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The Cyprus Puzzle and the Greek – Turkish Arms Race

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INTERIM 4

Two enemy nations may be engaged in battles for years striving for victory. However, it only takes one decisive day to indicate the winner.
Sun Tzu, "The Art of War"

It appears, therefore, that the law of comparative advantage works in this case as well! It is recommended that Greece focus on providing the capital equipment by investing in research and development, purchasing latest technology systems and modernizing the existing stock of weapons. Cyprus, on the other hand, will be required to provide the manpower indispensable to man this equipment in the most efficient way.

We feel, however, that one or two words of caution are necessary in this case: The first issue concerns the way in which Cyprus may contribute in terms of manpower. The conclusions drawn in the previous chapter concerning the alliance burden sharing between Greece and Cyprus are based on their population growth rates. The fact remains, however, that in terms of absolute figures Cyprus is too weak to face a large part of the personnel requirements of both allies, given that the number of male Cypriots which join the armed forces every year does not exceed a few thousand. This means, therefore, that Cyprus will only be in a position to contribute to the alliance manpower needs if it resorts to professionalism, over and above the compulsory military service which is a must for reasons similar to those applying for Greece and analyzed in Interim 1, earlier on. The second word of caution refers to the Greek case. The recommendation that Greece focuses on the provision of the equipment that will support the function of the alliance does not, by any means, imply that the importance of the human element is

to be neglected. The recommendation which concerns combining a professional army with a compulsory military service addresses both allies and leaves absolutely no room for cheap politics which imply that the two systems are substitute solutions. In fact, professionalism and compulsory service must complement one another in a way that combines thorough knowledge of modern technology with high morale. Since we have already discussed the reasoning behind this argument extensively earlier on in this book, we do not feel that we should expand on the extent to which the undoubtedly high skills of professional forces can ever be a substitute to the enthusiasm of conscripts. We can only point out that our current geopolitical and strategic environment does not enjoy the delicate, however, effective balance of powers it did during the Cold War era. To make things worse, and unlike what some people love to support[1], tension in the area that concerns the Greek-Cypriot alliance is far from easing given the recent Middle East crisis. This widespread volatility in the international setting, therefore, leads to underlining the importance of strong armed forces on both national and international levels. Thus, the initiative taken by Germany, France, Belgium and Luxemburg with regard to a European defence mechanism, which could function in a manner independent of the NATO structure has become the cause of serious reconsiderations that concern the extent to which national defence budgets should be curtailed. As regards Greece, the country has to face a considerable extra burden imposed on its economy by a number of defence programmes required to support its alliance commitments, which means that the government has no option but to increase the funds allocated to defence activities. This proves that not only is the relaxed attitude of the Greek government concerning external threat not justified, but, in addition, the statements made concerning reductions of the defence budget do not reflect the true picture.

History teaches that demagogy of this extent can entail a significant national cost. Greece has paid the cost of demagogy very dearly, starting with the Peloponnesian War (431-404bc.), through to the National Revolution in 1821 and the Asia Minor Ethnic Disaster in 1922. On the contrary, Greece reaped the benefits of not succumbing to

[1] See for example, the IMF latest report (February 13, 2003), following the mission's visit to Athens

demagogy in the early nineties, when the government devoted a large sum of money, despite the hysteria of the opposition leaders, to support the Hellenic Navy, a very wise move considering the results of the 1912–1913 Balkan Wars.

The post-Copenhagen summit period is a crucial one for the geopolitical and strategic interests of Greece and Cyprus. It is a period during which the international environment currently under considerable revision will play a much more important role compared to the past and during which nothing can be taken for granted not even the Cyprus full EU membership, leaving, therefore, absolutely no room for demagogy!

The following chapter aims at underlining the increased role of the international factors and the complexity of one of the problems faced, namely that of Cyprus.

In such cases, however, in which political uncertainty prevails, decision-makers and policy proponents usually face serious difficulties when approaching significant, real-world systems, the main one being the choice of the appropriate analytical tool that would reflect the complexity of such international geopolitical systems. Moreover, given the problems associated with the availability and reliability of data and the difficulties encountered when formulating a mathematical model, we feel that efforts to communicate and understand a particular system as well as to propose policies must rely on natural language arguments in the absence of formal models. This is why we have decided to treat the Cyprus issue by using the technique of Fuzzy Cognitive Maps which is particularly suitable for modeling political problems and supporting a decision-making process. The following chapter explains how this method is combined with Genetic Algorithms thus creating a hybrid model reflecting the complication of the Cyprus issue. Since the “cut-off date” of the paper that follows has been the first day of the US – UK operations against Iraq, the reader will notice that the forecasting ability of the algorithm used has been very satisfactory on the basis of the scenarios employed. These consider, among other variables, the extent to which an environment of intensity might prevail on the island, the possibilities of a viable solution of the Cyprus issue, as well as the reactions of the Greek and Turkish Cypriots following the full EU accession of Cyprus.

CHAPTER 5

The Cyprus Puzzle and the Greek – Turkish Arms Race: Forecasting Developments Using Genetically Evolved Fuzzy Cognitive Maps*

By

Andreas S. Andreou, Nicos H. Mateou and George A. Zombanakis

5.1 INTRODUCTION

During the Copenhagen summit conference on December 12 to 14, 2002, the 15 EU member sates decided on the enlargement of the Union by granting accession in May 2004 to ten new members, namely Poland, The Czech Republic, Slovakia, Hungary, Estonia, Latvia, Lithuania, Slovenia, Malta and Cyprus. The acceptance of the latter has been, formally at least, unconditional with reference to the solution of the Cyprus problem, with the summit declaration favoring further negotiations for a united Cyprus. In fact the declaration expresses satisfaction as the Greek and Turkish Cypriots are committed to continue their negotiations aiming at reaching an agreement until the end of February 2003. In case an agreement has not been reached by that date, then the "acquis communautaire" will be suspended for the north part of the island until the Cyprus issue has been resolved.

It is only straightforward, therefore, that failure to reach an agreement will deprive the Turkish Cypriots from an initial €273 million which the European Council has decided to pump to the north as part of a special development program which will allow

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it to catch up with the rest of the island. Such a failure, moreover, will doom the north, half the population of which is first – or second – generation settlers from Turkey, to continue to depend heavily on aid from Ankara. Ironically, it is the Turkish Cypriot authorities that insist on a loose confederate system with the two communities remaining independent sovereign states and their populations physically separated. Massive demonstrations in the north during late December 2002, however, have made it clear that the Turkish Cypriot population does not share its authorities' views on the subject.

The UN Secretary General has attempted to resolve the issue by submitting the so–called Annan Plan in November 2002, proposing a Swiss canton system. The government of Cyprus has agreed to accept the Annan Plan as a basis for a final settlement, despite the risk that the burden added on the Cypriot economy by the underdeveloped north may lead to its failure to meet the Maastricht criteria and, consequently, to join the EMU and the Eurozone[2]. While the Turkish Islamic government, however, has publicly maintained that a settlement based on the Annan Plan is possible by the deadline set, the Turkish military bluntly told the government at the National Security Council meeting on 29 November that it would not be allowed to determine Turkish policy on Cyprus. Privately, military officials insist that the threat will be backed by force if necessary, since it believes that a strong military presence in northern Cyprus, where it currently has 30,000 troops, is vital to Turkey's strategic needs (IISS 2002). It is obvious, therefore, that there is a serious conflict of interests on the Turkish side and more specifically, between the government and the military as it concerns the settlement of the Cyprus issue in the context of the Annan Plan. Given that Cyprus has been already granted accession to the EU, the position of Turkey is rather

[2] It is indicative that the Cypriot GDP amounted to $9.1 bn. for the period 1998–2001 while the corresponding figure for the North barely reached 10% of this figure (IISS 2002). The hesitant attitude of the Cypriot government vis-à-vis the Annan Plan, however, is due to more than what meets the eye, since it imposes indirect, however binding restrictions concerning the control of the Cypriot FIR and the weapons of the troops kept by Greece and Turkey on the island. Additional problems may arise concerning the approval of the Annan Plan by the concurrent referendums in the south and the north of Cyprus on March 30, 2003. The voters will be asked to approve or not a package of four crucial issues referring to the structure of the new Cypriot state, its constitution, the terms of the treaty between Cyprus, Greece, Turkey and the UK and the EU accession of Cyprus, all with a "yes" or "no".

delicate, as it has to compromise between the Turkish Cypriots interests and its own future as an EU candidate on one hand and its strategic interests on another.

