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QUALITATIVE MODELING MACROECONOMICS INDICATORS FOR PREDICTION OF PROGRESS BRANCH

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Abstract

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A qualitative modelling philosophy has been developed in an effort to produce a general and reasonably unified common sense approach to the modelling of unique, complex and unsteady state systems. Economics, Ecology, Sociology and Politics are sciences, which study such systems. An integration of sub models from those sciences into supermodels is inevitable if realistic decision making tasks are analysed. Therefore conventional formal tools (e.g. statistics) cannot be correctly applied because of lack of information. Qualitative variables are quantified using three values only – positive (increasing), zero (constant) and negative (decreasing). Knowledge items of qualitative nature (e.g. *if productivity goes up then profit does not decrease*) are often the only available information. The classical quantitative tools cannot deal with such information items. However, qualitative models can absorb shallow qualitative knowledge and generate all possible scenarios i.e. qualitative solutions. The complete list of scenarios guarantees that any analysis (decision making) based on it does not ignore any promising solution. The case study of oil related macro economical risks is presented in details (15 variables e.g. Inflation, Corruption, 14 qualitative relations among the variables). No a priory knowledge of qualitative analysis is required.

modelling, qualitative analysing, prediction, scenario, macroeconomics indicators

Numerical mathematics and statistical analysis are traditionally the key tools used in assessing engineering problem (Dohnal, 2004). Engineering systems e.g. oil pipelines, can be easily measured, they are well understood and therefore their models are accurate. The final consequence is that the models available in a form of a set of equations can be successfully used for predictions.

A traditional formal approach to problem solving can be characterised by the following steps (Scott, 2005):

- A conventional mathematical model is developed using available theories;
- Using experimental data or experience, numerical values of all constants in the model are identified;
- The resulting mathematical model is numerically solved;

The biggest disadvantage of this approach is that it is time consuming and usually expensive. Its greatest advantage is that the answer is numerically quantified.

Formal models generated by soft sciences, e.g. sociology, political science, macroeconomics, are (Williams, 1991):

- Based on shallow knowledge which cannot be confirmed by any controlled experiments, usually researchers are in a role of passive observers;
- Heavily, rather often prohibitively, simplified. For this there are the following reasons:
  - The problems under study are heavily interlined with their environment (e.g. macroeconomics, political situation, religious conditions etc.), that they are too complex to be studied as whole. Therefore many substantial variables and relations must be ignored;

- Many important variables cannot be quantified by numbers obtained through measurements. Therefore subjective ways of quantification must be used (e.g. verbal quantification);
- Information shortage cannot be proved using statistical methods, however the shortage is obvious. Therefore all available information items must be incorporated into models. The consequence is that the final model is based on a very heterogeneous network of inaccurate, sparse, subjective and vague information items.

These are the main reasons why prediction capabilities of models developed by soft sciences are usually poor (Davis,1990).

An alternative is to develop fundamentally new formal tools, which are capable of handling information, which currently is out of reach of the conventional tools. Many of those working in soft science areas will recognise that experience or common sense reasoning plays an important part in their decision making processing yet in most cases conventional techniques are not adapted to capture this important qualitative information (Luňáček, Dohnal, Meluzín, 2006; Terry, 1998). The development of a model capable of doing this would make a new and important addition to the understanding of the important political science problems.

However, for many real problems or tasks a set of traditional equations is not always helpful. In part this is because reasoning is required rather than merely calculations. Human thought is not usually based on equations and one of the most powerful tools which human beings bring to bear on real problems is common sense reasoning (Davis, 1990).

Modern computers provide a powerful basis for number manipulation but their contribution to problem solving based on common sense or qualitative inputs has so far been very small. (Li, 2005). However a methodology of vague modelling (e.g. fuzzy logic, qualitative modelling, rough modelling) is now gradually being built up to enable algorithms to be programmed which can be based on qualitative inputs (Dohnal, 2002). The important basis for this is that the vague knowledge must not be modified to fit the tools but that the tools should be sufficiently flexible that they can handle and integrate vague and sometimes inconsistent knowledge with the minimum amount of knowledge loss.

