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# **A decision support model for management of fuzziness in global risk assessment**

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## **ABSTRACT**

*Solving decision-making problems requires efficient handling of uncertainties. This task has been usually performed by means of expert systems which are based on classical logic and, therefore, need special methods such as heuristic approaches, probability theory, possibility theory, and fuzzy theory. The later approach, fuzzy reasoning and logic, offers a more natural way of handling uncertainty since it is similar to human logical reasoning.*

*In this paper, we develop a fuzzy logic model for assessment and prediction of country risk. This fuzzy method provides a systematic approach to analyzing a target country. By its nature, the decision making for global market involves various uncertain criteria; therefore, the fuzzy approach is suitable for this kind of analysis. The advantages of the approach are inclusion of economic data, consideration of political/social factors, and the ability to handle exact and fuzzy data.*

## **INTRODUCTION**

To effectively manage uncertainties in decision-making problems, it is essential to understand the source of ambiguity and its nature. There may be several reasons of uncertainty in a decision-making situation such as problem complexity, ill-posed questions, imprecision in computations, ambiguity in data/knowledge representation, problems in input interpretations, and noise, among others (Keller & Tahani, 1992). In the past, rule-based expert systems have been used for handling uncertainty in such problems. Generally, the expert systems are based on classical logic and developers need to add special methods for handling uncertainty. Some of the methods used for handling uncertainty in expert systems include heuristic approaches, probability theory, possibility theory, and fuzzy theory.

Fuzzy reasoning and logic offers a more natural way of handling uncertainty because it is similar to human logical reasoning. Using this method, all propositions can be modeled by possibility distributions over appropriate domains. A considerable amount of research work has been performed in this area, including its application in decision making (Takagi & Hayashi, 1991). This paper presents a detailed country risk analysis that uses a fuzzy decision support framework involving consideration of static and dynamic risk factors.

## **FUZZY LOGIC AND DECISION MAKING**

In general, human mind is not capable of handling a huge mass of numerical information. Instead, its excellence at classification and categorization tasks results from its capability of processing a mixture of symbolic and numeric information (Pedrycz, 1991). For the development of a decision-making methodology, there is also a need for interpretation of results of the classifier, and thus a need for user-friendly interface.

There are two major tools that are applicable to the design of a classification procedure – traditional artificial intelligence techniques (symbolic computation) and numerical computation. In pattern recognition, symbolic computations generally do not handle any numerical information. When numerical information is available, it is converted to symbolic form. Numerical computation methods that are generally used in science and engineering applications are complementary to artificial intelligence techniques. Although they are efficient and effective, they do not use any interpretation mechanisms for numeric data.

Because of the use of such characteristics as gradual membership, fuzzy sets form links between symbolic and numerical computation. In essence, a fuzzy set represents a collection of objects which is a general symbolic concept. And the grades of membership within the fuzzy set that specify the relationship of objects are numerical in nature. When specifying the degree of membership in a class, there is no requirement that it is to be denoted by a single number. Thus, it offers an ability to describe class membership in a linguistic format.

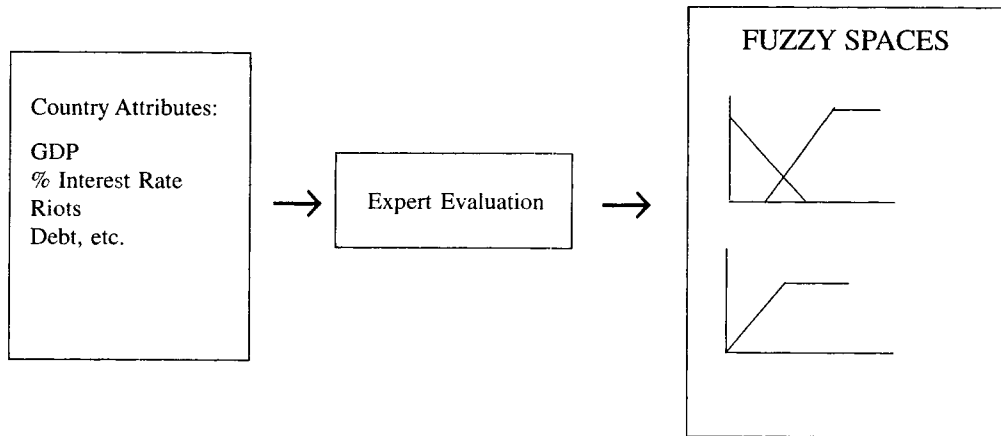
As an example, use of four terms such as high belongingness to the class, moderate belongingness, low belongingness, and no belongingness may be more appropriate in a situation rather than giving one single value. Compared to probability based pattern classification, the fuzzy logic based method does not impose any strict restrictions. In probability based classification, sum of probabilities stating class membership must be equal to one. Fuzzy logic is free of this kind of constraints and, thus, can handle unclear and ambiguous classification situations more easily.