Bearing the above developments in mind, therefore, one should start wondering to what extent the optimism expressed by the Greek side regarding the future of the Greek–Turkish relations is well founded. Indeed there has been a widespread impression that, following these latest developments, business between the two countries in the form of direct investment flows will be flourishing, with Greece being one of the leading supporters of the Turkish EU candidacy. Both countries have even applied to host the Euro 2008 football championship jointly! But above all the most striking conclusion drawn by those sharing this optimism is that the arms race between the two countries which for decades now devours considerable GDP shares in both countries (Andreou and Zombanakis 2000 and 2001) will be led to its end. And to make things even more preposterous, the Greek Ministry of Defence has proceeded to a one sided reduction of its defence procurement programme for a third time since 2001, while it has recently announced a further reduction of the compulsory military service term.

Given the contrast between this lackadaisical attitude from the part of the Greek authorities on one hand and the fundamental differences concerning the Cyprus issue between government and military in Turkey, this paper aims at forecasting the developments concerning the settlement of the Cyprus issue after the Copenhagen EU summit. What we plan to do, more specifically, is to evaluate the extent to which one should share the Greek optimism concerning the improvement of the Greek-Turkish relations and the subsequent reduction of tension that will lead in its turn, to the end of the arms race currently burdening the economies of both sides. Section 2 provides the technical background of this work. What it does, more specifically, is to explain how the use of Genetic Algorithms can contribute to the efficiency of Certainty Neuron Fuzzy Cognitive Maps (CNFCMs) in cases of crisis management and decision-making. The model that we use to represent the setting of the problem is presented in section 3. The combination of the two techniques contributes to the construction of our hybrid model that reflects the political and strategic setting as described in the Introduction. The next section deals with the various scenarios and the results forecasted following a number of

simulation exercises while the final section of the paper presents the conclusions derived.

5.2 TECHNICAL BACKGROUND

Cognitive Maps (CMs) were introduced by Axelrod (1976) and were mainly used to support political decisions in international relations. A CM employs a technique based on qualitative reasoning and can be used by an individual decision-maker to study or interpret knowledge that involves many interacting concepts. These concepts are represented as nodes while directed arrows are used to show the causal relationships between them. Each arrow is characterized by a weight, a real value that indicates the degree of influence of the causal relationship between any two connected nodes. This representation, in which concepts are considered as variables of the system, gives a figure of nodes and arrows called "cognitive map". Such a map may represent three different types of causal relationships underlining the links between them as well as the degree of influence between concepts and causal relationships:

- Positive (+) causality expressed by words like "promotes", "enhances", "is benefit to" etc. An increase / decrease of the causal relationship will cause an increase / decrease in both the "cause" and the "effect" variables.
- Negative (-) causality expressed by words like "retards", "prevents", "is harmful to" et c. In cases of a negative causal relationship an increase in the "cause" variable will result to a decrease of the "effect" variable.
- No effect (0) described as "no effect on", "does not influence" et c.

To indicate, in addition, the intensity of the relationships between these variables one needs to employ a Fuzzy Cognitive Map (FCM), which has been developed by political scientists in order to analyze, predict and understand decisions imitating the cognitive process of human experts on various fields of expertise. Fuzzy Cognitive Maps (FCMs) are soft computing tools (Zadeh 1997a,b) that combine elements of fuzzy logic and neural networks. FCM theory was developed recently (Kosko 1986, 1992) as an extension of cognitive maps used for planning and making decisions in the fields of international relations, in modeling social systems and in studying political

developments in the context of such systems. Strictly speaking, a FCM is a figure composed of nodes and edges, the former introducing the qualitative concepts of the analysis while the latter indicate the various causal relationships. Each concept node possesses a numeric state, which denotes the qualitative measure of its presence in the conceptual domain. Thus, a high numerical value indicates that the concept is strongly present in the analysis while a negative or zero value indicates that the concept is not currently active or relevant to the conceptual domain.

A FCM works in discrete steps (Kosko 1992). When a strong positive correlation exists between the current state of a concept and that of another concept in a preceding period, we say that the former positively influences the latter indicating this by a positively weighted arrow directed from the causing to the influenced concept. By contrast, when a strong negative correlation exists, it reveals the existence of a negative causal relationship indicated by an arrow charged with a negative weight. Two conceptual nodes without a direct link are, obviously, independent.

The activation level of the system nodes and the weighted arrows are each set to a specific value based on the experts believes. Afterwards the system is free to interact until the model:

- Reaches equilibrium at a fixed point with the values of the activation level remaining stable in the interval [-1 1] independently of time.
- Exhibits limit cycle behaviour, falling in loop of a specific period.
- Exhibits a chaotic behaviour.

In order to increase the reliability of the weight matrix Kosko (1986) suggested consulting more than one expert, while the experience of these experts has been rated with a value from 1 to 10. If S_i is the score of expert i and W_i is the weight matrix of the FCM defined by that expert, the final weight matrix is given by the following formula (Taber and Siegel 1987).

$$W = \frac{\sum_{i=1}^{N} S_i W_i}{\sum_{i=1}^{N} S_j} \tag{1}$$

In 1997, the introduction of the Certainty Neuron Fuzzy Cognitive Maps (CNFCMs) (i.e. Tsadiras and Margaritis 1996, 1998), provided additional fuzzification to FCMs, by allowing for various activation levels of each concept between the two extreme cases, i.e. between activation or not. In other words, this combination of Fuzzy Logic (Zadeh 1992, Cox 1994) and Neural Networks (Kartalopoulos 1996) creates models that emulate reasoning and the decision-making process using fuzzy causal relationship. The flexibility of such models is improved by allowing for a variety of activation levels of each concept thus creating a Certainty Neuron Fuzzy Cognitive Maps (CNFCM).

More specifically, a function $f()$ coming from the area of expert systems was used to return the new certainty factor of a fact after receiving new evidence for, or against previous believes based on the present certainty factor.

The updating function of a CNFCM is the following:

$$A_i^{t+1} = f\left(S_i^t A_i^t\right) - d_i \; A_i^t \tag{2}$$

where

$$S_i^t = \sum_{\substack{j=1 \\ j \neq i}}^{n} A_j^t w_{ij} \;, \tag{3}$$

A_i is the activation level of concept C_i at time $(t+1)$ or (t), equation (3) is the sum of the weighted influences that concept C_i receives at time step t from all other concepts, d_i is a decay factor (Tsadiras and Margaritis 1996), and

$$fm(A_i^t, S_i^t) = \begin{cases} A_i^t + S_i^t(1 - A_i^t) = A_i^t + S_i^t - S_i^t A_i^t, if\ A_i^t \geq 0, S_i^t \geq 0 \\ A_i^t + S_i^t(1 + A_i^t) = A_i^t + S_i^t - S_i^t A_i^t, if\ A_i^t < 0, S_i^t < 0, |A_i^t|, |S_i^t| \leq 1 \\ A_i^t + S_i^t \Big/ \left(1 - \min\left(\left|A_i^t\right|, \left|S_i^t\right|\right)\right), otherwise \end{cases} \tag{4}$$

is the function used for the aggregation of certainty factors (Kosko 1992). The meaning of the above function is that the external influence can affect the activation of a concept just to a certain degree.

We propose the following modification to the third case of equation (4) as follows:

$$A_i^t + S_i^t \Big/ (1 - \min(A_i^t, S_i^t)), otherwise \quad (5)$$

to cover the undesired situation in which one of A_i^t and S_i^t equals to 1 and the other to –1 leading the denominator to zero.

Given the structure of a CNFCM as described above it is easy to see that its ability to combine the input supplied by domain experts together with its flexibility makes it a useful tool for analyzing tough political problems and suggesting plausible solutions in an environment of political uncertainty (Tsadiras and Margaritis 1997).

5.3 THE MODEL

The structure of this model (Table1, Figure 1) relies heavily on previous research on the Cyprus issue using Fuzzy Cognitive Maps and Genetic Algorithms (Mateou et al. 2003, Andreou et al. 2003) and has been built to reflect the political framework describing the Cyprus problem shortly before the Copenhagen Summit Conference, in December 2002[3].