The purpose of this paper is to provide an introduction to such a model. It needs emphasising that this is a highly simplified example and that the qualitative inputs used are for illustration only. They have not been refined or moderated by any discussion with the industry. Nevertheless, it is hoped that it provides a sufficiently realistic example to demonstrate its potential for using qualitative analysis in understanding prohibitively complex political tasks and related problems.

MATHERIALS AND METHODS

There are basically two different approaches to solving complex risk related problems: *Common sense*, which requires minimum formal calculations, often back-of-the-envelope calculations and *Formal approaches*, usually computer based.

Both approaches are interlinked. The common sense approach normally dominates during the early stages and its application is required throughout, in order to cross-check computer results and other calculations.

A qualitative model is the most advanced calculus, which can be used as a theoretical background to formalise common sense reasoning. In brief, there are instances where traditional formal models may not be the most appropriate tools for understanding and explaining political tasks. In their place, common sense reasoning may provide an alternative.

As an explanation of a qualitative model, suppose there are only three qualitative values

positive, zero or negative (1)

a qualitative solution of a qualitative model is specified if all its *n* qualitative variables

$$X_1, X_2, \ldots X_n. \quad (2)$$

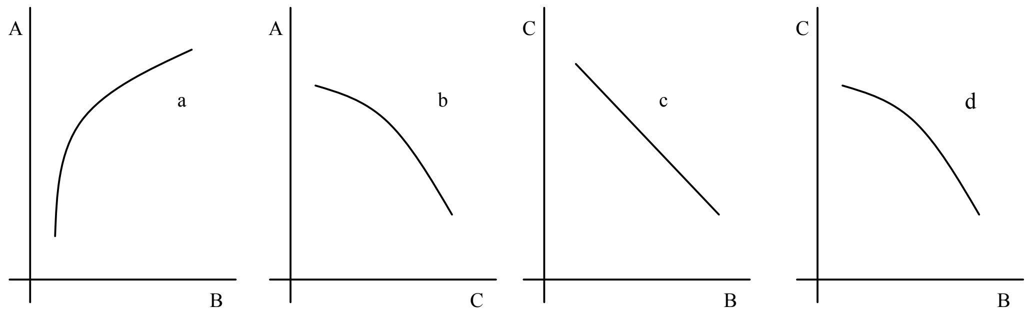
Are described in the qualitative triplets

$$(X_1, DX_1, DDX_1), (X_2, DX_2, DDX_2), \ldots (X_n, DX_n, DDX_n), \quad (3)$$

where X_i is the i-th variable and DX_i and DDX_i are the first qualitative and second qualitative derivations with respect to the independent variable to *t* (which is usually time). As an example if X is profitability, DX indicates how profitability is changing (growing, declining or constant) and DDX indicates what is happening to the rate of change in profitability. These relationships against time can be described in simple models (see A, B and C in Fig. 1). The precise relationships are not known. What is known is that profitability is rising, staying constant or falling at an unknown rate of change.

Using a simple theoretical example with three variables A, B and C and with mutual relationships between the variables ill-known, it is assumed that there are two possible models. The first model M1 is described by relations a, b and c (see Fig. 1). This fact shows, for example, a common sense view that if C declines then B increases at a linear rate. The second model M2 is represented by relations a, b and d (see Fig. 1).

Both models can be solved, meaning that all qualitative descriptions, which are compatible with the corresponding models, are identified. The model M1 has 13 qualitative solutions (see Tab. I). The second model has 17 solutions (see Tab. II). For example the first solution of the first model.



