REPTree and M5P for Measuring Fiscal Policy Influences on the Romanian Capital Market during 2003-2010

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***Abstract*—**The present paper is an extension of our latest studies [44] where we intend to analyze the importance of fiscal policy influences on the Romanian capital market, among other factors, during 2003-2010. By employing data mining techniques in our research, such as regression and model trees, which outline the average daily trading on Bucharest Stock Exchange (BVB), we assert that fiscal policy is a major factor influencing capital markets, its influence being found in the behavior of all factors mentioned as important for market capital strength, like interest rates, inflation rates and exchange rates. Although most of authors consider an undersized influence of fiscal policy on capital market, we affirm that fiscal policy can be a successful instrument for alleviating business rotations.

***Keywords*—** Fiscal policy, Capital markets, Interest rates, Inflation rates, Exchange rates, Model trees, Regression trees.

I. Introduction

ROMANIA represents a developing market economy, being one of the latest members of the EU. The national capital market has encountered a significant evolution mainly after 2004 when the Law 297, currently in force, was enacted, setting out the main legal framework applicable to the operations on the capital market. With the intention of harmonizing with European Union legislation, the regulatory framework has been completed by implementing the main European provisions, further developing the capital market in Romania.

Our local economy is vigorously influenced by political decisions and interests. The discretionary public policies are the dominant ones and the pro-cyclical policies are implemented in order to obtain immediate results, fiscal policy prevailing across the macroeconomic policies. GDP decreased by 7.2% in 2009 and the Government decided to adopt austerity measures and to lend large funds from the International Monetary Fund (IMF).

During the last four years, our country faced: credits decline, currency depreciation, decrease in foreign investments, taxation augmentation, consumer demand decline while IMF's role of last creditor aroused. In 2010 Romania was the penultimate in the European Union after the value of Great Domestic Product (GDP) per capita, with 45% of the EU, followed only by Bulgaria. The shadow economy was estimated in 2010 at a level of 35-40% of GDP (based on National Institute of Statistics data). For reestablishing the economic situation, the Government increased taxation and sharply reduced the public expenditure.

Fiscal policy, through changes in taxation and spending, is an important tool [38] the central administration utilizes to influence the economy. Based on the fiscal policy, the government is able to control the macroeconomic variables [39] such as aggregate demand, disposable income, and economic activity as a whole. The variation and redistributive objectives of the market are dealt with the same fiscal policy, so as to determine the economic growth.

The present paper includes further work based on our latest research [44], unveiling the fiscal policy as an important determinant for the stock market, which directly or indirectly influences all the other factors that determine stock market behavior. Then we utilize data mining techniques in an attempt to generate regression and model trees outlining the typical daily trading on Bucharest Stock Exchange (BVB).

II. Research Literature

A. Capital markets vs. Monetary and Fiscal Policies

There is a substantial amount of literature on the topic of financial markets and economic growth, which explain the essential dynamics of financial growth within the economic field [5]: Adam Smith (1776), John Maynard Keynes (1936), Modigliani & Miller (1958), Goldsmith (1969). Various theoretical groundwork can be found in their work, so as to develop substitute premises concerning the question of capital markets - which argues that "sound monetary and fiscal policy helps to develop strong capital markets" [5]. These works advocated for the first time a relationship among stock market behavior and tax policy, jointly measured with the monetary

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policy. Most of studies in this field have been focused on the developed countries and only a few refer to the developing ones as economies without mature capital markets.

Important studies on the stock market behavior and monetary policy include: Patelis (1997), Lee Unro (1997), Anderson (2004), Laopodis (2006), (2007) etc. But there are only a small number of studies on the relationship involving fiscal policy and stock market performance [25], most of these studies did not analyze the fiscal actions rather than from the perspective of the concept of "market efficiency" (Lee Unro, 1997; Ali, S.M., 2003; Dromel, 2007). Most recent contributions have focused on micro analyses of the fiscal policy and interest swap spreads (Afonso and Strauch, 2003; Engen, 2004; Faini, 2005), the cyclical response of fiscal policies in the euro area (Golinelli, R. and S. Momigliano 2008), or on event analysis (Laubach T., 2004; Muehleisen M. and C. Tower, 2004).

