PROBABILISTIC MODEL FOR AN ECONOMY COMING THROUGH INTEGRATION TRANSFORMATIONS

Peter I. Kamyshanov[(a)], Alexander P. Kamyshanov[(b)]

[(a),(b)]Faculty of Business, Plekhanov Russian Economic University
Nakhimovsky Avenue, 28-1-101, Moscow, 117218, Russian Federation

[(a),(b)] Email: a_kamyshanov@rbcmail.ru

ABSTRACT
The European Union countries are realizing economic integration transformations. Period of these reforms is coinciding in time with the global economic downturn. To overcome crisis the competitive growth in the integrated economies should begin. For description the factors of this growth probabilistic model based on cognitive science and context analysis of reforms' goals is presented. The model gives the possibility to apply stochastic methods as for the management of integration transformations, so for scheduling the creation of the competitive innovative knowledge economies in post industrial societies. Reforms' results are defined by the magnitudes of terminal probabilities that allow grouping the economies in four clusters. In future, new multi criteria approaches should be used at all levels of management hierarchy for planning the integration scenarios.

Keywords: Bayesian network, European economies, integration transformations, probabilistic clustering

1. INTRODUCTION

Over the last 20 years the European Union (EU) countries were realizing extra ordinary reforms targeting on integration of the old 15 EU countries with economies operating on the basis of market principles and the new 12, mainly Central East European (CEE) states, with economies defined as “transitional”. First of all, the transformations’ strategies in these countries were focused on macroeconomic stabilization and microeconomic restructuring in conjunction with institutional and political reforms. The implementations of these strategies varied across the countries in speed and specifics.

Nowadays the population of the 27 EU countries is exceeding 502 million (World Bank 2011). More than 102 million people are living in new CEE member states. Ineffective transformations of economies may negatively impact on the people living in the Europe.

Theorists working at the universities in the EU countries are representing most advanced and dynamically developing schools of the world economic science. Some of them worked out new sophisticated management concepts applied to market economy, participated in Noble Prize Committees in the field of Economy, and defined the Prize winners.

At the same time their colleagues in CEE countries as students had studied the principles and the practical methods of the socialist enterprises management. But in practice economic schools of the new EU member states are creating the competitive knowledge economies in post industrial information societies. These societies are operating on market principles with significant social constraints. In the European transformations as the historical experience of the Western Europe economic schools, so the advanced ideas of socialist financial and corporate management are utilizing. Applying early acquired knowledge the EU countries are realizing transformation scenarios from traditional market economies and from developed socialism to post industrial information societies with various successes.

Up to the world financial crisis at 2008 Poland, Czech Republic, Hungary, Slovenia and Slovakia were considered as most advanced countries coming through integrating transformations. Economic downturn had affected significantly on the EU countries. Certainly the income per capita indexes for the EU countries are far ahead from Russia. But today some macroeconomic parameters of the leading EU countries are not shining bright above the clouds.

In the framework of financial stabilization policy the Russian Federation had stored significant reserves in hard currencies. At the same time some the EU countries have the problems with service of their foreign debts. The existence of large reserves puts forward new financial problem, how to determine the effective variants for reserves investments.

2. RELATED RESEARCH

The problems of growth and competitiveness in the uniting Europe are very relevant in today’s economic context. Various methods have been worked out to evaluate the efficiency of integration strategies as for developed market, so for post socialist economies with the goal to ensure their future growth. In (Sachs, Zinnes, and Eilat 1999) the EU countries were clustered by the geographical principle and the state of economic development. After that comparative rating was

conducted by utilizing the current macroeconomic indicators as meta-variables for integrating the EU economies.

