included in the model because it was necessary to assess the banking system security. By introducing this variable we tried to establish whether bank liquidity influences the level of savings. Primary liquidity ratio presenting percentage of monthly day-to-day kuna free reserves averages in monthly day-to-day averages of deposits which constitute the reserve base.

The analysis covers a time series with 135 values of each variable included in the model (data for the period from July 1995 until September 2006). Due to limited space, Table 2 contains only some of the variable values.

Table 2: Selected data referring to the dependent variable and independent variables

MONTH/ YEAR	DV	IV1	IV2	IV3	IV4	IV5
07/1995.	10080.03	4.96	1798.0	0	6.7138	0.38
12/1995.	12741.04	4.59	1883.0	0.2	6.8122	0.63
12/1996.	20472.68	2.27	2217.0	0	6.8636	2.63
12/1997.	30543.74	2.91	2544.0	0.7	6.9472	2.92
12/1998.	37087.26	3.23	2935.0	0.3	7.3291	1.65
12/1999.	35913.26	2.75	3262.0	0.6	7.6791	1.30
12/2000.	44276.81	1.62	3499.0	0.4	7.5983	3.32
12/2001.	67660.04	1.24	3582.0	0.4	7.3700	3.23
12/2002.	67486.59	0.96	3839.0	0.4	7.4423	3.53
12/2003.	72978.58	0.69	4045.0	0.3	7.6469	0.98
12/2004.	79856.74	0.69	4312.0	0.7	7.6712	2.64
12/2005.	88612.85	0.57	4473.0	0.5	7.3756	0.96
09/2006.	97113.52	0.53	4542.0	0	7.3818	0.32

Sources: *"Time and Savings Deposits with Banks", http://www.hnb.hr;*
"Foreign Currency Deposits with Banks", http://www.hnb.hr;
"Banks' Interest Rates on Kuna Deposits Indexed to Foreign
Currency and on Foreign Currency Deposits", http://www.hnb.hr;
"Average Monthly Net Wages", http://www.hnb.hr;
"Prosječne mjesečne isplaćene neto plaće zaposlenih za rujan 2006.", http://dzs.hr;
"Consumer Price and Producer Price Indices", http://www.hnb.hr;
"Midpoint Exchange Rates of the Croatian National
Bank (period average)", http://www.hnb.hr;
"Banks' Liquidity Indicators", http://www.hnb.hr.

To establish the direction and strength of the relations obtaining between the analyzed variables, we first determined the Pearson correlation coefficients. In addition to their values, Table 3 contains the associated p-levels obtained through testing the hypothesis on significance of the calculated correlation coefficients.

Table 3 :Correlation coefficients between analyzed variables with related p-levels obtained when testing their significance (marked correlations are significant at p <0.05)

|	DV	IV1	IV2	IV3	IV4	IV5
DV	1.000	**-0.915** **p=0.000**	**0.972** **p=0.000**	-0.147 p=0.089	**0.561** **p=0.000**	-0.093 p=0.283
IV1	**-0.915** **p=0.000**	1.000	**-0.917** **p=0.000**	0.158 p=0.068	**-0.579** **0.000**	-0.103 p=0.236
IV2	**0.972** **p=0.000**	**-0.917** **p=0.000**	1.000	-0.152 p=0.079	**0.687** **p=0.000**	-0.093 p=0.286
IV3	-0.147 p=0.089	0.158 p=0.068	-0.152 p=0.079	1.000	-0.025 p=0.770	-0.033 p=0.704
IV4	**0.561** **p=0.000**	**-0.579** **p=0.000**	**0.687** **0.000**	-0.025 p=0.770	1.000	-0.079 p=0.364
IV5	-0.093 p=0.283	-0.103 p=0.236	-0.093 p=0.286	-0.033 p=0.704	-0.079 p=0.364	1.000

The obtained results lead to the conclusion that there is a very strong negative relation between the dependent variable and average interest rates on time and savings deposits of households (IV1). Even with the reduction of interest rates, time and savings deposits of households have been increasing in the observed period. These trends can be partly explained by the absence of a developed capital market where asset surpluses could be invested, but also by the fact that Croatian citizens still prefer traditional investment routes. There is a strong positive relation between time and savings deposits on the one hand, and average monthly net wages (IV2) on the other, which was to be expected. According to the calculated correlation coefficient, there is a moderate positive relation between dependent variable and monthly average HRK/EUR exchange rates (IV4). It follows that the strengthening of Euro stimulates the growth of time and savings deposits of households.

