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ESTIMACIÓN BORROSA DE LA CALIDAD DEL SISTEMA SOCIOECONÓMICO

RESUMEN

Un informe actual revisa los métodos difusos de la definición de la calidad del sistema socioeconómico. Para los fines de este estudio, un sistema socioeconómico se considera como un agregado del sistema social, económico, procesos de movilidad social, así como factores condicionadores de calidad social.

El informe consta de cuatro secciones.

En la primera sección se ha tratado el sistema social como un conjunto de entornos económicos, sociales, políticos, espirituales y naturales. Sobre la base de la información de las organizaciones internacionales y los dictámenes periciales se desarrollan formas tabulares de modelos difusos de estos ambientes. Para la solución de los problemas correspondientes a los modelos se ofrece el método del tratamiento difuso ponderado.

En la segunda sección, el modelo difuso tabular se ofrece para la definición de la calidad del sistema económico. El problema correspondiente a estos modelos también se requiere un método de las reglas difusas ponderadas.

En la tercera sección, cualidades del proceso de movilidad social son investigados. Para la solución de este problema se aplica el concepto de la serie de tiempo difuso, el gráfico borroso y una cadena lingüística de Markov.

En la cuarta sección se estudian factores condicionantes de la calidad social, tales como la protección social y económica, la integración social, la inclusión social y el derecho social. El método difuso se ofrece para definir la calidad de estos factores.

Los problemas mencionados anteriormente se estudiaron sobre la base de los datos disponibles para Azerbaiyán para 2008-2010.

En la conclusión, mediante el método de los efectos olvidados planteados por los profesores A. Kaufmann y Gil Aluja se definen los grados de las influencias latentes de la corrupción, la democracia, la productividad laboral, el nivel de los impuestos y la ecología de los indicadores sociales básicos.

Palabras clave: sistema social, sistema económico, movilidad social, calidad económica, calidad social

FUZZY ESTIMATION OF QUALITY OF THE SOCIOECONOMIC SYSTEMS.

ABSTRACT

Current report reviews fuzzy methods of definition of quality of socioeconomic system. For the purpose of this study, socioeconomic system is considered as aggregate of social, economic system, and processes of social mobility, as well as conditional factors of social quality.

The report consists of four sections.

In the first section investigated social system as a set of economic, social, political, spiritual and natural environments. On the basis of the information of the International Organizations and expert opinions tabular forms of fuzzy models of these environments are developed. For the solution of the problems corresponding to the models, the method of the fuzzy weighted rules is offered.

In the second section, the tabular fuzzy model is offered for definition of quality of the economic system. The problem corresponding to these models also requires a method of the fuzzy weighted rules.

In the third section, qualities of process of social mobility are investigated. For the solution of this problem the concept of fuzzy time series, the fuzzy graph and a linguistic Markov chain are applied.

In the fourth section conditional factors of social quality such as social and economic protection, social integration, social inclusion and the social right are studied. Fuzzy method is offered to define quality of these factors.

The above mentioned problems are studied on the basis of data available for Azerbaijan for 2008-2010.

In the conclusion, using the method of the forgotten effects offered by professors of A.Kofmann and J.Gil-Aluja, degrees of the latent influences of corruption, democracy, labor productivity, level of taxation and ecology to the basic social indicators are defined.

Keywords: social system, economic system, social mobility, economic quality, social quality.

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FUZZY ESTIMATION OF QUALITY OF SOCIOECONOMIC SYSTEM

I. INTRODUCTION

The economic, social and political events occurring in the world require revision of the evolution model of the problems of socioeconomic system. Functioning of every socioeconomic system should reflect the concrete social consequences. Existing models of socioeconomic system are not able to describe these effects.

Recent researches of this system, in particular J.Stiglitz, A.Sen and J-P. Fitoussi [1], offer methodological approaches to measurement of the economic performance and social progress. I believe the theory of fuzzy sets and fuzzy logic could solve this problem.

In order to estimate quality of the socioeconomic system we have studied following aggregated systems and processes:

- social system;
- economic system;
- social mobility;
- conditional factors of social quality

In order to define quality of social and macroeconomic systems, fuzzy weight-rules algorithms are proposed; fuzzy time series concept was applied for analysis and forecasting of social mobility; fuzzy approach was used for calculation of indices of conditional factors of social quality.

II. ESTIMATION OF QUALITY OF SOCIAL SYSTEM

There is a set of approaches existing to study theory of social systems, however in the most full and accomplished manner it has been presented in T.Parson's works [2,3], who has made an attempt to create the logic-deductive theoretical model of a society, covering a human reality in all its integrity and variety. In his opinion, it is accepted to understand the ordered, hierarchical set of individuals, social groups as social system, community of organizations united by stable connections and relations, interacting with environment as a single unit. Each social system should satisfy certain material, social and spiritual needs of the members of the society.

For modeling of the societal systems we have studied economical (EE), social (SE), political (PE), spiritual (SPE), and natural environments (NE) of person's environment. These environments are interconnected and the result of their functioning defines quality of social development of a society (SSQ). As components of social system act following:

1. Economic environment characterized by rates of increase of gross national product (Δ GDP), gross national product per capita (GDP/P), a rate of inflation (CPI), a share of import products in consumption (FIM), a share of hi-tech production in export (TEX), financial stability (FIS), business environment index (BEN). Output parameter of this subsystem is the economic environment quality index (EEQI).
2. Social environment includes such indicators, as life expectancy of the population (LEP), decile (a parity between the income of 10 % of the richest population and the income of 10 % of the poorest population) (DEC), a rate of unemployment (UNE), the relation of number of deaths to number of births (RDB), expenditures on education (EXE), public health services (EXH), culture (EXC), science (EXS) and a monthly average salary (WAG), the state pension expenses (PEN). Output of this subsystem is social environment quality index (SEQI).
3. Components of the political environment are the risk of the military conflict (RAC), risk of social explosion (RSE), the constitutional mechanisms of delegation of power (CMP), the relation between the state and opposition (GSO), threat of politically motivated violence (TPV), the international disputes and

tensions (IDT), a government policy towards business (GPB), effectiveness of political system in policy formulation and executing (EPS), quality of the bureaucracy (QUB), a transparency and fairness of legal system (TLS), efficiency of legal system (ELS), corruption (COR), impact of crime (CRI). Output of this subsystem – political environment quality index (PEQI).