The studies conducted before 2002 showed that strategy, priorities and pace were extremely important for the integrative economic reforms. Their impact on the subsequent growth in new EU countries was uncovered with the help of regression functions in (Staehr 2003). It was hypothesized, that the reorganization of economic entities with central planning inevitably led to shifts in efficiency and thus caused the increase in the measured parameters. Initial conditions e. g. the previous structure and the state of development seriously impacted the following growth during integration. The statistical models for effectiveness the government regulation of entrepreneurs' activity, education level, and employee wages were described in (Aghion, Algan, and Cahuc 2010). The probabilistic model for political support to the institutional markets reforms was published in (Desai and Olofsgard 2006). As shown in (Marangos 2001, Kolodko 2005) the establishment of integrating market institutions and their following development were the most challenging tasks for reformers in the new integrative EU economies. The inadequacy of European institutions made integration liberalization policies ineffective. Many research groups tried to synthesize the models for complex the European Union integrating economy. The model with closed social architecture, which replicated many of the known macro parameters for the market economy, was described in (Wright 2007). This model utilized the Laplace distribution of firms' growth, the power-law distribution for firms' sizes, the lognormal distribution of firm demises, the exponential distribution of firm lifespans, the normal distribution of the log of detrended Gross Domestic Product (GDP), the exponential distribution of the recessions duration, the lognormal-Pareto distribution of income and some others. This model gave the possibility to explain a broad range of macroeconomic phenomena in terms of some very basic and simple structural features of economy. Results of the work supported the argument that in order to understand macroeconomic phenomena the concept of statistical equilibrium was essential. The sophisticated research tools for integration reforms path analysis based on the theory of deterministic chaos lead to revealing results in the case of the new EU countries (Scarlat and Scarlat 2007). The roles of the governments as well as the key role of the public administrations were emphasized in integrating processes of the EU. Comparative review of the modelling principles was published in (Wallis 2004). Also there were discussed currently operating global models, some multi-countries' models, QUEST model of the European Commission. This model could be taken as typical modern-day mainstream for structural global modeling tradition. The influence of geographical features of high-tech and medium-tech manufacturing in knowledge-based economy in integrating the CEE country was examined in (Leydesdorff and Fritch 2006a). There was shown that high-tech knowledge intensive services coupled the knowledge functions synergy to geographical locations of R&D centers. The values of configuration information based on the high- and medium-tech industries were more pronounced in the regions where international firms had higher share. Analysis utilized three dimensional model of innovation system synergy (Leydesdorff and Fritch 2006b).

The current macroeconomic indicators received on the base of statistics were utilized as meta-variables for description the nation's development in (World Bank 2011). There were considered Gross Domestic Product (GDP) per capita, Current Account Balance, External Debt, Government Budget Balance, Private sector share, Domestic and Foreign Investments, Foreign Direct Investment, Consumer price inflation, Life Expectancy, Income inequality and many others.

Table 1: GDP per capita at purchasing power parity (PPP) rating for the EU countries in current in US international dollars

Country	**GDP per capita**		**Rank in the EU**	**Growth rate**	**Rank in the EU**
	2000	**2010**			
Austria	28 900.6	40 005.2	4	1.384	22
Belgium	27 644.0	37 600.4	7	1.360	25
Bulgaria	6 309.2	13 779.8	27	2.184	2
Cyprus	19 436.3	31 092.3	14	1.600	11
Czech Rep.	14 991.2	25 283.3	19	1.687	8
Denmark	28 825.9	39 489.2	5	1.370	24
Estonia	9 880.4	20 615.0	21	2.086	5
Finland	25 666.5	36 651.2	9	1.428	20
France	25 226.0	33 819.9	11	1.341	26
Germany	25 753.4	37 260.2	8	1.447	16
Greece	18 243.0	27 804.6	15	1.524	13
Hungary	11 880.0	20 028.7	22	1.686	9
Ireland	28 688.1	41 188.4	3	1.436	19
Italy	25 591.4	31 555.2	13	1.233	27
Latvia	8 041.0	16 311.8	25	2.029	6
Lithuania	8 613.0	18 184.0	24	2.111	4
Luxembourg	53 646.0	86 898.6	1	1.620	10
Malta	18 314.3	26 639.8	17	1.456	15
Netherlands	29 399.0	42 254.9	2	1.437	18
Poland	10 512.7	19 783.3	23	1.882	7
Portugal	17 748.6	25 610.5	18	1.443	17
Romania	5 661.0	14 287.3	26	2.524	1
Slovak Rep.	11 004.6	23 422.8	20	2.128	3
Slovenia	17 552.3	27 063.0	16	1.542	12
Spain	21 320.6	32 070.1	12	1.504	14
Sweden	27 958.0	39 029.2	6	1.396	21
United Kingdom	26 068.4	35 903.7	10	1.377	23
European Union	**21 859.0**	**31 624.4**		**1.447**	
To compare					
USA	35 080.7	47 198.5		1.345	
Switzerland	31 727.3	46 581.0		1.468	
Canada	28 407.2	38 989.0		1.373	
Japan	25 619.0	33 752.9		1.317	
Russia	6 832.7	19 840.5		2.904	
China	2 364.4	7 598.8		3.214	
India	1 568.2	3 582.5		2.284	

The problems of competitiveness in national economies and meta-variables for their description were

discussed by the World Economic Forum's Annual Global Competitiveness Report (World Economic Forum 2012). They are quite good for characterizing the EU integrating economies. There are Openness, Quality of Government (revenues, system's reforms, state expenditures, inflation), Compliance with international standards, Foreign investments, Infrastructure, Technology, Institutions (Political environment, Rule of law), and so on.

