Framework for forecasting of turnaround of the economy

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Abstract **The objective of this paper is to propose a framework for forecasting of turnaround of the economy that helps to deal with large and complex situations. The framework is developed using the Analytic Network Process (ANP) and the Priority Matrix (PM). The experience with the application of ANP suggests that it offers guidelines in the forecasting of turnaround of the economy.**

Keywords – **Decision analysis, Analytic Network Process, Economic turnaround.**

I. Introduction

In this paper, we analyze the forecasting performance that is based on the qualitative predictions of experts for factors affecting turnaround of the economy. A large number of studies have been conducted to identify factors affecting turnaround of the economy [1]-[4]. However, the factors are difficult to be defined. It is impossible to generate a universal checklist of factors suitable for all economies indeed. Factors will differ from economy to economy depending on a number of issues, for example, stage of development, uniqueness and complexity. Combining these findings from both practice and theory and in order to develop a framework for forecasting of turnaround of the economy had led to an interest in the use of Analytic Network process (ANP) and the Priority Matrix (PM).

II. Methodology

In this article, we propose a computer- based methodology for forecasting of turnaround of the economy. The framework, described in this paper, is adapted from the Saaty's Analytic Network Process (ANP) to describe and analyze relationships [1]. Different factors were included into the proposed ANP framework to rate the turnaround of the economy. In this paper, the PM approach is used for the identification of the factors affecting turnaround of the economy. Although there is reference or a previous study suggesting factors that may influence the turnaround process, we propose a framework for selecting the factors and analyzing relationships between the selected factors.

III. Proposed algorithm for forecasting of the turnaround of the economy

The framework consists of five phases:

Phase 1: Identification of factors.

Based on the previous studies, the researcher proposes a catalog of factors affecting turnaround of the economy as guidelines for this framework [1]-[4].

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In the framework is distinguished between factors assume the conventional adjustment and the status quo with regard to the system of cases and consequences in the economy and factors assume the economic restructuring. The presumption is that the underlying structure of the economy is stationary.

The conventional adjustment can formally be divided into macroeconomic factors: consumer spending, investment spending, exports, indicators of confidence in the economy, fiscal policy and monetary policy. We recognize that these factors are in some instances interdependent. The economic restructuring can formally be divided into factors: financial sector, defense posture and global competition.

With regard to the timing of the turnaround, we considered four possible time periods of adjustment. These periods were: 3 months, 6 months, 12 months, and 24 months.

In order to reduce the complexity, we focus on the priority aspects of the factors in the proposed framework. First, we apply the PM. Therefore, the factors, which may influence the turnaround process, are determined. The following question, "Can the factor influence the turnaround process?" can be used. In this step, decision maker can express his preference verbally using 1- 9 scale. Finally, the priorities of the factors with respect to the influence level are calculated. In this phase, the factors with the largest priority should be selected.

Phase 2: Model construction and problem structuring: The problem should be stated clearly and be decomposed into a rational system, like a network.

With regard to forecasting the strength of the recovery, we used a standard format for the network, beginning with the constructs (Fig.1).

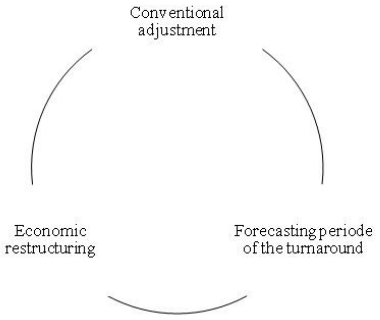

Fig. 1. Standard format for the network

Phase 3: Importance degrees of factors calculation: Decision maker can express his preference between every two elements verbally as equally important (or preferred, or likely), moderately more important, strongly more important, very strongly more important, or extremely more important. The Saaty's 1- 9 scale of relative importance enables the

decision maker to evaluate his preference between every two elements.

Phase 4: Importance degrees of factors calculation: The relative weighing for each factor is arrived at by pair wise comparison using the ANP theory. In each level, the factor's relative weighting is established by pair-wise comparison.

Phase 5: Forecasting of the turnaround: The turnaround should be forecasted using different operations.