The foundation of tax policy tested by Ross Levine, was former established by Adam Smith [5], who argued that higher taxes would determine persons with capital stock (who were not tied to a specific country) to invest in lower rates countries [35]. Anderson issued several statements in this matter [5]:

- interest rates, inflation rates, corporate taxes and exchange rate policy drive the level of investment
- the foundations of investment are interest rates.
- interest rates directly affect borrowing on credit, a facet essential to investment on capital market.
- corporate taxes affect the pay out of an investment. The corporate tax level within a country is often considered before the investment.

Faini's conclusions [18] from such literature are the following:

- fiscal policy, despite the modality of measurement, matters but its effects are quite small (an important issue which we want to challenge in present paper);
- national fiscal policy causing higher deficits or debt in one country may have impact on the level of interest rates, both nationally currency and for the whole currency union as a whole.

Passing from theory to practice, the contemporaneous reality demonstrates that different countries have different fiscal policies and various capital gains taxes. These might obstruct the possible investors or contrarily. Also, the contemporaneous reality demonstrates that different countries have developed or weakened the capital market. The question that rises in this case is if there exists a correlation between the two realities, which is if the fiscal policy in a country determines the strengths or the flaws of its capital market.

Based on the fiscal and monetary theories derived from the economic works mentioned above, we intend to argue that far from being a factor with small influence, fiscal policy is a major factor influencing capital markets, its influence being found in the behavior of others factors above mentioned as important for market capital behavior, like interest rates, inflation rates and exchange rates. This idea lies at the heart of the analysis in this paper.

B. Data Mining. Regression and Model Trees

The field of statistics has evolved in size and difficulty due to new economical and science issues, together with the development of computers and the information age, leading to the new "data mining" techniques [57]. Data mining can be defined as a process of extracting valuable information, relationships and hidden patterns in large databases [53]. The process of learning from data represents the extraction of important patterns and trends, and understanding "what the data says" [57]. Thus, the learning problems can be generally classified as: [57]

- supervised learning, where the purpose is to predict the value of an result measure founded on a number of input measures;
- unsupervised learning, where there is no result measure, and the objective is to describe the associations and patterns among a set of input measures.

Classification and regression are considered important predictive tasks in data mining, while regression and model trees (Table 1) gain in popularity conventional statistical techniques like standard regression or logistic regression, due to [53]:

- ease of application,
- fast operation and effectiveness,
- close resemblance to human way of decision making,
- natural and easy to understand even for inexperienced analysts.

Data mining, and statistical learning have important tasks in several social and economic areas, such as: [57]

- medicine: predicting the risk for hospitalized heart attack patients to have a second heart attack; identifying the risk factors for certain types of cancer, founded on medical and demographic data; estimating the amount of glucose in the blood of a diabetic person, based on the blood infrared absorption spectrum,
- finance and economics: predicting the stock prices several months from the present, based on company performance measures and economic data; sales and goods associations in supermarkets,
- education: predicting students capability of passing/failing certain exams, or continuing/dropping education,
- multimedia and writing: numbers recognition in handwritten codes from digitized pictures etc.

Model trees represent structured trees with graphically if-then-else rules, trying to extract implicit knowledge from datasets [50]. They are a type of decision tree with linear regression functions at the leaves [54] and form the basis of a successful technique for predicting continuous numeric values. Trees [43] used for numeric prediction resemble normal decision trees, with the exception of storing at each leaf a class value that represents the average value of instances that reach the leaf (regression tree), or a linear regression model that predicts the class value of instances reaching the leaf (model tree).

Table 1. Trees for Numeric prediction and Classification learning, based on [50],[43]

Numeric prediction		Classification learning
Model trees	**Regression trees**	**Decision trees**
solve regression problems (i.e., the output is a continuous value)	solve regression problems (i.e., the output is a continuous value)	solve classification problems (i.e., the output is a nominal attribute)
• hold linear regression models to calculate the final output • deliver better compactness and prediction accuracy • leverage potential linearity at leaf nodes.	• trees have a single value as the output in their leaves (corresponding to the average of values that reach the leaf)	• utilize inductive inference so to estimate a function that creates discrete values • practical techniques intended for learning disjunctive expressions.

