Models of estimation national economy*

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1. Introduction

Occurring at the end of XX and the beginning of XXI centuries the economic, political, social, and environmental world crises show that the existing methods of estimation of the economic system on the basis of the Gross Domestic Product is not suitable for the analysis and management of socioeconomic systems. Well-known economists, Nobel Prize - K. Arrow, S. Smith, D. Kahneman, R.Solou, Joseph Stiglitz, Amato Sen also in his investigation show the unsuitability assessment of the national economy on the basis of the Gross Domestic Product, as this approach does not fully describe the social and environmental impact to the system. The reasons for this are: 1. The luck of statistical information on quality indicators. 2. The traditional mathematical methods cannot describe quality indicators. Today develop new scientific method such as soft computing, which allow possibility to solve this problem of quality indicators.

We think so estimation level of development of the national economy should be based on the system analysis indicators of two subsystems such as national wealth and financial stability. In the report will propose a new approach to the assessment of the level of development of the national economy based on the tools of the Fuzzy set and Fuzzy logic theories. Results of the investigation were demonstrated by using information Azerbaijan Republic.

2. Measurement of national wealth

One of the important macro-economic categories, which give an idea of the aviable resources and the development potential of the country, is a national wealth.

There are different methods assessments of the national wealth. Today recognized methodology, developed by the World Bank [1], [2]. The methodology was constructed for analyze the structure of the national wealth. The concept proposed by experts of the World Bank, the national wealth is consist of following capitals: Natural capital, Produced capital, Social capital, Human capital.

2.1 Natural capital

Economical development every country depends on a base of natural resources – natural capital. Natural capital (NC) is sum of Crop, Pasture Land, Timber, Non Timber Forest, Protected Areas, Oil, Natural Gas, Coal, and Minerals.

Different methods estimations of natural capital of the countries in international statistics are used. Statistical Commission UNO recommended rent method of the estimation natural resources, which mainly use by countries with market economy. Natural capital of the country estimated by present market value.

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Using World Bank methodology was measured natural capital of the Azerbaijan for 2010. Indicators national capital for 2005 taken from [1], [2]
Results of computation demonstrated in table 1.

<table>
<thead>
<tr>
<th>Years</th>
<th>Oil</th>
<th>Gas</th>
<th>Timber</th>
<th>Non-timber</th>
<th>Cropland</th>
<th>Protection land</th>
<th>Pastureland</th>
<th>Natural capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>75.5</td>
<td>1.8</td>
<td>0.8</td>
<td>0.19</td>
<td>12.2</td>
<td>1.4</td>
<td>7.6</td>
<td>99.5</td>
</tr>
<tr>
<td>2010</td>
<td>240</td>
<td>8.4</td>
<td>0.95</td>
<td>0.22</td>
<td>14.8</td>
<td>2.6</td>
<td>14.3</td>
<td>281.27</td>
</tr>
</tbody>
</table>

Table 1 show that the growth of natural capital in 2010 compared to 2005 increased by 2.83 times, the cause of which was the growth of production and the price of oil and gas

2.2 Produced capital

According to World Bank methodology produced capital is sum of physical capital and urban land, which is valued at 24 percent of physical capital across all countries. Produced capital defined as accumulation of investment series (gross capital formation) taking into account depreciation at the rate of 5 percent. 20 years is the service lifetime assumption.

\[
F_c (physical capital) = 60.7 \text{ bln $ USA}
\]

\[
U (urban land) = 14.5 \text{ bln $ USA}
\]

\[
P_c (produced capital) = 75.2 \text{ bln $ USA}
\]

The volume of produced capital in 2010 increased by 5 times

2.3 Model of estimation Social capital

Social capital is defined by OECD as “networks together with shared norms, values and understandings that facilitate co-operation within or among groups”[10]. Social capital plays significant role in economic development. Estimation of social quality is almost impossible by using traditional methods. We do attempt to estimate social capital quality by using fuzzy approach. Problems corresponding to the models are solved applying fuzzy method. World Development and Azerbaijan Indicators were used in the process of solution of the problems.

