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# THE IMPACT OF RUMOURS RELATED TO POLITICAL AND MACROECONOMIC UNCERTAINTY ON IPO SUCCESS: EVIDENCE FROM A QUALITATIVE MODEL[1]

**[1]Tomas Meluzin**
*Faculty of Business and Management*
*Brno University of Technology*
*Kolejní 2906/4*
*612 00 Brno-Královo Pole*
*Czech Republic*
*E-mail: meluzint@fbm.vutbr.cz*

**[2]Adam P. Balcerzak**
*Faculty of Economic Sciences and Management*
*Nicolaus Copernicus University*
*Gagarina str. 13a*
*87-100 Toruń*
*Poland*
*E-mail: adam.balcerzak@umk.pl*

**[3]Michal B. Pietrzak**
*Faculty of Economic Sciences and Management*
*Nicolaus Copernicus University*
*Gagarina str. 13a*
*87-100 Toruń*
*Poland*
*E-mail: miachal.pietrzak@umk.pl*

**[4]Marek Zinecker**
*Faculty of Business and Management*
*Brno University of Technology*
*Kolejní 2906/4*
*612 00 Brno-Královo Pole*
*Czech Republic*
*E-mail: zinecker@fbm.vutbr.cz*

**[5]Karel Doubravsky**
*Faculty of Business and Management*
*Brno University of Technology*
*Kolejní 2906/4*
*612 00 Brno-Královo Pole*
*Czech Republic*
*E-mail: doubravsky@fbm.vutbr.cz*

**[1]Tomas Meluzin**, PhD is an Associate Professor at the Brno University of Technology, Faculty of Business and Management (Czech Republic). His main research areas include research of public capital markets in Central and Eastern European region.

**[2]Adam P. Balcerzak** is a lecturer in the Department of Economics at Nicolaus Copernicus University (Poland). He is a chairman of Polish Economic Society Branch in Toruń. His research interests include institutional economics, determinants of regional and macroeconomic productivity, entrepreneurship, sustainable growth theory, the role of financial markets in growth dynamics. He is the author of about 40 articles published in journals indexed in Web of Science and SCOPUS.

**[3]Michal B. Pietrzak** is a lecturer in the Department of Statistics and Econometrics at Nicolaus Copernicus University (Poland). He is a secretary of Polish Statistical Society Branch in Toruń. He specializes in spatial econometrics. He published about 35 articles indexed in Web of Science and SCOPUS.

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[4]**Marek Zinecker**, PhD is an Associate Professor at the Brno University of Technology, Faculty of Business and Management (Czech Republic). His main research areas include macroeconomic factors influencing corporate financing via venture capital and initial public offerings.

[5]**Karel Doubravsky**, PhD is an Assistant Professor at the Brno University of Technology, Faculty of Business and Management (Czech Republic). His main research areas include quantitative and qualitative modelling.

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***ABSTRACT**. This article is dedicated to the propagation of rumours in regard to political and macroeconomic uncertainty related to a going public strategy. Rumours might have an enormous impact on the decision making of market participants due to information asymmetry and thus can explain the time-varying character in volumes of initial public offerings. We model the relation between political uncertainty and firms' financing decisions while applying the SIRaRu rumour propagation model investigating the dynamics of the rumour spreading in complex social networks. We document how the IPO activity is adversely affected if confounding announcements in regard to political uncertainty are spread. Some realistic conditions on previous rumour spreading models are supplemented and a new qualitative on trends-based model is derived. Moreover, a transitional graph is developed to study all possible past/future behaviour of the examined variables. Additionally, we propose a graphical solution to reconstruct the development of the variables under study over time.*

***KEYWORDS***: macroeconomics, politics, rumours, IPO, qualitative models.

***JEL classification***: E44, G23, G32.

## Introduction

There are many research papers dedicated to the issue why initial public offering (IPO) volumes vary with economic and market conditions. Starting with Ibbotson, Jaffe (1975) and back to Ritter (1984), Loughran *et al.* (1994), Ritter, Welch (2002) and Pástor, Veronesi (2005) we recall the phenomenon called 'hot' issue markets. This phenomenon explains clustering of IPOs due to favourable economic conditions supporting the growth of going public companies. The cyclic nature of IPOs is furthermore explained by time variation in overall stock market conditions (Lucas, McDonald, 1990; Ritter, Welch, 2002) and industry conditions of IPO firms (Pagano *et al.,* 1998; Lowry, 2003). Moreover, Lowry (2003) documents that firms' demand for capital and investor sentiment are important determinants of IPO volume. Alti (2005) and Çolak, Gunay (2011) deliver evidence that information spillovers support IPO clustering. Recently, in the context of increasing political uncertainty, there has been more interest in the economic impact of political risk. Çolak *et al.* (2017) show that political uncertainty surrounding gubernatorial elections in the United States causes

dampening effect on IPO activity which is related to lower IPO offer price during election years.

This paper is an attempt to contribute to the discussion on time-varying IPO volumes. We join several recent studies to examine the impact of rumours related to political and macroeconomic uncertainty on IPO success and thus probable variations in IPO volumes. The novelty of this study consists in the research approach. To our knowledge, we are the first to model the relation between political uncertainty and firms' financing decisions while applying the SIRaRu rumour propagation model (Wang *et al.,* 2014). This model is derived from the models of infectious diseases and investigates the dynamics of the rumour spreading in complex social networks. While applying a case study approach we document how the IPO activity is adversely affected if confounding announcements in regard to political uncertainty are spread. We add some realistic conditions on previous rumour spreading models and derive a new qualitative on heuristics-based model. A transitional graph is developed to study all possible past/future behaviour of the examined variables. Additionally, we propose a graphical solution to reconstruct the development of the variables under study over time.

In our study, the SIRaRu model is solved qualitatively; this suggests that information shortage in relation to IPO exists and this is available only as a verbal description based on trends. We distinguish three directions for development of variables under study: decreasing, constant, or increasing. It means that no quantifiers, numbers, and fuzzy/rough sets are needed (Dohnal, 1992).

We believe that the results represent a tool supporting both IPO companies and investors in their decision making if rumours occur and thus conceivable scenarios of the subsequent developments have to be analysed and evaluated.

The rest of this paper proceeds as follows. First we review the literature on the political instability and its impact on IPO activity. Section 3 provides an overview of the methodological approach. Section 4 presents detailed findings and the last sections discuss and summarise main conclusions.