Table 1. Description of the concepts

C1	Cyprus EU Full Accession
C2	Escalation of Tension
C3	Settlement of the Cyprus Issue
C4	Turkish - Cypriot Position
C5	Position of the Turkish Government
C6	The Cyprus Issue Solution Framework
C7	Position of Cypriot Government
C8	Position of the European Union
C9	Position of the Greek Government
C10	Reactions of U.S. – U.K.
C11	Invasion in Iraq

[3] Given that our revision has taken place after the end of the Copenhagen Summit Conference (CSC) we had an excellent opportunity to evaluate our model in terms of its applicability by simply comparing the results obtained in the form of conclusions after the (CSC) to the findings derived by the initial dynamic simulation exercise.

The construction of the model has been based on the method of questionnaires and interviews (Roberts 1976). According to this we have identified the important concepts or variables influencing our strategic target, i.e. the EU accession of Cyprus (C1) as well as the various causal links between them. This was a procedure, which has been based on input provided by a team of domain experts. These experts filled in a questionnaire concerning the causal relationships and the weights characterising them, i.e. the degree to which concepts influence each other, using a scale between -1 and 1, to indicate the direction and intensity of these relationships (Taber and Siegel 1987).

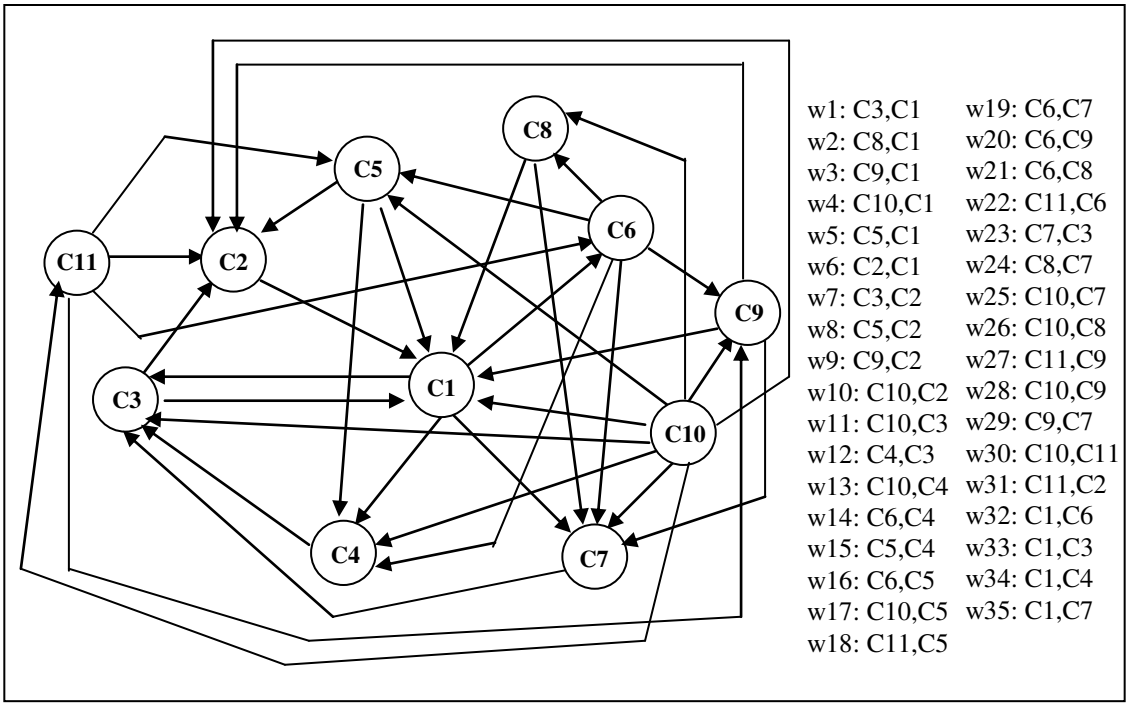

Figure 1. The Cyprus issue CNFCM model

Bearing in mind that fuzzy variables can be positive, zero, or negative and quantifying their magnitude as small, medium, or large (Kosko 1992) we can obtain six fuzzy-set values excluding zero:

- NL : Negative Large
- NM: Negative Medium
- NS: Negative Small

- ZE: Zero
- PS: Positive Large
- PM: Positive Medium
- PS: Positive Small

Using the above classification the experts constructed the initial fuzzy matrix used by the model as knowledge base, appearing in Table 2. This knowledge base has been built to describe the magnitude of each concept determining the initial equilibrium conditions of the model and facilitating the forecasting procedure.

The general model of Figure 1 was then built, in which the various concepts of the model interact with one other. The two leading or fundamental concepts of interest in this model are the EU accession of Cyprus's (C1), and the role of the UN through the submission of the Annan Plan (C6), with the answer to our crucial question concerning the relations between Greece and Turkey depending, to a large extent, on concept C2 representing an environment of tension on the island. The various weights are listed on the right-hand side of Figure 1 in a form that indicates the link from the initial to the terminal concept, with concepts separated by commas.

Promising as they may appear, the CNFCMs have two weak points: The first involves the invariability of the weights, which leaves only the activation levels to participate in the configuration of a political problem. The second lies with the inability of the method to model a certain political situation by performing all possible computational simulations following the change of a certain weight or group of weights. These problems are solved by combining CNFCMs with Genetic Algorithms (GAs) thus creating a hybrid model: The CNFCM part of the algorithm computes the final activation levels given the weights and relationships between concepts (see the Appendix for details on the computation process), while the GA part develops the weight matrix attempting to find the optimal set of weights that satisfy a predefined activation level for a specific concept. A hybrid model of this type, therefore, traces the degree of the causal relationships between the various concepts such that it can “force” them to be activated to a certain level. Hybrid models of this type are expected to contribute to the effectiveness of decision-making by defining, for each concept, the

activation level achieved using a certain set of weights evolved by the GA (Goldberg 1989, Michalewicz 1994).

Table 2. Fuzzy model analysis

Concept	Fuzzy Values	Description
C1: Cyprus EU Full Accession	0.66 to 1	Cyprus EU Full Accession. Freedom of Authority Exercise Ranges Between Considerable and Complete.
	0.31 to 0.65	Cyprus EU Full Accession. Freedom of Authority Exercise Ranges Between Considerable and Inadequate.
	0 to 0.3	Cyprus EU Full Accession. No Solution to the Cyprus Issue.
	-0.32 to 0	Cyprus EU Full Accession Revised in Anticipation of a Pending Solution.
	-0.33 to –0.65	Cyprus EU Full Accession Suspended until a Final Solution.
	-1 to -0.66	Cyprus EU Full Accession Rejected. No Solution to the Cyprus Issue.
C2: Escalation of Tension	0.66 to 1	Tension Escalation. Warfare
	0.31 to 0.65	Large Scale Provocative Incidents
	0 to 0.3	Small Scale Provocative Incidents
	-0.32 to 0	Statements and Intensions to Actions Aiming at Reducing Tension.
	-0.33 to –0.65	Actions Aiming at Reducing Tension.
	-1 to -0.66	Stability on the Island.
C3: Settlement of the Cyprus Issue	0.66 to 1	Generally Acceptable Solution of the Cyprus Issue.
	0.31 to 0.65	Basis for Settlement of the Cyprus Issue.
	0 to 0.3	Talks Aiming at Reaching an Agreement on the Cyprus Issue.
	-0.32 to 0	Stagnation Concerning the Cyprus Issue.
	-0.33 to –0.65	Adverse Developments Concerning the Cyprus Issue. Dead end.
	-1 to -0.66	No Possibilities for Solution. Two Separate States on the Island.
C4: Turkish – Cypriot Position	0.66 to 1	Acceptance of Annan Plan After a Referendum.
	0.31 to 0.65	Acceptance of Annan Plan After Negotiations.
	0 to 0.3	Acceptance of Annan Plan as it Stands.
	-0.32 to 0	Rejection of Annan Plan After Negotiations.
	-0.33 to –0.65	Rejection of Annan Plan After a Referendum.
	-1 to -0.66	Rejection of Annan Plan as it Stands.