A strong negative relation was observed between average interest rates on time and savings deposits of households (IV1) and average monthly net wages (IV2). A statistically significant negative relation of moderate strength was found between independent variables IV1 and IV4. The only other instance of statistically significant positive relation of moderate strength was confirmed between independent variables IV2 and IV4.

The above results are presented in the software package STATISTICA 6.0 in the format shown in Figure 2.

Figure 2: Presentation of the correlation analysis results in the software package STATISTICA 6.0
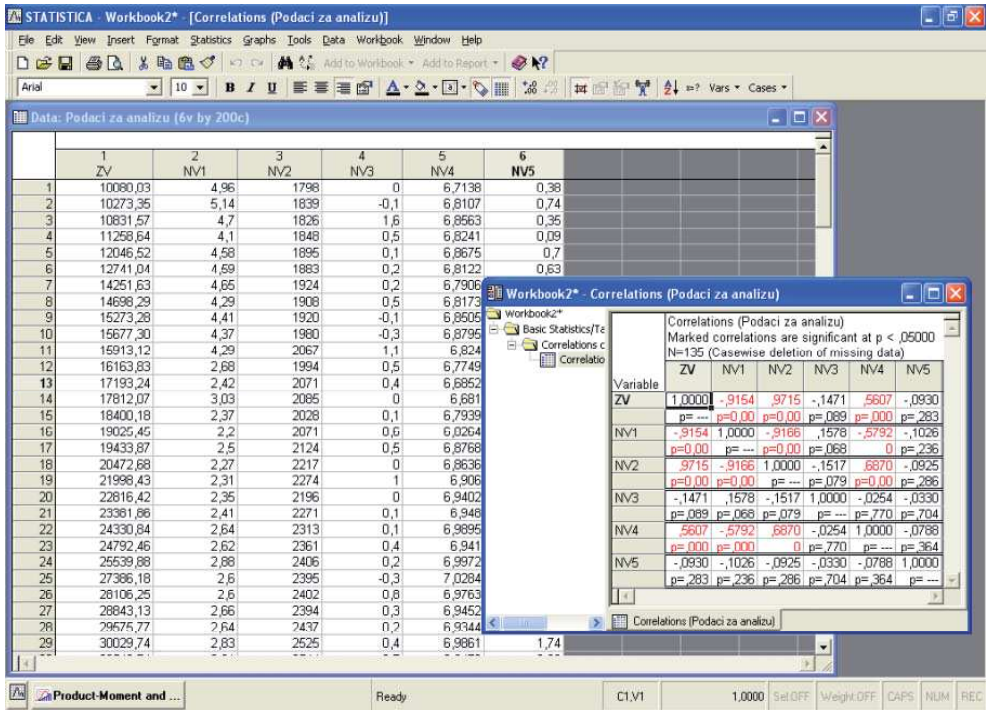
Table 4: Basic results of multiple linear regression analysis of dependent variable presenting times and savings deposits of households in the Republic of Croatia depending on five identified independent variables

MULTIPLE CORRELATION COEFFICIENT (R)	MULTIPLE COEFFICIENT OF DETERMINATION (R^2)	ADJUSTED MULTIPLE COEFFICIENT OF DETERMINATION ($\overline{R}^2$)	STANDARD ERROR OF ESTIMATE
0.984	0.968	0.967	4472.0

The basic results of multiple regression analysis (coefficient of multiple correlation, coefficient of multiple determination, adjusted coefficient of multiple determination and standard error of estimate) are given in Table 4.

Table 5: The multiple regression summary for response variable presenting times and savings deposits of households in the Republic of Croatia depending on five identified predictor variables (regression coefficients of marked variables are significant at p<0.05)

CONSTANT AND VARIABLE	β	SEE (β)	B	SEE (B)	t-value	p-level
CONSTANT			**79310.822**	**12683.258**	**6.253**	**0.000**
IV1	**-0.132**	**0.046**	**-2675.659**	**920.904**	**-2.905**	**0.004**
IV2	**0.983**	**0.050**	**28.802**	**1.478**	**19.481**	**0.000**
IV3	0.017	0.016	861.450	817.744	1.053	0.294
IV4	**-0.193**	**0.022**	**-16178.669**	**1864.371**	**-8.678**	**0.000**
IV5	-0.030	0.018	-575.089	341.553	-1.684	0.095

The coefficient of multiple correlation shows that there is a very strong correlation between the observed response variable and five predictor variables. According to the coefficient of multiple determination, the applied model of multiple linear regression managed to interpret 96.8% of total variations. Only slightly different is the value of adjusted coefficient of multiple determination. Both results indicate that the model used here is highly representative and confirm the hypothesis that there is a linear relation between the analyzed variables.