Let y_t represents a turnaround binary variable, which equals 1 when the economy is in expansion in month t and equals 0 in recession. Typical models of forecasting h-period-ahead expansion probabilities using the information available at time t assume that

$$Prob(y_{t+\Delta t}) = 1 \mid \beta_t) = p_t \quad (1)$$

$$Prob(y_{t+\Delta t}) = 0 \mid \beta_t) = 1 - p_t \quad (2)$$

$$Prob(y_{t+\Delta t}) = 1 \mid \beta_t) = F(\beta_t) \quad (3)$$

$$E(y_{t+\Delta t}) = p_t = \frac{e^{\beta t}}{1 + e^{\beta t}} \quad (4)$$

$$1 - p_t = \frac{1}{1 + e^{\beta t}} \quad (5)$$

where β_t is a vector of coefficients associated with a vector of predictors β_t ($\beta_t = [\beta_{1t};\ldots; \beta_{it}]$, and i is the number of factors included.

In an empirical analysis, I will set $\Delta t = 3$ and focus on 24-month-ahead predictions. In this formulation, predicting expansion probability involves two issues that are possibly related to each other. The first one is to choose a set of predictor variables, so that we can obtain useful signals from data.

I estimate a forecasting model again to produce a forecast for the 24-month-period using the expected utility function. Let $u\{yt+\Delta t/\beta t\}$ represents the expected end-of-period utility and β_t represents initial vector of coefficients. In this study this utility function is standardised using the formula:

$$u\{y_{t+\Delta t}) = 1 \mid \beta_t\} = u(\beta_t) = 1 - e^{-\beta t} \quad (6)$$

This utility function is used to summarise the information taking into account all the factors thereby providing decision makers with an integrated and more informative overview than would otherwise be attainable.

For a lottery with two outcomes, the expected utility is:

$$E\{u(\beta_t)\} = p'_t.u(1) + (1 - p'_t).u(0) \quad (7)$$

$$1 - e^{-\beta t} = p'_t.(1 - e^{-1}) + (1 - p'_t).(1 - e^{-0}) \quad (8)$$

The probability p' is used as likelihood of a turnaround. The value of probability p' using can be found.

$$p'_t = \frac{1 - e^{-1}}{1 - e^{-\beta t}} \quad (9)$$

For the calculation of the probability for

Following Clements and Galvao [4], I will use a measure for evaluating expansion probability predictions. The measure is the probability analogue of mean squared error, the quadratic probability score (QPS), which is commonly used in evaluating probability forecasts. The QPS is defined as

$$QPS = \frac{2}{T} \sum_{t=1}^{T} (p_t - p'_t)^2 \quad (10)$$

where p_t is the expansion probability forecast month t and p't is likelihood of a turnaround using the expected utility function. The QPS takes values between 0 and 2 and smaller value indicates more accurate forecasts.

Now, we can frame a general expression considering the entire factors. The expression is framed in such a manner that the factors are converted into consistent, dimensionless indices.

IV. Application of the Proposed ANP Model

Phase 1: Identification of factors and alternatives

In this phase the factors should be define. We will use for the illustration the factors consumer spending, investment spending, exports, indicators of confidence in the economy, fiscal policy, monetary policy, financial sector, defense posture and global competition. From this it allows that we should evaluate factors in respect to link the turnaround of the economy using PM. Table I illustrates the extent to which different factors proposed can be used in the framework. We select for the illustration the factors: consumer spending (C), investment spending (I), exports (E), indicators of confidence in the economy (Co), financial sector (FS), defense posture (DP) and global competition (GC).

TABLE I
CATALOG OF FACTORS AFFECTING TURNAROUND OF THE ECONOMY

Construct	Factors	IS	NS	P
Conventional adjustment (CA)	Consumer spending (C)	9	0,14	1
	Investment spending (I)	9	0,14	1
	Exports (E)	8	0,12	3
	Indicators of confidence (Co)	8	0,12	3
	Fiscal policy (FP)	4	0,06	8
	Monetary policy (MP)	3	0,05	9
Economic restructuring (R)	Financial sector (FS)	8	0,12	3
	Defence posture (DP)	8	0,12	3
	Clobal competition (GC)	8	0,12	3

IS, Influence scores; NS, normalized; P, Priority.

Phase 2: Model construction and problem structuring: The turnaround within the factors developed for this study are placed in the forecasting model. The problem is converted into a hierarchical structure in order to transform the selected factors into a state in which they can be measured by the ANP technique. Table II contains the operationalization of the hierarchy. In this phase, the factors are evaluated using the ANP theory. These factors are compared pair wise and 1 or 9

is assigned based on the importance of one perspective over another.