Table 2. Fuzzy model analysis (continued)

Concept	Fuzzy Values	Description
C5: Position of the Turkish Government	0.66 to 1	Acceptance of Annan Plan in Line with a Turkish – Cypriot Decision.
	0.31 to 0.65	Acceptance of Annan Plan After Negotiations.
	0 to 0.3	Acceptance of Annan Plan as it Stands.
	-0.32 to 0	Rejection of Annan Plan in Line with a Turkish – Cypriot Decision.
	-0.33 to –0.65	Rejection of Annan Plan After Negotiations.
	-1 to -0.66	Rejection of Annan Plan as it Stands.
C6:The Cyprus Issue Solution Framework	0.66 to 1	Full Approval of Plan.
	0.31 to 0.65	Satisfactory Plan.
	0 to 0.3	Negotiable Plan.
	-0.32 to 0	Adverse Elements in the Plan.
	-0.33 to –0.65	Unsatisfactory Plan.
	-1 to -0.66	Unacceptable Plan.
C7: Position of Cypriot Government	0.66 to 1	Acceptance of Annan Plan After a Referendum.
	0.31 to 0.65	Acceptance of Annan Plan After Negotiations.
	0 to 0.3	Acceptance of Annan Plan as it Stands.
	-0.32 to 0	Rejection of Annan Plan After Negotiations.
	-0.33 to –0.65	Rejection of Annan Plan After a Referendum.
	-1 to -0.66	Rejection of Annan Plan as it Stands.
C8:Position of the European Union	0.66 to 1	Cyprus Full Accession and Solution of the Cyprus Issue.
	0.31 to 0.65	Cyprus Full Accession. Further Talks for a Solution.
	0 to 0.3	Cyprus Full Accession. No Solution to the Cyprus Issue.
	-0.32 to 0	Cyprus Full Accession Pending Until Solution.
	-0.33 to –0.65	Cyprus Full Accession Postponed Anticipating Negotiations Results.
	-1 to -0.66	Cyprus Full Accession Fails.
C9:Position of the Greek Government	0.66 to 1	Acceptance of Annan Plan in Line with a Cyprus Government Decision.
	0.31 to 0.65	Acceptance of Annan Plan After Negotiations.
	0 to 0.3	Acceptance of Annan Plan as it Stands.
	-0.32 to 0	Rejection of Annan Plan in Line with a Cyprus Government Decision.
	-0.33 to –0.65	Rejection of Annan Plan After Negotiations.
	-1 to -0.66	Rejection of Annan Plan as it Stands.

Table 2. Fuzzy model analysis (continued)

Concept	Fuzzy Values	Description
C10: Reactions of U.S. – U.K.	0.66 to 1	Strong Pressure for a Solution and Support of Cyprus Full Accession.
	0.31 to 0.65	Discrete Pressure on Both Sides for Full Accession and Solution.
	0 to 0.3	Neutral Position. Distances Kept against Both Sides on the Island Regarding Full Accession and Solution.
	-0.32 to 0	Reduced Interest in a Solution Following Full Accession.
	-0.33 to –0.65	Reduced Interest in a Solution Before Full Accession.
	-1 to -0.66	Indifference Regarding Full Accession and Solution of the Cyprus Issue.
C11: Invasion in Iraq	0.66 to 1	Attack Against Iraq.
	0.31 to 0.65	Preparatory Stage for Assault.
	0 to 0.3	Considerable Chances for an Assault.
	-0.32 to 0	Small Chances for an Assault.
	-0.33 to –0.65	Remote Chances for an Assault.
	-1 to -0.66	No Possibilities for an Assault.

The essence of the Genetically Evolved Certainty Neuron Fuzzy Cognitive Map (GECNFCM) model lies with tracing the optimal weight matrix corresponding to a desired activation level for a given concept as computed by a simple CNFCM model (Andreou et al. 2003). More specifically, the GA evolves a population of individuals each of which consists of a weight matrix describing the degree of causal relationships between the concepts of Figure 1. The initial generation contains weights matrices with random values. The evolution of the individuals is performed with the help of the CNFCM model, which computes the final activation levels of the concepts using equations 3 to 5. The activation level of a certain concept in focus denoted by $A_{d,i}$ is used to calculate the fitness of each individual-weight matrix WM_i according to the following function:

$$\text{fitness}(WM_i)=1/(1-\text{abs}(A_{d,i} - \text{mean}_{50}(A_{a,i})) \quad (6)$$

where $A_{d,i}$ is the target (desired) value of the activation level for the concept in focus C_i and mean50($A_{a,i}$) is the mean value of the last fifty actual activation levels of concept C_i as these are computed by the CNFCM (t variable in equation (4)). It is clear

from equation (6) that the closer to the target value this mean is, the more appropriate the weight matrix. In fact, the fitness function uses the average of the last fifty activation levels to take into consideration a possible final state of the model which presents limit-cycles, that is, a state in which the $A_{d,i}$ exhibit periodic fluctuations and do not stabilize at equilibrium values. Thus, if the activation level of the concept in focus reaches equilibrium then the corresponding weight matrix in this case can be considered more appropriate compared to another individual-matrix that has resulted to limit cycle behaviour.

The simulations conducted to test the functionality and predictability of our model were based on the following constant values for the variables involved: The population size has been set equal to 100 and the number of generations equal to 400. The weight values were initialised in the range [-1.0, 1.0] while the probability of applying the genetic operator of crossover was set to 0.25 and that of mutation to 0.01.The simulations that follow retrieve the final activation levels of the rest of the concepts, as well as the strength of the causal relationship between them. The analyst is thus given the means to proceed to tactical movements in his decision-making by varying the degree of such relationships taking into account the final activation levels that the model has suggested.

Table 3. Weight matrix according to the domain experts

W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**
C3-C1	**C8-C1**	**C9-C1**	**C10-C1**	**C5-C1**	**C2-C1**	**C3-C2**	**C5-C2**	**C9-C2**
0.02	0.22	0.22	-0.11	-0.11	-0.19	-0.16	0.18	-0.16
W10	**W11**	**W12**	**W13**	**W14**	**W15**	**W16**	**W17**	**W18**
C10-C2	**C10-C3**	**C4-C3**	**C10-C4**	**C6-C4**	**C5-C4**	**C6-C5**	**C10-C5**	**C11-C5**
0.22	-0.16	-0.18	0.12	0.20	0.20	0.20	0.14	0.17
W19	**W20**	**W21**	**W22**	**W23**	**W24**	**W25**	**W26**	**W27**
C6-C7	**C6-C9**	**C6-C8**	**C11-C6**	**C7-C3**	**C8-C7**	**C10-C7**	**C10-C8**	**C11-C9**
0.2	0.2	0.16	0.02	0.19	0.16	0.14	0.16	0.01
W28	**W29**	**W30**	**W31**	**W32**	**W33**	**W34**	**W35**	
C10-C9	**C9-C7**	**C10-C11**	**C11-C2**	**C1-C6**	**C1-C3**	**C1-C4**	**C1-C7**	
0.11	0.14	0.22	0.12	0.06	0.11	0.06	0.13	

Our model, using the weights depicted in Table 3 as these were defined by the experts, has reached equilibrium, as indicated in Figure 2, after 250 interactions (t variable in eq. (3) to (5)), thus calculating the new activation levels of the eleven concepts presented in Table 4.

Table 4. Activation levels (A_i) for the Baseline scenario

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
0.2	-0.25	0.32	-0.35	-0.58	0.49	0.38	0.52	0.58	0.32	-0.57

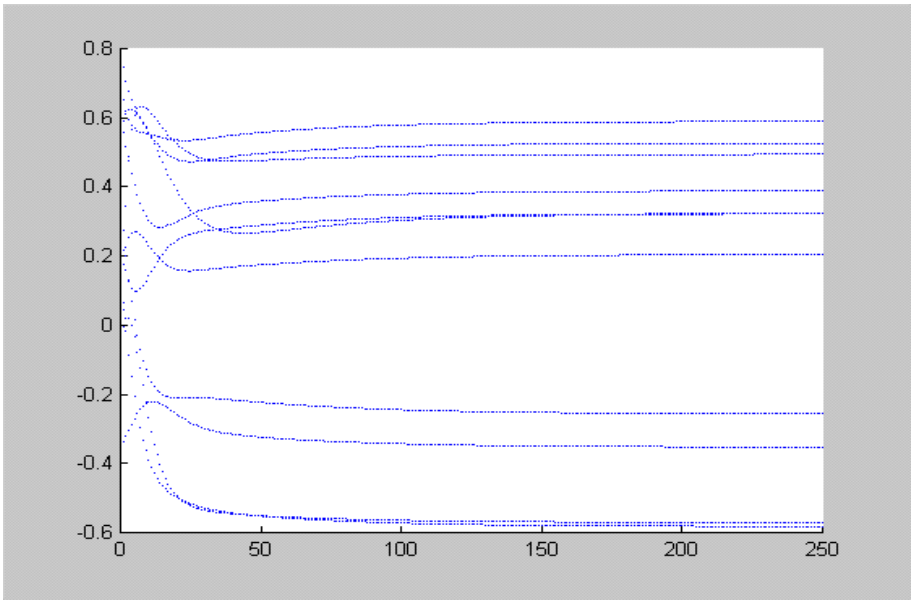

Figure 2. Stabilization of the model in equilibrium

It is very encouraging to point out that although the baseline simulation providing the initial equilibrium conditions of our model was performed before the CSC on December 12–14, 2002, it has nevertheless captured the dynamics of the Cyprus issue as follows:

i. The activation level (AL) of concept C1 representing the EU accession of Cyprus has stabilised to 0.2. Given that the range of possible values has been set between –1 and +1, and by looking at Table 2 denoting the ranges of the various ALs used in our fuzzy model analysis, this value lies within the range of PS (Positive Small), indicating the existence of a distinct possibility of EU accession without a settlement of the Cyprus issue. The results of the CSC of December 02 simply confirmed our forecast.