It is commonly recognized that countries need to become internationally competitive for long-term sustainable growth. The so-called competitiveness of national economies was examined in business literature rather detailed (Sachs, Zinnes, and Eilat 1999, Sundbo 2001). As the result the conclusion was done that competitiveness is much more than simply having efficient and low cost firms. There were pointed to a host of potential externalities between firms (both within and across sectors) and network effects that could yield synergies of competitiveness. The quality of government, its institutions as well as laws and policies affect significantly on economy. The country's geography and culture are also of great importance.

Table 2: Life expectancy at birth in total years

Country	Life expectancy		Rank in the EU	Growth rate	Rank in the EU
	2000	**2009**			
Austria	78.03	80.08	8	1.026	16-18
Belgium	78.17	79.74	12	1.020	25
Bulgaria	71.66	73.41	24	1.024	22
Cyprus	77.96	79.20	15	1.016	26
Czech Rep.	74.97	77.08	19	1.028	14
Denmark	76.59	78.60	18	1.026	16-18
Estonia	70.42	74.82	22	1.062	1
Finland	77.46	79.72	13	1.029	12-13
France	78.96	81.07	4	1.027	15
Germany	77.93	79.84	11	1.025	19-21
Greece	77.89	80.19	6	1.030	9-11
Hungary	71.25	73.91	23	1.037	5
Ireland	76.54	79.50	14	1.039	3-4
Italy	79.43	81.44	2	1.025	19-21
Latvia	70.31	73.08	26	1.039	3-4
Lithuania	72.02	72.91	27	1.012	27
Luxembourg	77.87	80.09	7	1.029	12-13
Malta	78.20	79.90	10	1.022	23-24
Netherlands	77.99	80.55	5	1.033	6
Poland	73.75	75.69	20	1.026	16-18
Portugal	76.31	78.73	17	1.032	7-8
Romania	71.16	73.31	25	1.030	9-11
Slovak Rep.	73.05	74.91	21	1.025	19-21
Slovenia	75.41	78.97	16	1.047	2
Spain	78.97	81.48	1	1.032	7-8
Sweden	79.64	81.35	3	1.022	23-24
United Kingdom	77.74	80.05	9	1.030	9-11
European Union	**77.15**	**79.36**		**1.029**	
To compare					
USA	76.64	78.09		1.019	
Switzerland	79.68	82.04		1.030	
Canada	79.24	80.66		1.018	
Japan	81.08	82.93		1.023	
Russia	65.34	68.60		1.050	
China	71.24	73.06		1.026	
India	61.61	64.78		1.051	

Leading economists tried to define the end of integrating transition period. For example in (Gelb 1999), it was considered as a state, when the problems and the policy issues confronting by today's "integrating transition countries" resemble those faced by other countries at similar levels of development. In (Svejnar 2002) the finish of transition was defined as a state, when the new EU economies replace central planning by the functioning market system, which would generate rapid rates of sustainable economic growth, that enable them to interact with more advanced market economies without major forms of protection. Financial crisis at autumn 2008 significantly affected the European countries. Some of them met with severe problems to service their state's debts. So, economic downturn had caused the end of integrating transition reforms in the EU countries. Summarizing the lessons of this period the principles of successful reforms were formulated in (Marangos 2001, Kolodko 2005).

Table 3: Global competitiveness index for the EU countries (World Economic Forum 2012) (the 1st is the best)

Country	Global Competitive-ness Index Rating		Rank in the EU	Growth rate	Rank in the EU
	2000	**2011**			
Austria	13	19	9	- 6	12
Belgium	12	15	7	- 3	9
Bulgaria	55	74	25	- 19	20
Cyprus	--	47	19	--	--
Czech Rep.	34	38	14	- 4	11
Denmark	6	8	5	- 2	4
Estonia	27[1]	33	12	- 6	13
Finland	1	4	2	- 3	8
France	15	18	8	- 3	10
Germany	3	6	3	- 3	6
Greece	33	90	27	- 57	24
Hungary	32	48	20	- 16	16
Ireland	22	29	11	- 7	14
Italy	24	43	16	- 19	19
Latvia	42[1]	64	23	- 22	21
Lithuania	49[1]	44	17	5	1
Luxembourg	--	23	10	--	--
Malta	--	51	21	--	--
Netherlands	4	7	4	- 3	7
Poland	41	41	15	0	3
Portugal	28	45	18	- 17	18
Romania	61[1]	77	26	- 16	17
Slovak Rep.	36	69	24	- 33	23
Slovenia	32[1]	57	22	- 25	22
Spain	23	36	13	- 13	15
Sweden	7	3	1	4	2
United Kingdom	8	10	6	- 2	5
European Union	--	--	--	--	--
To compare					
USA	2	5		- 3	
Switzerland	5	1		4	
Canada	11	12		- 1	
Japan	14	9		5	
Russia	52	66		- 14	
China	44	26		18	
India	37	56		- 19	
[1)] Global Competitiveness Index Rating for 2001					
-- No data					