TABLE II
FACTORS AFFECTING TURNAROUND OF THE ECONOMY

Construct	Factors
Conventional adjustment (CA)	Consumer spending (C) Investment spending (I) Exports (E) Indicators of confidence (Co)
Economic restructuring (R)	Financial sector (FS) Defence posture (DP) Clobal competition (GC)
Forecasting periode of the turnaround (p)	3 months (t_1=3) 6 months (t_2=6) 12 months (t_3=12) 24 months (t_4=24)

The aim of "forecasting of the turnaround of the economy" is placed in the first level of the ANP model, the constructs are placed in the second level, the factors are in the third level and the time are in the forth level. The time did not have equal importance for the turnaround; time should be rated in the analysis. The time includes four periods: 3 months, 6 months, 12 months and 24 months. Constructs and factors did not have equal importance for the turnaround. Therefore, they should be rated in the analysis.

Phase 3: Importance degrees of factors calculation

Step 1: Calculate the priorities of the constructs (β^F) with respect to each time period

Assuming that there is no dependence among the constructs, pair-wise comparison of the constructs using a 1-9 scale is made with respect to the forecasting. The comparison results are shown in Table III.

The following question, "What is the relative importance of conventional adjustment (CA) when compared with economic Restructuring (R) on controlling time?" may arise in pair-wise comparisons and lead to a value of 9 (absolute importance). The resulting relative importance weights β^F are presented in the last column of Table III.

Step 2: Calculate the priorities of the factors ($\beta^{CA}{}_F$ and $\beta^R{}_F$) with respect to each factors

In this step, the priorities of the factors are calculated using the pair-wise comparison matrix. The pair-wise comparison matrices are detailed in Table IV and Table V. Using the computed relative importance weights, β_F is found.

Step 3: Calculate the priorities of the factors (β_T) with respect to each time periods (Table VI and Table VII)

Using the computed relative importance weights, the matrix β_T is formed (Table VII).

Step 4: Measuring the functional couplings among constructs and factors

Using the mapping between factors the structure of the economy can be identified. For this mapping can be used the equation

$$\beta_{ijt} = \sqrt[3]{\beta_{iT} \cdot \beta_j^F \cdot \beta_{iF}} \qquad (11)$$

TABLE III
PAIRWISE COMPARISON OF THE FACTORS BY ASSUMING THAT THERE IS NO DEPENDENCE AMONG THE FACTORS

Turnaround 3 months	CA	R	Importance degrees of the factors β^F
CA	1	5	0,83
R	0,2	1	0,17
Turnaround 6 months	CA	R	Importance degrees of the factors β^F
CA	1	5	0,83
R	0,2	1	0,17
Turnaround 12 months	CA	R	Importance degrees of the factors β^F
CA	1	1	0,5
R	1	1	0,5
Turnaround 24 months	CA	R	Importance degrees of the factors β^F
CA	1	0,2	0,17
R	5	1	0,83

TABLE IV
PAIRWISE COMPARISON MATRICES FOR FACTORS WITH RESPECT TO "CONVENTIONAL ADJUSTMENT"

	C	I	E	Co	$\beta^{CA}{}_F$
C	1,00	6,00	4,00	0,33	0,30
I	0,17	1,00	0,25	0,20	0,06
E	0,25	4,00	1,00	0,20	0,13
Co	3,00	5,00	5,00	1,00	0,51

TABLE V
PAIRWISE COMPARISON MATRICES FOR FACTORS WITH RESPECT TO "RESTRUCTURING"

	FS	DP	GC	$\beta^R{}_F$
FS	1,00	3,00	3,00	0,57
DP	0,33	1,00	3,00	0,29
GC	0,33	0,33	1,00	0,14

The equation can be also expressed in terms of its element, where β_{ijt} known as dependency, relates factors to time periods. Therefore the functional couplings among constructs and factors (Table VIII) can be identified.