In order to estimation social capital was used indicators of the four conditional factors of the social quality - social-economic security, social cohesion, social inclusion, social
empowerment. The theory of social quality has been offered by U. Beck, V. Maesen, L. Thomese and A. Walker [3], [4], [5]. Social quality represents degree of participation of citizens in the social and economic life of a society in which their well-being and individual potential raises.

**Social-economic security indicators are following:**

1. number of square meters per household member (NSM);
2. Proportion of population living in houses with lack of functioning basic amenities (PPL);
3. Proportion of people covered by compulsory/voluntary health insurance (PHI);
4. Number of medical doctors per 10 000 inhabitants (MED);
5. Length of notice before termination of labor contract (LNT);
6. Proportion of employed workforce with temporary, non-permanent, job contract (PET);
7. Proportion of workforce that is illegal (PWI);
8. Number of fatal cases (NFC);
9. Number of nonfatal cases (NNC);
10. Number of hours a full-time employee typically works a week (NHE);
11. Proportion of pupils leaving education without finishing compulsory education (PLE);
12. Study fees in school as proportion of national mean net wage (SFS);
13. Study fees in high school as proportion of national mean net wage (SFH);
14. Proportion of students who, within a year of leaving school, are able to find employment (PSE);
15. People affected by criminal offences per 10 000 inhabitants (CRI);
16. Ecocivilization index (ECC).

Quality of socioeconomic security index (SESI) is the output indicator.

**Social cohesion indicators are following:**

1. Extent to which most people can be trusted (TRU);
2. Trust to authorities (TRA);
3. Trust to religion (TRR);
4. Number of cases being referred to European Court of Law (ECO);
5. Respect for parents (IFA);
6. Blood donation (%) (BLO);
7. Multiculturalism (tolerance) (TOL);
8. Willingness to pay more taxes if you were sure that it would improve the situation of the poor (WMT);
9. Help elders (VOL);
10. Membership (active or inactive) of political, voluntary, charitable organizations or sport clubs (MVO);
11. Frequency of contact with friends and colleagues (CWF);
12. Sense of national pride (NAP).

Quality of social cohesion index (SCOI) is the output indicator.

**Social inclusion indicators are following:**

1. Proportion having right to vote in local elections (POV);
2. Proportions exercising in local elections (PPV);
3. Proportion with right to a public pension (PEN);
4. Proportion of ethnic minority groups elected or appointed to parliament, boards of private companies an foundations (ETH);
5. Proportion of women elected or appointed to parliament, boards of private companies and foundations (WPA);
6. Long – term unemployment (12+ month) (LTU);
7. Proportion of population with entitlement to and using public primary health care (PPH);
8. Proportion homeless, sleeping rough (HLP);
9. Average waiting time for social housing (WAI);
10. School participation rates and higher education participation rates (HED);
11. Proportion of people in need received care services (PPN);
12. Density of public transport system and road density (TRD);
13. Number of public sport facilities per 10 000 inhabitants (NPS);
14. Number of public and private civic and cultural facilities (e.g. cinema, theatre, concerts) per 10 000 inhabitants (NPC);
15. Duration of contact with relatives (cohabitating and non-cohabitating (PRC).

Quality of social inclusion index (SIQI) is the output indicator.
Social empowerment indicators are following:

1. Extend to which social mobility is knowledge-based (SOM);
2. Percentage of population literate and numerate (PLN);
3. Availability of free media (FME);
4. Percentage of labor force that is member of a trade union (TRU);
5. Percentage of labor force covered by a collective agreement (LCA);
6. Percentage of employed labor force receiving work-based training (TRA);
7. Index of democracy (DEM);
8. Percentage of organizations/institutions with work councils (WCC);
9. Percentage of the national and local public budget that is reserved for voluntary, non-for-profit citizenship initiatives (CIL);
10. Proportion of national budget allocated to all cultural activities (CUL);
11. Percent expenses of national and local budgets devoted to disabled people (DIL).

