GAME THEORY IN THE ANALYSIS OF MONETARY AND FISCAL POLICY ON THE EXAMPLE OF REPUBLIC OF CROATIA

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ABSTRACT

The paper explored the interaction of monetary and fiscal policy through game theory. In the first part of the paper it isin short presented theoretical basis of fiscal and monetary policy, and then explained the theoretical part of game theory also in short. After theoretical part, the analysis was conducted based on the collected data and then the results of the paper are presented. A function of payments for monetary and fiscal policy have been created on the basis of data inflation, unemployment rate, total liquidity and the rate of government spending in the Republic of Croatia. Multiple linear regression, which is processed using software solutions Eviews, derived parameters for independent variables. In this way, holders of monetary and fiscal policy can decide on quantities of independent variables, and based on that, determine their strategy. The obtained result, based on the functions of payments for monetary and fiscal policy, generated the matrix of payments. Solving the matrix of payments resulted with non-dominated solutions. For solving the problem, PROMETHEE method has been applied. Analysing the game by using the PROMETHEE method, it generated optimal solutions in terms of assumption when a greater impact on the economy, in this case on the inflation and unemployment, has the fiscal policy and in terms of assumption when a greater impact on the economy has monetary policy. As the optimal results we obtained only two strategies although the game has been repeated in many stages.
Key words: monetary policy, fiscal policy, game theory, PROMETHEE method

INTRODUCTION

Game theory represents strategic interaction between two or more subjects. It was developed by the mathematicians but it is applicable not only on mathematical sciences but also on others science. For example evolutionary biologists have a rich tradition of borrowing analytical tools from economists to address a diverse array of problems in nature (Sherlin, 2012). Most famous example in game theory might be prisoner's dilemma, where focus is on the interactions between two prisoners. Both prisoners are faced with few scenarios depending on strategies they will choose.

This paper researched interaction between fiscal and monetary policy within the frame of game theory and preference ranking method. In the first part of the paper it is represented theoretical part of the monetary and fiscal policy. After that, terminology used in game theory approach and will be shown.

Data collected will be processed and presented in the part with numerical part of the paper. Numerical approach is consisting form two smaller parts. Reason for that lies in the dominant strategies in both players, monetary and fiscal authority. Such a dominant strategies enabled finding the equilibrium. Second part of the numerical approach consists of the PROMHETHEE method. In the last part the results and conclusion are shown.

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MONETARY AND FISCAL POLICY AND GAME THEORY

Monetary and fiscal Policy

In the simplest way explained, monetary policy is how central banks manage liquidity to create economic growth (Amadeo, 2017).Implementation of the monetary policy is carried on by the central bank. There are two types of monetary policy: expansionary and restrictive monetary policy. Expansionary monetary policy is when a central bank uses its tools to stimulate the economy which increases the money supply, lowers interest rates, and increases aggregate demand (Amadeo, 2016). Restrictive monetary policy means low money supply in the financial system and that has the opposite effects on the economy unlike the expansionary monetary policy. In this paper main assumption is, when it comes to function of payments for monetary policy, that total liquidity in financial system has the most effect on the inflation and that central bank control total liquidity. "At its monetary policy meeting on 2 June 2016, the Governing Council assessed that the comprehensive package of decisions taken in early March underpins the momentum of the euro area's economic recovery and fosters the return of inflation to levels below, but close to, 2%"(European central bank, 2015).Considering the aim of the European central bank, it will be supposed that the same goal, considering the rate of inflation, has the Croatian central bank (HNB) (Croatian Central Bank, online).

Fiscal policy is the use of government spending and taxation to influence the economy (Horton and El-Ganainy, 2009). When government wants to boost economy they increase spending or decrease taxes. In the opposite case, when government wants to prevent economy from overheating, it decreases spending or increases taxes. In this paper main assumption for the fiscal policy is that government spending effects the most on the unemployment rate in Croatia. Main reason for this assumption is fact that total GDP of Croatia is consisting of government spending with share of 46,9% in 2015 (Eurostat, 2015). Goal for fiscal authority is decrease unemployment rate because as much as possible because it is assumed that unemployment rate is the most visible macroeconomic indicator which represents how successful government works. Low unemployment rate increases possibilities for winning the next parliament election.

Game theory

In all game theoretic models the main entity is the player, and he may be faced as an individual, a group of individuals, or a government, making decisions and if players in a game act independently of each other, then we have a non-cooperative model while if they correlate their actions, then we have a cooperative solution (Santos et al., 2010). The goal of game theory is to define also the most favourable behaviour of participants in agiven conflict situation or the game, and that definition is assume rationality (Bosnjak, 2017).Model in this paper is based on the assumption that monetary and fiscal authority are in conflict. In that way we have non-cooperative game (Perić, 2015).