## 1. Theoretical Framework

The financial system in continental Europe is traditionally bank oriented (Balcerzak *et al.,* 2017). However, we can observe an increasing role the primary stock markets in raising equity capital play within the last two decades (Lizińska, Czapiewski, 2016; Boldeanu, Tache, 2016; Meluzín, Zinecker, 2016; Hes, Jílková, 2016; Mačí, Valentová, 2017; Bonaventura, Giudici, 2017; Sosnowski, 2017). This partial transformation is not surprising for one particular reason: the globalisation and foreign direct investment inflows and outflows has accelerated capital market interconnections (Vukovic *et al.,* 2017; Balcerzak, Pietrzak, 2016, 2017; Balcerzak, 2016; Heryan, Ziegelbauer, 2016; Zinecker *et al.,* 2016; Fałdziński *et al.,* 2016; Pohulak-Żołędowska, 2016; Pietrucha, Acedański, 2017; Pietrzak *et al.,* 2017b; Masood *et al.,* 2017; Śliwiński, Łobza, 2017). The going public strategy is becoming more attractive even for middle-sized enterprises and belongs to essential aspects taking influence on business environment (Pietrzak, Balcerzak, 2016; Ivanová, 2017; Pietrzak *et al.,* 2017a; Kruk, Waśniewska, 2017; Zygmunt, 2017; Cheba, Szopik-Depczyńska, 2017).

Since the early 1990s, there has been an increased interest in the effects of political uncertainty on financial markets and firms' reactions to such uncertainty (e.g Çolak *et al.,* 2017; Chansog *et al.,* 2012; Durnev, 2010; Julio, Yook, 2012; Pástor, Veronesi, 2013; Rodrik,

1991). Çolak *et al.* (2017) report that the research has primarily focused on the link between political risks on one side and macroeconomic issues including economic growth, inflation, welfare, stock market development, stock market volatility and stock market performance on the other side. Surprisingly, less attention has been payed to the impact of political uncertainty on firms' financing decisions.

It is well known that political and macroeconomic uncertainty represents an obstacle when an investor is, at least partially, not able to alter his decision. Recent theoretical works on impact of political uncertainty on firms' financial decision making point out several aspects (Çolak *et al.,* 2017). First of all, a state government is essential while shaping the external environment that firms operate in. Thus, changes in the policy of a government can either directly (e.g. through tax code or subsidy policies) or indirectly (through customer demand or sentiment) affect companies' future return on investment. Pástor, Veronesi (2013) and Çolak *et al.* (2017) provide empirical evidence that firms' financing choices are adversely affected by political uncertainty because this increases firms' cost of capital; hence, asset prices slow down and risk premia go up. Additionally, Çolak *et al.* (2017) conclude that political uncertainty plays a role in driving business cycles. A vast number of other studies on this issue exist. Rodrik (1991) proposed a model intended to link policy uncertainty and decision making of private investors. He concludes that even "moderate amounts" of policy uncertainty may result in a significant drop in investments in the country. Julio, Yook (2012) report a negative relation between political uncertainty and firm investments. Similarly, Pástor, Veronesi (2013) document a dramatic decline in stock prices if the future government policy is perceived as hardly predictable. Hence, the policy that cannot be anticipated results in an increase of volatility, risk premia and correlations among stocks. Additionally, Durnev (2010) documents a decreasing trend in the efficiency of corporate investments if a significant political uncertainty occurs.

Substantial academic research also deals with the relationship between the political uncertainty and capital flight. The main idea is that private investors will suspend their investment activity in the country as long as the impact of political actions on the real value of their assets remains unpredictable and otherwise net present value of assets abroad is positive because of a small risk premium. Erb *et al.* (1996) document a correlation between the country risk and future returns of investment. Moreover, Ben-Nasr *et al.* (2012) examined the influence of political orientation and the extent of government expropriation on the cost of equity in 236 companies that had undergone ownership transformation over the period between 1987 and 2006 in 38 countries. According to the research results the political risk and thus the cost of equity tend to increase if the company is state-owned and the extent of government expropriation is deep.

The main channels how to convey information about countries, industries and enterprises going public are represented by institutional rating agencies, business magazines, prospectus, or high-tech information intermediaries. The information asymmetry takes a direct influence on the initial trading price of stocks, i.e. the extent of their under-pricing (Pagano *et al.,* 1998). Supriya (2016) reviews recent academic research on determinants affecting the IPO valuation and concludes that companies going public are always "a subject to greater risk" because some investors perceive available information as insufficient.

The information on political uncertainty very often takes the form of confounding announcements or rumours. In the epidemiology, studying the transmission of infectious diseases has a long tradition. Back to Goffmann, Newill (1964) the "epidemic" process is

defined as "transition from one state (susceptible) to another (infective) where the transition is caused by exposure to some phenomenon (infectious material)". Many researchers share the opinion that the transmission of disease is in certain respects comparable to the transmission of ideas (see in *Table 1*).

**Table1. Analogy between infectious disease and intellectual epidemics in the IPO process**

| Elements of the epidemics process | Elements interpreted in terms of | |
|---|---|---|
| | **Infectious disease epidemic** | **Intellectual epidemic** |
| Host | | |
| • Agent | Infectious material | Idea (released in financial press, blogs, social networks, etc.) |
| • Infective | Case of disease | Author of the paper (columnists, financial analysts) |
| • Susceptible | Person who will be infected given effective contact | Reader of paper who will be infected given effective contact (investors) |
| • Removal | Death or immunity | Death or loss of interest |
| Vector | | |
| • Agent | Infectious material (as for host) | Idea (as for host) |
| • Infective | Vector harbouring the agent | Paper containing useful ideas |
| • Susceptible | Vector not harbouring the agent | All papers containing potentially useful ideas |
| • Removal | Death | Deletion or loss |

Source: Goffmann, Newill, 1964, modified.

Galam (2003) characterizes rumours as an essential form of social communications resulting in an enormous role the rumours play in shaping the public views and judgments. The information content of announcements can take several forms varying from a simple gossip to advanced marketing propaganda. Hence, rumours could be perceived as an "infection of the mind", and their transmitting documents a close similarity to that of epidemics (Nekovee *et al.,* 2007). Rumours unambiguously have psychological impact on the market participants, might cause serious panic and thus distort the financial markets (Kimmel, 2004; Kosfeld, 2005). Palmon *et al.* (2009) point out that in particular business magazines and high-tech information intermediaries such as websites, blogs and social networks are very often a source of rumours that take an enormous influence on the decision making of investors. They conclude that columnists as well as financial analysts have a significant power to be a source of the "intellectual epidemic".