Quality of social empowerment index (SEQI) is the output indicator. Indicators of conditional factors of social quality were adopted from [5].

In order to estimation indices of factors of social quality were proposed method, which is based on L. Zadeh’s composite rules of inference [6] and consist of the following steps:

1. development of a table describing parameters of the model on the basis of information obtained from international organizations and experts. In the first column of the table shows the input parameters of the model, and in the following columns - terms and their intervals. The last column specifies crisp meaning of input parameters for a fixed period;
2. definition of membership degrees of the crisp meaning of the input parameters to the relevant terms;
3. determination of the minimum degree of membership to the corresponding term of input parameters, i.e. \( \min \mu_i \); 
4. determination of the maximum of the minimum values of the degrees of membership to the corresponding term, i.e. \( \max \left( \min \mu_i \right) \);

The obtained value will reflect the quality of the social factor.

The proposed methodology is tested on the basis of information on quality parameters of the model of socio-economic security (Table 2). The source materials are obtained from the
Table 2. Parameters of the model of social-economic security

<table>
<thead>
<tr>
<th>Input variable</th>
<th>Terms and its intervals</th>
<th>Azerbaijan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. NSM</td>
<td>L 0 – 15, M 14 - 20, H 18 - 30, VH 28 - 70</td>
<td>12.6</td>
</tr>
<tr>
<td>2. PPL</td>
<td>L 0.5 – 0.25, M 0.24 – 0.15, H 0.14 – 0.1, VH 0.09 – 0</td>
<td>0.15</td>
</tr>
<tr>
<td>3. PHI</td>
<td>L 0 – 10, M 9 - 21, H 20 - 60, VH 59 - 100</td>
<td>0.2</td>
</tr>
<tr>
<td>4. MED</td>
<td>L 0 – 300, M 299 - 350, H 300 - 400, VH 370 - 600</td>
<td>36.8</td>
</tr>
<tr>
<td>5. LNT</td>
<td>L 1 – 31, M 30 - 51, H 50 - 61, VH 60 - 90, VH 60</td>
<td></td>
</tr>
<tr>
<td>6. PET</td>
<td>L 100 – 50, M 49 - 20, H 19 - 10, VH 9 - 1</td>
<td>68</td>
</tr>
<tr>
<td>7. PWI</td>
<td>L 0.5 – 0.2, M 0.19 – 0.14, H 0.13 – 0.09, VH 0.18 – 0</td>
<td>0.002</td>
</tr>
<tr>
<td>8. NFC</td>
<td>L 10 – 8, M 7 - 5, H 4 - 2, VH 1 - 0</td>
<td>0.00128</td>
</tr>
<tr>
<td>9. NNC</td>
<td>L 10 – 8, M 7 - 5, H 4 - 2, VH 1 - 0</td>
<td>0.00172</td>
</tr>
<tr>
<td>10. NHE</td>
<td>L 50 – 44, M 43 - 39, H 38 - 36, VH 35 - 20</td>
<td>42</td>
</tr>
<tr>
<td>11. PLE</td>
<td>L 50 – 20, M 18 - 9, H 8 - 7</td>
<td>6 - 0</td>
</tr>
<tr>
<td>12. SFS</td>
<td>L 6 – 3, M 2.9 - 2, H 1 – 0.5, VH 0.4 - 0</td>
<td>2.8</td>
</tr>
<tr>
<td>13. SFH</td>
<td>L 7 – 3, M 2.9 - 2, H 1 – 0.5, VH 0.4 - 0</td>
<td>6</td>
</tr>
<tr>
<td>14. PSE</td>
<td>L 0 – 5, M 4 - 10, H 9 - 20, VH 19 - 100</td>
<td>30</td>
</tr>
<tr>
<td>15. CRI</td>
<td>L 180 – 80, M 79 - 50, H 49 - 20, VH 19 - 0</td>
<td>13.5</td>
</tr>
<tr>
<td>16. ECC</td>
<td>L 0 - 0.2, M 0.19 – 0.5, H 0.49 – 0.7, VH 0.7 - 1</td>
<td>0.632</td>
</tr>
</tbody>
</table>
international socio-economic organizations and the expert opinion data. Information on the socio-economic security of Azerbaijan in 2010, which is given in the last column of Table 2.