Table 5 shows the multiple regression summary for dependent variable (standardized coefficients of regression β, their standard errors of estimate (SEE), non-standardized coefficients of regression B, their standard errors of estimate (SEE) and t-values with related p-levels obtained when testing their significance).

The constant in the determined regression equation has the value 79310.822 million kuna. It shows how high the predicted value of the dependent variable would be if all the independent variables were 0. This parameter has no practical significance in this model.

On the basis of the calculated regression coefficient *B* standing next to the independent variable IV1 it can be concluded that during the analyzed period, under the condition that other independent variables remain unchanged, the increase of weighted average of monthly interest rates (expressed annually) by 1% resulted in the average decrease of time and savings deposits of households by 2675.659 million kuna. Under the same condition, the increase of average net monthly wages (IV2) by 1 kuna increased time and savings deposits on average by 28.802 million kuna. The increase of monthly average midpoint exchange rates HRK/EUR by 1 kuna, under the condition that other independent variables remain unchanged, resulted in the average decrease of total time and savings deposits by 16178.669 million kuna in the analyzed period. It follows from the above that the results of multiple regression analysis deviate from the results obtained for this variable in correlation analysis.

The calculated t-values and p-levels lead us to the conclusion that independent variables representing month-on-month rate of change of retail price indices, i.e. consumer price indices (IV3) and banks' primary liquidity ratios (IV5) are not statistically significant for explaining the dependent variable variations. They can therefore be taken as superfluous in the model. If we those two variables, we get a reduced form of the model expressed by the following regression equation:

$$DV = 79310.822 - 2675.659IV1 + 28.802IV2 - 16178.669IV4 \ .$$

To facilitate comparison and comprehend the relative importance of regression coefficients included in the model, the standardized coefficients of regression β are presented in a standardized form. According to the standardized coefficients of regression, the variable representing average monthly net wages (IV2) is the most important predictor of total time and savings deposits of households in the Republic of Croatia. It is followed by the variables defined as monthly average midpoint exchange rates HRK/EUR (IV4), and weighted averages of monthly interest rates on time and savings household deposits in kuna and foreign currency (IV1).

The next figure illustrates how multiple regression analysis is carried out in the software package *STATISTICA 6.0*.
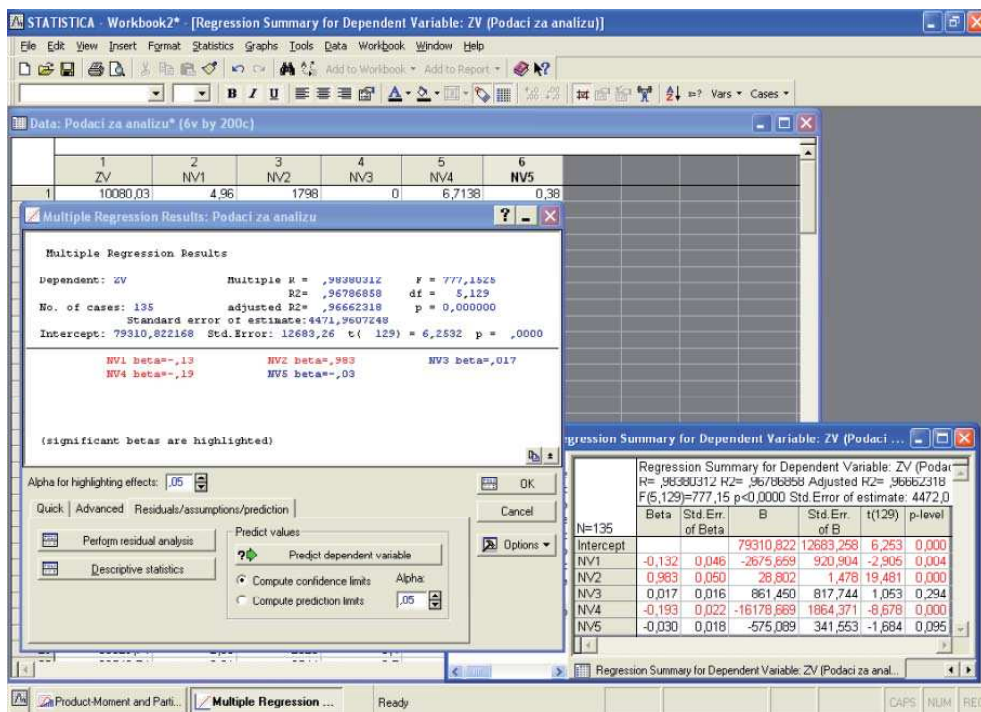
The statistical software package *STATISTICA 6.0* offers a wide range of possibilities for exploring the relations between variables in the framework of multiple regression analysis, but they cannot be presented in this paper owing to the its limited scope. Within its multiple regression analysis module the software package *STATISTICA 6.0* provides the option of determining the table Analysis of Variance, descriptive statistics, partial and semi-partial correlation coefficients, covariances of regression coefficients and indicators of redundancy of independent variables. There are especially numerous possibilities of analyzing the relations of predicted and observed values, and of residuals. Within this option there is a choice of different graphic presentations. In addition to some other features, their numerousness and flexibility are what made the software package *STATISTICA* very popular with users.