## **ASSESSMENT METHODOLOGY**

An approximate shape of a country status and its future development, can be reached through a process of attribute evaluation and elimination, coupled with expert speculation. Both attribute evaluation and expert speculation are further translated in linguistic variables that rep-

resent the main structure of fuzzy reasoning models (Figure 1). A linguistic variable is the representation of a fuzzy space. The fuzzy space, in turn, is a fuzzy set derived from the evaluation of the linguistic variable. A fuzzy model consists of a series of conditional and unconditional fuzzy propositions. A proposition establishes a relationship between a value in the underlying domain and a fuzzy space. For example, "x is Y," where x is a scalar from the domain and Y is a linguistic variable. The effect of evaluating a fuzzy proposition is a degree (or grade) of membership derived from the transfer function,  $\mu_A - (x \in Y)$ . The derived truth membership value establishes compatibility between x and the fuzzy space Y. The final solution fuzzy space is created by aggregating the collection of correlated fuzzy propositions. This correlation is based on the truth of each fuzzy proposition and based on the application of connector operators AND an OR.

**Figure 1. Basic Fuzzy Reasoning Model**



There are two major methods of inference in fuzzy systems: min-max and the fuzzy additive methods (Cox, 1995). Both of the methods have certain benefits and are useful when applied appropriately. In min-max compositional rule of inference, the consequent fuzzy region is restricted to the minimum of the predicate truth. The output fuzzy region is updated by taking the maximum of these minimized fuzzy sets. In fuzzy notation, the method can be summarized as follows:

$$\mu_{cfs}[X_i] - \min(\mu_{pt}, \mu_{cfs}[X_i]) \quad (1)$$

$$\mu_{sfs}[X_i] - \max(\mu_{sfs}[X_i], \mu_{cfs}[X_i]) \quad (2)$$

According to equation 1, the consequent fuzzy set (cfs) is modified before it is used. This modification sets each truth function element to the minimum of either the truth function or the truth of the proposition's predicate (pt.). The solution fuzzy set (sfs) is updated by taking (using equation 2), for each truth function value, the maximum of either the truth value of the solution fuzzy set (sfs) or the fuzzy set that was correlated using equation 1. The result is reduction in the height of the fuzzy set output to equal the maximum truth of the predicate and then applying it to the output by using the union operator.

The alternative method is the fuzzy additive compositional method. The first part of the operation is similar to the above approach. That is, the consequent fuzzy set is reduced by the maximum truth value of the predicate. However, the solution fuzzy region is updated by a modified rule.

$$\mu_{cfs}[X_i] - \min(\mu_{pt}, \mu_{cfs}[X_i]) \quad (3)$$

$$\mu_{sfs}[X_i] - \min(1, \mu_{sfs}[X_i] + \mu_{cfs}[X_i]) \quad (4)$$

Instead of taking the maximum at each point in the output fuzzy set, the truth membership functions are added. This addition is bounded by 1.0 so that the results of the additions cannot exceed the maximum truth value of a fuzzy set. In either of the two methods, the final step is to defuzzify the output membership functions to obtain a scalar value.

In min-max implication method, only those rules that have a truth greater than a certain level in the output fuzzy set will make any contribution to the solution, while in the fuzzy additive method all the rules contribute something to the final solution. However, if there are several rules that have the same conclusion, the fuzzy membership value quickly reaches to 1. Therefore, a third reasoning approach called the scalable monotonic chaining approach is useful in cases where there are several rules with the same conclusion. This approach does not create and then defuzzify a solution fuzzy set; rather it uses monotonic chaining to map the risk specified in individual rules to an intermediate risk measuring fuzzy set. The result of this mapping is a scalar value from the domain of the risk metric (ratios) indicating the degree of risk for this particular model factor (category). The monotonic reasoning results from each rule are summed to produce a final risk value. In the present research work, the authors have utilized both min-max and scalable monotonic chaining methods in the fuzzy reasoning approach.