To calculate the quality of the social factors the following terms are used: low (L), medium (M), high (H) and very high (VH), which are scaled in the interval [0, 1].

In order to define linguistic variables intervals following calculations have been used, given in [7]: The second stage we have determined the degree of membership of national indicators of socio-economic security to the appropriate term. In determining the degrees of membership, we have used triangular membership functions.

At the task level membership of 16 indicators of the terms is as follows:

<table>
<thead>
<tr>
<th>Low (L)</th>
<th>Mean (M)</th>
<th>High (H)</th>
<th>Very high (VH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \mu_{NSM} = 0.32 )</td>
<td>( \mu_{PPL} = 0.25 )</td>
<td>( \mu_{MED} = 0.64 )</td>
<td>( \mu_{PWT} = 0.05 )</td>
</tr>
<tr>
<td>( \mu_{PHI} = 0.4 )</td>
<td>( \mu_{NHE} = 0.66 )</td>
<td>( \mu_{LNT} = 0.18 )</td>
<td>( \mu_{NFC} = 0.003 )</td>
</tr>
<tr>
<td>( \mu_{PET} = 0.72 )</td>
<td>( \mu_{PLE} = 0.22 )</td>
<td>( \mu_{ECC} = 0.65 )</td>
<td>( \mu_{NNC} = 0.003 )</td>
</tr>
<tr>
<td>( \mu_{SFH} = 0.5 )</td>
<td>( \mu_{SFS} = 0 )</td>
<td>( \mu_{PSE} = 0.27 )</td>
<td>( \mu_{CRI} = 0.58 )</td>
</tr>
</tbody>
</table>

Among the minimum values the maximum value is determined, which is equal to 0.32. This value corresponds to the term - "low", thus defining quality index of socio-economic security: SESI as low. Likewise, the indices of the quality of social inclusion - SIQI is 0.86 (high), the index of the quality of social empowerment - SEQI is 0.9 (high), the index of the quality of social cohesion - SCQI is 1 (moderate). Estimated meanings of the conditional factors social quality give us possibility estimate social capital quality. In order to estimation social capital quality index (SCQ), we used fuzzy union operation, i.e.

\[
\mu_{SCQ} = \max(\mu_{SESI}, \mu_{SIQI}, \mu_{SEQI}, \mu_{SCQI}) = \max(0.32; 0.86; 0.9; 1) = 1 \text{(moderate)}.
\]

The proposed model for estimation of social quality gives us possibility to define human capital quality.

### 2.4 Model of estimation of quality of national human capital

Human capital is one of the main factors, which provides information on the development level of the socioeconomic system. Fundamental concepts of the human capital theory were founded by the American economists, Nobel Prize Laureates, T. Shultz [8] and G. Becker [9]. According to the definition of the Organization Economic Cooperation and
Development (OECD) experts’ human capital is “the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being” [10].

The conventional standard to measure human capital stock has been largely categorized into three parts [10]:

- School enrollment rates, scholastic attainments, adult literacy, and average years of schooling are the examples of the output-based approach;

- Cost based approach is based on calculating costs paid for obtaining knowledge;

- Income-based approach is closely linked to each individual’s benefits obtained by education and training investment.

Professor D.Kwon [11] refers that human capital is difficult to identify and measure directly. So, many researchers have used indirect measurements. Concept of the human capital needs to be considered both from monetary and non-monetary characteristics. Human capital is closely linked to the social capital. It is necessary to analyze the results of human capital measurement within the socio-cultural framework of a society and all levels such as individual, organizational, national.

Human capital on the national level expresses intellectual potential of the society.