TABLE VI
PAIRWISE COMPARISON MATRICES FOR TIME PERIODS WITH RESPECT TO THE FACTORS

C	3	6	12	24	$\beta^{CA}{}_T$
3	1,00	0,33	0,17	0,14	0,05
6	3,00	1,00	0,20	0,20	0,11
12	6,00	5,00	1,00	0,33	0,31
24	7,00	5,00	3,00	1,00	0,53
I	3	6	12	24	$\beta^{CA}{}_T$
3	1,00	1,00	0,20	0,20	0,08
6	1,00	1,00	0,20	0,20	0,08
12	5,00	5,00	1,00	0,33	0,31
24	5,00	5,00	3,00	1,00	0,52
E	3	6	12	24	$\beta^{CA}{}_T$
3	1,00	1,00	0,20	0,20	0,08
6	1,00	1,00	0,20	0,20	0,08
12	5,00	5,00	1,00	1,00	0,42
24	5,00	5,00	1,00	1,00	0,42
Co	3	6	12	24	$\beta^{CA}{}_T$
3	1,00	3,00	5,00	5,00	0,50
6	0,33	1,00	5,00	5,00	0,29
12	0,20	0,20	1,00	5,00	0,14
24	0,20	0,20	0,20	1,00	0,06

TABLE VII
PAIRWISE COMPARISON MATRICES FOR TIME PERIODS WITH RESPECT TO THE FACTORS

FS	3	6	12	24	$\beta^{R}{}_T$
3	1,00	0,33	0,20	0,14	0,05
6	3,00	1,00	0,20	0,14	0,10
12	5,00	5,00	1,00	0,20	0,24
24	7,00	7,00	5,00	1,00	0,60
DP	3	6	12	24	$\beta^{R}{}_T$
3	1,00	0,33	0,20	0,14	0,05
6	3,00	1,00	0,20	0,14	0,10
12	5,00	5,00	1,00	0,20	0,24
24	7,00	7,00	5,00	1,00	0,60
GC	3	6	12	24	$\beta^{R}{}_T$
3	1,00	1,00	0,33	0,20	0,09
6	1,00	1,00	0,33	0,20	0,09
12	3,00	3,00	1,00	0,20	0,22
24	5,00	5,00	5,00	1,00	0,59

Step 6: Calculate the forecasting

Using the mapping between constructs and factors, Eq.(4) and Eq.(9) the probabilities p_t and p'_t of turnaround can be calculated (Table IX).

The analysis results indicate that 24 months is the best time forecast. The QPS is 0,03. The small value indicates an accurate forecast.

TABLE VIII
MATRIX β_T

Factors	3	6	12	24
C	0,05	0,11	0,31	0,53
I	0,08	0,08	0,31	0,52
E	0,08	0,08	0,42	0,42
Co	0,5	0,29	0,14	0,06
FS	0,05	0,10	0,24	0,60
DP	0,05	0,10	0,24	0,60
GC	0,09	0,09	0,22	0,59

TABLE IX
PROBABILITY P_t

t	3	6	12	24
p_t	84%	84%	90%	92%
p'_t	100%	100%	100%	100%

V. Conclusions

In conclusion, the proposed framework could be used as an intelligent decision support system in a real time base. The framework allows forecasting turnaround of economy that is based on the qualitative predictions of experts for major factors affecting turnaround of the economy. The proposed model, will certainly help the users of this model to forecast the turnaround.

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References

[1] Cameron, A.C., Trivedi, P.K. (1986), 'Econometric Models Based on Count Data: Comparisons and Applications of Some Estimators and Tests', *Journal of Applied Econometrics*, Vol.1, pp. 29-53.

[2] Gourieroux C., Monfort, A., Trognon, A. (1984). 'Pseudo Maximum Likelihood Methods: Applications to Poisson Models', *Econometrica*, Vol. 52 (3), pp. 701-720.

[3] Haab, T., McConnell (2002), Valuing Environmental and Natural Resources: The Econometrics of Nonmarket Valuation, Forthcoming, Edward Elgar Publishers.

[4] Clements, M. P., Galvao, A. B., (2006),: 'Combining Predictors & Combining Information in Modelling: Forecasting US Recession Probabilities and Output Growth', in Nonlinear Time Series Analysis of Business Cycles, ed. by Milas, C., Rothman, P., and Dijk, D., Elsevier, vol. 276 of Contributions to Economic Analysis, chap. 2, pp. 55 - 74.

[5] Dimitrova, V. (2009), Application of the Analytic Network Process (ANP) in a framework for forecasting of turnaround of the economy, IASK, International Conference "E-Activity and Leading Technologies 2009", Seville, Spain.