5. CONCLUSION

Conducting serious statistical research in today's circumstances is virtually unthinkable without computers and adequate software. Computer data analysis has thus become a basic prerequisite for constructing different economic models. The model for establishing the factors which determine household savings in the Republic of Croatia, as described in this paper, is also founded on computer data analysis. It is prominent not only within statistical analysis, but also in the phases of data collection, preparing the data for analysis, and presenting the research results.

To illustrate particular aspects of implementing computer analysis in model development we have used in this paper the statistical programme package *STATISTICA 6.0*. This software application is an integral system for statistical and graphic data analysis. It allows for numerous manipulations of the entered data, and moreover, it supports the conversion of other standard formats (Microsoft Excel, dBASE, SPSS Portable, Lotus/Quatrro, Text, HTML and Rich Text Files).

The proposed model, whose usage value was confirmed by the analysis of real data, makes it possible to determine the major factors of household savings in the Republic of Croatia. Regression analysis has shown that in the period between July 1995 and September 2006 total times and saving deposits of households were influenced most significantly by the changes in net wages, monthly average midpoint exchange rates HRK/EUR, and weighted averages of monthly interest rates on time and savings household deposits. In contrast, month-on-month rate of change of retail price indices, i.e. consumer price indices and banks' primary liquidity ratios were not shown to be statistically significant predictors of the dependent variable.

The model presented in this paper is a basis for identification and systematic monitoring of factors which determine household savings in the Republic of Croatia. If the model is proved inadequate by future research, it will have to be modified. In this respect it

is necessary to ensure a proper information basis on which such modifications can be founded.

REFERENCES

▪ Blanchard, O.: Makroekonomija, Treće izdanje, prijevod, Mate, d.o.o., Zagreb, 2005.

▪ Haag, S., Cummings, M., McCubbrey, D.J.: Management Information Systems for the Information Age, Third Edition, McGraw-Hill/Irwin, Boston, 2002.

▪ Mankiw, N.G.: Macroeconomics, Fifth Edition, Worth Publishers, New York, 2003.

▪ Spiegel, M.R., Stephens, L.R.: Statistics, Third Edition, McGraw-Hill, New York, 1999.

▪ Van Horne, J.C.: Financijsko upravljanje i politika (Financijski menedžment), Deveto izdanje, prijevod, Mate d.o.o., Zagreb, 1993.

▪ "Average Monthly Net Wages", *http://www.hnb.hr*

▪ "Banks' Interest Rates on Kuna Deposits Indexed to Foreign Currency and on Foreign Currency Deposits", *http://www.hnb.hr*

▪ "Banks' Liquidity Indicators", *http://www.hnb.hr*

▪ "Consumer Price and Producer Price Indices", *http://www.hnb.hr*

▪ "CNB Bulletin - Notes of Metodology", *http://www.hnb.hr*

▪ "Foreign Currency Deposits with Banks", *http://www.hnb.hr*

▪ "Midpoint Exchange Rates of the Croatian National Bank (period average)", *http://www.hnb.hr*

▪ "Prosječne mjesečne isplaćene neto plaće zaposlenih za rujan 2006.", *http://dzs.hr*

▪ "Time and Savings Deposits with Banks", *http://www.hnb.hr*