The very first rumour spreading model was developed by Daley, Kendall (1964). Here, the population is subdivided into three groups and the relationship between spreading an infectious disease and the dissemination of information is mathematically formalized. Another approach proposed by Moreno *et al.* (2004) considers that different dynamical propagation behaviours are possible depending on how complex heterogeneous networks are interconnected. In their ISS model each of the N elements of the network can be in three different states; thus, there are three groups corresponding to ignorants (I), spreaders (S) and stiflers (R). The ignorants have not heard the rumour and hence they are susceptible to be informed. The second group of investors, the spreaders (S), are active individuals that are spreading the rumour. Finally, the stiflers (R) representing the third group have heard the rumour but they are no longer spreading it. The spreading process evolves by directed contacts of the spreaders with others in the total population (Moreno *et al.,* 2004). Piqueira (2010) studied the ISS model and established stability of equilibrium according to propagation parameters and initial conditions. Wang *et al.* (2014) based on previous rumour spreading

models developed a new approach called SIRaRu model in complex networks. In this model a closed and mixed population is considered that consists of N individuals as a complex network, where individuals can be represented by vertexes and contacts between people. The authors assume that the rumour is disseminated through direct contacts of spreaders with the rest of the population and derive the mean-field equations both in homogeneous and inhomogeneous networks.

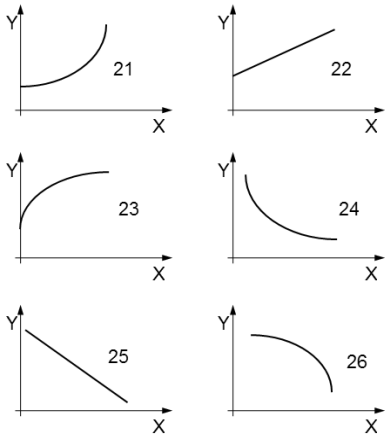
## 2. Methodology

### *2.1 Quantitative and Qualitative Scenarios*

The key problem of realistic complex tasks is a serious shortage of information (Dohnal, 1992). Objective and subjective methods must be synthesized to gain the obvious benefits of objective precision (deep knowledge) and semi-subjective common sense abilities (shallow knowledge), see e.g. (Jiang *et al.*, 2014; Dai *et al.*, 2014).

Deep knowledge items are the laws which reflect undisputed elements of the corresponding theory, for example the law of gravity. However, soft sciences, such as economics, sociology, and ecology, are just very rarely based on deep knowledge items. A shallow knowledge item is usually a heuristic or a result of a statistical analysis, see e.g. (Orrell, McSharry, 2009; Orrell, Fernandez, 2010; Pavláková Dočekalová *et al.*, 2017).

Many shallow knowledge items are available just as verbal trend descriptions; this can be decreasing, constant or increasing (Yan *et al.*, 2013). For example – if political uncertainty is increasing, then the level of local investments is decreasing. Typical examples of such pair wise trend relations are given in *Figure 1*.




*Source:* Dohnal (1992).

*Figure 1*. **Examples of Qualitative Pair Wise Relations**

All pair wise relations *X*, *Y* in *Source:* Dohnal (1992).

*Figure* are trend relations. It means that nothing is quantified.

Decision tree is a powerful induction method in data mining. However, real world applications of decision trees exhibit uncertainty through missing and/or imprecise data,

vagueness, ambiguity, etc. (see e.g. Lertworaprachaya *et al.*, 2014). Decision trees based on sets of scenarios are used to deal with these uncertainties.

Broadly speaking, the diversity of techniques employed in scenario planning can be classified into qualitative and quantitative, based on the nature of the procedures they employ (Moreno-Garcia *et al.*, 2014). There are several qualitative procedures. The methods presented in this paper are based on three qualitative values, see e.g. (Žabkar *et al.*, 2013):

*Positive, zero, negative.* 1)

A set of $m$ qualitative $n$-dimensional scenarios is described by a sequence of qualitative triplets:

$$\mathbf{S}(n, m) = [(X_1, DX_1, DDX_1), (X_2, DX_2, DDX_2), \ldots, (X_n, DX_n, DDX_n)]_j, j = 1, 2, \ldots, m \quad 2)$$

Where $j = 1, 2, \ldots, m$. $DX_i$ is the first and $DDX_i$ is the second time qualitative derivatives of variable $X_i$.

A qualitative model $Q$ based on shallow knowledge, studied in this paper, is a set of $w$ pair wise relations:

$$P_v(X_i, X_j), v = 1, 2, \ldots, w. \quad 3)$$

For example, the pair wise relation No. 23, see *Figure 1*, indicates that: 1) the relation is increasing, if the first derivative is positive; 2) there is a "saturated"' relationship between $Y$ and $X$, thus, the second derivative is negative; 3) if $X = 0$, then $Y =$ positive value.

This set of relations can be figured out to assess those scenarios (2) which are in line with the model (3). For example, if the following set of pair wise relations is studied:

| | Shape | $X$ | $Y$ | |
|---|---|---|---|---|
| 1 | 22 (see *Figure 1*) | | $X_1$ | $X_2$ |
| 2 | 26 (see *Figure 1*) | | $X_3$ | $X_2$ |

4)

Where $X_1$ means *Political Certainty*, $X_2$ means *IPO Volume* and $X_3$ means *Underpricing*. The solution of the model (1) is represented by 13 three-dimensional scenarios, see (2):

| | $X_1$ | $X_2$ | $X_3$ |
|---|---|---|---|
| 1 | + + + | + + + | + – – |
| 2 | + + 0 | + + 0 | + – – |
| 3 | + + – | + + – | + – + |
| 4 | + + – | + + – | + – 0 |
| 5 | + + – | + + – | + – – |
| 6 | + 0 + | + 0 + | + 0 – |
| 7 | + 0 0 | + 0 0 | + 0 0 |
| 8 | + 0 – | + 0 – | + 0 + |
| 9 | + – + | + – + | + + – |
| 10 | + – 0 | + – 0 | + + – |
| 11 | + – – | + – – | + + + |
| 12 | + – – | + – – | + + 0 |
| 13 | + – – | + – – | + + – |

5)

### *2.2 Unsteady State Qualitative Behaviours*

A simple common sense analysis of an oscillator indicates that a spring which is currently moving in one direction must stop first and then it can move in the opposite

direction. It means that the following transition between two one-dimensional triplets is not possible:

$$(+\,+\,+) \rightarrow (+\,-\,-) \qquad 6)$$

Where the triplet has the following meaning: ($X$, D$X$, DD$X$), where e.g. D$X$ is the first qualitative time derivative of $X$ and DD$X$ is the second qualitative time derivative of the variable $X$.