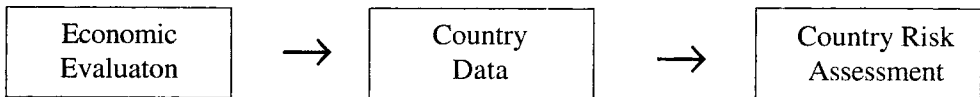
## FUZZY REASONING APPROACH TO COUNTRY RISK ASSESSMENT

The aim of the country risk assessment and prediction model is to obtain a careful evaluation of target countries in order to make appropriate diagnoses and decisions. Timing of market entry in the host country is important for the overall performance of international production and for individual aspects of performance. In a study by Yadong Luo (1998), it was found that early investors outperform late entrants in market growth in the host country. There has been a few recent attempts to model global market entry decision (Levy et al., 1995). The approach used by Levy requires specific data from the countries to develop the model. Therefore the model is dependent on the country under consideration. The approach discussed in this paper differs from

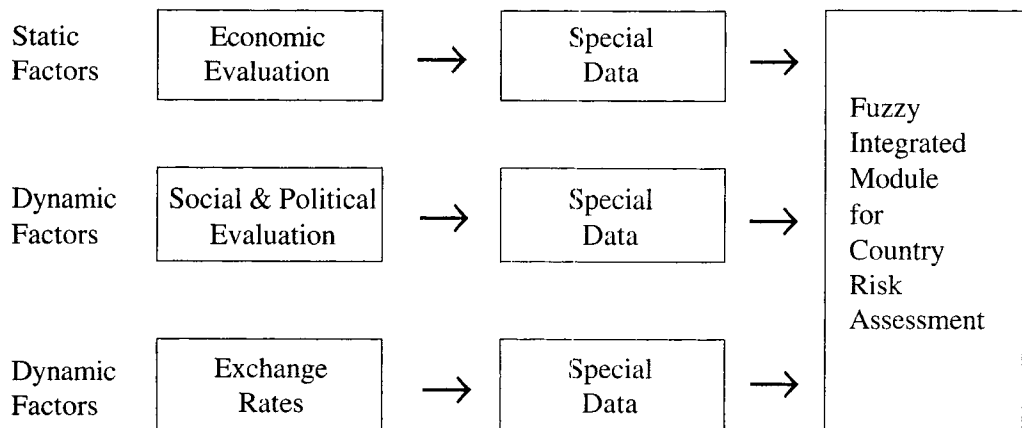
that of Levy since it is developed from the knowledge acquired from experts of a major international bank and it is independent of the country (Figure 2). Additionally, the assessment and prediction approach used in this research effort is based on two main types of factors: static and dynamic (Figures 3 and 4). Static factors reflect the sensitivity of the country to the fluctuations of dynamic factors.