Some characteristics of model trees can be described as following [52]:

- generalization of regression trees concepts, but smaller than them,
- analogous to piecewise linear functions (and hence non-linear),
- learn efficiently and tackle tasks with very high dimensionality - up to hundreds of attributes,
- regression functions usually involve less variables,
- the decision strength is clear.

In our present research we employed the Weka software, using the following methods: REPTree and M5P. Weka was developed at University of Waikato and represents a collection of machine learning algorithms for data mining tasks, including tools for data pre-processing, classification, regression, clustering, association rules, and visualization.

REPTree generates regression trees [49] based on information gain as the splitting principle, using reduces-error pruning, and sorts values for numeric attributes once. Weka's M5P generates M5 model trees [49], combining a conventional decision tree with the incorporation of linear regression functions at the leaves.

There are several application of regression and model trees in most recent studies form the research literature. Successful applications of machine learning in water management inspired the modeling of the water level–discharge relationship [52] are built with artificial neural network M5 model trees. Other researchers propose [56] algorithms for inducing multi-target model trees with low computational complexity, founded on the predictive clustering trees standards and probability bounds for supporting splitting decisions. Social networks (such as Twitter) experienced a fiery growth arousing the interest of many developers of analytic and metric tools. In their studies Campo-Avila et al. [49] revised the reliability of such tools and show how data mining techniques can help or influence users, actions and companies.

III. Theoretical considerations

The government fiscal policies determine certain consequences on capital markets. An example of how the administration seeks to influence the investments [5], and obliquely the potency of capital markets can be found on the tax policies and the level of corporate taxes.

As noticed in introduction, the empirical results show (and most researchers agree) that inflation, interest rates, corporate taxes and exchange rates all contribute to the strength of capital markets. Based on our latest studies [44], lets name this proposition P1, premise no.1 and note the variables:

Inflation rate: i

Interest rates: r

Corporate taxes: μ

Exchange rates: e

Strength of capital markets: scm

Premise number 1 becomes:

$$P1: scm = i + r + \mu + e \qquad (1)$$

Table 2. Variables and their influence on investors, based on [5], [44]

Variables	Influence
Inflation	Low inflation protects the investor from artificially higher prices
Interest taxes	Lower rates open the market to new investors Lower interest rates allow the entrepreneur to receive loans without the worry to pay back a massive amount Money borrowed through debt or equity loans is invested in different firms on the capital market The influx of capital provides for economic growth and a more robust market
Corporate taxes	Investors looking for the best payoffs will look for a country with low corporate taxes
Exchange rates	Countries with a strong exchange rate would have higher levels of direct foreign investment

In general, the investors who seek top outcome will find interesting countries with low corporate taxes, interest and

inflation rates, but also strong exchange rates [5]. The judgment behind our premise, is presented in Table 2.

P1 is not a descriptive phrase, but a relationship one, stating the link between variables, namely the strength of capital markets and inflation rates, interest rates, corporate taxes and exchange rates. In P1, Fiscal policy is recognized as a factor in the capital market through the variable "corporate taxes"..

Because corporate taxes (μ) represent only a part of fiscal policy, we will consider fiscal policy like a distinct variable, which include the variable "corporate taxes" as follows:

Fiscal policy: pf

becomes the premise no. 2, P2.

$$\mu \neq pf,\ \ but\ \mu \subset pf,\ \ so\ \mu = f(pf) \qquad (2)$$

Lower inflation rates increase investor confidence generating more investment, with which capital markets are stronger. According Anderson's research, as soon as the inflation becomes significantly superior to the interest rates, there will be a weaker economic development in capital markets [5]. The rationalization is based on the expectation of a negative rate of return on the investment which discourages the investors.

High inflation rates within a country also generate higher interest rates, who determine the enhancement of private savings. The high interest rates abate investments and suppress the capital and economic development [5]. So, according to P1, inflation affects capital market. The problem is to see if there are a relationship between inflation and fiscal policy. A government usually collects revenues through levying taxes or fees on goods, services, consumption or incomes of businesses and individuals. High government expenditure (by investing in infrastructure or services) determines a high demand (for goods and services). Reducing taxation may encourage investments and production, thus increasing the supply (for services and goods). As a result, fiscal policy can manipulate the drivers of inflation, demand and supply. Let's name this proposition P3, premise no 3.

$$P3:\quad i = \ddot{f}(pf) \qquad (3)$$

Regarding interest rates, as we show before, most researchers highlight its impact on capital markets' strength; several authors emphasizing that it have a psychological effect on many investors. "When investors observe a low interest rate, then they believe the incentive of investing will be superior to the risk of borrowing" [5].