As integration transformations have come to their final, new strategies and driving forces are demanded

for sustainable economic growth. In history there are quite distinctive examples of the states (e.g. Switzerland, Singapore, and the UK) with remarkable economic results and lack of natural resources. However these countries had utilized new type of unrestricted resources such as knowledge, innovations, information technologies and systems (Hovelja 2009) not only for the analysis of economic processes (Staehr 2003; Leydesdorff and Fritch 2006a; Klapper and Tzioumis 2008) but for strategic management of the competitive growth (Thompson and Strickland III 1987).

As the result of transformations the new EU countries had created the economic interfaces for the expansion to foreign markets at the Eastern Europe, Caucuses, and Southern Mediterranean. Some companies from Central East Europe, such as "Škoda", JSC "Gorenje" are highly successful on these markets. But great number of other companies' products is often considered old fashioned or technologically poor developed (Baković 2010). So, competitive catch up is a hot item of current economic agenda as for the new, so for the old EU countries. Science, research and innovations, information and communication technologies at the different levels of business management e.g. strategic, financial, marketing and technological, all of them, should provide the competitiveness growth (Sundbo 2001).

3. BAYESIAN NETWORK MODEL FOR THE EU INTEGRATING TRANSITION ECONOMY

Bayesian inference theory appeared at the 18th century, Bayesian Network (BN) tools for statistical modeling so humanitarian, mathematically poor described subject domains as natural language processing, medicine, and economy were developing in computer science since 1980s (Pearl 1988, Russel and Norvig 2003). In financial management the predictive Bayesian algorithm for analysis the spreads of interest rate was published by (Bernanke 1990). Further development these ideas got in (Carlin, Polson, and Stoffer 1992).

BN is a probabilistic network with complex topology for description the expert knowledge and the observed data samples in particular domain. It is presenting by a directed acyclic graph with nodes as domain's entities and their prior probabilities. Nodes are connecting by arcs that describe "cause-effect" relations. As interdependences between various model predicates have been determined, so we get the possibility to manage the terminal state of the economic system by controlling the statistical values at the intermediate nodes. In BN model for the complex event the full joint probability distribution over multiple variables is computed by the next formula:

$$P(X_1, X_2, \ldots, X_n) = \prod_{i=1}^{n} P(X_i \mid parents(X_i)). \quad (1)$$

Where n represents the number of BN nodes, $parents(X_i)$, $i=1, \ldots n$ is the set of parents for the node X_i. Otherwise it can be written as:

$$P(X_1,X_2,\ldots,X_n) = P(X_n \mid X_{n-1}, \ldots X_1) \times P(X_{n-1} \mid X_{n-2}, \ldots X_1) \times \times P(X_{n-2} \mid X_{n-3}, \ldots X_1) \times \ldots \times P(X_1). \quad (2)$$

Within cognitive science a promising approach revealed in (Andrews and Vigiocco 2010), how the meanings of the words and concepts can be learned from their statistical distribution across the problem domain. This approach was motivated by the so-called distribution hypothesis, which suggested that the meaning of the concept could be derived from the subject domain context.

BN model for competitiveness growth in post integrated the EU economies has to reflect the dynamics and the results of reforms as the necessary preconditions for further growth, so the entities providing successful competitive catch-up. The structure of the model is presented on Figure 1. It was synthesized following the research published in (Marangos 2001, Kolodko 2005, Wright 2007). The values of nodes' probabilities are presented in the Tables 4, 5. They were received from the economic statistical reports. Even in simplified BN model we can see that great number of input nodes is determining competitive economic growth.