In this paper we study problem of estimation of quality of the national level of human capital. With this purpose, following elements are taken as recourses of human capital:

1. Education quality - QUE;
2. Level of the health care development - QHC;
3. Cultural level of society - QSC;
4. Innovation index - INO;
5. Quantity of patent - PAT;
6. Quantity of articles - ART;
7. Labor productivity – PRO;
8. Socioeconomic security index - SEQ;
9. Social cohesion index - SCI;
10. Social inclusion index -- SII;
11. Social empowerment index – SEI.

Estimation parameters – national human capital quality index - NHCQI.

Linguistic parameters of the level of education, health care, culture of society were defined by scaling these parameters in the interval [0 - 10]. As factices meaning, results of expert opinion of the specialist, working in this sphere have been used.

In order to define quality of science following indices have been used: resident patent applications index, scientific and technical journal articles, patent application per million of population, innovation index. For this purpose, corresponding world development indicators [12] and component knowledge economy were applied [13]. Labor productivity indicators are taken from [14]. Indicators of socioeconomic security index, social cohesion index, social inclusion index and social empowerment index, are the results of the solution of the problem of social quality estimation.
By using a mentioned approach was defined quality index of national human capital (NHCQI) which equal is “low”.

Proposed approach to estimation of social and national human capital quality gives possibility to define country’s level compared to the world development indices. It is necessary to further develop this idea on the individual and organizational level for the forthcoming investigation of the social and human capital quality.

3. Results of estimation national wealth

Estimate of the national wealth of Azerbaijan for 2010 shows that if the weight of natural capital in total national wealth in 2005 was 0.75, then in 2010 this value was 0.79. In the last column of Table 3 presents the relation between the total national wealth per capita and GDP per capita. In economic theory, this relation is known as the "Kuznets effect" [15]. Nobel Prize S.Kuznets noted the long-term declining tendency of the relation between national wealth and Gross Domestic Product. According to S.Kuznets decrease this value lead to increase the marginal productivity of the national wealth [16]. According to calculations, if in 2005 this value was 9.7, then in 2010 - 6.9.

According to World Bank in 2005, national wealth per capita in Azerbaijan equal to 15298 U.S. dollars. With this indicator Azerbaijan apply to low group National Wealth per capita. Results of our calculations show that this indicator in 2010 is increase more twice, equal to 39644 and concerning to average group.

Social and human capital in World Bank report are investigated as intangible capital and its value per capita for Azerbaijan in 2005 was estimate 195 U.S. dollars.. In our calculations for 2010 intangible capital is divided into social and human capital and by using tools of fuzzy sets and fuzzy logic, were define value of this capitals, which equal respectively, medium and low.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>National wealth per capita (in USA dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td>Natural capital</td>
</tr>
<tr>
<td>2010</td>
<td>31 252</td>
</tr>
<tr>
<td>%</td>
<td>267</td>
</tr>
</tbody>
</table>
4. Model of Financial Stability

Analysis and estimation of financial situation are very important issues for the governments for ensure sustainable socioeconomic development of the state.

In order to estimation financial situation necessary:
- Control monetary rules;
- Control fiscal rules.

<table>
<thead>
<tr>
<th>Table 4 Results of monetary rules (in decile)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicators</strong></td>
</tr>
<tr>
<td>International reserves - INR</td>
</tr>
<tr>
<td>Exports - EXP</td>
</tr>
<tr>
<td>The terms of trade - TRA</td>
</tr>
<tr>
<td>Real exchange rate - DRE</td>
</tr>
<tr>
<td>Commercial bank deposits - CBD</td>
</tr>
<tr>
<td>Output - OUT</td>
</tr>
<tr>
<td>Stock prices - SMI</td>
</tr>
<tr>
<td>Central Bank credit to the public sector / GDP - CBC</td>
</tr>
<tr>
<td>Credit rating - CRA</td>
</tr>
<tr>
<td>Current account balance / GDP - CAB</td>
</tr>
<tr>
<td>Current account balance / Investment - CAI</td>
</tr>
<tr>
<td>Domestic credit / GDP - DOC</td>
</tr>
<tr>
<td>Domestic-foreign interest rate differential on deposits - IRD</td>
</tr>
<tr>
<td>Excess real M1 balance - EMB</td>
</tr>
<tr>
<td>Foreign direct investment / GDP - FDI</td>
</tr>
<tr>
<td>General government consumption / GDP - GGC</td>
</tr>
<tr>
<td>Import - IMP</td>
</tr>
<tr>
<td>=Ratio of lending rate to deposit rate - LED</td>
</tr>
<tr>
<td>M2 multiplier - MMV</td>
</tr>
<tr>
<td>M2 / reserves - MRE</td>
</tr>
<tr>
<td>Net credit to the public sector / GDP - NCR</td>
</tr>
<tr>
<td>Overall budget balance / GDP - BUD</td>
</tr>
<tr>
<td>Real interest rate on deposits - RIR</td>
</tr>
<tr>
<td>Short-term capital inflows / GDP - SCI</td>
</tr>
</tbody>
</table>