ANALYSIS OF CONFLICT SITUATION BETWEEN MONETARY AND FISCAL POLICY IN CROATIA

The model in this paper will analyze the interaction of monetary and fiscal policy in the Republic of Croatia using tools of the game theory. The main assumption of the analysis is that monetary and fiscal policy are in mutual conflict influence. Primary objective of the central bank, which has authority of monetary economic policy, is to control inflation. Target Inflation rate of the European Central Bank is below but close to 2% (Draghi, 2016).Therefore, it will be assumed that the target inflation rate of the Croatian National Bank will also be below but close to 2%. In this model it will be assumed that central bank achives its objective through monetary agregates. The variable which is controlled by the central bank in the model is total liquid assets. The objective of fiscal policy or government is a greater GDP growth and other macroeconomic indicators such as employment, exports, wages and others.In the model, it will be assumed that the unemployment rate is the most visible indicator that shows how sucsessful government runs the country.Therefore, the objective of a fiscal authority is a reduction in the unemployment rate to ensure political points to win another election. Furthermore, it will be also assumed that government spending is an instrument through which the fiscal authority seek to reduce the unemployment rate. The conflict assumption between fiscal and monetary authority arises from the short-term goal of a political party that holds the power in the government.

The political party uses government spending such as public works and other investments that are not a priority at the given moment, to decrease unemployment rate and therefore such moves lead to procyclical movements. Therefore, the central bank takes steps to stabilize the exchange rate and inflation.

Payment function for fiscal authority

The payment function for fiscal policy is a linear shape and is obtained as a result of multiple linear regression form $y = c + \alpha x1 + \beta x2$, where: y – unemployment rate, c – constant, x1 – government spending, x2 – inflation rate, α – regression coefficient for government spending β – regression coefficient for inflation rate,regression was carried out using Eviews software solutions. Through multiple linear regression coefficients α and β were derived. Annual data on unemployment and inflation rate were used as input for calculating the parameters of linear regression. Processing data through EViews software solution resulted with regression coefficient α and β, - 0,202875 and - 0,741174 respectively.

In economic theory, interpretation of the coefficients would mean that the increase in government spending for the unit, while all the other variables remain unchanged, would lead to an approximate reduction of unemployment on average of 0.20287 percentage points (Bahovec, online). Also, a negative sign in front of the coefficient β, agrees with economic theory and such an inverse relationship between the unemployment rate and the inflation rate can be found in a Phillips curve (Blanchard and Johnson, 2012). Using the equation from multipla regression with calculated coefficients (α and β) and given strategies for fiscal authority, matrix of payment was created.

Payment function for monetary authority

Function of payments for monetary authority is the same shape as the function of payment for fiscal authority but variables and parameters are changed. Dependent variable y represents the rate of inflation and the independent variables x1 and x2 are the total liquid assets and government spending rate, respectively. Furthermore, function of payments for monetary authority is shown in form:$y = c + \alpha x1 + \beta x2$, where: y – inflation rate, c – constant, x1 – total liquid assets, x2 – government spending rate, α – regression coefficient fortotal liquid assets, β – regression coefficient forgovernment spending rate. Annual data on inflation rate and total liquid assets were used as input for calculating the parameters of linear regression. These data are for period form 2005. to 2015.

Processing data through EViews software solution resulted with regression coefficient α and β, 0,374395 and 0,125136, respectively.

In economic theory, interpretation of the coefficients would mean that the increase in total liquid assets for the unit, while all the other variables remain unchanged, would lead to an approximate increase of inflation on average of 0,374395 percentage points, and increasing government spending for the unit, while all the other variables remain unchanged, lead to an increase in inflation by an average of 0.125136 percentage points (Bahovec, online).

Matrix of payments for both players

In this chapter, matrix of payments for monetary and fiscal authority, is shown and it is visible every payment for each strategies combination that monetary and fiscal authority choose at given moment. If monetary authority chooses to play strategie 2,1, and fiscal authority chooses to play strategie 10, that strategies combination will results with inflation rate of 4.31% and unemployment rate of 14.66%.Table below shows matrix of payments.