**Figure 2. Levy Model and Author’s Alternate Model**

**Levy Model**



**Alternate Model** (using Expert speculation data)



**Figure 3. The Structure of the Country Risk Assessment Model**

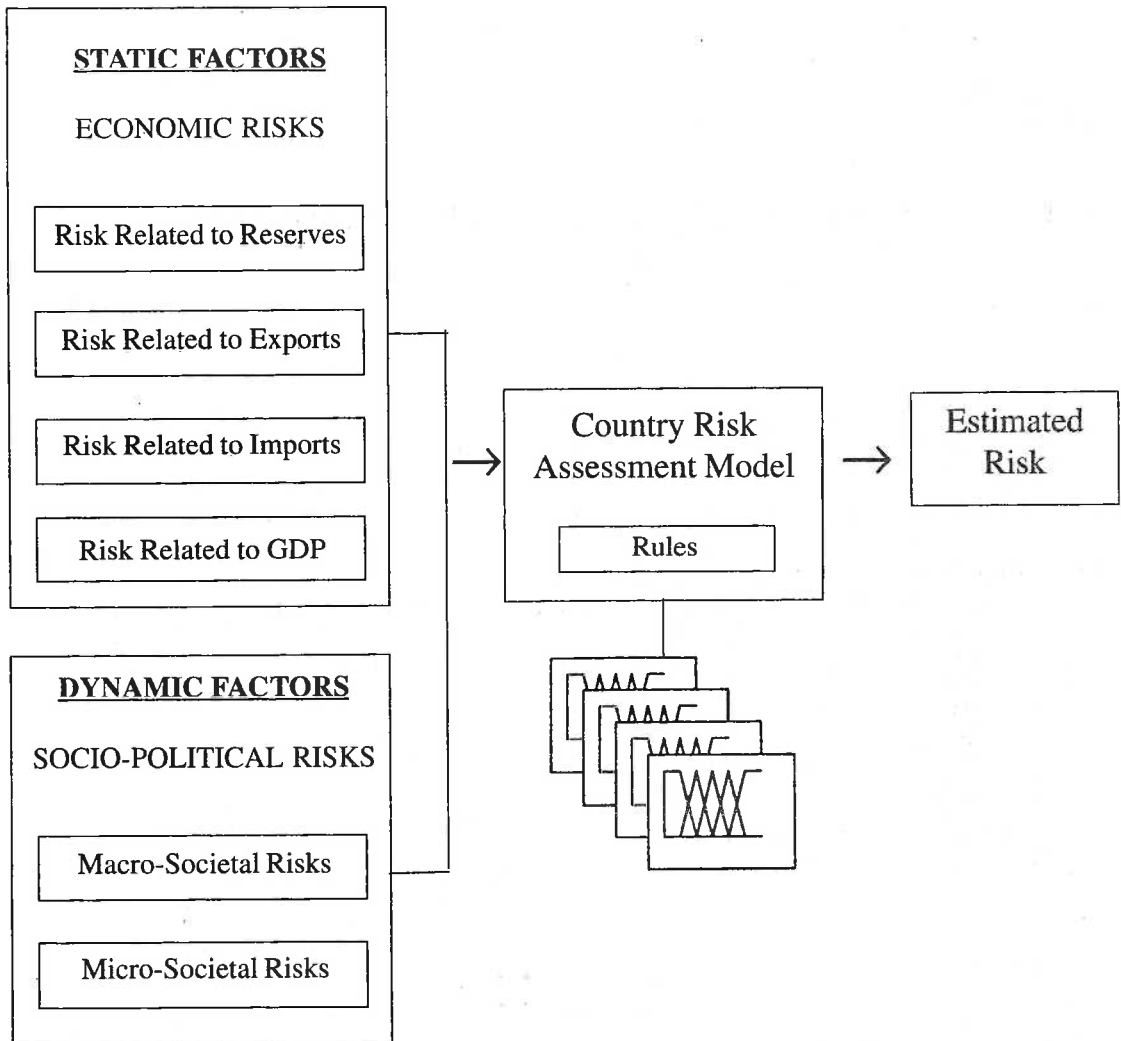
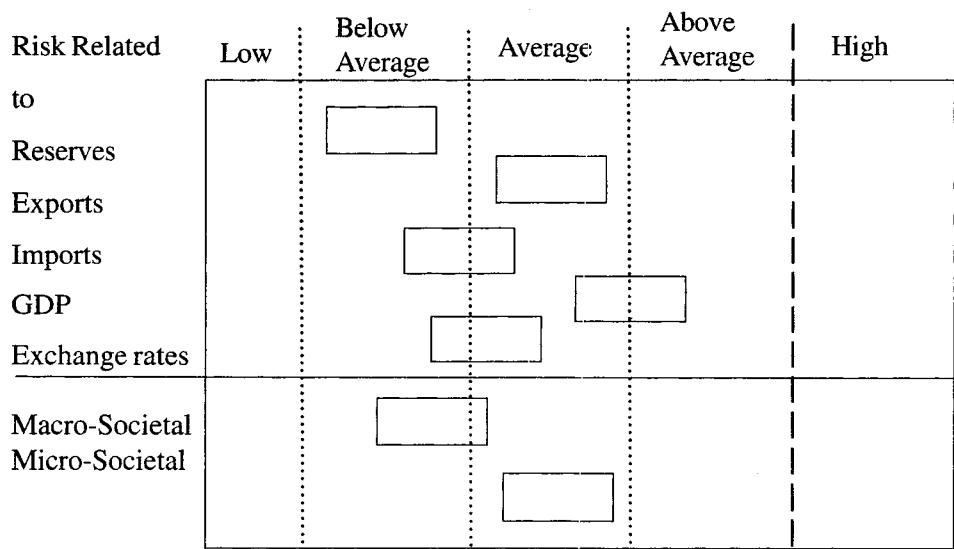