In order to estimation monetary rules by using indicators, which propose [15], were constructed fuzzy model. Problems corresponding to model were solve using monetary monthly information Azerbaijan for 2007/09 – 2008/08. Result for one month given in table 4. Term E1 demonstrate stabile and E3 – weak stabile situations.

In order to estimation fiscal rules were used indicators, which proposed in paper [17] and budget deficit as a percentage of GDP.

**Table 5**

<table>
<thead>
<tr>
<th>Parameters of the models fiscal rules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicators</strong></td>
</tr>
<tr>
<td>1. The current account deficit as a percentage of GDP</td>
</tr>
<tr>
<td>2. The long-term debt as a percentage of GDP</td>
</tr>
<tr>
<td>3. The short-term debt as a percentage of GDP</td>
</tr>
<tr>
<td>4. The current account minus foreign direct investments a percentage as a percentage of GDP</td>
</tr>
<tr>
<td>5. The debt service in relation to the nation’s exports</td>
</tr>
<tr>
<td>6. The number of months of imports that the nation can finance with its international reserves</td>
</tr>
<tr>
<td>7. Budget deficit as a percentage of GDP</td>
</tr>
</tbody>
</table>

In order to this problem, mainly were used information of IMF, WB, Journal of Institutional Investor, data provided by the Central Bank of Azerbaijan. From the table 5 show, that all the indicators of the Republic of Azerbaijan reflects the sustainable of the financial sector.
Conclusion

This approach to the measurement / estimation of the national economy gives possibility
to define of the level main economical, social, financial and ecological parameters of the country.
Investigations indicators of the development of national economy show necessity of reform the
statistical information. Statistical reports should be reflecting not only quantity parameters and
also quality parameters.

References
1. The Changing Wealth of Nations, Measuring Sustainable Development in the New
2. Where is the Wealth of Nations, Measuring Capital for the 21st Century, The World Bank,
3. Beck, W., van der Maesen, L. And Walker, A. Social quality: from issue to concept“ in
Beck, W., van der Maesen, L. and Walker, A.(eds) The Social Quality of Europe. The
5. I.Van der Maeson, A.Walker, M.Keizer, European Network Indicators of Social Quality –
ENIQ -, ‘Social Quality’ the final report. European Foundation on Social Quality, 105 p.,
(April 2005)
6. L.A.Zadeh, Outline of a new approach to the analysis of complex systems and decision
no1, 1 – 17 pp. (1961)
Economy, Vol. 70, pp. 9-44, (1962)
(2001)
11. Kwon, Dae-Bong, Human capital and its measurement, The 3rd OECD World Forum on
“Statistics, Knowledge and Policy” Charting Progress, Building Visions, Improving Life,
Busan, Korea, 15 p., (27 – 30 October 2009)
board.org/data/economydatabase/, (January 2013)
16. G. Kaminsky, C. Reinhart. The Twin Crisis: The Causes of Banking and Balance-of-
Payments Problems, The American Economic Review, USA Washington, pp. 473-500,
(1999).
17. Dominick Salvatore and Fred Campano, The Asian Financial Crisis and Warning