A complete set of all possible one-dimensional transitions is given in the *Table 2*.

**Table 2. A set of one-dimensional positive transitions**

| | From | | To | Or | Or | Or | Or | Or | Or |
|---|---|---|---|---|---|---|---|---|---|
| 1 | + + + | → | + + 0 | | | | | | |
| 2 | + + 0 | → | + + + | + + – | | | | | |
| 3 | + + – | → | + + 0 | + 0 – | + 0 0 | | | | |
| 4 | + 0 + | → | + + + | | | | | | |
| 5 | + 0 0 | → | + + + | + – – | | | | | |
| 6 | + 0 – | → | + – – | | | | | | |
| 7 | + – + | → | + – 0 | + 0 + | + 0 0 | 0 – + | 0 0 + | 0 0 0 | 0 – 0 |
| 8 | + – 0 | → | + – + | + – – | 0 – 0 | | | | |
| 9 | + – – | → | + – 0 | 0 – – | 0 – 0 | | | | |

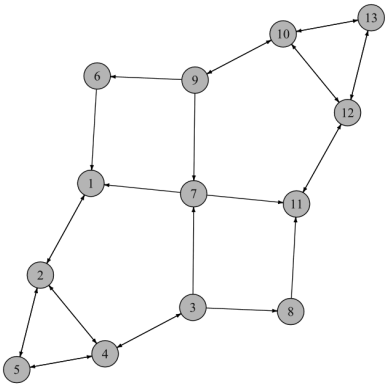
*Source:* Dohnal (1992).

For example, the second line of *Table 2* indicates that it is possible to transfer the triplet (+ + 0) into the triplet (+ + +) or (+ + –).

A transitional graph $H$ is defined as an oriented graph. Its nodes represent the set of scenarios $S$ (2) and oriented arcs are defined as the transitions $T$ obtained according to transitions from *Table 2*:

$$H(S, T) \qquad 7)$$

It is possible to generate the set of $n$-dimensional transitions $T$ by the appropriate set of scenarios $S$ using *Table 2* of one-dimensional transitions. All $n$ one-dimensional transitions must satisfy *Table 1* if $n$-dimensional scenarios are studied. For example, the transitional graph $H$ of the set of scenarios $S$ (5) and the transitions $T$ obtained according to transitions from *Table 2* is shown in *Figure 2*.




*Source:* Dohnal (1992).

*Figure 2*. **Tutorial Example of a Transitional Graph**

A path $P$ comprises an oriented sequence of scenarios. The graph $H$ (7) can have loops and therefore a path $P$ can go through the loop infinitely many times. A tree has no loop by definition. Therefore, just such a path $P$ is studied which is a sub path of a qualitative tree $R$ and this tree is a sub-graph of the transitional graph $H$.

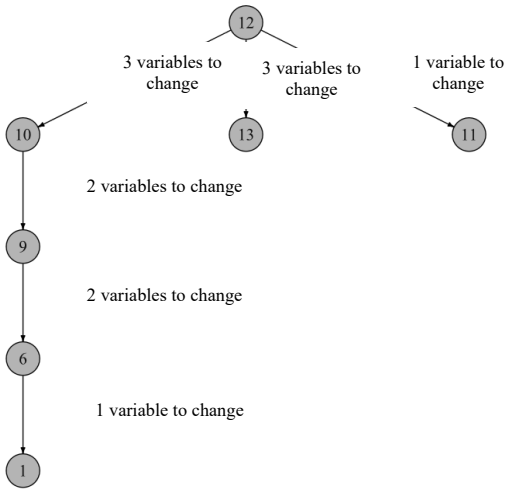
Let the scenario No. $i$ be a root scenario of a tree. A decision maker must choose such a set of terminal scenarios $E_i$ which uniquely specify a tree $R$ which has the scenario $S_i$ as its root and $E_i$ as its set of terminal scenarios:

$$R(S_i, E_i) \qquad 8)$$

Let the scenario No. 12 (see *Figure 2*) be the current situation, i.e. $S_{12}$ is the root (8). The chosen set of terminal scenarios $E_{12}$ is as follows:

$$\boldsymbol{E}_{12} \equiv \{S_1, S_{11}, S_{13}\} \qquad 9)$$

The qualitative tree $R$ ($S_{12}$, $E_{12}$) (8) is shown in *Figure 3*.




*Source:* created by the authors.

*Figure 3*. **Qualitative Tree**

Each node of the qualitative tree (see *Figure 3*) has its description/characteristic, e.g. the scenario No. 1 is the terminal scenario connected with a profit which is increasing more and more rapidly (+ + +), see (5). The list of all possible transfers from the scenario No. 12 is, see *Figure 2* and *Figure 3*:

$$\begin{array}{ll} 12 \rightarrow 10 & (a) \\ 12 \rightarrow 11 & (b) \\ 12 \rightarrow 13 & (c) \end{array} \qquad 10)$$

The transition (b) is fully under control of the government as it is the taxation that is the driving force of this transition, see (5)(5):

$$\begin{array}{llll} X_1 & X_2 & X_3 & \\ 12 & + - - & + - - & + + 0 \quad \text{From} \\ 11 & + - - & + - - & + + + \quad \text{To} \end{array} \qquad 11)$$

The only further step is to return to the scenario No. 12 (see *Figure 2*). However, if the taxation is increased to (+ + +), then the move to the scenario No. 11 is unavoidable. There is just one escape route from the scenario No. 11 (see *Figure 2*). The taxation $X_3$ is not under

control of a decision maker. It means that the transitions (b) and (c), see 10) can be done against the will of the decision maker. The transition (a) can be done if the taxation is (+ + –) and the investment $X_1$ is (+ – 0). The next step is the transition 10 → 9. This is again a conditional transition as it depends on the taxation. It can be done only if the taxation remains unchanged.