Table 4: The conditional probabilities distribution for nodes

Node	Value of parent X_{11}	Value of parent X_{12}	Probability
X_{14}	true	true	0.25
	true	false	0.15
	false	true	0.08
	false	false	0.01
	Value of parent X_1	**Value of parent X_2**	**Probability**
X_{11}	true	none true	0.01
	true	first true, second false	0.15
	true	first false, second true	0.30
	true	both true	0.54
	false	none true	0.001
	false	first true, second false	0.05
	false	first false, second true	0.08
	false	both true	0.35
	Value of parent X_9	**Value of parent X_{10}**	**Probability**
X_{18}	true	true	0.6
	true	false	0.3
	false	true	0.08
	false	false	0.005
	Value of parent X_{15}	**Value of parent X_{16}**	**Probability**
X_{27}	true	true	0.95
	true	false	0.65
	false	true	0.75
	false	false	0.05

Table 5: The probabilities distribution for economic factors

Node	Value of the factor	Probability
X_1	true	0.50
	false	0.50
X_2^1	none true	0.01
X_2^2	first one true	0.14
X_2^3	second one true	0.25
X_2^4	both true	0.60
X_{12}	true	0.80
	false	0.20
X_{19}	X_{14} = true	0.85
	X_{14} = false	0.05
X_{20}	X_{14} = true	0.88
	X_{14} = false	0.10
X_{25}	X_{18} = true	0.8
	X_{18} = false	0.2

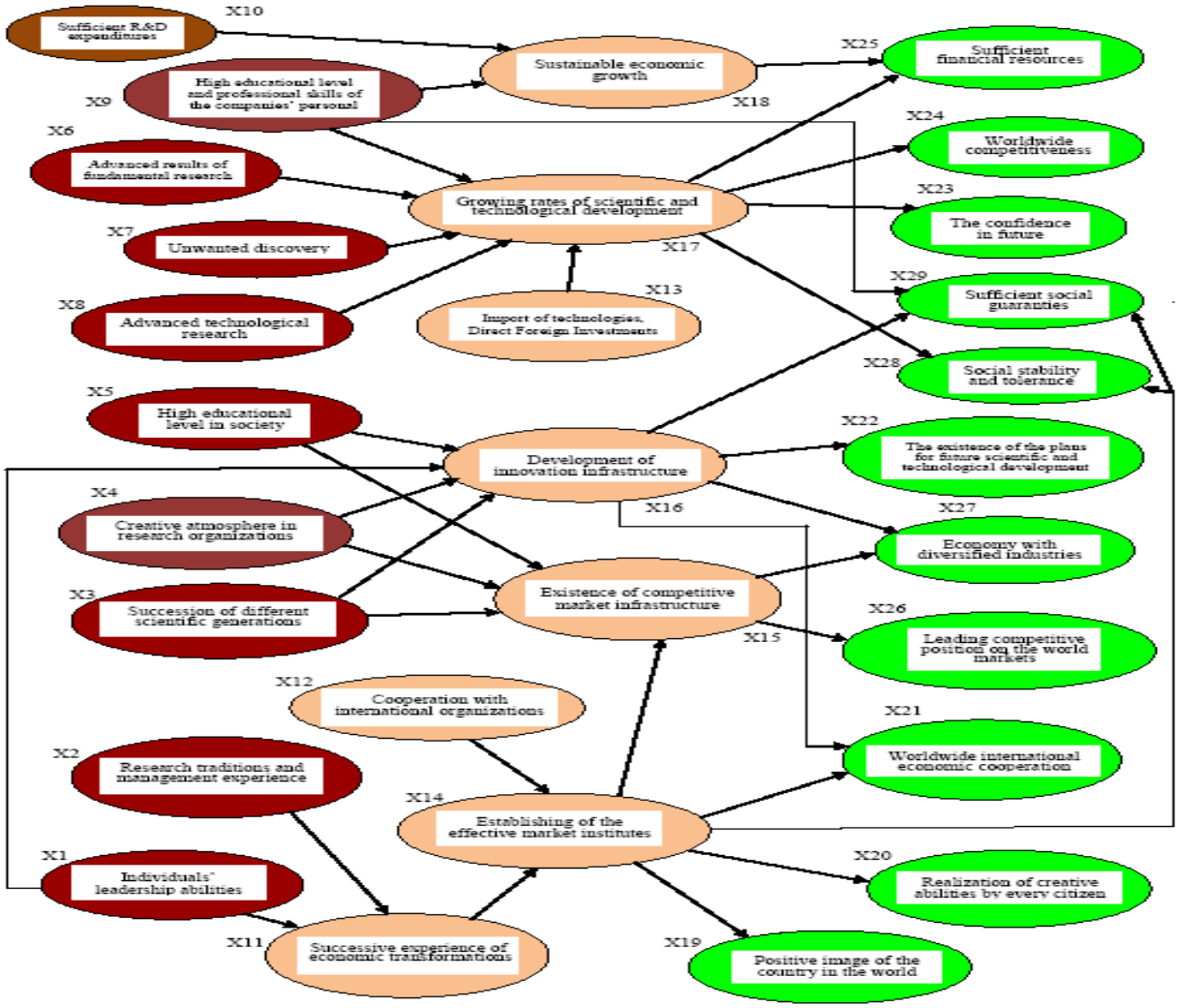

Figure1: The fragment of Bayesian Network model for the economic factors of competitive growth