4. Spiritual environment includes level of religiousness of a society (LOR), tolerance level (LOT), level of impact of religious institutes to development of society (LOI), quality of culture of the society (QCS), level of information support (LIS), quality of science (QIS), and quality of healthcare (QHC). Output of this subsystem – spiritual environment quality index (S_p EQI).

5. Natural environment is characterized by air quality (AQI), water quality (WQI) and land quality (LQI), biodiversity (EBI), environmental protection investments (EPI), environmental damage (NED). Output of this subsystem – natural environment quality index (NEQI).

The system of indicators of various environments is multidimensional, i.e. the majority of its indicators have not only quantitative measurement but also qualitative.

At an initial stage of gathering of the necessary information on subsystem indicators and societal systems, reports of the United Nations Organization, the World bank [4], the International Monetary Fund [5] and other international organizations [6], and also expert opinions of various profiles were consulted. Indicators of political environment are completely borrowed from [7]. Information collected has allowed us to define linguistic variables and their corresponding intervals.

On the base of the following indices – EEQI, SERI, PEQI, S_p EQI, NEQI we calculate composite social system quality index – SSQI.

Algorithm of fuzzy weighted rules was used for solution of this problem. The application of this algorithm is required when solving problems with linguistic variables and when it is necessary to determine the weights of input and output characteristics. This can significantly reduce the number of admissible rules, and it allows improvement of the accuracy of the results

During formation of the algorithm of the weighted rules ideas of fuzzy inference method and algorithm of the batch least square of groups [8] were used. In order to demonstrate steps of algorithm, information of the economical environment model (tab 1) was applied.

In the table 1, indicators: GDP/P – GDP per capita in thousand USD, Δ GDP – GDP rate of gross in percent, CPI – level of inflation, FIM – portion of imported food in consumption, TEX – portion of advanced technology products in export, FIS – financial stability index, BEN – business environment score are inputs and EEQI – economical environment quality index is the output variable

First, fuzzification using Gaussian functions is carried out. Further, on the basis of quantity of terms, initial fuzzy rules (in our case terms 5, quantity of initial rules is equal to five) are defined. By using n-factorial base on inputs and outputs, considering terms, all possible rules are generated in the program

Parameters of the economical environment model Table 1

Variables	Terms and supports					Azerbaijan
1 GDP/P	Very low 0.320- 17	Low 16.5 – 33	Moderate 32.5 – 50	High 49.5 – 67	Very high 66.5 – 84	Very low 4.0
2 Δ GDP	Very low - ∞ - 1	Low 0.8 - 3	Moderate 2.8 – 5	High 4.5 - 8	Very high 7.5 - ∞	Moderate 5
3 CPI	Very low 0.1 – 3	Low 2.5 – 5.0	Moderate 4.5 – 8	High 7.5 - 10	Very high 9 - ∞	Moderate 5.8
4 FIM	Very high 0 – 4	High 6 – 12	Moderate 10 – 20	Low 18 – 30	Very low 25 - 100	Low 30
5 TEX	Very high 10 – 7.5	High 8 – 5.5	Moderate 6 – 3.5	Low 4 – 1.5	Very low 2 – 0	Very low 2
6 FIS	Crises 100 – 79	Nearly crises 80 – 59	Weak stability 60 – 39	Stability 40 – 19	Very sta- bility 20 – 1	Stability 40
7 BEN	Very bad 0 – 2	Bad 1.9 – 4	Moderate 3.9 – 6	Good 5.9 – 8	Very good 7.9 – 10	Moderate 5.3
EEQI	Very bad 0 – 2	Bad 1.5 - 4	Moderate 3.5 - 6	Good 5.5 – 8	Very good 7.5 - 10	Moderate 4.7

Further, the mean point- c_j^i of of each basis of unimodel fuzzy number corresponding to i terms of the j linguistic variable of the fuzzy number are defined. On the basis of c_j^i matrix $C = (c_j^i)$ has constructed. Initial rules are expressed on the basis of c_j^i .

In our case matrix C may be defined as follows:

$$C = \begin{pmatrix} C1 & C2 & C3 & C4 & C5 & C6 & C7 \\ 8.66 & -1.50 & 1.55 & 2.00 & 8.75 & 89.50 & 1.00 \\ 24.75 & 1.90 & 3.75 & 9.00 & 6.75 & 69.50 & 2.75 \\ 41.25 & 3.90 & 6.25 & 15.00 & 4.75 & 49.50 & 4.75 \\ 58.25 & 6.25 & 8.75 & 24.00 & 2.75 & 29.50 & 6.75 \\ 75.25 & 10.25 & 14.50 & 62.50 & 1.00 & 10.50 & 8.75 \end{pmatrix}$$

Further, by means of the below-mentioned formula (1), degree of membership for every point of support part fuzzy number corresponding to linguistic variables is defined:

$$\mu_i(x) = \prod_{j=1}^n \exp \left[-\frac{1}{2} \left(x_j^i - c_j^i / \sigma_j^i \right)^2 \right] \quad (1)$$

Where n is - number of input variables; x_j^i - value of support points of the fuzzy number of the terms; i - an index of the term; c_j^i - a mean point of corresponding terms i; σ_j^i - average square deviation of an interval of the corresponding term.

In our case meaning of σ_j^i is calculated as follows:

	VERYLOW	LOW	MODERATE	HIGH	VERY HIGH
GDP/P	4.8208	4.8499	5.0517	5.0517	5.0808
Δ GDR	0.3317	0.6364	0.6708	1.0400	0.7517
CPI	0.8367	0.7517	1.0400	0.7517	0.9000
FIM	2.3402	1.7635	2.8870	3.4643	21.6797
TEX	0.7517	0.7517	0.7517	0.7211	0.5788
FIS	6.0918	6.0918	6.0623	6.0623	5.4850
BEN	0.5788	0.6055	0.6364	0.6364	0.6519

Using value of σ_j^i we define value of $\mu_i(x)$ for all terms:

	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH
GDP/P	0.000000	0.000000	0.000000	0.000000	0.000000
Δ GDP	0.004087	0.000017	0.000010	0.000000	0.000002
CPI	0.000001	0.000002	0.000000	0.000002	0.000000
FIM	0.000000	0.000000	0.000000	0.000000	0.000000
TEX	0.000002	0.000002	0.000002	0.000004	0.000045
FIS	0.000000	0.000000	0.000000	0.000000	0.000000
BEN	0.000045	0.000028	0.000017	0.000017	0.000017

After that weights antecedent to initial rules are defined:

$$w_i^a = \mu_i(x) / \sum_{i=1}^R \mu_i(x) \quad (2)$$

$$\sum_{i=1}^n w_i^a = 1$$

Where w_i is- weight antecedent of initialed rules, $\mu_i(x)$ - degree of fuzzy variables entered in the antecedent part of rules.