1: *Binary relationships of components*

I: *Identification of Qualitative Solutions to Model M1*

Solution No.	A Triplet	B Triplet	C Triplet
1	+ + +	+ + +	+ - -
2	+ + 0	+ + +	+ - -
3	+ + -	+ + +	+ - -
4	+ + -	+ + 0	+ - 0
5	+ + -	+ + -	+ - +
6	+ 0 +	+ 0 +	+ 0 -
7	+ 0 0	+ 0 0	+ 0 0
8	+ 0 -	+ 0 -	+ 0 +
9	+ - +	+ - +	+ + -
10	+ - 0	+ - +	+ + -
11	+ - -	+ - +	+ + -
12	+ - -	+ - 0	+ + 0
13	+ - -	+ - -	+ + +

For example, following text

A	DA	DDA	B	DB	DDB	C	DC	DCC
+	+	+	+	+	+	+	-	-

Indicate that the qualitative behaviour of concentrations A & B is the same. Both first derivatives with respect to time (equation 3) are positive. Both second derivatives are positive as well. However, the variable C is decreasing since the first derivative is negative.

The solutions, which are common to both models, are

$$M1 \cap M2 = (1,2,3,5,8,9,10,11,12,13,15).$$

Solution is taken from Tab. II. Being common these solutions cannot be used to distinguish between the models and are thus not useful in this context.

TRANSITIONS

A set of qualitative solutions or scenarios is not the only result of a qualitative modelling. A set of possible transitions between the set of solutions is another very information intensive result. If every solution is represented by a node and all transitions

II: *Identification of Qualitative Solutions to Model M2*

Solution No.	A Triplet	B Triplet	C Triplet
1	+ + +	+ + +	+ - -
2	+ + 0	+ + +	+ - -
3	+ + -	+ + +	+ - -
4	+ + -	+ + 0	+ - -
5	+ + -	+ + -	+ - +
6	+ + -	+ + -	+ - 0
7	+ + -	+ + -	+ - -
8	+ 0 +	+ 0 +	+ 0 -
9	+ 0 0	+ 0 0	+ 0 0
10	+ 0 -	+ 0 -	+ 0 +
11	+ - +	+ - +	+ + -
12	+ - 0	+ - +	+ + -
13	+ - -	+ - +	+ + -
14	+ - -	+ - 0	+ + -
15	+ - -	+ - -	+ + +
16	+ - -	+ - -	+ + 0
17	+ - -	+ - -	+ + -

are graphically represented by oriented arcs between corresponding pairs of solutions, the result is an oriented graph of possible transitions. Any time behaviour of the system under study can be characterised as a path in the transition graph. The transition graph is thus a condensed description of all possible unsteady state behaviours.

Using a simple algorithm based on the multidimensional interpretation of the set of possible one dimensional transition (shown in Tab. III) that are considered by the user as reasonable, all possible transitions among qualitative solutions can thus be generated for a particular system. A simple example of the one-dimensional variation of a variable about a mean is shown in Fig. 4a with the possible transitions shown in Fig. 4b. Transition numbers shown in Figure 4b correspond to transitions in Tab. III. (e.g. transition 3b is row 3, column b).

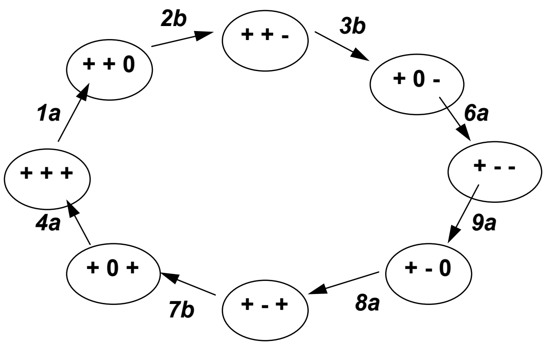
Returning to the example with models M_1 and M_2, the graph shown in Fig. 2 represents the three-dimensional transition possibilities for the first model M_1. For example, the solution 6 (see Tab. I) can pro-

III: *All Possible one-Dimensional Transitions*

Transition No.	From	To (a)	(b)	(c)	(d)	(e)	(f)	(g)
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				
10	0 + +	+ + 0	+ + -	+ + +				
11	0 + 0	+ + 0	+ + -	+ + +				
12	0 + -	+ + -						
13	0 0 +	+ + +						
14	0 0 0	+ + +	- - -					
15	0 0 -	- - -						
16	0 - +	- - +						
17	0 - 0	- - 0	- - +	- - -				
18	0 - -	- - 0	- - +	- - -				
19	- + +	- + 0	0 + +	0 + 0				
20	- + 0	- + -	- + +	0 + 0				
21	- + -	- + 0	- 0 -	- 0 0	0 + -	0 0 -	0 0 0	0 + 0
22	- 0 +	- + +						
23	- 0 0	- + +	- - -					
24	- 0 -	- - -						
25	- - +	- - 0	- 0 +	- 0 0				
26	- - 0	- - -	- - +					
27	- - -	- - 0						

ceed only to solution 1 and this solution can proceed only to solution 2. However, solution 2 can be followed either by solution 3 or by solution 4.