The conclusion is that a policy change would cause an increase of investment within the country which would strengthen the capital market. The question is if exists a determination between fiscal policy and interest rates. We also found some opinions in the mentioned literature. Large future deficits generate a decrease in investor confidence which in turn generate adverse effects on the exchange rate.

Thus becomes clear the link between fiscal policy and interest rates. Let's name this proposition P4, premise no 4.

$$P4:\ r = \dot{f}(pf) \qquad (4)$$

So, according to P1, exchange rates affect capital market. The problem is to see if there are a relationship between exchange rates and fiscal policy. We also found several opinions in the mentioned research literature. The combined reaction of trade balance, consumption and real exchange rate can be found on Perotti and Monacelli's studies[31]. Corsetti and Müller (2006) review the trade reaction [33]. There can be observed an obvious connection between fiscal policy and exchange rates. Let's name this proposition, premise no 5, P5.

$$P5:\ e = \dddot{f}(pf) \qquad (5)$$

From the cited research literature incursion follows that the cited authors agree on the existence of the relationships, therefore we can sustain the accurateness of the premises.

IV. Problem Solution

A. Premises

Being gathered n premises; a correct inference is logically possible obtaining certain conclusions that result from accepted existing premises. To build an argument is to find some generally accepted premises from which derive logical a new proposition which is the conclusion.

Our premises are:

P1: Inflation, interest rates, corporate taxes and exchange rates contribute to the strength of capital markets.

$$scm = i + r + \mu + e \qquad (1)$$

P2: Corporate taxes (μ) represent a part of fiscal policy, so it depends on fiscal policy

$$\mu = f(pf) \qquad (2)$$

P3: interest rates depends on fiscal policy

$$r = \dot{f}(pf) \qquad (3)$$

P4: fiscal policy can alter the drivers of inflation – supply and demand – and thus cause inflation to rise or fall

$$i = \ddot{f}(pf) \qquad (4)$$

P5: exchange rates depends on fiscal policy

$$e = \dddot{f}(pf) \qquad (5)$$

Substituting variables in equation 1 is obtained as follows:

$$scm = \ddot{f}(pf) + \dot{f}(pf) + f(pf) + \dddot{f}(pf) \qquad (6)$$

As a result, we can infer the conclusion that fiscal policy influences all the capital market factors (inflation, interest rates, and exchange rates), meaning that fiscal policy is the main tool to be used for influencing capital markets' strength.

While we view the results of this paper as an important first

step within a neoclassical framework towards an understanding of fiscal policy importance like macroeconomic tool for influence strength capital market, there are some key areas that clearly deserve further attention. In the future paper work we propose to measure the amount of influence of fiscal policy on capital markets, both as a direct factor and indirect factor acting on capital market through inflation, interest rates, and exchange rates.

A second area of further research is the behavior of tax rates. Anchored in the research literature, economists stated that tax rates were also procyclical in developing countries (i.e., tax rates increase in bad times and decrease in good times). Some authors [36] envisaged that tax rates should be set countercyclical when output is not highly persistent as in developed countries and procyclical when output is persistent as in developing countries.

A third area would be to investigate an intermediate case of market incompleteness and check the procyclicality of fiscal policy. A potential research we intent to do on the case on Romania capital market.

And finally, it remains to explain why is that developed countries (the private sector or the government) face a richer menu of assets to diversify idiosyncratic risk.

B. Practical Data Mining Experiment

For the practical part of our research we used a series of specific technologies in the field of data mining, namely regression and model trees [44]. These tasks were applied to datasets collected from the National Bank of Romania, Bucharest Stock Exchange and National Institute of Statistics, containing the following variables during the years 2003-2010: net product taxes, inflation, gross domestic product, national currency exchange rates (eg.RON-US Dollar), monetary policy interest rate, average daily trading on Bucharest Stock Exchange (BVB).