Substituting value of the formula (1) in the formula (2), we obtain following:

$$w_i^a = \prod_{j=1}^n \exp \left[-\frac{1}{2} \left(\frac{x_j^i - c_j^i}{\sigma_j^i} \right)^2 \right] / \sum_{i=1}^R \prod_{j=1}^n \exp \left[-\frac{1}{2} \left(\frac{x_j^i - c_j^i}{\sigma_j^i} \right)^2 \right] \quad (3)$$

w_i^a - weights of terms of the antecedent part looks like :

	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH
GDP/P	0.0000	0.0000	0.0000	0.0000	0.0000
Δ GDP	0.9884	0.3425	0.3480	0.0007	0.0350
CPI	0.0001	0.0464	0.0005	0.0996	0.0029
FIM	0.0000	0.0000	0.0000	0.0000	0.0000
TEX	0.0005	0.0464	0.0777	0.1641	0.7034
FIS	0.0000	0.0000	0.0000	0.0000	0.0000
BEN	0.0110	0.5647	0.5738	0.7356	0.2588
$\sum_{i=1}^n w_i^a$	1.00	1.00	1.00	1.00	1.00

On the next stage, by means of the mentioned below formula(4), w_i^c - defines weighted values for consequence part of rules:

$$w_i^c = \frac{\sum_{i=1}^R b_i \prod_{j=1}^n \exp[-\frac{1}{2}(\frac{x_j^i - c_j^i}{\sigma_j^i})^2]}{\sum_{i=1}^R \prod_{j=1}^n \exp[-\frac{1}{2}(\frac{x_j^i - c_j^i}{\sigma_j^i})^2]} \quad (4)$$

b_i - mean point of corresponding terms of the consequence part of the rules,.

Further, using the maximum values w_i^c , w_i^a we define new system of rules:

R1: If GDP/P=Moderate – 41.3 ($w_1^a=0.000$) and Δ GDP= Very Low – 0.5 ($w_2^a=0.9884$) and CPI=High - 8.8 ($w_3^a=0.0996$) and FIM=Very Low – 4 ($w_4^a=0.000$) and TEX=Very High - 1 ($w_5^a=0.7034$) and FIS=Very High – 10.5 ($w_6^a=0.000$) and BEN=Moderate 5 ($w_7^a=0.5738$) then EEQI =Moderate – 4.8

R2: If GDP/P = Very Low -4.0 ($w_1^a=0.000$) and Δ GDP = Moderate -5 ($w_2^a=0.9884$) and CPI= Moderate -5.8 ($w_3^a=0.0001$) and FIM= Low-30 ($w_4^a=0.0005$) and TEX=Very Low-2.0 ($w_5^a=0.7034$) and FIS=Stable-40 ($w_6^a=0.000$) and BEN=Moderate -5.3 ($w_7^a=0.0110$) then EEQI=?

In the new system R1-is rule, which we find and R2- is rule, which corresponds to the fixed meaning of input variables (last column table 1). By using composition operation corresponding fuzzy number is defined.

At the last stage, using Centroid methods defuzzification of fuzzy numbers is carry out.

As result, we find both crisp and linguistic meaning of EEQI =Moderate-4.763.

Using this algorithm we define – SEQI = (moderate – 0.5); PEQI = (moderate – 2.95); S_pEQI = (moderate – 4.75); NEQI = (bad – 2.95).

On the basis of defined indices – EEQI, SEQI, PEQI, S_pEQI and NEQI social system quality index (SSQI) has been defined and is equal to moderate - 4.7. Meaning of Azerbaijan SSQI basically was affected by moderate qualities of economical, political, social, spiritual environments and bad level of natural environment.

The average percent of inflation (5,8 %), high share of imported products (30) in consumption and a low share of high technological products (2) in export has affected quality of the economic environment; quality of the social environment was characterized by very low level of the monthly average salary (401 USD), low level of expenses on public health services (3,7), low level of pension expenses (3,7), expenses for education (1,9) and very low level on development of a science (0,241); quality of the political environment was affected, mainly, by poor mutual relations between the government and the opposition, low degree of transparency and justice of political system, efficiency of legal system and high level of corruption; quality of the spiritual environment was defined by very low level of influence of the religious organizations on increase of a standard of living of the population, a low degree of quality of public health services and education; on quality of natural environment very poor quality of air, poor quality of water, a low index of a natural biodiversity and very low level of capital investments for environmental protection had an effect.

III. ESTIMATION OF QUALITY OF ECONOMIC SYSTEM

Quality of social system mainly depends on quality of functioning of the economic system. For fuzzy modeling following indicators of a financial and monetary policy have been used:

1. Rate of increase of gross national product - Δ GDP;
2. The rate of refinancing of the Central Bank - RCB;
3. Consumer price index - CPI;
4. External government debts - EGD;
5. Budget deficit - BD;
6. Tax revenue - TR;
7. Parity of purchasing capacity of national currency – PPP;
8. Currency reserves - CR.