### *2.3 Quantifications of Trees Probabilities*

It is highly desirable to evaluate the probabilities of all/some branches of the qualitative tree *R* (8) under study. However, the information shortage usually does not allow applications of traditional statistical methods. Hence, several different heuristics are used to formalize common sense reasoning. For example:

*A transition between two scenarios is less probable if more variables must be changed.* 12)

The examples of interpretations of (12) are as follows:

*If all n variables must be changed to move from* i-*th scenario to* j-*th scenario then this transition is the least probable.*

*If just one variable is changed to move between two scenarios then this transition is the most probable.*

The following algorithm is used to evaluate numerical probabilities of the tree (9) using the above-mentioned heuristics:

*E* Set of terminals, see 9), *Figure 3*.

*N* Set of all tree nodes (scenarios).

$l_{i,j}$ Number of changed variables in the transition of *i*-th scenario into *j*-th scenario.

$l_{12,\,11} = 1$, see *Source:* created by the authors.

*Figure* and (5).

$L_i$ The number of changed variables of the sub-tree where *i* is the sub-root, i.e. variable resistance of *i*-th node.

$L_i = \sum_j l_{i,j}$ , see e.g. $L_{12} = l_{12,1} + l_{12,11} + l_{12,13} = 8 + 1 + 3 = 12$, see 13)

*Figure 3*

Where *j* represents nearest node (scenario) of the sub-tree next to the *i*-th node (scenario).

$l^*_{i,j} = L_i - l_{i,j}$, for all $i, j \in \mathbf{N} - \mathbf{E}$, $l_{12,11}{}^* = L_{12} - l_{12,11} = 12 - 1$ 14)

$L^*_i$ The sum of all changed variables for all transition of the *i-th* 15) sub-tree:

$L^*_i = \sum_j l^*_{i,j}$ , see e.g. $L^*_{12} = l^*_{12,1} + l^*_{12,11} + l^*_{12,13} = 24$ 16)

Where *j* represents nearest node of the sub-tree next to the *i-th* node.

Let us suppose that the tree (see *Figure 3*) is a system of pipes and one litre of water per second is pumped into the root node No. 12. Simple common sense reasoning indicates that short branches have lower hydraulic resistance, and therefore the water outflow from the nodes 11 and 12 must be higher than the outflow from the node No. 1 (see *Figure 3*). However, the hydraulic resistance of each pipe, which represents a transition between two scenarios, must take into consideration the number of changed variables as well, see (12).

The following splitting ratios α are used to evaluate the flow of water through a tree, through each its branch:

$\alpha_{i,j}$ Splitting ratio from *i-th* node (scenario) to *j-th* node (scenario):

$$\alpha_{i,j} = l^*_{i,j} \Big/ L^*_i \text{, for all } j \in \mathbf{N}-\mathbf{E} \text{, see e.g. } \alpha_{12,11} = l_{12,11}{}^*/L^*_{12} = 11/24 \quad 17)$$

The heuristic (12) can be used to evaluate splitting ratios (17), see *Figure 3*.

$$\begin{aligned} &\alpha_{12,11} = 11/24 = 0.458 \\ &\alpha_{12,13} = 9/24 = 0.375 \\ &\alpha_{12,10} = 7/42 = 0.167 \\ &\alpha_{12,1} + \alpha_{12,13} + \alpha_{12,10} = 1 \\ &\alpha_{10,9} = 2/2 = 1 \\ &\alpha_{9,6} = 2/2 = 1 \\ &\alpha_{6,1} = 1/1 = 1 \end{aligned} \quad 18)$$

The water flow rate through each node is equal to its probability as the flow satisfies to all probability axioms, namely:

For all $A \in \Omega$, $p(A) \geq 0$ 19)

$p(\Omega) = 1$ 20)

$p(A_1 \cup A_2 \cup ... \cup A_i) = \sum p(A_i)$ 21)

The probability $p_r$ of a root node is always equal one as one litre per second of water.

$p_r = 1$ 22)

The non-root probability $p_{i,j}$ of the transition from *i*-th scenario into *j*-th scenario can be evaluated very easily by:

$$p_{i,j} = \sum_{i=1}^{k} \left( p_{k,i} \cdot \alpha_{i,j} \right), \; j \in (\mathbf{N}-\mathbf{E}) \quad 23)$$

Where *k* is the sub-root. **The principle of calculation is shown in the following** example – see *Figure 3*:

$$\begin{aligned} &p_{12,11} = 1 \times \alpha_{12,11} = 1 \times 0.458 = 0.458 \text{ ; see (22), (23)} \\ &p_{12,13} = 1 \times \alpha_{12,13} = 1 \times 0.375 = 0.375 \\ &p_{12,10} = 1 \times \alpha_{12,10} = 1 \times 0.167 = 0.167 \\ &p_{10,9} = p_{12,10} \times \alpha_{10,9} = 0.167 \times 1 = 0.167 \\ &p_{9,6} = p_{10,9} \times \alpha_{9,6} = 0.167 \times 1 = 0.167 \\ &p_{6,1} = p_{9,6} \times \alpha_{6,1} = 0.167 \times 1 = 0.167 \end{aligned} \quad 24)$$

## 3. Empirical Results: A Case Study Analysis

Here, we model the relation between political uncertainty and firms' financing decisions while applying the SIRaRu rumour propagation model. A case study approach is used in order to examine how rumours related to political and macroeconomic uncertainty might impact going public success and thus probable variations in IPO volumes. Within this

study we build on our previous works (Meluzín *et al.*, 2017; 2018) that sought propose a qualitative model based on trends dealing with propagation of cofounding announcements within going public procedure and timing of initial public offerings.

The academic literature indicates the IPO as successful if the entire issue is subscribed allowing the sale of shares at the most advantageous price while at the same time the investors are provided with the opportunity to collect profits in a long time horizon.

In our case study rumours related to political and macroeconomic instability in country *"A"* are considered. As a result, there is great uncertainty on the side of investors. A confounding announcement ($F_1$) is spread as follows:

$F_1$: *The previous government left office and the new political leader repeatedly claimed during the pre-election political campaigns that there will be fundamental changes in the future economic policy.*

This announcement has been regularly published in economic sections of prominent international business magazines and contains essential information which might have a negative impact on the sale of stocks within going public procedures. It is highly probable that the wide public of investors will change its investment sentiment. We consider that the rumour is a lottery, i.e. the investors cannot take any action to limit the risk.