The REPtree method built a regression tree using information gain/variance reduction and pruned it using reduced-error pruning in the following manner [43]:

- only sorted values for numeric attributes once due to its speed optimization;
- dealt with missing values by splitting instances into pieces, as C4.5 another traditional algorithm does.

For the REPtree application we set the following options: minimum number of instances per leaf(1), minimum proportion of training set variance for a split (0.0010), and number of folds for pruning (3).

The generated REPtree regression tree (Appendix I) has the following structure in graphical form (Fig.1):

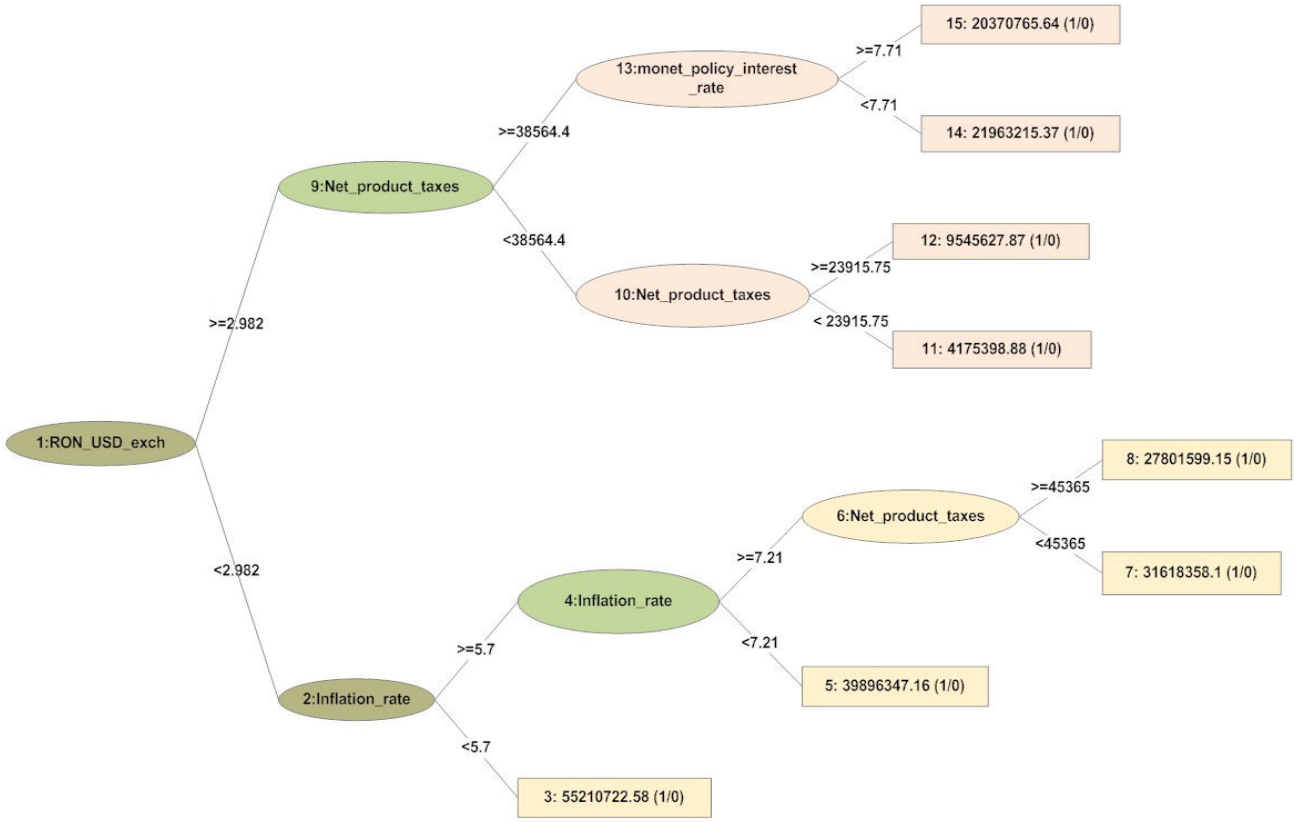

Fig.1. REPtree generated regression tree

It can be seen that the exchange rate (in our case RON-US dollar) has a role for the future evolution of trading on the Bucharest Stock Exchange, by hovering around the 2.982 RON per US dollar. The next joints of the decision tree reveal the importance of other factors, namely net_product_taxes, and Inflation_rate. Finally, the latest split occurs in the National Bank of Romania's monetary_policy interest_rate with its 7.71% value that influences the BV stock average daily

trading.