PARAMETERS OF THE MODEL OF MACROECONOMIC SYSTEM Table 2

Terms Variables	Very low	Low	Moderate	High	Very high	Azerbaijan
1. Δ GDP	Very low <1	Low 0.8 – 3	Moderate 2.8 – 5	High 4.5 - 8	Very high > 7.5	Moderate 5
2. RCB - %	<1	0.75 – 2	1.75 – 3	2.75 - 5	> 4.75	High 5
3. CPI - %	<4.5	5 – 9	8-10	9.5 - 12	> 11.5	Low 5.8
4. EGD - % GDP	0 – 19	18 – 26	25-30	28 – 35	> 34	Very low 6
5. BD - % GDP	0 – 0.6	0.7-1.5	1.4-3	2.8 – 6	> 5.5	Low 0.9
6. TR - % GDP	1 - 10	9 - 20	19 – 30	29 - 40	> 39 - 70	Low 17.8
7. PPP	<2	2.85 - 1.85	2.2 - 1.9	2 - 1	> 0.94	Very low 2
8. CR – in days	<30	29 – 60	59 – 370	360 - 730	> 720	Moderate 219
Economic system quality index – ESQI	Very bad 0 – 0.2	Very bad 0.15 – 0.4	Moderate 0.35 – 0.6	Good 0.55 – 0.8	Very good 0.75 - 1	Moderate 0,5

For solution of this problem the algorithm of the weighed rules has been applied again. The economic system quality index equals to - average – 0,5. Value of the economic system quality index was affected, mainly, by low level of tax revenue. It is necessary to notice that in Azerbaijan in addition to currency reserves, there are also reserves of oil fund which could be used as social investments that, undoubtedly, would improve quality of social system.

The constructed approach to definition of social and economic systems quality indices allow decision makers at the macrolevel to control and regulate development parameters of the socioeconomical systems. At the following stage, quality of social mobility and conditional factors of the social quality were defined.

IV. ESTIMATION QUALITY OF SOCIAL MOBILITY

According to the definition proposed by the well-known American sociologist P. Sorokin, social mobility is represented as “any transition of an individual or social object or value, anything that has been created or modified by human activity, from one social position to another” [1]. Vertical and horizontal mobility are the primary types of social mobility, while the determinant factors of the social mobility in the society are following: historical type of social stratification, condition and development index of the economy, social atmosphere in the country, ideology, traditions, religion, education, family, place of residence and individual characteristics of a person.

Social mobility is measured by means of two basic indicators:

1. Speed of mobility, i.e. number of steps that individuals were able to ascend, or had to descend;
2. Intensity of mobility, i.e. number of individuals that moved along the social ladder in the vertical direction during a certain time span.

Concepts of fuzzy time series and Markov’s fuzzy linguistic chain have been applied in the current paper in order to analyze and forecasting social mobility

In order to analyze social mobility we have developed a table III of distribution of population across economical strata in 2005-2010, on the basis of information on the value of the poverty line (PL) in Azerbaijan [21] and grouping scale of population in accordance with the income, proposed in [10].

As it is shown in the table 3, population is divided into 5 economic strata in accordance with the income grouping scale:

Absolutely poor – S_1 ; Relatively poor – S_2 ; Low-income – S_3 ; Of moderate means – S_4 ; Better off – S_5 .

Distribution of population across economic strata Table 3

Economic strata	2005		2008		2010	
	PL=42,6	Proportion of population	PL=78,6	Proportion of population	PL=98,7	Proportion of population
Absolutely poor – up to 0,5 PL	up to 21,6	0,001	up to 39,3	0	up to 49,35	0
Relatively poor 0,5 – 1 PL	21,6 – 42,6	0,270	39,3 – 78,6	0,15	49,35– 98,7	0,101
Low-income 1,0 – 2,0 PL	42,6 – 85,2	0,696	78,6 – 157,2	0,773	98,7– 197,4	0,789
Of moderate means 2,0 – 3,0 PL	85,2– 127,8	0,027	157,2– 165,8	0,050	197,4– 296,1	0,089
Better off– more than 3,00 PL	127– greater	0,006	165,8– greater	0,027	296,15– greater	0,021

Analysis of 2005–2010 data on mobility scale indicates that portion of “absolutely poor” population group has been decreased to 0, portion of “relatively poor” population has decreased by 16.9 points, portions of population of “low income” and “of moderate means” have increased by 9.3 and 6.2 points respectively. At the same time, if, during 2005–2008 portion of “better off” population has increased by 2.1 points, during 2008–2010 its portion has decreased by 0.6 points.

In order to analyze speed of mobility lets consult graph provided on the Fig 1.

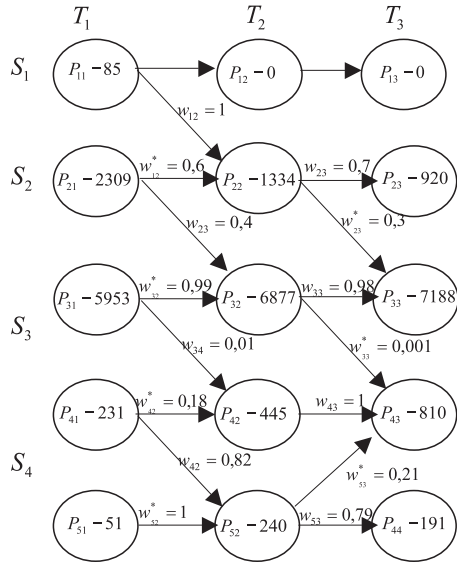


Fig.1. Social mobility speed graph

In the graph $S_i (i = 1, \dots, 5)$ economic strata of population is denoted, $T_j (j = 1, \dots, 3)$ – years of analysis, $P_j (i = 1, \dots, 5; j = 1, \dots, 3)$ – number of population in the economic strata in the corresponding year, w_j and w_j^* – portion of population moving to different strata and staying in the same strata correspondingly.

As it is shown in the graph, number of steps for which it was possible to ascend from S_1 to S_2 , from S_2 to S_3 , from S_3 to S_4 – is only one; in the meantime there is a case when portion of “better off” population S_5 descended to a lower strata S_4 .

In order to forecast value of poverty line, concept of fuzzy time series initially proposed by Q.Song and B.S.Chissorn [11,12], and further developed by a number of authors, has been applied. However the greatest contribution to the development of this concept was done by S.M.Chen [13].

In order to forecast value of poverty line (PL) according to Azerbaijan data we have used time series reflecting this indicator for 2001–2010 (table 4):

Value of poverty line Table 4

Years	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PL in AZN	24	35	35,8	38,8	42,6	58	64	78,6	89,5	98,7

Calculated forecasted value (102.56 AZN) of the poverty line and the grouping scale of population allows us to evaluate parameters of the economic strata for 2011.