The qualitative degradation of quantitative measurements of variables A, B and C can always be described by a path (or set of paths) in the transition graph. For example, the path (see Fig. 2)



2: *Possible Transitions*

from 9 .. to .. 10 .. to .. 9 (4)

can model a certain oscillatory behaviour described by the following time sequence of qualitative solutions (see Table 1):

	(A,DA,DDA)	(B,DB,DDB)	(C,DC,DDC)
9	(+ - +)	(+ - +)	(+ + -)
10	(+ - 0)	(+ - +)	(+ + -)
9	(+ - +)	(+ - +)	(+ + -)

It is clear that the qualitative behaviours of variables B and C do not change while A moves from a position of declining at a slowing rate to declining at a linear rate and then back to the slowing rate. In order fully to understand this, the third derivative DDDA is required. If this third derivative is negative then the transition is:

from (A, DA, DDA, DDDA) = (+ - + -)
to (A, DA, DDA, DDDA) = (+ - 0 -).

This shows that the rate of slow-down in the decline of A is itself declining so that eventually it will become a linear decline which in turn will turn back into slowing decline as the third derivative serves to slow the rate of linear decline.

This transition is the driving force behind the transition from 9 .. to .. 10 .. to .. 9

In reality it is difficult enough to arrive at qualitative judgements about the changes in variables across the first two derivatives let alone for the third and it is not considered further in this example.

RESULTS

Oil is definitely the most important aspect of international policy if Central Asia is considered. Any case study related to evaluation of political risks in Central Asia is prohibitively complex. (Walker, 2002; Scott, 2005, Terry, 1998). An obvious problem is a manageable specification of a problem under study. For example Central Asia cannot be separated from Transcaucasus. It means that all-important countries of both regions must be taken into consideration. This means an enormous increase in problem dimensionality. This is the price, which must be paid for model's applicability.

Caspian Sea is now the most ecologically devastated area in the world because of severe water pollution incurred during Soviet rule. It is possible to incorporate some ecological parameters into qualitative model. However, it would be inevitable to take into consideration some engineering aspects making the model even more complex. Therefore ecology together with some other important points of view is completely ignored.

The following sets of variables are identified as important by a group of experts:

- Economics;
- Oil Industry;
- Ethnic Diversity;
- Religious Aspects;
- Corruption; (5)
- Economic Inequality;
- Water shortages;
- Foreign influences.

The information structure based on the set of important variables (5) is very sophisticated. For example it is not possible to separate different sets completely. For example Oil Industry is a target of many corruption attempts etc.

Moreover, one must keep in find the obvious fact that if the same variables (5) are differently important in different countries then the number of variables is multiplied by the number of differences. For example ethnic differences in Azerbaijdzan, the ethnic differences in Kazachstant etc. The complete model would be so complex that it would not be possible to solve it.

Therefore a careful common sense screening seems to by the only way to decrease the total number of variables. As an example of such study is an attempt to discover if the foreign influences are (qualitatively) identical for all countries.

The last century's of fighting between Russia and Great Britain over the sphere of influence was relatively transparent and therefore predictable if economical potentials of both countries were taken into consideration. However, the current "Great Game" consists of economic competition for oil. The break-up of the Soviet Union prompted a renewed struggle for influence in Central Asia and the Transcaucasus among the regions' three traditional competitors, Russia, Iran and Turkey.

However, because of globalisation of new participants take important roles. They are: USA, China and European Union.