National research traditions and management experience with individuals' leadership abilities are the key factors for the success. General levels of education in CEE post-socialist countries are much closer to the Western Europe and the North America than to the Third World (Baković 2010).

The formulae for calculation the probability of the node X_{14} illustrate the modeling process.

$$\begin{aligned} P(X_{14}) = {} & P(X_{14} \mid X_{12}, X_{11}) \times P(X_{12}) \times P(X_{11}) + \\ & + P(X_{14} \mid X_{12}, -X_{11}) \times P(X_{12}) \times P(-X_{11}) + \\ & + P(X_{14} \mid -X_{12}, X_{11}) \times P(-X_{12}) \times P(X_{11}) + \\ & + P(X_{14} \mid -X_{12}, -X_{11}) \times P(-X_{12}) \times P(-X_{11}) \end{aligned} \quad (3)$$

$$\begin{aligned} P(X_{11}) = {} & P(X_{11} \mid X_2^1, X_1) \times P(X_2^1) \times P(X_1) + \\ & + P(X_{11} \mid X_2^1, -X_1) \times P(X_2^1) \times P(-X_1) + \\ & + P(X_{11} \mid X_2^2, X_1) \times P(X_2^2) \times P(X_1) + \\ & + P(X_{11} \mid X_2^2, -X_1) \times P(X_2^2) \times P(-X_1) + \\ & + P(X_{11} \mid X_2^3, X_1) \times P(X_2^3) \times P(X_1) + \\ & + P(X_{11} \mid X_2^3, -X_1) \times P(X_2^3) \times P(-X_1) \\ & + P(X_{11} \mid X_2^4, X_1) \times P(X_2^4) \times P(X_1) + \\ & + P(X_{11} \mid X_2^4, -X_1) \times P(X_2^4) \times P(-X_1) \end{aligned} \quad (4)$$

$$\begin{aligned} P(X_{11}) = {} & 0.01 \times 0.01 \times 0.5 + 0.01 \times 0.01 \times 0.5 + \\ & + 0.15 \times 0.14 \times 0.5 + 0.15 \times 0.14 \times 0.5 + \\ & + 0.30 \times 0.25 \times 0.5 + 0.30 \times 0.25 \times 0.5 + \\ & + 0.54 \times 0.60 \times 0.5 + 0.54 \times 0.60 \times 0.5 + \\ & + 0.001 \times 0.01 \times 0.5 + 0.001 \times 0.01 \times 0.5 + \\ & + 0.05 \times 0.14 \times 0.5 + 0.05 \times 0.14 \times 0.5 + \\ & + 0.08 \times 0.25 \times 0.5 + 0.08 \times 0.25 \times 0.5 + \\ & + 0.35 \times 0.60 \times 0.5 + 0.35 \times 0.60 \times 0.5 \approx 0.65711 \end{aligned} \quad (5)$$

$$P(-X_{11}) = 1 - P(X_{11}) \approx 0.34289. \quad (6)$$

$$P(X_{12}) = 0.8; \; P(-X_{12}) = 0.2. \quad (7)$$

$$\begin{aligned} P(X_{14}) = {} & 0.25 \times 0.8 \times 0.65711 + 0.08 \times 0.8 \times 0.34289 + \\ & + 0.15 \times 0.2 \times 0.65711 + 0.08 \times 0.2 \times 0.34289 \approx 0.178567. \end{aligned} \quad (8)$$

$$P(-X_{14}) = 1 - P(X_{14}) \approx 0.821433. \quad (9)$$

These calculations only for few intermediate nodes show that adequate modeling of integrating economies by Bayesian Network is very complex computational problem. Great work should be done to construct the

precise evaluations of conditional probabilities for every node, otherwise, "to learn the net". The correctness of the 'learned network" depends on amount of available training data. Moreover as pointed in (Albert and Chib 1993, Basu 1997) conditional probabilities of the nodes are time-varying in conjunction with phase of business cycle as well as disturbances on international or financial market, and with strategic management decisions. To produce high correlation between business cycle's dates and the estimated posterior state of the model, nodes transition probabilities should vary systematically on condition with information reflecting the future course of economy (Kolodko 2010).