Absolutely poor: 51.28; Relatively poor: $51.28 \div 102.56$; Low-income: $102.56 \div 205.12$;

Of moderate means: $205.12 \div 307.68$; Better off – more than 307.68.

Zadeh’s linguistic approach [14] and Markov’s linguistic chains [15], [16] were applied in order to forecast social mobility.

For this purpose, first of all, we fuzzificated specific share of population in different economic strata as linguistic variables: low L (0–0.3), average M (0.29–0.66), high (H) 0.65–1.

Vector of the current (2010) condition of economic stratas: $S_{2010} = (0, 0.101, 0.789, 0.089, 0.021)$, corresponds to the linguistic vector (L, L, H, L, L).

Discrete mobility matrix of conditions of economic strata to according the analysis (fig. 1) can be represented as follows:

$$T_{2011} = \begin{matrix} & \begin{matrix} S_1 & S_2 & S_3 & S_4 & S_5 \end{matrix} \\ \begin{matrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \end{matrix} & \begin{vmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0.8 & 0.2 & 0 & 0 \\ 0 & 0 & 0.8 & 0.2 & 0 \\ 0 & 0 & 0 & 0.8 & 0.2 \\ 0 & 0 & 0 & 0.2 & 0.8 \end{vmatrix} \end{matrix}$$

Discrete matrix of mobility can be represented by means of linguistic variables as follows:

$$T_{2011} = \begin{vmatrix} L & H & L & L & L \\ L & H & L & L & L \\ L & L & H & L & L \\ L & L & L & H & L \\ L & L & L & L & H \end{vmatrix}$$

For forecasting of conditions of the economic strata in 2011 Markov's fuzzy linguistic chain has been applied: $S_{2011} = S_{2010} \circ T_{2011}$, where element S_i , is calculated via the following equation:

$$S_i = \bigcup_n (S_i \cap t_j) \quad (5)$$

Fuzzy linguistic vector is forecasted by means of equation S_i (5):

$$S_{2011} = (L, L, H, L, L),$$

As it is obvious from the results obtained, vector of conditions of economic strata repeats conditions of year 2010. This is mainly, connected to the fact that the mobility matrix covers situation for 2005–2010.

Let's assume that individuals, who make decisions in the field of social policy, have decided to improve its conditions. In this case mobility matrix will take following shape:

$$T_{2011}^{opt} = \begin{pmatrix} L & H & L & L & L \\ L & M & M & L & L \\ L & L & M & M & L \\ L & L & L & M & H \\ L & L & L & L & H \end{pmatrix}$$

And the state vector: $S_{2011}^{opt} = (L, L, M, M, M)$

V. ANALYSIS OF THE CONDITIONAL FACTORS OF SOCIAL QUALITY

The theory of social quality has been offered by U.Beck, V.Maesen, L.Thomese and A.Walker [17,18,19]. Social quality represents degree of participation of citizens in the social and economic life of a society at which their well-being and individual potential raises.

Conditional factors of social quality are defined as “the extent to which people are able to participate in the social and economic life of their communities under conditions which enhance their well-being and individual potential” [18].

As one of the four conditional factors of social quality, socio-economic security refers to the materials and other resources required for “the enhancement of the interactions of individual people as social beings” [20]. Hence, socio-economic security encompasses issues such as risk related to existential security, basic security of daily life, freedom, safety, justice, and life changes dependent on institutions, norms and regimes. Whether from employment, social security, health care or other sources, socio-economic security will protect people from poverty and other forms of material or immaterial deprivation. So we defined its subject matter as the degree to which people have command over material and immaterial sources over time in the context of social relations.

Socio-economic security indicators: number of square meters per household member (NSM); proportion of population living in houses with lack of basic ame-

nities (PPL); proportion of people covered by compulsory/voluntary health insurance (PHI); number of medical doctors per 10 000 inhabitants (MED); length of notice before termination of labour contract (LNT); proportion of employed workforce with temporary, non-permanent, job contract (PET); proportion of workforce that is illegal (PWI); number of fatal cases (NFC); number of nonfatal cases (NNC); number of hours a full-time employee typically works a week (NHE); proportion of pupils leaving education without finishing compulsory education (PLE); study fees in school as proportion of national mean net wage (SFS); study fees in high school as proportion of national mean net wage (SFH); proportion of students who, within a year of leaving school, are able to find employment (PSE); people affected by criminal offences per 10 000 inhabitants (CRI); ecocivilization index (ECC). Index of quality of socioeconomic security (SESI) is the output indicator.

Second factor - social cohesion, refers to the nature of outcomes of processes of integration and disintegration. Cohesion is influenced and changed by processes of social, economic and cultural differentiation in societies. In order to measure cohesion, the emphasis should be on the positions, ideas and feelings of social beings in concrete circumstances. Cohesion is relational concept that expresses the strength or weakness of social relations at the societal, community and local level.

Social cohesion indicators: extent to which most people can be trusted (TRU); trust to authorities (TRA); trust to religion (TRR); number of cases being referred to European Court of Law (ECO); respect for parents (IFA); blood donation (%) (BLO); multiculturalism (tolerance) (TOL); willingness to pay more taxes if you were sure that it would improve the situation of the poor (WMT); help elders (VOL); membership (active or inactive) of political, voluntary, charitable organizations or sport clubs (MVO); frequency of contact with friends and colleagues (CWF); sense of national pride (NAP). Quality of social cohesion (SCOI) index is the output indicator.

Social inclusion is the third factor of social quality and is the degree to which people are and feel integrated in social relationships, organizations, subsystems and structures. More specifically, it is degree to which people have access to a wide range of social relations that constitute everyday life. As we will see in the

following indicators, social inclusion is concerned with processes that are dynamic; is comprehensive in terms of the processes and subsystems it refers to; is multi layered in that it may cover exclusion from personal relationships, neighborhoods, organizations or supra national blocks; it has both, an objective and subjective side.

Social inclusion indicators: proportion having right to vote in local elections (POV) and proportions exercising it (PPV); proportion with right to a public pension (PEN); proportion of ethnic minority groups elected or appointed to parliament, boards of private companies and foundations (ETH); proportion of women elected or appointed to parliament, boards of private companies and foundations (WPA); long – term unemployment (12+ month) (LTU); proportion of population with entitlement to and using public primary health care (PPH); proportion of homeless, sleeping rough (HLP); average waiting time for social housing (WAI); school participation rates and higher education participation rates (HED); proportion of people in need received care services (PPN); density of public transport system and road density (TRD); number of public sport facilities per 10 000 inhabitants (NPS); number of public and private civic and cultural facilities (e.g. cinema, theatre, concerts) per 10 000 inhabitants (NPC); duration of contact with relatives (cohabitating and non-cohabitating (PRC). Index quality of social inclusion (SIQI) is output indicator.