ii. Concept C2 is of considerable importance for the analysis, since it stands for the degree of tension on the island, assuming a simulated activation level of A_2=-0.25. This value together with the negative sign forecast the reduction of tension and the conciliatory attitude of the new Turkish government following the submission of the Annan Plan. Indeed, it seems that the Islamists do not insist on their predecessors' threats involving "unlimited reactions" in case of an accession before a settlement of the Cyprus issue.

iii. The commitment of the two sides to continue working for a settlement of the Cyprus issue until the end of February 2003 is reflected to a forecasted activation level of A_3=0.32 for the third concept C3 representing a solution to the Cyprus problem.

iv. The rejection of the Annan Plan, as proposed by both the Turkish-Cypriot authorities and the Turkish Government under the pressure of the Turkish National Security Council, is forecasted by the values assumed for the fourth and the fifth concepts respectively, i.e. A_4=-0.35 and A_5=-0.58. The validity of our forecasts concerning the inflexibility of the Turkish side has been verified during the CSC, when then UN Secretary envoy, Mr Alvaro De Soto, failed to arrange a new round of direct bilateral talks based on the Annan Plan, following a rejection by the Turkish Cypriot regime. By contrast, the attitude of the Cyprus government, which regards the Annan Plan as a sound basis for further talks, is very successfully forecasted by the model that yields a value of the AL for the relevant concept C7 equal to A_7=0.38. In fact, the Cyprus Government was ready to start negotiations during the CSC, a position supported by the Greek

Government (C9), which is forecasted to favour a solution of the problem following negotiations, given that its AL is simulated to A_9=0.58.

v. Turning, finally, to the forecasted attitude of the international environment, the eighth concept that represents the position of the European Union assumes a baseline activation level of A_8=0.52. This is considered reasonable given that the EU favours both the accession of Cyprus and the continuation of the talks aiming at a settlement of the Cyprus issue. The moderate pressure exercised by the US and the UK on both sides on the island is reflected in an AL value of A_{10}=0.32 for this tenth concept, while available information thus far indicates a possibility to avoid an invasion in Iraq, at least until the submission of the UN experts report on the nuclear and biological arsenal of Iraq.

5.4 POLICY CONSIDERATIONS

Having thus established, following our CNFCM baseline simulation, the functionality of our model which reflects the complexity of the Cyprus issue in its pre-Copenhagen Summit Conference form, we can now proceed to examining a variety of possible policy scenarios. As it has already been pointed out, this task that will be performed using Genetic Algorithms and Scenario Analysis (Godet 1987, Bunn and Salo 1993), requires assigning our two leading targets, namely the EU accession of Cyprus and the solution of the Cyprus issue, a certain activation level that reflects the degree to which they are designed to attain, according to each scenario. Once this has been established, the algorithm will then provide the values required for the instrumental variables of the system, namely its activation levels and concept weights to attain the specific target set. The evaluation and interpretation of the results will be based on the predetermined range of possible values presented in Table 2.

Taking into account the picture, as it stands on a cut–off date, sometime in early January 2003, we have decided to consider the forecast for the following three possible scenarios:

Scenario A: The Optimistic Case

The optimistic outlook of the Cyprus issue provides for the following scenario: Cyprus becomes a full EU member while the Cyprus issue is resolved by allowing the Cypriot government a large number of degrees of freedom in order to implement its economic and social policy for the entire island. Our genetic algorithm requires that this framework is described by increasing the activation level of C1 to A_1=0.9, yielding in equilibrium mode (Figure 3) the optimal weight matrix depicted in Table 5, while Table 6 provides the corresponding ALs which verify the reliability of our model. Indeed, the AL of concept C1 that represents full EU accession converges from an initial 0.2 to 0.82, a figure that reveals that the Cypriot government has been allowed unconstrained freedom of movement in order to implement its economic and social policy for both communities on the island. Such an event, however, as the model indicated, will trigger tension on the island, given that the AL of the corresponding concept C2 rises to A_2=0.73. It is interesting to point out, however, that the Turkish Cypriot community will be eager to accept the "carte blanche" given to the Cypriot State (A_4= 0.8) since this arrangement will entail considerable welfare improvement following their full EU membership[4].

By contrast, the expected reaction of the Turkish side to such an arrangement is forecasted to be a straightforward rejection since the corresponding C5 assumes a strongly negative value (A_5=-0.62), thus generating a further source of tension between the two sides. Concerning the Annan Plan, the forecast concerning both the Cypriot and the Greek governments indicates that they will accept its final form following a referendum (A_7=0.77 and A_9=0.88), with the consensus of Athens (A_6=0.1).

The reaction of the international community is forecasted as a certain amount of pressure by the US and the UK (A_{10}=0.67) for a settlement of the problem, while the position of the EU in this case, represented by an A_8=-0.65 might be a surprise to a certain extent. In fact, according to Table 2 such a figure corresponds to the possibility of suspension of the EU accession of Cyprus in anticipation of a final solution.

[4] The reaction of the Turkish Cypriots is expected to contribute to promoting tension on the island and to complicate matters. In fact, Mehmet Ali Talat, head of the Turkish Cypriot opposition Republican Turkish

Table 5. GECNFCM optimal weight matrix for the Optimistic Case scenario

w1	**w2**	**w3**	**w4**	**w5**	**w6**	**w7**	**w8**	**w9**
C3-C1	**C8-C1**	**C9-C1**	**C10-C1**	**C5-C1**	**C2-C1**	**C3-C2**	**C5-C2**	**C9-C2**
0.89	0.04	0.91	0.38	-0.02	0.68	1	-0.18	0.41
w10	**w11**	**w12**	**w13**	**w14**	**w15**	**w16**	**w17**	**w18**
C10-C2	**C10-C3**	**C4-C3**	**C10-C4**	**C6-C4**	**C5-C4**	**C6-C5**	**C10-C5**	**C11-C5**
0.72	0.28	0.97	0.10	0.01	-0.2	-0.18	-0.59	-0.27
w19	**w20**	**w21**	**w22**	**w23**	**w24**	**w25**	**w26**	**w27**
C6-C7	**C6-C9**	**C6-C8**	**C11-C6**	**C7-C3**	**C8-C7**	**C10-C7**	**C10-C8**	**C11-C9**
-0.20	0.18	-0.52	0	0.80	-0.53	-0.23	0.88	0
w28	**w29**	**w30**	**w31**	**w32**	**w33**	**w34**	**w35**	
C10-C9	**C9-C7**	**C10-C11**	**C11-C2**	**C1-C6**	**C1-C3**	**C1-C4**	**C1-C7**	
-0.76	0.69	-0.68	-0.36	-0.54	-0.14	0.73	0.66	

Table 6. Activation levels calculated with GECNFCM's optimal weights for the Optimistic Case scenario

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**
0.82	0.73	0.87	0.80	-0.62	0.10	0.77	-0.65	0.88	0.67	-0.33