In the case when data are insufficient, various forms of prior knowledge about the domain are executing to improve the accuracy of learned model. In (Niculescu, Mitchel, and Bharat Rao 2006) Newton-Raphson method and Maximum Likelihood Estimation were utilized for calculation the intermediate nodes' conditional probabilities.

Significant difference between the EU countries and insufficient training data samples for determination the intermediate conditional probabilities are the peculiarities of discussing problem. In this case the correctness of the model significantly depends on experts' prior knowledge about terminal probabilities $P(X_{19})$, $P(X_{20})...P(X_{29})$.

Indicators from the World Bank database for 2000 – 2010 were utilized to "learn" the model. The conditional probabilities of the intermediate nodes were determined by random search method in the vicinity of prior values. Finally the model was tested by statistical information from the World Bank database for 2011.

Bayesian Network gives the possibility to model the integration transition processes and to apply stochastic management methods as for governing the transformations, so for creating the competitive innovative knowledge economies. This model allows grouping the EU countries into four clusters, which are characterized by the values of terminal probabilities depending on results of the reforms.

The first cluster unites the leader-countries solving successfully the problems of competitive economic growth. They are the core of integration in the European Union.

The second is formed by the states with steadily growing economies, confirming the correctness of the integration ideals.

The third cluster groups together the most successful new EU member states, which overcame shocks of integration, as well as "traditional" European countries experiencing problems with implementation of innovative scenarios for transforming the economies.

New EU member countries with the difficulties in implementation of the integration reforms and small island European countries are included in the fourth.

Table 6: The clusters of the EU countries defined by the vector of terminal probabilities

The first cluster of the EU countries defined by the vector of the terminal probabilities (X19 – X29)		
Terminal probabilities	**Intervals of magnitudes**	**Countries**
X19	0.90 – 0.95	Denmark
X20	0.90 – 0.95	Finland
X21	0.90 – 0.95	Germany
X22	0.90 – 0.95	Netherlands
X23	0.90 – 0.95	Sweden
X24	0.90 – 0.95	United
X25	0.90 – 0.95	Kingdom
X26	0.90 – 0.95	
X27	0.90 – 0.95	
X28	0.90 – 0.95	
X29	0.90 – 0.95	

The second cluster of the EU countries defined by the vector of the terminal probabilities (X19 – X29)		
Terminal probabilities	**Intervals of magnitudes**	**Countries**
X19	0.85 – 0.90	Austria
X20	0.85 – 0.90	Belgium
X21	0.85 – 0.90	France
X22	0.85 – 0.90	Italy
X23	0.85 – 0.90	Luxembourg
X24	0.85 – 0.90	
X25	0.85 – 0.90	
X26	0.85 – 0.90	
X27	0.85 – 0.90	
X28	0.85 – 0.90	
X29	0.85 – 0.90	

The third cluster of the EU countries defined by the vector of the terminal probabilities (X19 – X29)		
Terminal probabilities	**Intervals of magnitudes**	**Countries**
X19	0.80 – 0.85	Czech
X20	0.80 – 0.85	Republic
X21	0.80 – 0.85	Estonia
X22	0.80 – 0.85	Ireland
X23	0.80 – 0.85	Poland
X24	0.80 – 0.85	Portugal
X25	0.80 – 0.85	Spain
X26	0.80 – 0.85	
X27	0.80 – 0.85	
X28	0.80 – 0.85	
X29	0.80 – 0.85	

The forth cluster of the EU countries defined by the vector of the terminal probabilities (X19 – X29)		
Terminal probabilities	**Intervals of magnitudes**	**Countries**
X19	0.75 – 0.80	Cyprus
X20	0.70 – 0.80	Hungary
X21	0.75 – 0.80	Latvia
X22	0.75 – 0.80	Lithuania
X23	0.75 – 0.80	Malta
X24	0.70 – 0.80	Slovak
X25	0.65 – 0.70	Republic
X26	0.65 – 0.70	Slovenia
X27	0.75 – 0.80	Bulgaria
X28	0.75 – 0.80	Romania
X29	0.75 – 0.80	

4. DISCUSSION

The results of economic development for 2000 – 2011 show that the "integration choice" of the new EU member states was correct. In 2011 only 6 from 27 the European Union countries had GDP per capita less than that for the Russian Federation with its vast reserves of oil and gas, highly developed metal production industry and internationally recognized scientific schools.