Social Empowerment is fourth factor and is concerned with the means and processes necessary for people to be capable of actively participating in social relations and actively influencing the immediate and more distant social and physical environment. It is a process that is concerned with the individual or a social group of which the status being empowered is one which is inherent in the individual rather being linked to the factors outside the personal side. It is obvious that we cannot just measure empowerment. What we can try to do is to analyze it from different perspectives, while bearing in mind its three dimensions: access, participation and control.

Social empowerment indicators: extend to which social mobility is knowledge-based (SOM); Percentage of population literate and numerate (PLN); availability of free media (FME); percentage of labor force that is member of a trade

union (TRU); percentage of labor force covered by a collective agreement (LCA); percentage of employed labor force receiving work-based training (TRA); index of democracy (DEM); percentage of organizations/institutions with work councils (WCC); percentage of the national and local public budget that is reserved for voluntary, non-for-profit citizenship initiatives (CIL); proportion of national budget allocated to all cultural activities (CUL); percent expenses of national and local budgets devoted to disabled people (DIL). Quality of social empowerment (SEQI) index is output indicator.

Indicators of conditional factors of social quality were adopted from [20].

For calculation of indices of conditional factors of social quality method, which consists of the following steps is proposed:

1. development of a table describing the parameters of the model on the basis of information from international organizations and experts;
2. definition of membership degrees of input parameters presented in the form of relevant terms;
3. determination of the minimum degree of membership to the corresponding term of input parameters, ie $\min_j \mu_j$;
4. determination of the maximum of the minimum values of the degrees of membership to the corresponding term, i.e. $\min_i \left(\min_j \mu_j \right)$;

Value obtained will reflect the quality of the social factor.

Proposed methodology is tested on the basis of information on quality parameters of the model of socio-economic security (Table 5). The source materials are of international socio-economic organizations and the data of expert opinions. Using the information on the socio-economic security of Azerbaijan in 2010, which is given in the last column of Table 5, we have estimated index of a socio-economic security, applying methodology described above.

Parameters model of socio-economic security Table 5

Input variable	Terms and its intervals				Azerbaijan
1.NSM	Low 0 - 15	Moderate 14 - 20	High 18 - 30	Very high 28 - 70	12,6
2.PPL	Very low 0,5 - 0,25	Low 0,24-0,16	Moderate 0,15 - 0,1	High 0,09 - 0	15 %
3. PHI	Very low 0 - 10	Low 9 - 21	Moderate 20 - 60	High 59 - 100	0,2 %
4.MED	Very low 0 - 300	Low 299 - 350	Moderate 300 - 400	High 370 - 600	36,8 %
5.LNT	Very bad 1 - 31	Below normal 30 - 51	Normal 51 - 30	Good 31 - 1	60 days
6. PET	Very high 100 - 50	High 49 - 20	Moderate 19 - 10	Low 9 - 1	68 %
7. PWI	High 0,5 - 0,2	Moderate 0,19-0,14	High 0,13-0,09	Very low 0,18 - 0	0,002 % (10 тыс.)
8. NFC	High 10 - 8	Moderate 7 - 5	Low 4 - 2	Very low 1 - 0	Fat - 0.00128
9. NNC	High 10 - 8	Moderate 7 - 5	Low 4 - 2	Very low 1 - 0	Non Fat - 0.00172
10. NHE	Very high 50 - 44	Normal 43 - 39	Below nor- mal 38 - 36	Very low 35 - 20	42
11. PLE	Very high 50 - 20	High 18 - 9	Moderate 8 - 7	Low 6 - 0	10 %
12. SFS	Very high 6 - 3	High 2,9 - 2	Low 1 - 0,5	Very low 0,4 - 0	2,8
13. SFH	Very high 7 - 3	High 2,9 - 2	Low 1 - 0,5	Very low 0,4 - 0	6
14. PSE	Very bad 0 - 5	Bad 4 - 10	Satis- factory 9 - 20	High 19 - 100	30 %
15. CRI	High 180 - 80	Moderate 79 - 50	Low 49 - 20	Very low 19 - 0	13,5
16. ECC	Low 0 - 0.2	Moderate 0,19 - 0,5	Above mod- erate 0,49 - 0,7	High 0,7 - 1	Above mod- erate 0,632
Output - SESI	Low 0 - 0.25	Moderate 0,2 - 0,5	High 0,4 - 0,75	Very high 0,07 - 1	0,12

In order to estimate quality of the social factor the following terms: low (L), medium (M), high (H) and very high (VH), scaled in the interval [0, 1] were applied.

The second stage is determined by the degree of membership of national indicators of socio-economic security to the appropriate term. In determination of the degrees of membership, we used triangular membership functions.

At the last stage membership of 16 indicators of the terms is as follows:

Low (L)	Mean (M)	High (H)	Very high (VH)
$\mu_{HSM} = 0,32$	$\mu_{PPL} = 0,25$	0	$\mu_{PWI} = 0,05$
$\mu_{PHI} = 0,4$	$\mu_{MED} = 0,64$		$\mu_{NFC} = 0,003$
$\mu_{PET} = 0,72$	$\mu_{LNT} = 0,18$		$\mu_{NNC} = 0,003$
$\mu_{SFH} = 0,5$	$\mu_{NHE} = 0,66$		$\mu_{PSE} = 0,27$
	$\mu_{PLE} = 0,22$		$\mu_{CRI} = 0,58$
	$\mu_{ECC} = 0,65$		
min:0.32	min:0.18	0	min:0.003

Among minimum values we have determined the maximum, which is equal to 0.32. This value corresponds to the term - "low". Thus defined quality index of socio-economic security: SESI = low. Likewise, the indices of the quality of social inclusion - SIQI = 0,86 (high), the index of the quality of social empowerment - SEQI = 1 (high), the index of the quality of social cohesion - SCQI = 1 (moderate).