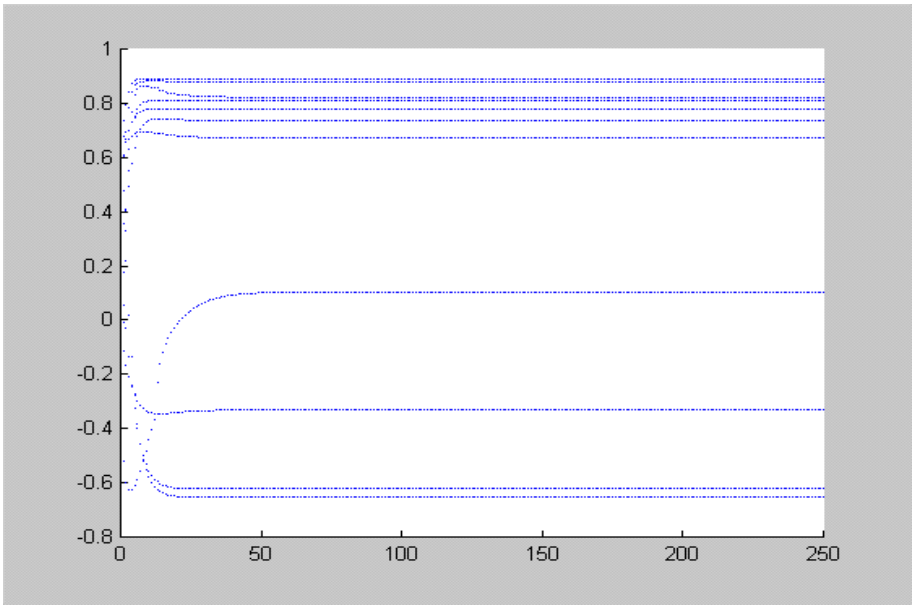

Figure 3. Optimistic Case (scenario 1): Equilibrium for A_1=0.9

Scenario B: The Complex Case

This scenario provides for a full EU membership, together with a settlement of the Cyprus issue such that the government is not allowed to implement its policy on the entire island. This scenario, therefore, requires that the initial AL of concept C1 be increased from 0.2 to 0.4. The model is shown to have reached equilibrium in Figure 4 with the calculated optimal weight matrix presented in Table 7 and the eleven concepts activated as indicated in Table 8.

Following the recalculation of weights by our genetic algorithm the model leads to an AL equal to A_1= 0.39. The reduced degrees of freedom allowed to the authority of the Cypriot government by the finalized version of the Annan Plan lead to the consensus of the Turkish Cypriot authorities and the subsequent tension reduction, since the AL of C2 reaches A_2=-0.42. It follows, therefore, that the referendum on the Turkish Cypriot side will lead to accepting the Plan (A_4=0.77), with the approval of the Turkish government (A_5=0.77), unlike the one conducted by the Cypriot government which is forecasted to reject it (A_7=-0.51). It is interesting to see that the Greek government might be inclined to accept an improved version of the Plan following a period of negotiations (A_9=0.45). The apparent contrast of positions between the Greek and the Cypriot government is not

altogether that unexpected given the emphasis that the former places on the improvement of the relations between the EU and Turkey. Finally, the pressure from the US–UK is always strong (A_{10}=0.84), while the position of the EU is clearly in favor of a deferment of Cyprus's accession (A_8=-0.52), since the last thing it would ask for is another extra domestic problem to solve in the event of an unsatisfactory solution for one of its members involved in the Cyprus issue.

Table 7. GECNFCM optimal weight matrix for the Complex Case scenario

W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**
C3-C1	**C8-C1**	**C9-C1**	**C10-C1**	**C5-C1**	**C2-C1**	**C3-C2**	**C5-C2**	**C9-C2**
0.43	0.23	0.91	0.61	-0.77	-0.26	-0.29	-0.94	0.22
W10	**W11**	**W12**	**W13**	**W14**	**W15**	**W16**	**W17**	**W18**
C10-C2	**C10-C3**	**C4-C3**	**C10-C4**	**C6-C4**	**C5-C4**	**C6-C5**	**C10-C5**	**C11-C5**
0.46	-0.67	0.71	0.61	0.95	0.51	-0.89	-0.99	-0.38
W19	**W20**	**W21**	**W22**	**W23**	**W24**	**W25**	**W26**	**W27**
C6-C7	**C6-C9**	**C6-C8**	**C11-C6**	**C7-C3**	**C8-C7**	**C10-C7**	**C10-C8**	**C11-C9**
-0.36	-0.60	0.65	0	-0.22	0.48	-0.25	0.31	0
W28	**W29**	**W30**	**W31**	**W32**	**W33**	**W34**	**W35**	
C10-C9	**C9-C7**	**C10-C11**	**C11-C2**	**C1-C6**	**C1-C3**	**C1-C4**	**C1-C7**	
0.55	0.28	-0.03	0.11	0.75	0.41	-0.66	0.50	

Table 8. Activation levels calculated with GECNFCM's optimal weights for the Complex Case scenario

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**
0.39	-0.42	0.67	0.77	0.77	-0.73	-0.51	-0.52	0.45	0.84	-0.7

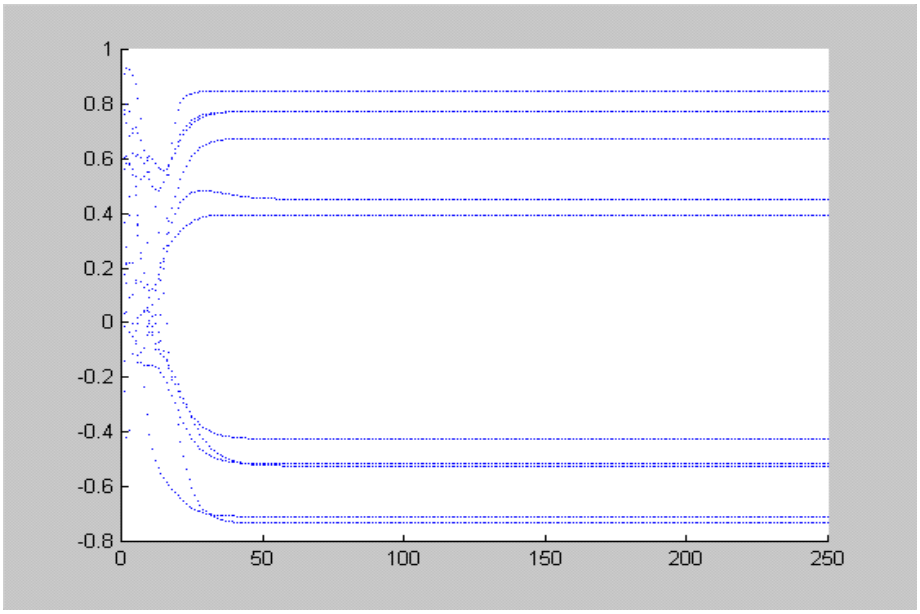

Figure 4. Complex Case (scenario 2): Equilibrium for A_1=0.4

Scenario C: The Pessimistic Case.

This scenario faces the possibility of a suspended EU full accession, despite the Copenhagen summit decision[5], in anticipation of a solution to the Cyprus issue by setting the activation level of C1 to A_1=-0.2, thus obtaining the optimal weight matrix depicted in Table 9 in equilibrium mode (Figure 5).

Table 9. GECNFCM optimal weight matrix for the Pessimistic Case scenario

W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**
C3-C1	**C8-C1**	**C9-C1**	**C10-C1**	**C5-C1**	**C2-C1**	**C3-C2**	**C5-C2**	**C9-C2**
0.56	0.61	-0.69	-0.11	-0.95	-0.93	0.16	-0.47	-0.70
W10	**W11**	**W12**	**W13**	**W14**	**W15**	**W16**	**W17**	**W18**
C10-C2	**C10-C3**	**C4-C3**	**C10-C4**	**C6-C4**	**C5-C4**	**C6-C5**	**C10-C5**	**C11-C5**
0.33	-0.09	-0.55	0.83	0.9	-0.55	0.01	-0.04	0.3
W19	**W20**	**W21**	**W22**	**W23**	**W24**	**W25**	**W26**	**W27**
C6-C7	**C6-C9**	**C6-C8**	**C11-C6**	**C7-C3**	**C8-C7**	**C10-C7**	**C10-C8**	**C11-C9**

[5] Indeed, despite the fact that Cyprus's EU accession has never been linked to the solution of the Cyprus issue by any means, the Helsinki Agreement signed in December 1999 (Paragraph 9b) states that before the ratification of the Cyprus EU accession, the Council will take into consideration all relevant factors concerning the Cyprus issue. Any possibility for a postponement, therefore, is expected to arise on these rounds, rather than as a result of a rejection in one of the member-states parliaments where such a rejection can only apply for all ten newly appointed members.