Figure 4. Outcome of Fuzzy Analysis



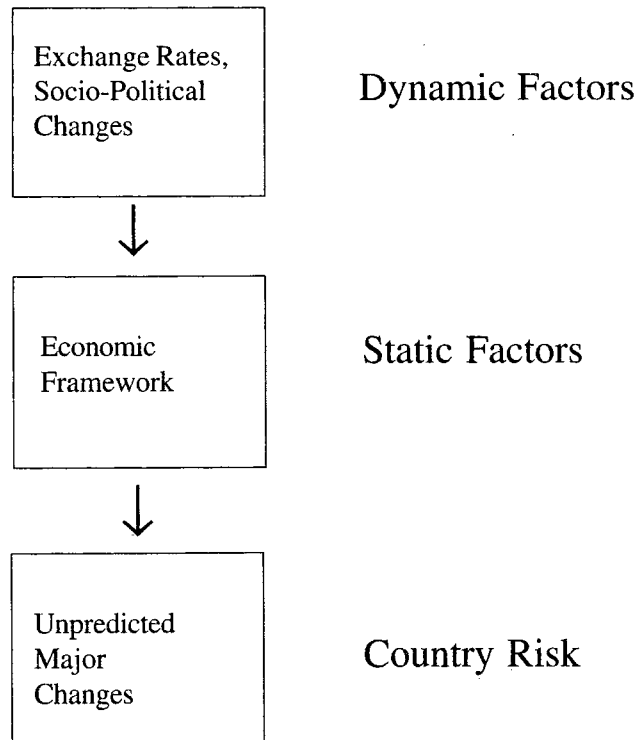
Total Estimated Country Risk: \_\_\_\_\_

The static factors fluctuate relatively slowly and generally are affected by the long-term plans and activities of the country. The changes in these factors affect the economy and social/political situations in the long term and their effects in short run can be ignored. Some of these types of factors are exports, imports, GDP, and reserves. On the other hand, dynamic factors fluctuate very fast, are affected by short-term plans and decisions, and usually affect the economy of a country quickly and rather dramatically. Some of these factors are exchange rates, political changes, decisions on exchange/interest rates, taxes, etc., and social changes (Figure 5). According to Reeb et al. (1998), there is a highly significant positive relationship between globalization and a multi-national corporation's systematic risk, due to foreign exchange risk, political risk, etc.

Additional debt has become a very important parameter for defining the country risk. Recent history shows that debt has played a major role in triggering unexpected crisis and being responsible for fluctuations in economy as well as in social/political conditions. Although debt is a static factor, it is different from exports, reserves, and other similar factors due to its feedback power. A crisis of confidence in any country translates into pressure on the exchange rates (a dynamic factor) which forces devaluation of the currency. The devaluation will lead to potential debt-servicing difficulties with unhedged foreign currency borrowings, weakening the country's economy and ultimately dramatically increasing its sensitivity to dynamic factors.