INSTEAD OF CONCLUSION

Results of the fuzzy analysis of the socioeconomic system quality show, that following indicators strong influence to the development of this system:

A_1 - level of corruption; A_2 - level of taxes revenue; A_3 - level of natural environment; A_4 - productivity of the economy; A_5 - index of the democracy.

Indicators above have a lowering effect on the following indicators:

B_1 – Quality of Education; B_2 - Quality of Science; B_3 - Quality of healthcare; B_4 - Quality of Housing; B_5 - Average Wages; B_6 - Level of Poverty; B_7 – Level of Unemployment; B_8 - Social Mobility; B_9 - Level of Employment of the Youth.

For estimation of degree of influence of factors of A_i on indicators of social system - B_j , we have used the method of the forgotten effects offered by professors A.Kaufmann, J.Gil Aluja [21]. The idea of this method is as follows.

The scale of influence in the range of $[0,1]$ is defined:

- The matrix of $[M]$ – direct impact of the elements A_i on B_j is defined;
- The matrix $[And]$, describing extent of influence between the elements A_i is defined;
- The matrix $[B]$ describing extent of influence between the elements B_j is defined;
- By max-min composition, $[M^*]=[A] \circ [M] \circ [B]$ is defined;
- At the last stage, composition of three matrixes $[M^*]$, results of the forgotten effects is defined by $[O]=[M^*] (-) [M]$.

We will use following fuzzy linguistic indicators, in order to define degree of influence:

very low - VL (0 - 0,2); low - L (0,18 - 0,4); medium - M (0,38 - 0,6);
 high - H (0,58 - 0,8);
 very high - VH (0,78 - 1).

In order to define [O] - matrix of forgotten effects, we used vertex method calculated distance between two triangular fuzzy numbers [22], which consist of the following;

$$d(\hat{a}, \hat{b}) = \sqrt{\frac{1}{3} \{ (a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2 \}},$$

where $\hat{a} = (a_1, a_2, a_3)$ and $\hat{b} = (b_1, b_2, b_3)$ are two triangular fuzzy numbers.

Elements [A], [M], [B] matrixes, were define by expert opinion and results of some investigation, which are given in tables 6-8.

Matrix of Effects Table 6

B	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈	B ₉
B ₁	VH	VH	VH	VH	M	M	H	H	H
B ₂	VH	VH	VH	L	M	VL	L	H	H
B ₃	H	H	H	VL	M	VL	H	L	VL
B ₄	M	M	M	VH	VL	VL	VL	L	VL
B ₅	VH	VH	VH	VH	VH	VH	H	VH	H
B ₆	VH	VH	VH	VH	VH	VH	VH	VH	VH
B ₇	VL	VL	VL	VL	VL	VH	VH	H	VH
B ₈	M	M	M	H	M	H	L	VH	M
B ₉	L	L	L	VL	L	H	VH	H	VH

Matrix of Causes Table 7

A	A ₁	A ₂	A ₃	A ₄	A ₅
A ₁	VH	VH	VH	VH	M
A ₂	L	VH	VH	H	VL
A ₃	L	M	VH	H	VL
A ₄	L	VH	VH	VH	VL
A ₅	M	M	M	M	VH

Matrix of Direct Incidents Table 8

M	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈	B ₉
A ₁	VH	VH	VH	VH	H	H	H	VH	H
A ₂	VH	VH	VH	H	VH	VH	VH	VH	H
A ₃	VL	VL	VL	VL	VL	M	VL	VL	VL
A ₄	VH	VH	VH	VH	VH	VH	VH	VH	VH
A ₅	M	M	M	M	M	M	M	M	M

Matrix of Cumulated Effect Table 9

M*	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈	B ₉
A ₁	VH	VH	VH	VH	VH	VH	VH	VH	VH
A ₂	VH	VH	VH	VH	VH	VH	VH	VH	VH
A ₃	H	H	H	H	H	H	H	H	H
A ₄	VH	VH	VH	VH	VH	VH	VH	VH	VH
A ₅	M	M	M	M	M	M	M	M	M

Matrix of Forgotten Effects Table 10

O	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈	B ₉
A ₁	0	0	0	0	0,2	0,2	0,2	0	0.2
A ₂	0	0	0	0.2	0	0	0	0	0.2
A ₃	0.69	0.69	0.69	0.69	0.69	0.2	0.69	0.69	0.69
A ₄	0	0	0	0	0	0	0	0	0
A ₅	0	0	0	0	0	0	0	0	0

Tables 9 is constructed by composition of matrices A, M, B. Table 10 demonstrates forgotten effects between investigated indicators.

The proposed paper does not pretend to contain a full research of this problem. In the future, it is necessary to construct the subsystem of “decision making”, which will allow co-ordination of the results of decisions of other subsystems studied in the paper. Also, it is necessary to apply other methods of fuzzy sets and fuzzy logic to define parameters of the socioeconomic system

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Discurso de contestación por el Académico de Número

EXCMO. SR. DR. D. FRANCISCO JAVIER MAQUEDA LAFUENTE



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Excelentísimo Señor Presidente,
Excelentísimos Señores Académicos,
Excelentísimas e Ilustrísimas Autoridades,
Señoras y Señores:

Es un gran honor para la Real Academia de Ciencias Económicas y Financieras dar la bienvenida una vez más y recibir en su seno al Profesor Dr. Gorkhmaz Imanov como Académico Correspondiente para Azerbaijan, y un honor para mí recibir el encargo por parte de nuestra Junta de Gobierno de responder al discurso de ingreso de la relevante figura de nuestro Académico recipiendario.

En su Discurso de Ingreso el Profesor Imanov nos ha ofrecido una excelente visión del Sistema Socioeconómico Global, el cual es fruto de sus largos años de investigación y de experiencia en el apasionante mundo de la Teoría de los Subconjuntos Borrosos, en los Modelos para la Investigación de los Efectos Olvidados y en los Conceptos de las Series Temporales Fuzzy. Su magnífico Discurso de hoy nos ha introducido, como decimos, en el ámbito de “La Estimación Borrosa de la Calidad del Sistema Económico”.