Mankiw (2014) explains how rumours about political uncertainty are able to change the economy's equilibrium, asset prices and going public volumes. First of all, most of the investors perceive the information very sensitively, which is a stimulus for decision to rebalance their asset structure in the country *"A"*. The revenues are used to purchase assets in a politically stable country (in a save harbour). This will lead to an enormous increase in net capital outflow (*NCO*) resulting in a greater demand for loanable funds (*FL*), which are used to finance purchases of foreign assets abroad. This results in an increase in the real interest rate (*r*) in the country *"A"*. Thirdly, due to surplus supply over demand on the foreign exchange market the exchange rate (*E*) of domestic currency depreciates. These changes in macroeconomic equilibrium that are driven up by rumours on political uncertainty will affect some other macroeconomic indicators. The trade balance (*TB*) will be in positive numbers because of currency depreciation and domestic real investment (*RI*) will be pushed downwards as a result of a higher real interest rate (Jovanovic, Rousseau, 2004). The reaction of the securities market to an increase of the real interest rate in the country *"A"* will cause a drop in prices of stocks (*SP*) because an inverse relationship between interest rates and stock prices is assumed (Mankiw, 2014). Therefore, a vast majority of companies will face declines in their stock prices (*SP*) as more expensive money is connected with a drop in consumption and thus profits. Additionally, in the country's economy a significant decline in investment can be expected limiting their growth opportunities. An IPO strategy is less attractive as both IPO firms and investors are exposed to a greater degree of information asymmetry determining the initial stock prices. Higher interest rates and greater uncertainty in relation to future developments will increase the value under-pricing (*UP*). To sum up, the volume of IPOs the country *"A"* is at a very low level because both investors and prospective public firms are motivated to wait for "the window of opportunity".

On the basis of the previous knowledge, for the model of rumour propagation SIRaRu and its impact onto the IPO activity, the following variables have been identified: *NCO*, *FL*, *SP*, and *UP* and their relations (25), recorded by means of the pair relations from *Figure 1*:

$$P_1(NCO, FL) = 22$$
$$P_2(NCO, SP) = M_+ \qquad 25)$$

$P_3(NCO, UP) = M_+$

The $M_+$ label is used due to the fact that on the basis of formulations in the above text, it is not obvious whether the speed of changes between the relevant variables *NCO*, *SP* and *UP*, see (12), is constant, increasing or declining. Therefore, $M_+$ represents the relations 21, 22 and 23 taken from *Source:* Dohnal (1992).

*Figure* .

The pair relations (25) formulate the qualitative model $Q_{H1}$, based on heuristics. Propagating the rumour $F_1$ is described by the qualitative model $Q_R$, based on the model (Wang *et al*., 2014) and extended with the infection rate of the population by the rumour $P_P$.

$$DI = -I \cdot S$$
$$DS = +I \cdot S - S\,(S + R_a + R_u) - S$$
$$DR_a = I \cdot S + S\,(S + R_a + R_u) + S$$
$$DR_u = I \cdot S \qquad 26)$$
$$P_p = \frac{S + R_a}{S + R_a + R_u + I}$$

The impact of the rumour propagation onto the IPO may be described by suitably interconnecting the model $Q_R$ (26) with the model $Q_{H1}$ (25). Interconnecting both models $Q_{H1}$ and $Q_R$ may be performed by means of introducing the additional pair relations, i.e. by introducing another qualitative model $Q_{H2}$ based on heuristics.

Based on research by Seymour-Ure (2003) and Meluzín *et al.* (2017), the following statement is derived. Investors are affected by rumours and decide to sell some of their assets which they own in the country "*A*". The proceeds will be used to purchase assets abroad, which will result in the increase in capital outflows. Based on this statement, the heuristics *H2* may be formulated.

(*H2*) *The growing knowledge of the rumour* $F_1$*, i.e. the growing infection rate of the population* $P_P$*, will deepen the negative balance between the capital inflows and outflows (NCO)*.

The heuristics *H2* formulation does not clearly indicate the changes in the speed of the net capital outflow *NCO* as the population infection rate $P_P$ grows. This means that the relation 24 or 25 or 26 (see *Figure 1*) may be used for the purposes of expressing the relation between the *NCO* and $P_P$. These possible mutual links will be represented by the label $M_-$.

In such a case, the heuristics *H2* may be recorded by the pair relation (27).

$$P_4(P_P, NCO) = M_- \qquad 27)$$

This pair relation is represented by the qualitative model $Q_{H2}$, based on one heuristics *H2*.

The model describing the rumour propagation and its impact onto the IPO may be obtained by merging the models $Q_{H1}$, $Q_R$ and $Q_{H2}$. The resulting model is a mixed qualitative model $Q_S$.

$$Q_S = Q_{H1} \vee Q_R \vee Q_{H2} \qquad 28)$$

The solution to the mixes qualitative model $Q_S$ consists in the set $S_S$, comprising 15 scenarios (see *Table 3*).

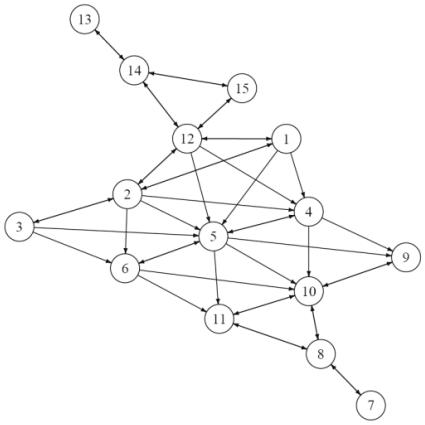
Due to the number of variables, what is also used is the simplification of the description of the scenarios for individual variables, when the header indicates only the variable label, e.g. *I*; the first and second derivation, e.g. *DI* and *DDI*, are left out of the description. This means that the first scenario + – + for the header *I* may also be recorded as *I* = +, *DI* = – and *DDI* = +.

**Table 3. A list of all one dimensional transition**

| Scenario | $P_P$ | NCO | FL | SP | UP | I | S | $R_a$ | $R_u$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | ++- | +++ | ++- |
| 2 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | ++- | ++0 | ++- |
| 3 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | ++- | ++- | ++- |
| 4 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +0- | +++ | ++- |
| 5 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +0- | ++0 | ++- |
| 6 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +0- | ++- | ++- |
| 7 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +-+ | ++- | ++- |
| 8 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +-0 | ++- | ++- |
| 9 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +-- | +++ | ++- |
| 10 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +-- | ++0 | ++- |
| 11 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +-- | ++- | ++- |
| 12 | ++- | +-+ | +-+ | +-+ | +-+ | +-0 | ++- | +++ | ++0 |
| 13 | ++- | +-+ | +-+ | +-+ | +-+ | +-- | +++ | +++ | +++ |
| 14 | ++- | +-+ | +-+ | +-+ | +-+ | +-- | ++0 | +++ | +++ |
| 15 | ++- | +-+ | +-+ | +-+ | +-+ | +-- | ++- | +++ | +++ |

*Source:* created by the authors.