Table1. Matrix of payments for both players

	Strategy	Monetaryauthority					
		1.5	1.8	2.1	2.4	2.7	3
Fiskal authority	4	16.32	16.10	15.87	15.65	15.43	15.21
		1.99	2.03	2.06	2.10	2.14	2.18
	6	15.91	15.69	15.47	15.25	15.02	14.80
		2.74	2.77	2.81	2.85	2.89	2.92
	8	15.51	15.28	15,06	14.84	14.62	14.40
		3.49	3.52	3.56	3.60	3.64	3.67
	10	15.10	14.88	14.66	14.43	14.21	13.99
		4.23	4.27	4.31	4.35	4.38	4.42
	12	14.70	14.47	14.25	14.03	13.81	13.58
		4.98	5.03	5.06	5.10	5.13	5.17
	14	14.29	14.07	13.84	13.62	13.40	13.18
		5.73	5.77	5.1	5.84	5.88	5.92

Source: autors calculations by using Decision Lab software

This game, represented in the matrix of payment, does not provide equilibrium because strategies in both players are dominant. Furthermore, the game in the matrix of payment will be analysed by the multiple criteria, where will be assumed that minimum inflation rate is objective for monetary authority. Target inflation rate below but close to 2%, form European Central Bank (ECB), is the reason for minimum criteion and it is assumerd that Croation Nation Bank (HNB) target the same inflation rate.Fiscal authority tends to minimize unemployment rate. Hence their criterion will also be minimum. The game will be repeated in two stages, based on the preference functions. The multicriterial analysis will be used to find equilibrium strategies by using PROMETHEE method with software solution Decision Lab. Using a PROMETHEE method it is necessary to determine the σ parameter. For fiscal authority, it is set to be 1 and for monetary authority, it is set to be 1.5. The parameters are determined to be slightly larger than the standard deviation (Perić, 2008).The game

will repeat in two stages and in each stage, weight coefficient will be changed. Hence, in the first stage weight coefficient will be 0.7 and 0.3 for fiscal and monetary authority, respectively. In the second stage weght coefficient will be 0.3 and 0.7 for fiscal and monetary authority. A difference between stages is the influence that is given either to fiscal or monetary authority.The blue color in the matrix of payment represent payoffs for fiscal authority and the red color represents payoffs for monetary authority.

Optimum result of the game

The first stage will be played under the assumption that bigger influence is given to the fiscal authority which means that stronger effect on the unemployment rate an inflation rate has government spending. Hence, the weight coefficient for fiscal authority will be 0.7 and for monetary authority 0.3. Below is shown result obtained by the software solution Decision Lab using PROMETHEE II method.
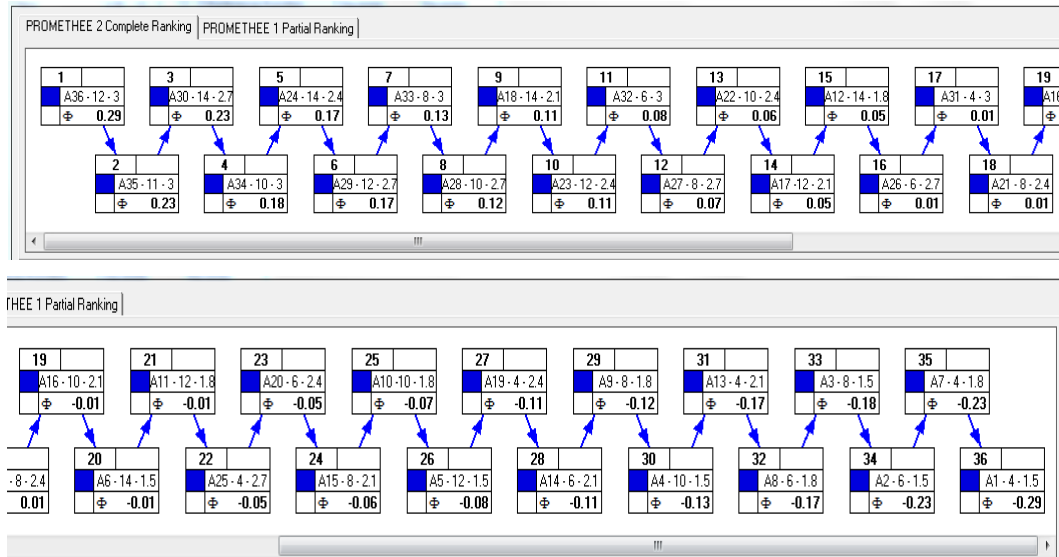
Figure1. Result from software solution Decision Lab, PROMETHEE II method.
Source: autors' calculations by using Decision Lab software

From the above figure, it is visible that PROMETHEE II method gives the full rank of nondominated alternatives. Highest rank has A36 solution which represents payoff for the fiscal authority of 13.18 and that is also unemployment rate when both players choose to play strategies combination 14 and 3. Also under that combination payoff for monetary authority is 5.92 which represents inflation rate.