Permítanme que, previo al comentario de su contenido, rememore –aunque sea por muchos conocida- la relevante personalidad del nuevo Académico en el ámbito profesional, docente e investigador, a los que quisiera añadir su excelente personalidad humana pues, coincidirán conmigo en que, únicamente un adecuado conocimiento del autor nos permitirá disfrutar plenamente de su obra.

Quisiera destacar que hoy nos honramos en dar la bienvenida a nuestra Real Corporación no solo a un pionero y brillante investigador de las Ciencias Económicas y Sociales sino a un hombre comprometido con la innovación, la igualdad y el desarrollo de los pueblos. Buena muestra de ello es su permanente colaboración con el Observatorio de Investigación Económica que me honro en presidir junto con el Excmo. Académico Profesor Dr. D. Alfredo Rocafort Nicolau y que cuenta como Presidente de Honor con el Premio Nobel de Economía y Académico de nuestra Real Academia el Dr. Finn E. Kydland.

En cuanto a su Curriculum Vitae quisiera destacar que el Profesor Gorkhmaz Imanov nació en Baku (Azerbaijan) en Abril de 1941. Estudió en la Universidad Estatal de Azerbaijan durante los años 1959 a 1964 donde se graduó con Diploma de Honor.

De 1964 a 1967 se traslada a Moscú donde obtiene un Posgrado en Ciencias Económicas en el Instituto Central de Matemáticas y Economía de la Academia de las Ciencias de la URSS, Institución en la cual cursó sus estudios de Doctorado en el periodo 1973 a 1975.

En el ámbito laboral, el Dr. Imanov trabajó como Director del Departamento de Modelización de Sistemas Macroeconómicos dentro del Instituto de Cibernética de la Academia Nacional de las Ciencias de Azerbaijan de 1968 a 1987.

Posteriormente, entre los años 1987 y 1993, dirige el Instituto Estatal de Economía y del GOSPLAN de Azerbaijan.

En 1993 es nombrado Investigador principal del Instituto para el Estudio de los Problemas de los Mercados de la Academia de las Ciencias de Rusia, puesto que desempeñó hasta el año 1999, momento en el que fue designado asesor científico del Ministerio de Desarrollo Económico de Azerbaijan.

Desde el año 2000, y hasta la actualidad, es Director del Departamento “Fuzzy Economics” del Instituto de Cibernética de la Academia Nacional de Ciencias de Azerbaijan.

Entre las numerosas menciones y reconocimientos de carácter internacional que posee quisiera destacar el Premio Estatal de Azerbaijan en el Campo de la Ciencia obtenido por el Profesor Imanov en el año 1984.

Es autor de doce libros relacionados, principalmente, con los Modelos de Planificación Económica Nacional, los Modelos de Sistemas Económicos, el Comportamiento del Consumidor y la Lógica Fuzzy.

En el año 2011 publicó, dentro de las Colecciones de nuestra Real Corporación, el Trabajo realizado de manera conjunta con nuestro Observatorio de

Investigación Económica titulado: “Nuevos Mercados para la Recuperación Económica: Azerbaijan”.

Es autor de innumerables trabajos y artículos, más de 170, relacionados preferentemente con la temática anteriormente descrita y ha participado, asimismo, como ponente en una larga lista de Seminarios, Congresos y Conferencias de carácter internacional.

Ha dirigido numerosas Tesis Doctorales. Es Asesor del Presidente de Azerbaijan. Editor de la Revista Científica: “Neuro-fuzzy Technologies Modelling in economy” de Kiev y Miembro del Consejo Académico de la Fundación Internacional para la Investigación Económica Nikolai Fedorenko de Moscú.

El Dr. Imanov revisa en su Trabajo: “Fuzzy Estimation Of Quality Of Socioeconomic System” los métodos borrosos, a partir de la definición de la calidad del sistema socioeconómico. Nos señala que, para los fines de este estudio, un sistema socioeconómico se considera como un agregado del sistema social, del sistema económico, de los procesos de movilidad social, así como de una serie de factores acondicionadores de la calidad social. El trabajo consta de cuatro Secciones.

En la primera Sección ha tratado el sistema social como un conjunto de entornos económicos, sociales, políticos, espirituales y naturales. Sobre la base de la información de las organizaciones internacionales y los dictámenes periciales, desarrolla formas tabulares de modelos borrosos de estos ambientes. Para la solución de los problemas correspondientes a los modelos ofrece un método para el tratamiento borroso ponderado.

En la segunda Sección, se ofrece el modelo difuso tabular para la definición de la calidad del sistema económico. El problema correspondiente a estos modelos también requiere un método con reglas borrosas ponderadas.

En la tercera Sección, se investigan los temas relacionados con las cualidades del proceso de movilidad social. Para la solución de este problema se aplica, en este caso concreto, el concepto de la serie de tiempo borroso, un gráfico borroso y una cadena lingüística de Markov.

En la cuarta Sección se estudian los factores condicionantes de la calidad social, tales como la protección social y económica, la integración social, la inclusión social y el derecho social. Se propone una metodología borrosa para definir la calidad de estos factores.

Hay que hacer constar que los problemas mencionados anteriormente, en cada una de las cuatro Secciones referidas, se estudiaron sobre la base de los datos disponibles para Azerbaiyán durante el periodo comprendido entre los años 2008 y 2010.

En las conclusiones del brillante trabajo que nos acaba de resumir, el Dr. Imanov, mediante la teoría de los efectos olvidados, ideada por los profesores A. Kaufmann y Gil Aluja, nos demuestra los grados de las influencias latentes de la corrupción, la democracia, la productividad laboral, el nivel de los impuestos y la ecología de los indicadores sociales básicos.

Welcome to the Academy, Mr. Imanov, and now let's work together. Bienvenido Dr. Imanov a esta Real Corporación que hoy le acoge en su seno con gran satisfacción y con enormes esperanzas de futuro. Con su incorporación, la Real Academia de Ciencias Económicas y Financieras de España cuenta desde hoy con una personalidad de un elevado prestigio intelectual, reconocido a nivel mundial, y con una persona que posee un gran valor humano. Su compromiso personal con la innovación, la investigación permanente, la justicia social y la búsqueda de la igualdad entre los pueblos nos ayudarán, sin ningún género de dudas, en el avance de la eficiencia económica y en la construcción de un mundo mejor.

Muchas gracias a todos ustedes por la atención prestada.