Using a transformation table (*Table 2*) determines 46 possible transitions between all 15 scenarios of *Table 2*. *Figure 4* shows the transitional graph *G*, which belongs to these scenarios and their transitions.




*Source:* created by the authors.

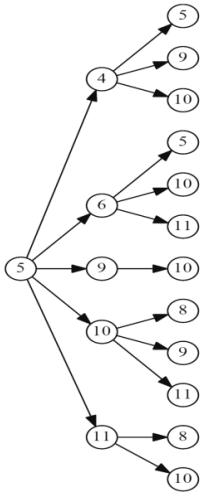
*Figure 4.* **Transitional Graph *G***

The transitional graph in *Figure 4* lists all possible orientated paths between the individual nodes/scenarios. These oriented paths are a qualitative description of the past and future behaviour of the model. The transitional graph displays all possible past/future behaviour of the model or the examined variables, such as economic indicators. It may thus be said that the change in the state of the examined model/examined variables, i.e. the prediction, is identical to selecting a particular path in the transitional graph (see *Figure 4*).

Most practical tasks involve the efforts to determine what will or will not happen in the future. This prediction is a result of the decision of rationally thinking participants (decision-makers, such as the issuing company and the investment bank), and unknown steps of an indifferent participant, such as the government, columnists, social media contributors, etc.

All possible future states result from the transitional graph (see *Figure 4*). The application of the proposed approach assumes that the scenario 5 describes the current situation. Each edge of the transitional graph represents the transition from one node to another. This transition is associated with a certain amount of time expressed in certain time units. For the reasons of simplicity, it is possible to consider that each transition takes one time unit.

It is required to determine the possible future states in the next two time units. Graphically, these states may be represented by means of a qualitative tree (see *Figure 5*).




*Source:* created by the authors.

*Figure 5*. **Qualitative Tree**

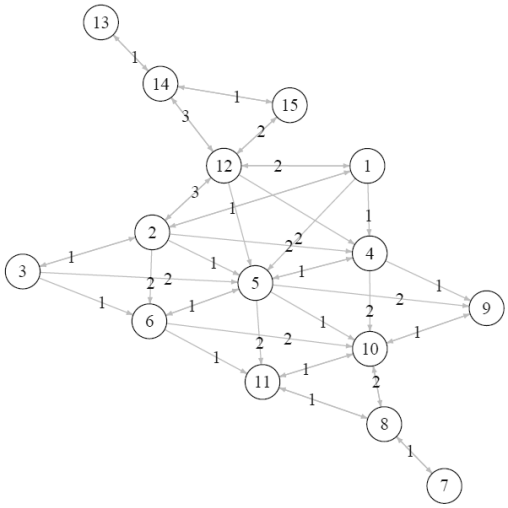
*Figure 5* shows that there are in total twelve possible states (12 nodes on the third level of the qualitative tree). The most likely state may be determined using heuristics (12) and procedures (13)–(17) and (19)–(21). This procedure is based on the fact that the transition is associated with a change in some of the variables (see *Table 4*). For instance, within the change from the scenario 3 to the scenario 5, there is a change in the variables $S$ and $R_a$ (see *Table 4* and *Figure 4* ). The variable $S$ changes from the trend (+,+,−) into the trend (+, 0,−), while the variable $R_a$ changes from the trend (+,+,−) into the trend (+,+, +).

**Table 4. Trends Changes in Variables**

| Scenario | $P_P$ | NCO | FL | SP | UP | I | S | $R_a$ | $R_u$ |
|---|---|---|---|---|---|---|---|---|---|
| 3 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | ++- | ++- | ++- |
| 5 | ++- | +-+ | +-+ | +-+ | +-+ | +-+ | +0- | ++0 | ++- |

*Source:* created by the authors.

*Figure 6* shows the edges of the transitional graph (see *Figure 4*) marked with numbers expressing the number of variables which have to change at these transitions.




*Source:* created by the authors.

*Figure 6.* **Qualitative Tree**

Based on the number of changing variables at the transition between individual scenarios (see *Table 3*), it is possible to determine the likelihood of the transitions in the qualitative tree (see *Figure 5*).

**Table 5. Probability of Transitions**

| From Node No. | To Node No. | Probability | From Node No. | To Node No. | Probability |
|---|---|---|---|---|---|
| 5 | 4 | 0.205 | 9 | 10 | 1 |
| 5 | 10 | 0.193 | 6 | 11 | 0.375 |
| 5 | 9 | 0.216 | 6 | 10 | 0.25 |
| 5 | 6 | 0.193 | 6 | 5 | 0.375 |
| 5 | 4 | 0.193 | 4 | 10 | 0.25 |
| 11 | 10 | 0.5 | 4 | 9 | 0.375 |
| 11 | 8 | 0.5 | 4 | 5 | 0.375 |
| 10 | 11 | 0.375 | | | |
| 10 | 9 | 0.375 | | | |
| 10 | 8 | 0.25 | | | |

*Source:* created by the authors.

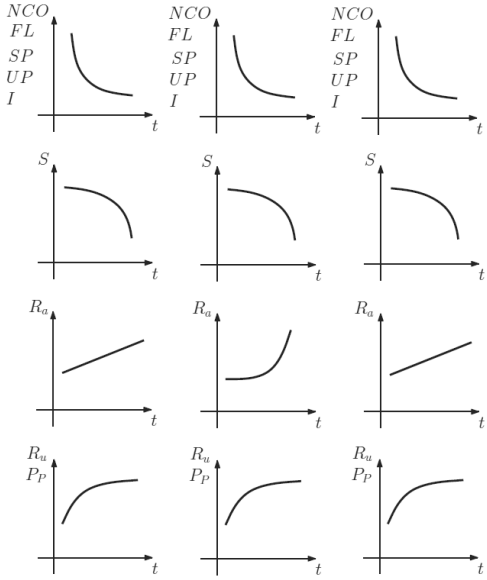
*Table 5* and *Figure 5* show that the most likely future state within two time units includes the path 5 → 9 →10. The trends of individual variables are shown in *Table 6*.