The short characteristics given above will be studied form the point of view of the sets (5). Let us suppose that the conclusion is that:

- Certain countries have their interests expressed using such variables, which are not, covered by the sets (5), e.g. energy shortage of China. Such aspects can be ignored because those who specified the list (5) do not consider them as important.
- If there are variables, which are on the list (5), but their influences are considered to be identical, then there is no need to distinguish the corresponding effects of different countries. E.g. Iran and Turkey cannot offer enough capital, all other countries have the required capital, therefore the foreign capital as an independent variable can be ignored.

A choice of important variables can be heavily influenced by a specific point of view. E.g. If the investor from the Muslim country is able to ignore religious aspects. Mathematically speaking a set of (temporally) interesting variables **I** and **U** uninteresting variables can be introduced:

$$\mathbf{X} = \mathbf{I} \cup \mathbf{U}$$
$$\mathbf{I} \cap \mathbf{U} = \emptyset. \quad (6)$$

The split of variables **X** (2) into two subsets represents an ad hoc point of view. The same problem can be solved using different subsets **I** and **U**. Therefore the projection of the set **X** onto the set **I** decreases the number of variables, represents a specific point of view etc.

In comparison with the complete model it is felt that the model presented below represents a relatively trivial task. Yet even this presents considerable complexities.

The following set of variables is studied:

Abbreviation	Variable
NIR	Nominal Interest Rate
IN	Inflation
NGR	Nominal Growth Rate
SBD	State Budged Deficit
ICB	Level of Independency of Central Bank
PS	Political Stability
NBD	New Bad Debts
DCC	Deficit of Current Account

(7)

FDI	Foreign Direct Investment
LP	Level of Banking Prudency
LPR	Level of Politising Religious Activities
COR	Corruption (7)
INT	Integration of Political and Criminal Worlds
OP	Oil Production
DO	Drop in oil prices.

For the purpose of this exercise variable pairs were identified which felt to be most closely related. This generated 14 qualitative relations as follows:

No	Relation	Variable X	Variable Y (see Fig. 6)	
1	24	NIR	PS	
2	23	IN	PS	
3	23	NGR	PS	
4	26	SBD	PS	
5	26	ICB	NBD	(8)
6	21	IN	DCC	
7	26	PS	FDI	
8	26	LP	NBD	
9	21	LPR	PS	
10	21	COR	NBD	
11	21	INT	COR	
12	21	EI	PS	
13	21	OP	NGR	
14	26	DO	NGR.	

The second column identifies the corresponding qualitative shape, see Fig. 3.

All variables (7) are positive because of their very nature. All second derivatives are not taken into consideration, for which there are usually two reasons:

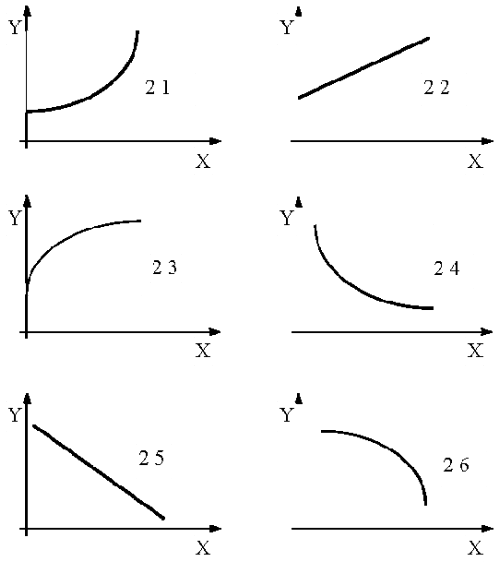
- They are unknown;
- The model is in the early stages of development and therefore even the first derivatives are not known and are still to be evaluated. In order to keep the total number of qualitative solutions down at this stage, the second derivatives are thus not considered until the first derivative behaviour is established.