It should be noted, that the smallest among the EU states GDP per capita index for Bulgaria was more than 1.8 times higher than the same one for China. But over the period 2000 – 2011 the growth rate of discussing index in Bulgaria, which is one of the most dynamically growing economies in the EU, was in 1.47 times less than in China. In competitiveness ranking of national economies for 2011 China took the 26th position, Bulgaria - 74th, Romania – 77th, Greece – 90th (World Economic Forum 2012).

The implementation of reforms and integration, the creation of the single European space for knowledge and research are opening new opportunities for the economic growth. In the framework of Bayesian Network model this means that the probabilities defined by the root nodes X3, X4, …, X10 are nearly the same for all the EU countries. The probabilities at the root nodes X1, X2 are depending on the national peculiarities and are varying from Greece through Hungary, Spain and Denmark to Sweden. The differences in magnitudes of terminal probabilities X19, X20, …, X29 are defined by the values of the conditional probabilities at the nodes X14, X15, X16, X17, X18.

Bayesian Network is a statistical tool to model mathematically poor described complex systems. It gives the possibility to cluster the EU countries. The next step is to improve the quality of integration policy with the goal to increase the number of states referring to the first and second groups and to decrease the amount of the EU citizens living in countries united into the third and forth clusters.

To do this, the successful experience of the leading countries should be studied by the European Commission. After that probabilistic optimization methods can be utilized for determination the parameters of competitive growth. In management science stochastic problems are usually solved by portfolio methods.

For decision making and planning within the complex probabilistic scenarios different Analytic Hierarchy Process (AHP) dynamic criteria were proposed in (Bruzzone, Masei, and Tarone 2011). This approach considered the human factors and environmental variables. Thus the possibility appears to quantify and to measure the impact and the reaction of the EU citizens on the integration processes and competitive growth.

5. CONCLUSSIONS AND FUTURE WORK

Management of innovations for competitiveness growth is multilevel process, so portfolio approach should be realized at every level. First of all, the portfolio of technological and business innovations has to be composed. After that the portfolio for implementations' strategies ought to be worked out. At the marketing management level portfolio of various sale technologies is executing to move the new products and business processes to the markets as domestic, so foreign.

Many innovations have different chance for success on various markets. There are a lot of oil and gas in Russia, but it is very difficult to implement here energy efficient technologies created in Denmark, Sweden, and Finland. The economies of southern and the new European Union states are friendlier for these innovations. Reduction of energy expenditures can raise the competitiveness of such touristic countries as Italy, Spain, Cyprus, Malta, Bulgaria, Slovenia, and Greece.

European environment friendly technologies have also considerable export potential, which can be realized in the framework of Euro-Mediterranean Partnership (EUROMED) and Eastern Partnership programs.

Next steps to synthesize the portfolios competitive growth were defined in (Petrillo, Cooper, and De Felice 2012):

1. Structure the problem of national economic growth with respect to its goal.
2. Create the networks benefits, opportunities, costs, and risks.
3. Establish the control probabilities to evaluate the benefits, opportunities, costs, and risks.
4. Define the decision subnets for each control probability.
5. Complete the pair wise comparisons for portfolios' elements.
6. Evaluate the rating model to combine the benefits, opportunities, costs, and risks.
7. Synthesize combined scenarios portfolio with respect to the strategic criteria.
8. Perform sensitivity analysis to test the stability of results.

Nowadays economies of the EU countries are coming through very complex market oriented integration transformations, which are synchronizing in time with restructuring of the traditional industries producing commodities into a new era competitive knowledge economies in post industrial information societies. In future research for adequate description these temporal-indistinct processes the Dynamical Bayesian Network model should be designed. It will give the possibility to apply multi criteria approaches for economic stochastic analysis and management.

The innovative competitive development in the EU economies is very complex multilevel stochastic problem. The success can't be achieved without participation as European, so national scientific communities and universities.

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AUTHORS BIOGRAPHY

Peter I. Kamyshanov received his doctor degree in Economy in 1960. He is the author of more than 10 books and textbooks for universities in accounting and audit.

Alexander P. Kamyshanov got his PhD in computer modeling and stochastic management of large scale systems in 1989. As co-author he published several books and textbook in accounting and economic analysis.

Peter I. Kamyshanov is currently professor and **Alexander P. Kamyshanov** – assistant-professor in the Department of Accounting and Audit at the Faculty of Business of Plekhanov Russian Economic University. Their research interests focus on stochastic description and modeling of economic systems.