**Table 6. Prediction of the Development of Variables**

| Prediction / Variable | 5 → | 9 → | 10 |
|---|---|---|---|
| $P_p$ | ++- | ++- | ++- |
| *NCO* | +-+ | +-+ | +-+ |
| *FL* | +-+ | +-+ | +-+ |
| *SP* | +-+ | +-+ | +-+ |
| *UP* | +-+ | +-+ | +-+ |
| *I* | +-+ | +-+ | +-+ |
| *S* | +0- | +-- | +-- |
| $R_a$ | ++0 | +++ | ++0 |
| $R_u$ | ++- | ++- | ++- |

*Source:* created by the authors.

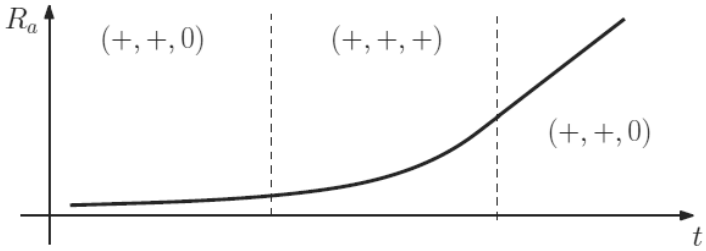
Graphically, the trends recorded as triplets in *Table 6* may be represented by means of the relations (a)–(f), see *Figure 7*.




*Source:* created by the authors.

*Figure 7*. **Visualization of Triplets from the Table 6**

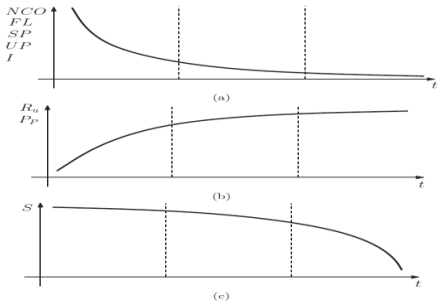
Based on *Figure 7*, for each examined variable, it is possible to reconstruct its development over time. For instance, *Figure 8* shows the development of the variable $R_a(t)$ over time $t$.




*Source:* created by the authors.

*Figure 8*. **Development of the Variable over Time**

*Figures 9(a) – 7(c)* show the remaining variables *NCO*, *FL*, *SP*, *UP*, *I*, *S*, $R_u$ and $P_P$ over time.




*Source:* created by the authors.

*Figure 9*. **Time Series**

As for the results shown in *Table 5*, it needs to be pointed out that the examined variables have the identical trends for the final scenarios from *Figure 5*. This means that the graphical representation of other paths from *Figure 5* would correspond to *Figure 7* and *Figure 8*. This case has shown a certain limitation of qualitative modelling which could nevertheless be avoided by adding further variables into the qualitative model *Q*.

## Conclusions

In this paper, we applied the SIRaRu rumour propagation model investigating the dynamics of the rumour spreading in complex social networks. More precisely, we model the relation between political uncertainty and firms' financing decisions and document how the IPO activity is affected if confounding announcements in regard to political uncertainty are spread. The SIRaRu model is solved qualitatively; this means that there are no quantifiers, numbers, and fuzzy/rough sets and a qualitative on trendsbased approach is applied. We consider that the rumour is a lottery, i.e. it cannot be under control of decision makers.

We established a new qualitative on heuristics-based model and derived a transitional graph to study all possible past/future behaviour of the examined variables. Additionally, we propose a graphical solution to reconstruct the development of the variables under study over time. We believe that our model will support both issuing companies and investors in their decision making if rumours are spread and there is a need to study possible scenarios of the upcoming development. Our set of scenarios, the transitional graph and the visualization of the development of variables under study over time represent a tool which makes sure that no reasonable variant is overlooked, i.e. all possible changes of the situation are covered.

There are five main benefits of our analytical approach. Firstly, no numerical values of constants and parameters are needed. Next, it is possible to develop a multidimensional model based on verbal knowledge items. Third, the set of qualitative scenarios is a superset of all meaningful networks of scenarios, i.e. forecasts. Fourth, no significant forecast can be omitted if the analysis is based on a good qualitative model. Finally, all possible time transitions among the generated set of scenarios are identified.

The above benefits provide a comprehensive approach to solving economic problems. Narrow-looking models are not immediately applicable in practice, since they ignore important aspects, such as the impact of a policy onto macroeconomic indicators, the impact of rumours onto financial markets, etc. These aspects have not yet been considered in theories

even though they play an important role in decision-making. Failure to consider these aspects does not allow a systematic description of the issues at hand. The trends-based models allow these aspects to be integrated into the solved economic issues, serving as a generator of possible future states of the model under study.

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**GANDŲ, SUSIJUSIŲ SU POLITINIU IR MAKROEKONOMINIU NETIKRUMU, POVEIKIS PRADINIO VIEŠO AKCIJŲ PLATINIMO (PVAP) SĖKMEI: KOKYBINIO MODELIO ĮRODYMAI**

**Tomáš Meluzín, Adam P. Balcerzak, Michał B. Pietrzak, Marek Zinecker, Karel Doubravský**

**SANTRAUKA**

Straipsnis skirtas gandų dėl politinio ir makroekonominio netikrumo, susijusio su vykstančia viešąja strategija, skleidimo tyrimui. Gandai gali turėti didžiulės įtakos rinkos dalyvių sprendimų priėmimui dėl informacijos asimetrijos. Taip galima paaiškinti pradinių viešųjų pasiūlymų apimčių kiekybinį pobūdį. Straipsnyje modeliuojama politinio neapibrėžtumo ir įmonių finansavimo sprendimų sąsaja taikant „SIRaRu“ gandų plitimo modelį, tiriant gandų plitimo sudėtinguose socialiniuose tinkluose dinamiką. Buvo užfiksuota, kaip neigiamai gali būti paveikta PVAP veikla, kai yra skleidžiami neigiami politinio netikrumo pranešimai. Kai kurios realios sąlygos, susijusios su ankstesniais gandus skleidžiančiais modeliais, buvo papildytos, ir nustatyta nauja kokybinė tendencijų modelio išraiška. Buvo sukurta pereinamoji grafika, skirta tirti visų galimų praeities / ateities nagrinėjamų kintamųjų elgesį. Straipsnyje siūlomas grafinis sprendimas, kuriuo, laikui bėgant, bus rekonstruota studijuojamų kintamųjų raida.

*REIKŠMINIAI ŽODŽIAI:* makroekonomika, politika, gandai, viešas vyksmas, PVAP, kokybiniai modeliai, scenarijai.