This solution in an ideal economy would not be considered as optimal, but on the basis of data collected in the Republic of Croatia and the analysis of these data, it can be found similar value in the unemployment rate and the inflation rate when the Croatian economy was on the highest growth rates in 2008. A slightly higher inflation rate of 6.1% and a lower unemployment rate of 8.5%, can be justified by the fact that the real sector is excluded from the impact on the unemployment rate and inflation.

In the second stage, it is assumed that monetary authority has a bigger influence on the unemployment rate and inflation. Hence, the weight coefficient for monetary authority is set to be 0.7 and for fiscal authority 0.3.
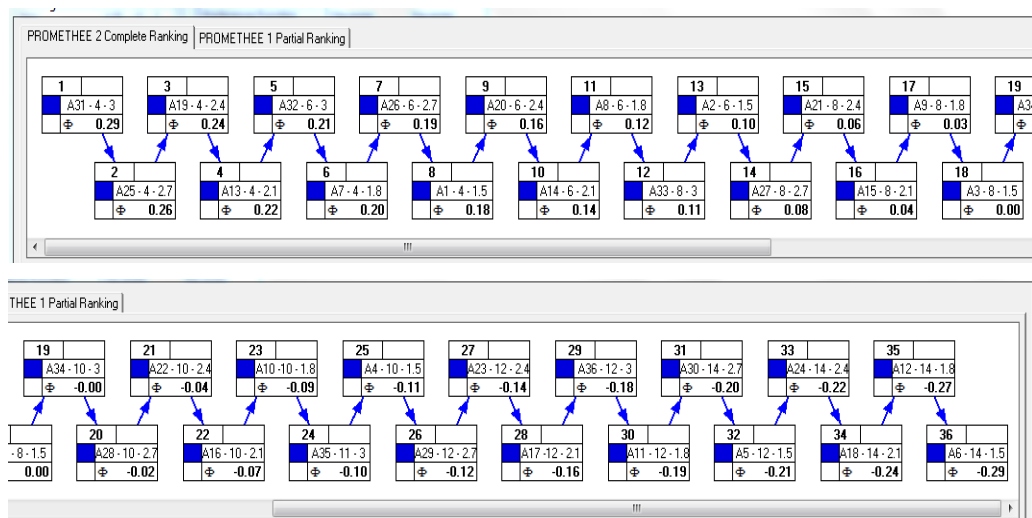

Figure2. Result from software solution Decision Lab, PROMETHEE II method.
Source: Authors' calculations by using Decision Lab software

Second stage results with a different optimal alternative. In this stage optimum alternative is A31. This alternative is obtained by strategies combination of 4 and 3. Strategies 4 is played by fiscal authority and strategy 3 is played by the monetary authority. This solution represents payoff for fiscal authority of 15.2 and that is unemployment rate in procentage. Payoff for the monetary authority is 2.2 whic is inflation rate in procentage. This solution represents the optimum because the primary objective of the Croatian National Bank is price stability.

CONCLUSIONS

Fiscal and monetary policies are the main economic policies that direct movement of the economy in countries. Efficient and effective implementation is therefore crucial for the growth of GDP.

With the implementation of fiscal policy major impact have political cycles and the political organization of the country. On the other hand, monetary policy is strongly correlated with the development of the money as the main payment methods. At the beginning of the monetary system with money as the main payment method, development and economic growth are significantly accelerated. However, the strong economic development has brought certain risks for the monetary system. For that reason, mechanisms that monitor and control the money and the money supply itself were needed. Analyzing data on government spending in the Republic of Croatia and also analyzing date on total liquidity in the Republic of Croatia, function of payment for monetary and fiscal policy were created.

Function of payments for fiscal policy has represented impact of government spending on the unemployment rate under the assumption that governments spending has the most effect on unemployment rate because of the high share of public services in the total GDP (over 46% in 2015) (Eurostat, 2015).

Implementation of monetary policy in the Republic of Croatia was a bit challenge since its independence. Generated matrix of payments, in this paper, gives nondominated alternatives because players objectives are in conflict. Optimal solution was generated by PROMETHEE method in Decision Lab software, which is suitable tool for solving this types of games. Through this work they were obtained two alternatives as the optimum solution from which only one is preferred, the one which is in line with the economic theory. The reason for the lower influence of the

Croatian National Bank on inflation in the Republic of Croatia might be because the largest commercial banks in Croatia are in foreign ownership and thus their credit policies can be crucial for attracting investment in the economy.

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