0.94	0.67	-0.92	0	0.44	-0.98	-0.57	0.8	0
W28	**W29**	**W30**	**W31**	**W32**	**W33**	**W34**	**W35**	
C10-C9	**C9-C7**	**C10-C11**	**C11-C2**	**C1-C6**	**C1-C3**	**C1-C4**	**C1-C7**	
-0.25	-0.98	0.65	0.81	0.23	-0.58	0.65	-0.29	

As shown in Table 10 the concept representing EU accession of Cyprus is activated almost to its target value (A_1=–0.13), while tension is expected to rise in this case as well (A_2=0.43) following the stagnation prevailing as it concerns the Cyprus issue. The general attitude facing the Annan Plan involves rejections by both the Greek (A_9=-0.55) and the Turkish (A_5=-0.25) government, the position of the former being considerably stronger, while the two sides on the island are hesitant to accept (A_4=0.03 for the Turkish Cypriots) or reject it (A_7=-0.02). These results explain the position of the EU, which favors postponement of the Cyprus's accession until conclusion of the talks (A_8=-0.26). The US–UK side, finally, keeps pressing for a solution (A_{10}=0.69), in anticipation of its invasion to Iraq which will require the use of a number of Turkish military air bases, a variable which is expected to carry increased weight in the bargain for a solution to the Cyprus issue[6].

Table 10. Activation levels calculated with GECNFCM's optimal weights for the Pessimistic Case scenario

C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**
-0,13	0,43	-0,01	0,03	-0,25	-0,45	-0,02	-0,26	-0,55	0,69	0,63

[6] "On the Turkish side, the deadline of 28 February 2003 means that Ankara is unlikely to come under effective pressure from the US to reach a settlement, as Washington is currently more concerned with placating, rather than antagonizing, Turkey in order to secure its support for a possible military campaign against Iraq early next year" (IISS 2002). This means that the pressure for concessions on the Cyprus issue is expected to fall on the Greek side.

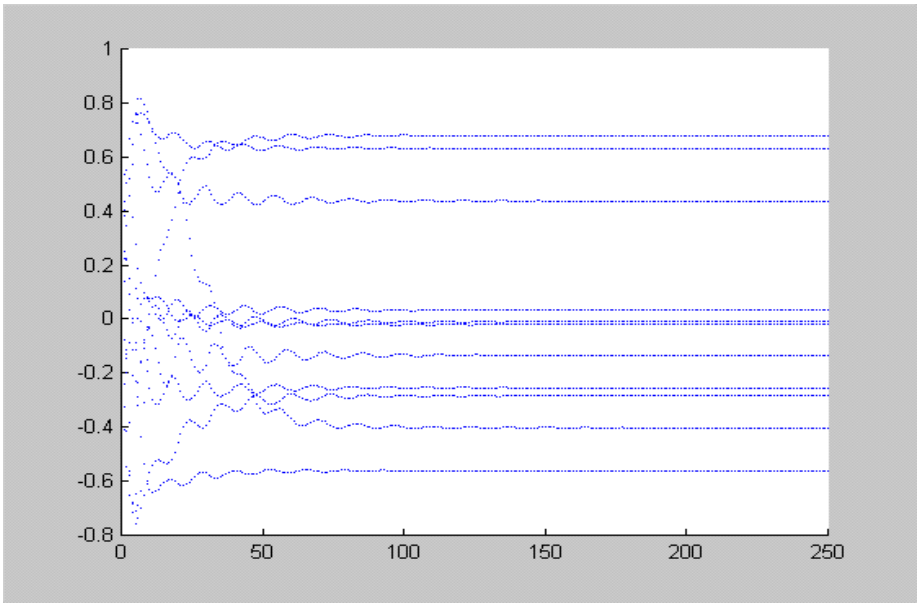

Figure 5. Pessimistic Case (scenario 3): Equilibrium for A_1=-0.2

5.5 CONCLUSIONS

It is straightforward, therefore, that under the circumstances there is very little room for optimism with regard to possibilities of a drastic tension reduction concerning the relations between Greece and Turkey. In fact, in all the cases analyzed, one or both sides will be strongly opposed to the proposed solution of the Cyprus issue on the basis of the Annan Plan. The prospects are even gloomier as a result of the extent to which the two sides affect the decisions taken by Cyprus itself. In the case of the Turkish military, in particular, the pressure which it exercises may comply with the Turkish Cypriot authorities' inflexibility; it is, however, in direct conflict to the aspirations of the overwhelming majority of the Turkish Cypriots, a position revealed by their massive demonstrations during late 2002 and early 2003. If one includes the conflict that has arisen between the Islamic government and the Turkish military after the November 2002 elections in Turkey, then our hybrid model simply confirms the prolongation of tension between the two sides as a result of the difficulties in reaching an agreement on the Cyprus issue.

Concerning the international environment, the Cyprus government must not rely on the decisions taken during the Copenhagen summit, until May 2004, the deadline for the

approval of these decisions by the 15 EU parliaments. The forecasted lack of enthusiasm from the part of the EU concerning Cyprus full membership is related to the skepticism of certain member states that would prefer avoiding an extra burden to the various EU problems, preferring to postpone Cyprus's EU accession until the issue has been resolved. Regarding the pressure exercised by the US–UK for a quick solution in view of an invasion of Iraq, this will hardly contribute to smoothening the tension between the Greek and the Turkish side.

The hesitant attitude of the Cypriot state towards the Annan Plan may be due, among other things, to the enormous financial cost which it will bear in its effort to integrate the underdeveloped north. The prior experience of Germany on this issue raises serious concerns that this cost will be prohibitive for the economy of Cyprus, given its effort to comply with the Maastricht criteria and join the EMU and the Eurozone.

A direct conclusion of the above is that the relaxed attitude of the Greek government regarding the prospects of its relations with Turkey is far from being justified. Given the pronounced clash of interests on the Cyprus problem between the two sides on one hand and the intense domestic conflict concerning political decision-making in Turkey and on the Turkish–Cypriot side on another, the prospect of friction between Greece and Turkey will remain high. Consequently, the Cyprus issue, which we must be careful to regard as simply one of the problems concerning the Greek–Turkish relations, is expected to promote the arms race that burdens the economies of both sides in the foreseeable future.

5.6 UPDATE

We have completed this paper on March 20, 2003, Day One of the US–UK invasion to Iraq. This is a major international crisis, which we have considered in our model as affecting the Cyprus issue in more ways than one. In fact we are now in a position to evaluate the validity of our results and the predictability of our model, given that the developments concerning the Cyprus issue and the global political setting are currently at a very delicate phase.

What seems to be the case, therefore, is that the current developments with respect to the Cyprus issue and the associated international environment are very close to what we have called "the Complex Scenario". Given that no solution has been attained by the end of February 2003, it appears that the Adhesion Act for the ten new members will be signed in Athens on April 16, 2003 and it will refer to the Republic of Cyprus as one entity. To what extent the EU will be willing to bargain the membership application of Turkey against the settlement of the Cyprus issue is a matter that remains to be seen.

According to our "Complex Case", therefore, it seems that the solution of the Cyprus issue may be left up to the EU dynamics in the context of an "acquis communautaire", possibly leading to accessing the north of the island along the lines of the German renunciation. This means that whatever this solution may be is certainly going to be a question of long-term character. We must point out once again, however, in the light of the latest developments that we still cannot share the optimism of the Greek side concerning its bilateral relations with Turkey. The distance between the "Complex Case" and what we have termed the "Pessimistic Case" is far too small to be neglected. A possible incorporation of the third version of the Annan Plan to the Adhesion Act, or even a rejection of all ten applications by a member-state parliament, as a reaction to the backing offered by some of the EU newly selected members to the US foreign policy are possibilities which the Greek side must seriously consider.

5.7 REFERENCES

Andreou, A.S. and Zombanakis G. (2001) A Neural Network Measurement of Relative Military Security: The Case of Greece and Cyprus. *Defence and Peace Economics* **12**(4), 303-324.

Andreou, A.S. and Zombanakis, G.A. (2000) Financial Versus Human Resources in the Greek-Turkish Arms Race. A Forecasting Investigation Using Artificial Neural Networks. *Defence and Peace Economics* **11**(4), 403 - 426.

Andreou, A.S., Mateou N.H. and Zombanakis, G.A. (2003) Evolutionary Fuzzy Cognitive Maps: A Hybrid System for Crisis Management and Political Decision

Making. *Proceedings of the International Conference on Computational Intelligence for Modelling Control and Automation (CIMCA2003)*, Vienna, Austria.