To indicate that a value, e.g. the second derivative, is unimportant or not known the following values is used:

* = *positive* or *zero* or *negative.*

There are 9 scenarios if only the first derivatives are taken into considerations, see the triplets (3):

If the second derivative is involved then 11 169 scenarios exist. There are too many scenarios. It means that the model (8) is not very restrictive. A simple



3: *Qualitative shape*

way how to decrease the number of scenarios is to specify additional restrictions. The restrictions can reflect e.g. the current situation (see (3))

OP	++-	
DO	+--.	(10)

There are 2 363 scenarios. Therefore even more restrictive query is submitted (compare with (10)):

IN	++-	
PS	++X	
LP	++X	(11)
OP	++-	
DO	+--,	

where X means *to be calculated / evaluated*. Therefore the qualitative description of variable IN is fixed (see (11)). The first derivative of PS is fixed as well. However, the second derivative of PS is not fixed and must be evaluated.

The model (8) and the query (11) give 81 solutions if only the following variables are considered as currently interesting (6):

IN, SBD, PS, NBD, DCC, FDI, OP, DO

NIR	IN	NGR	SBD	ICB	PS	NBD	DCC	FDI	INT	OP	DO	
++*	+-*	+-*	++*	++*	+-*	+-*	+-*	++*	+-*	+-*	++*	
++*	+-*	+-*	++*	+0*	+-*	+0*	+-*	++*	+0*	+-*	++*	
++*	+-*	+-*	++*	+-*	+-*	++*	+-*	++*	++*	+-*	++*	
+0*	+0*	+0*	+0*	++*	+0*	+-*	+0*	+0*	+-*	+0*	+0*	
+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	(9)
+0*	+0*	+0*	+0*	+-*	+0*	++*	+0*	+0*	++*	+0*	+0*	
+-*	++*	++*	+-*	++*	++*	+-*	++*	+-*	+-*	++*	+-*	
+-*	++*	++*	+-*	+0*	++*	+0*	++*	+-*	+0*	++*	+-*	
+-*	++*	++*	+-*	+-*	++*	++*	++*	+-*	++*	++*	+-*	

The complete list of nine scenarios is given below:

IN	SBD	PS	NBD	DCC	FDI	OP	DO	
++-	+-+	++-	+-+	+++	+-+	++-	+--	
++-	+-+	++-	+-+	+++	+-0	++-	+--	
++-	+-+	++-	+-+	+++	+--	++-	+--	
++-	+-+	++-	+-+	++0	+-+	++-	+--	
++-	+-+	++-	+-+	++0	+-0	++-	+--	(12)
++-	+-+	++-	+-+	++0	+--	++-	+--	
++-	+-+	++-	+-+	++-	+-+	++-	+--	
++-	+-+	++-	+-+	++-	+-0	++-	+--	
++-	+-+	++-	+-+	++-	+--	++-	+--.	

Four second derivatives are not restricted. The indication that the variable FDI is not restricted is the regular sequence of +, 0, -, see the column FDI (12). Therefore all 4 can be ignored. This gives the following query

Query		
IN	++-	
SBD	+X*	
PS	+XX	
NBD	+-*	
DCC	+X*	(13)
FDI	+X*	
LP	++X	
OP	++-	
DO	+--.	

The model (8) and the query (13) give just one scenario:

IN	SBD	PS	NBD	DCC	FDI	OP	DO	
++-	+-*	++-	+-*	++*	+-*	++-	+--	(14)

A possible verbal interpretation of the scenario (14) is:

IN	Inflation	prescribed / reflects the current situation fully described by the query (13)
SBD	State Budged Deficit	decreasing
PS	Political Stability	increasing, but there is an upper limit
NBD	New Bad Debts	decreasing, see the query
DCC	Deficit of Current Account	increasing
FDI	Foreign Direct Investment	decreasing
OP	Oil Production	prescribed / reflects the current situation fully described by the query (13)
DO	Drop in oil prices	prescribed / reflects the current situation fully described by the query (13).

DISCUSSION

As indicated earlier the purpose of this paper is not to provide results but to give an outline of possible approaches to vague political modelling as it could be applied to the risk analysis. The important point is that if it is possible to identify the key relationships between variables that influence it is possible from this to build up scenarios showing the behaviour of each variable against time and to identify possible transitions from one scenario to another.