The next utilized method implemented routines for generating a M5 model tree. Weka's M5P algorithm is a coherent modernization with several developments of the original M5 algorithm invented by R. Quinlan. This procedure offered the advantages of knowledge discovery through analyzing the patterns in the Bucharest Stock Exchange average daily trading. It incorporated a large amount of statistics, learns efficiently and automatically produced multi-rule combinations over a set of data and also applies a more computationally efficient strategy to build linear models, as it follows [41]:

- primary built a piecewise constant tree;
- followed by a linear regression model to the data in each leaf node.

The approach used in the M5 trees was to reduce the intra-subset deviation in the resulted values behind each branch [40], the splitting process being completed when the output values of all the instances that reach the node varied only vaguely, and only a small number of instances were left. The formula to compute the standard deviation reduction (SDR) is [52]:

$$SDR = sd(T) - \sum_i \frac{|T_i|}{|T|} sd(T_i) \qquad (7)$$

where T represents a set of examples that reaches the node;
Ti - the subset of examples that have the i^{th} outcome of the potential set;
sd - the standard deviation.

The generated M5P tree (Appendix II) has the following structure in graphical form (Fig. 2):

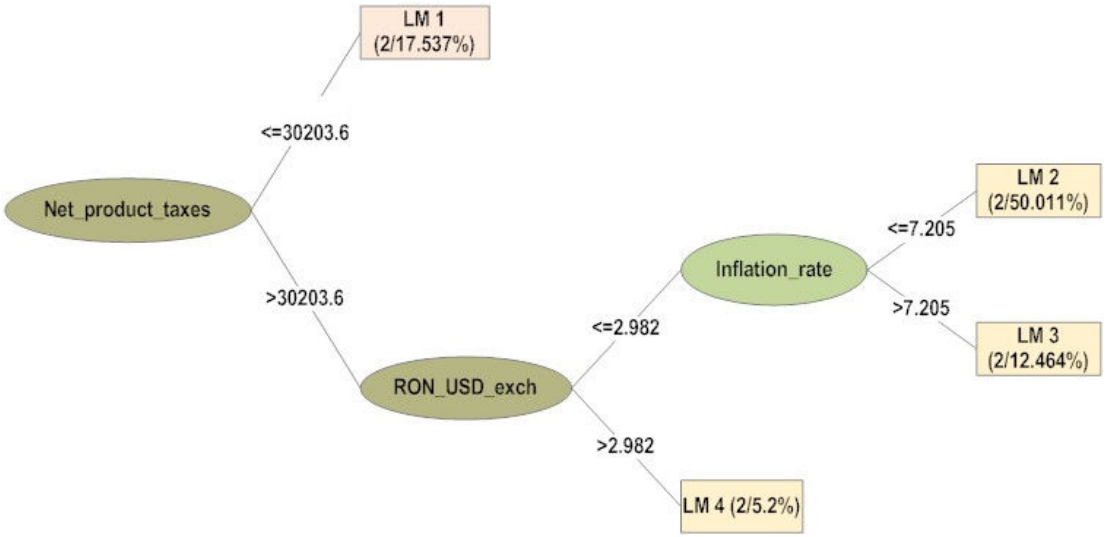

Fig. 2. M5P generated model tree

From this we can observe the importance of the variable Net_product_taxes in the model tree, for being the root node. Under a value below or equal to 30203.6 RON it determines the LM1 model. The next split is found at the variable RON_USD_exchange rates which, by exceeding the value of 2.982 RON per U.S. Dollar, determines the LM4 model. The last split is the Inflation rate that ultimately determines LM2 and LM3 models. Based on each model's indicator we can observe that the model LM2 (50.011%) is the most representative of this tree, distantly followed by LM1 (17.537%).

It is important to notice that there are certain common issues among both generated trees:

- Net_product_taxes appears in both as one of the main nodes
- the RON_US dollar exchange rate is around the edge 2.982 influencing the BV stock average daily trading
- also the inflation rate around the 7.205 % edge has a vast role in the BV stock average daily trading.