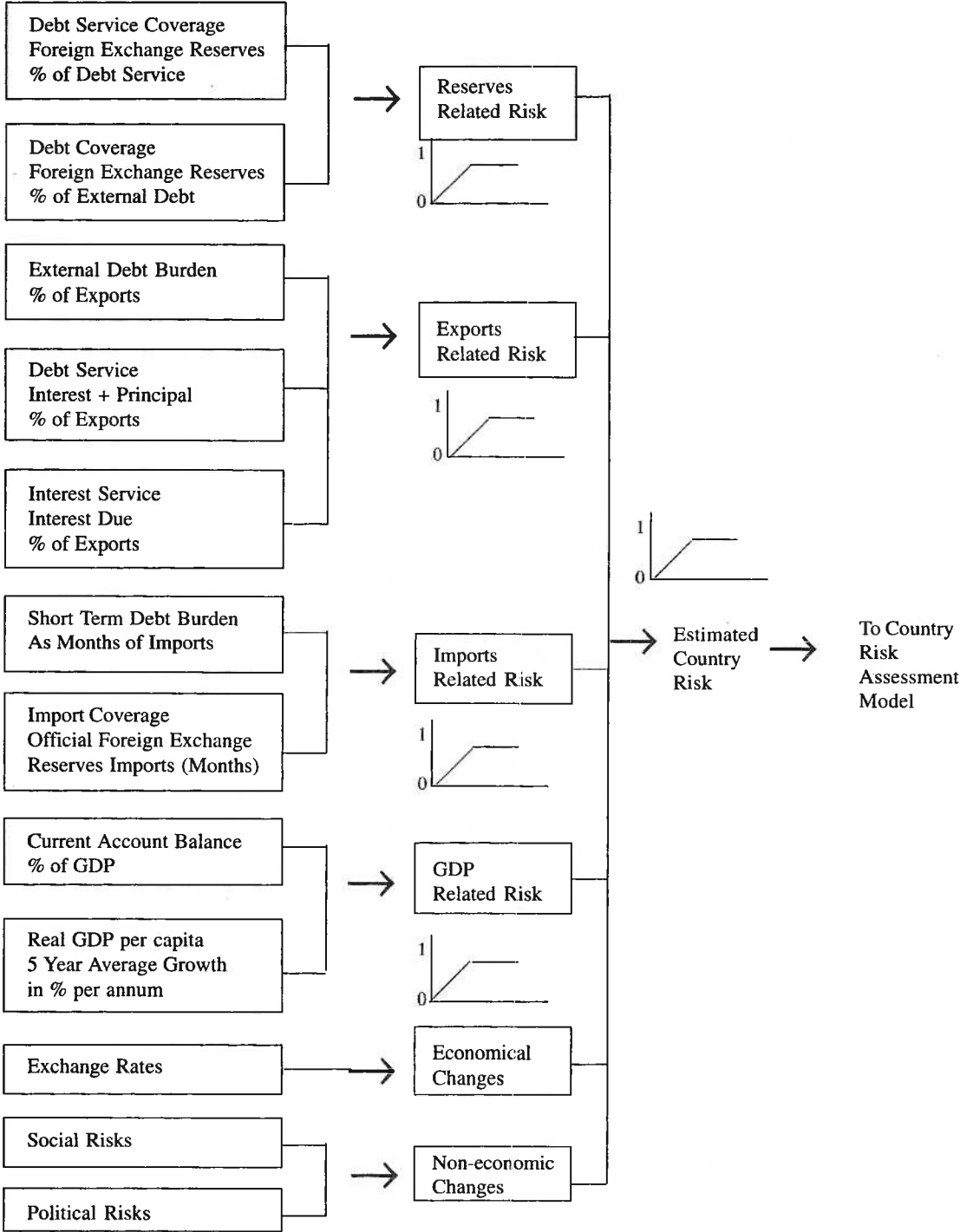
**Figure 5. Basic Static-Dynamic Factors for Country Risk Analysis**



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In order to appropriately incorporate this feedback characteristic of debt on the set of static factors, the economic risk assessment and prediction model is based on debt-ratio parameters such as external debt as percent of exports, short-term debt as months of imports, reserves as percent of debt service (Figure 6). The model is able to predict the country risk both based on fuzzy input data relating to dynamical factors and on the exact (crisp) data about static factors. Both of the components of this risk assessment model – economic and socio-political – are described below.

**Figure 6. Decision Framework for Risk Assessment and Prediction  
(Economic Assessment)**



## ECONOMIC ASSESSMENT

The economic risk assessment component of the model analyzes risk in four major categories: Export-related risk, import-related risk, reserves-related risk, and GDP-related risk. A fuzzy rule-based approach is used to ascertain various types of economic risks. The model utilizes two sets of rules, one set to determine the risk within each of the risk categories discussed above and the second set of rules helps determine the total country risk using the risk ascertained in each category. Given below is an example set of rules that are used for evaluating economic country risk.

- [RI1] If short-term debt burden [STDB] as months of imports is *small* then the import-related risk [IRR] is *low*
- [RI4] If import coverage [IMCO] in months of imports is *large* then the import-related risk [IRR] is *low*
- [RG4] If real GDP per capita (RGPC) growth per year is *high* then the GDP-related risk [GRR] is *low*
- [RT1] If export-related risk [ERR] is *high* then the country risk [CR] is *high*

The major strength of the fuzzy reasoning approach is its capability of processing either fuzzy inputs (such as "the risk of strikes is medium") or exact values for ratios (like, "GDP/Debt = .8"). Thus, this model can be utilized in absence of available exact data as long as the user is able to provide some fuzzy values for the ratios. Therefore, users can use the model for prediction of country risk if they are able to predict the values for various ratios approximately.