The obvious significance of this is that, if some of the variables are known, for example, from national statistics, from industry figures or from internal operating figures, then it is possible to identify scenarios, which indicate how other variables will behave. Further, if the correct scenario can be identified then the next scenario or scenarios can be identified, as can the variables that need to be changed in order to reach the next, desired scenario or to avoid the next, undesired scenario. This provides the beginnings of a basis for a highly useful management tool.

This potentially can provide important additional information from which to make decisions about future actions in relation to the variables over which the manager has control. Obviously the knowledge does not provide solutions but it does give additional and potentially helpful information about the environment within which the decisions are taken.

SUMMARY

The objective of the article is to describe non-traditional methods for prediction of development of selected branches. Commonly, the mathematical-statistical tools are used, however, it is essential to use also procedures of other social sciences because without them the assessment would be highly inaccurate. These applications do not always bring the accurate results. Another deficiency is the fact that these procedures require the specialized surrounding. The article presents the ways of predicting the different development of branches with respect to changing input parameters. This can be done with the use of "common sense", with the use of elements of qualitative modeling. In the first part of the work the apparatus for qualitative assessment is analyzed. Its use is limited to positive, negative and neutral relations of individual variables. The case study deals with the issue of development of crude-oil production in the Caspian region in association with the increasing influence of the Islamic movements. As the main variables of the model were selected: the nominal interest rate, the inflation, the GDP growth, the national debt, the independency of central bank, the political stability, the granting of "bad" loans, the national budget deficit, the foreign direct investments, the prudence in lending, the religious influences, the corruption, the influence of organized crime, the crude oil production, the price of crude oil. On the basis of these variables the possible scenario development was modeled. After changing of input data the case study can be used for the assessment of relationship and development of any branch. The results do not represent the sole possibility of the development, but they can be regarded as the auxiliary tool for decision-making, as they bring additional and auxiliary information on the relations between input variables. The main advantage of this procedure is that there is no need for numerical values of parameters; it provides a comprehensive set of possible scenarios that could not be determined by quantitative modeling.

SOUHRN

Kvalitativní modelování makroekonomických indikátorů pro predikci vývoje odvětví

Cílem článku je popsat netradiční metody pro predikci vývoje zvoleného odvětví. Běžně se využívá matematicko-statistických nástrojů. Je ale nezbytné využívat i postupy z ostatních společenských věd, protože bez nich by bylo hodnocení velice nepřesné. Tyto aplikace ale vždy nepřinášejí přesné výsledky. Dalším nedostatkem je i to, že tyto postupy vyžadují specializované prostředí. Článek přináší možnosti, jak s využitím pouze „zdravého selského rozumu" s využitím prvků kvalitativního modelování předpovídat různý vývoj odvětví s ohledem na měnící se vstupní parametry. V první části práce je stručně rozebrán aparát pro kvalitativní hodnocení. Jeho využití je omezeno pouze na kladný, záporný a nulový vztah jednotlivých veličin. Případová studie se zabývá problematikou vývoje těžby ropy v kaspické oblasti v souvislosti s rostoucím vlivem islamistických hnutí. Jako hlavní proměnné modelu byly vybrány: nominální úroková míra, míra inflace, růst HDP, státní deficit, nezávislost centrální banky, politická stabilita, poskytování „špatných" úvěrů, schodek státního rozpočtu, zahraniční přímé investice, uvážlivost v úvěrování, náboženské vlivy, korupce, vliv organizovaného zločinu, produkce ropy, cena ropy. Na základě těchto veličin byl modelován možný scénář vývoje. Případovou studii je možno využít po změně vstupních údajů pro hodnocení vztahu a vývoje jakéhokoliv odvětví. Výsledky samozřejmě nepředstavují pouze jedinou možnost vývoje, ale jsou pomocným nástrojem pro rozhodování, protože přinášejí dodatečné a pomocné informace o vztazích mezi vstupními veličinami. Mezi hlavní výhody tohoto postupu patří hlavně to, že není potřeba numerických hodnot parametrů, poskytuje ucelený soubor možných scénářů, který by kvantitativním modelováním nebylo možné zjistit.

modelování, kvalitativní analýza, předpovídání, scénáře, makroekonomické ukazatele

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