V. Conclusions

This work examines the effects of fiscal policy on the strength of capital markets. Although most of authors consider a small influence of fiscal policy on capital market, we argued that fiscal policy can be a successful instrument for alleviating business rotations. The novelty of our work consists of the idea that fiscal policy can be used by the government like very effective means to deal with potential market inconsistencies and to attain redistributive goals. In this fashion, fiscal policy determines a positive development of the economic background and strengthens the capital markets. Unfortunately, a major disadvantage of discretionary fiscal policy in Romania consists in fiscal unpredictability due to frequent changes of tax system, which increases the uncertainty, with negative influences on capital markets.

We propose in our future research to deeply analyze the influence of fiscal policy on the capital market in Romania, and extend it to the European Union countries. Investors looking to enhance their profits will always search for a place

with low corporate taxes, interest and inflation rates, as well as strong exchange rates. All this can be attained through a sound fiscal policy, considered together with a sound monetary policy.

APPENDIX

Appendix I .

```
=== Run information ===

Scheme:weka.classifiers.trees.REPTree -M 1 -V 0.01 -N 3 -S
1 -L -1 -P
Relation: tabele_milRON2_eng
Instances:8
Attributes:6
        Net_product_taxes
        Inflation_rate
        GDP
        RON_USD_exch
        monet_policy_interest_rate
        BVB_average daily trading
Test mode:evaluate on training data

=== Classifier model (full training set) ===


REPTree
============

RON_USD_exch < 2.98
|   Inflation_rate < 5.7 : 55210722.58 (1/0) [0/0]
|   Inflation_rate >= 5.7
|   |   Inflation_rate < 7.21 : 39896347.16 (1/0) [0/0]
|   |   Inflation_rate >= 7.21
|   |   |   Net_product_taxes < 45365 : 31618358.1 (1/0) [0/0]
|   |   |   Net_product_taxes >= 45365 : 27801599.15 (1/0) [0/0]
RON_USD_exch >= 2.98
|   Net_product_taxes < 38564.4
|   |   Net_product_taxes < 23915.75 : 4175398.88 (1/0) [0/0]
|   |   Net_product_taxes >= 23915.75 : 9545627.87 (1/0) [0/0]
|   Net_product_taxes >= 38564.4 : 21166990.51
(2/633974035644.25) [0/0]

Size of the tree : 13

Time taken to build model: 0seconds

=== Evaluation on training set ===
=== Summary ===
Correlation coefficient                  0.9997
Mean absolute error                 199056.2163
Root mean squared error             398112.4325
Relative absolute error                  1.6172 %
Root relative squared error              2.6002 %
Total Number of Instances                8
```

Appendix II .

```
 === Run information ===

Scheme:weka.classifiers.trees.M5P -N -R -M 4.0
Relation: tabele_milRON2_eng
Instances:8
Attributes:6
        Net_product_taxes
        Inflation_rate
        GDP
        RON_USD_exch
        monet_policy_interest_rate
        BVB_average daily trading
Test mode:evaluate on training data

=== Classifier model (full training set) ===

M5 unpruned regression tree:
(using smoothed linear models)

Net_product_taxes <= 30203.6 : LM1 (2/17.537%)
Net_product_taxes >  30203.6 :
|   RON_USD_exch <= 2.982 :
|   |   Inflation_rate <= 7.205 : LM2 (2/50.011%)
|   |   Inflation_rate >  7.205 : LM3 (2/12.464%)
|   RON_USD_exch >  2.982 : LM4 (2/5.2%)

LM num: 1
BVB_average daily trading  =
    + 24033078.9357

LM num: 2
BVB_average daily trading  =
    + 28589606.9495

LM num: 3
BVB_average daily trading  =
    + 28463336.7593

LM num: 4
BVB_average daily trading  =
    + 27784933.7919

Number of Rules : 4

Time taken to build model: 0.01seconds

=== Evaluation on training set ===
=== Summary ===

Correlation coefficient                  0.8094
Mean absolute error                 11165704.0608
Root mean squared error             13874410.8806
Relative absolute error                 90.7117 %
Root relative squared error             90.6177 %
Total Number of Instances                8
```

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