The fuzzy reasoning approach can be summarized as follows:

1. If exact values for any ratios are provided, convert them to fuzzy values (fuzzification).
2. For each category of risks (e.g., export-related, import-related, etc.), find the risk level using min-max method of implication. The advantage of using the min-max principle is that only those ratios will contribute to the risk level that are above a certain level during reasoning process. Defuzzify the values received at this stage.
3. Using the risk level from each category, apply the scalable monotonic chaining method of reasoning to determine overall country risk.
4. The first three steps deal with the static factors. To combine the results of the above processing with the dynamic factors, the authors have developed a set of rules as shown in the decision matrix.

## SOCIO-POLITICAL ASSESSMENT

Socio-political assessment is a major category of country risk analysis and prediction. It is a result of thorough consideration of factors that affect and continuously reshape the social environment of a country by emphasizing the causal relationships with the dynamics of political

instability. A systems approach looks at two aspects of evaluation attributes: the macro-environment and the micro-environment. The study of the macro-environment focuses on the relationships between societal and governmental characteristics. The former category includes such social dynamical attributes as revolutionary activities, cross-national guerilla wars, boycotts, religious turmoil, international terrorism, etc. The latter category consists of government dynamics, like nationalization/expropriation, interest rates, political corruption, leadership struggles, and nuclear/convention war among others. The study of micro-environment focuses on the same attributes but in a qualitative level of focused and target actions. The systemic decision framework of the assessment attributes used as evaluation criteria is shown in Figure 7. It reflects the complexities associated with the combinatory dynamics of nowadays' socio-political engineering.

The assessment methodology followed here consists of a step-by-step approach as follows: a) selection of appropriate risk attributes as evaluation criteria, b) development of the relative importance of the attributes by means of a systemic study, and c) computation of the socio-political assessment index by fuzzification and defuzzification of the attributes. A complete review of the indices and assessment methods that are most widely used can be found in Buckhans and Meyer (1986).