Axelrod, R. (1976) *Structure of Decisio. The Cognitive Maps of Political Elite*, Princeton University Press.

Bunn, D.W. and Salo, A.A. (1993) Forecasting with scenario. *European Journal of operational Research* **68**, 291-303.

Cox, C. (1994) Forwarded by Zadeh L.A. *The Fuzzy Systems Handbook A practitioners guide to building, using and maintaining fuzzy systems,* Academy Press.

Godet, M. (1987) *Scenario and strategic management*. London: Butterworths Scientific.

Goldberg, D. (1989) *Genetic Algorithms in search optimisation and machine learning*. Reading, Mass: Addison-Wesley

International Institute for Strategic Studies (IISS 2002) Strategic Comments **8**(10).

Kartalopoulos, S.V. (1996) *Understanding Neural Net Works and Fuzzy Logic.* New York: IEEE Press

Kosko, B. (1986) Fuzzy Cognitive Maps. *Inter. Jour. of Man-Machine Studies* **24**, 65-75.

Kosko, B. (1992) *Neural Networks and Fuzzy Systems, A dynamic systems Approach to Machine Intelligence.* Englewood Cliffs, NJ: Prentice Hall.

Mateou N.H., Zombanakis, G.A. and Andreou, A.S. (2003) Crisis Management and Political Decision Making Using Fuzzy Cognitive Maps: The Cyprus Issue. *Proceedings of the International Conference on Computational Intelligence for Modelling Control and Automation (CIMCA2003)*, Vienna, Austria.

Michalewicz, Z. (1994) *Genetic Algorithms + Data Structures = Evolution Programs*, Springer-Verlag.

Roberts, F.S. (1976) *The questionnaire method, Structure of Decision.* R. Axelrod (ed.), Princeton University Press, 333-342.

Taber, W.R and Siegel, M. (1987) Estimation of Expert Weights and Fuzzy Cognitive Maps. *First IEEE International Conference on Neural Networks* **2**, 319-325,

Tsadiras, A.K. and Margaritis, K.G (1996) Using Certainly Neurones in Fuzzy Cognitive Maps. *Neural Network World* 6, 719-728.

Tsadiras, A.K. and Margaritis, K.G (1997) Cognitive Mapping and the Certainty Neuron Fuzzy Cognitive Maps. *Information Sciences* **101**, 109-130.

Tsadiras, A.K. and Margaritis, K.G. (1998) The MYCIN Certainly Factor Handling Function as Uninorm Operator and its Use as Threshold Function in Artificial Neurons. *Fuzzy Set and Systems* **93**, 263-274.

Zadeh, L.A, (1992) *An introduction to fuzzy logic applications in intelligent systems*. Boston: Kluwer Academic Publisher.

Zadeh, L.A. (1997a) The role of fuzzy logic and soft computing in the conception, design and deployment of intelligent systems, in H.S. Nwana and N. Azarmi (eds) *Software agents with soft computing: concepts and applications.* Springer-Verlag.

Zadeh, L.A. (1997b) What is soft computing? *Soft Computing* **1**, 1-2.

EPILOGUE

Μάλλον γάρ πεφόβημαι τάς οικίας ημών
αμαρτίας ή τάς τών εναντίων διανοίας
(I would rather be concerned about our
own errors rather than our adversaries' plans)
Thoukidides

What we have done in this book is to examine certain key issues related to the Cyprus problem and the Greek–Turkish arms race and to provide answers to questions related to these issues. Our points and suggestions presented in this book are certainly not original. In fact, a large number of experts may have supported similar views now and then. We believe, however, that we have contributed a small step further in studying the relations between Greece and Turkey in the light of the Cyprus issue by using positive rather than normative analysis. Offering mathematical proofs to such issues beyond any reasonable doubt can entail a considerable number of benefits the least important being the time saved during the endless TV debates on the issue.

Using this straightforward reasoning, therefore, we have shown how important the role of human resources is in arms races in general and in the case of the Greek–Turkish conflict, in particular, in which Turkey obviously has the upper hand, given the demographic developments in the two countries. The relative security measure we propose is merely one extra way to show the importance of human resources in the arms race between the two sides. We have shown that no matter how paradoxical it may sound, the state of an arms race between Greece and Turkey is the only way in which peace can be safeguarded in the broader area of Cyprus and the Aegean, given the

profound differences between the two sides, the role of each of which in this race, be it leader or follower, is clearly identified. The difference between the actual and the financially optimal defence expenditure for Greece and Cyprus which can be taken to approximate the peace dividend for the two partners, points out the excessive burden that the two countries must bear, given their commitments along the lines of the Integrated Defence Doctrine. This alliance, moreover, may prove much more fruitful if the two participants make use of their comparative advantage which dictates that Greece emphasizes on the procurement of equipment while Cyprus provides the manpower for both countries. The shift of the Greek defence doctrine towards flexibility, speed of action and modernization of equipment is certainly a good start. One should not forget, however, that this is an expensive solution and consequently it is not compatible with any defence budget cuts, given the fragility of the international equilibrium in the Middle East and the reaction of Turkey which remains a question mark following the U.S. - U.K. invasion and the post Saddam regime in Iraq. In fact, the Pentagon and the State Department, to a lesser extent, do not seem to be exactly pleased with the contribution of their traditional ally in the area, especially after the refusal of the parliament to allow the use of Turkish territory by US troops aiming at invading Iraq from the north. It seems that the extra cost in terms of both time and money which the allied forces suffered following the Turkish rejection of their demands has been subtracted from the admittedly generous US financial support to Turkey, although the latter did eventually collect a substantial fraction of this support. In fact there is a widespread opinion that Erdogan's political maneuvers in this case have been admirable as he manages so far to keep a delicate balance between his strong Islamic backing, the Turkish military and the alliance commitments of his country. The fact remains, however, that irrespective of the extent to which Erdogan's political balance will be fruitful, there is a distinct possibility that Turkey will invest on a more pronounced presence in the Aegean if not in Cyprus, even if this requires a more aggressive attitude from its part. History teaches that Turkey tends to export its domestic problems in the form of a variety of demands against neighboring countries. It follows, therefore, that in cases in which developments in the area turn against its strategic interests like, for example, the case of a US support to a Kurdish independent state, Turkey may shift its

focus towards alternative targets in Cyprus and the Aegean theatre. In the opposite case, again, in which its position as a US ally is upgraded, it will feel strong enough to press for increased American backing to its demands against Cyprus and Greece. Consequently, whatever the gains or losses for Turkey may be during the post Saddam era, the possibilities of friction in Cyprus and the Aegean continue to remain high during a period of detrimentally relaxed euphoria of the Greek side.

A word of caution is required in this case: Both the Cyprus problem and the demands of Turkey in the Aegean Sea are issues which affect the relations between Greece and Turkey to a considerable extent, without, however, by any means being interdependent. In fact the Greek side has always rejected the logic of a package deal between the two countries. Concerning Cyprus, in particular, it seems that its EU full membership outlines a completely new strategic, political and socio-economic background very similar to the pre-Annan Plan era. What the Annan Plan proposed, in broad terms, has been a co-operation between Greece and Turkey on the island at the expense, at least to a very large extent, of its national sovereignty. What is more, the statements made by the UN Secretary praising the Greek and Cypriot side for their co-operation and support could reveal much more than what meets the eye. We believe that what it does, in fact, is to point to the Greek side as the weakest of the two, in the sense of being more liable to negotiations, given the Turkish firm position which leaves no room for bargaining. In that sense, the Cyprus EU full membership by leaving no such room, allows the "acquis communautaire" to provide the unique framework for a final solution of the problem through the integration of the Turkish-Cypriot community on the island. The generous flow of financial support directed to the North and the measures taken by the Cypriot government in April 2003 promoting unobstructed labor mobility and trade flows throughout the island are certainly expected to contribute to this end.

This does not mean, however, that we should all rely on the acquis communautaire and the international treaties for the settlement of our problems. Our recent experience based on developments in the Middle East points out to a very important message. In a strongly volatile political and strategic environment, which no longer enjoys the luxury of a delicate balance as a result of the Cold War, questions of legitimacy arise after any

arbitrary political or military move, questions that the UN has proved that it cannot answer effectively. This automatically implies that establishing the legitimacy of any such move or action will be left to those who undertake it. And it seems that in such cases the stronger the armed forces of those who seek legitimacy of their actions, the more convincing their arguments are.