## **SOCIO-POLITICAL EVALUATION ATTRIBUTES**

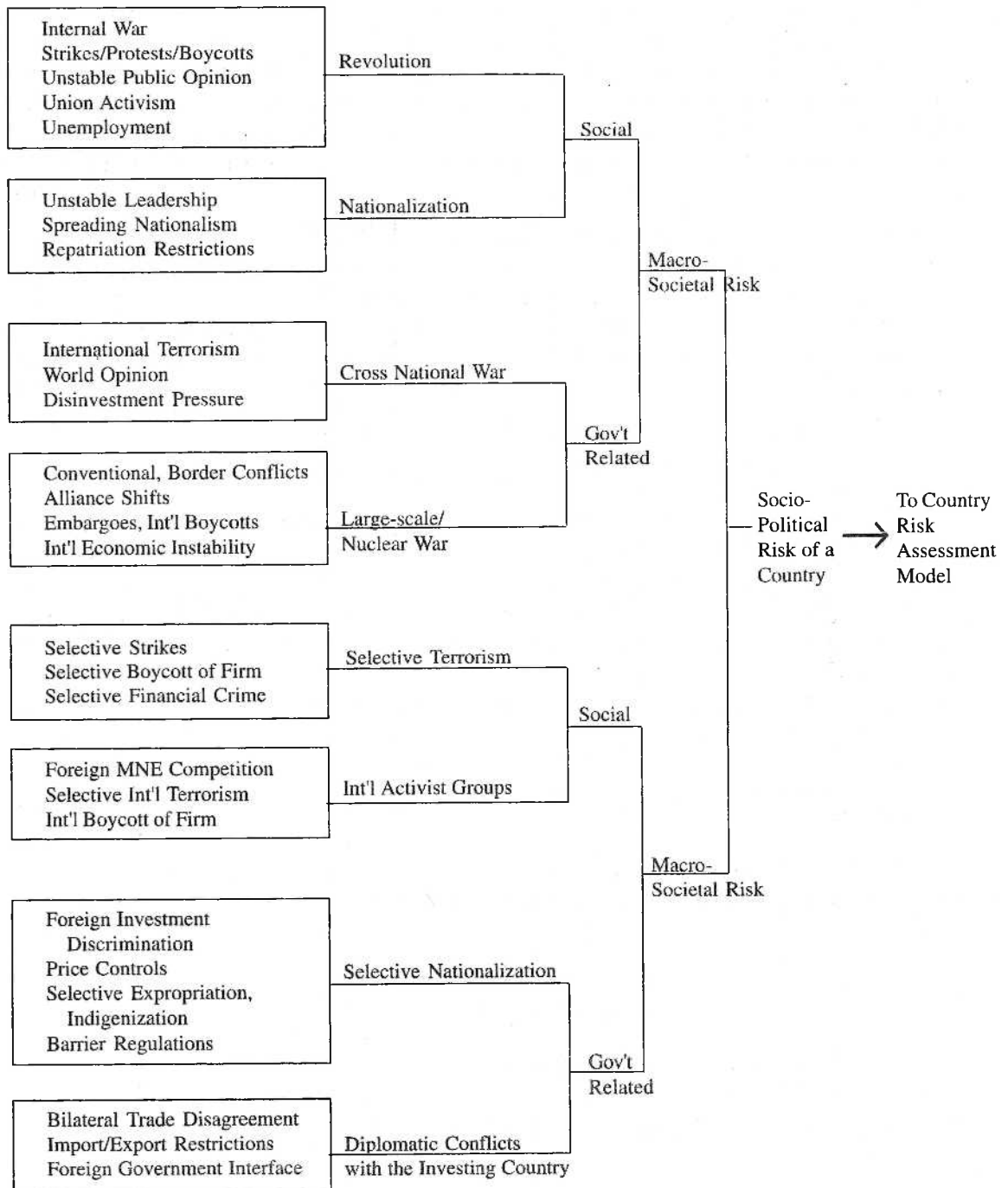
The complexities of modern socio-political environments were initiated in the first years of this last decade of the century when the outlines of a new world order emerged with astounding speed and in rapid succession. Now, at the end of the century, the exact shape of this world order remains unclear and large zones of the world endure a state of latent or manifest upheaval and social unrest. The main characteristics of the expression of modern social turmoil are its unexpectedness, the fact that they happen quickly, lasting rarely more than a few days, and leave no visible forms of organization. In some cases they are more of a catharsis for accumulated anger and frustration than a coherent form of struggle. Though very violent and pervasive, they are relatively easy to control. However, a current social turmoil that gives rise to violence, in association with a framework of economic disturbances, has the likelihood of having the state lose its legitimacy.

The following sections discuss briefly the main approach, along with the past research, adopted in this paper to develop the logical reasoning method for evaluation of the above mentioned factors.

## **MACRO-SOCIETAL FACTORS**

The macro-societal factors comprise socio-political outcomes of turbulence such as coup d'etats, riots, strikes, protests, or ethnic/religious turmoil among others. This form of social conflict is an extreme result of dysfunction among the different sectors of the society and very often,

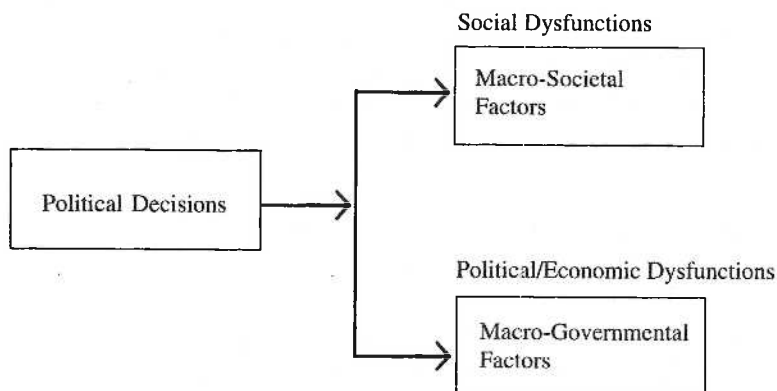
**Figure 7. Decision Framework For Risk Assessment and Prediction  
(Socio-Political Assessment)**



social inequality appears to be its main cause. In Latin America, wealth and income gaps, already the highest in the world in the 1970s, widened dramatically in the 1980s, and have continued to increase even with the resumption of growth in the 1990s. The ratio of average income of the richest country in the world to that of the poorest has risen from 9 to 1 at the end of the nineteenth century to at least 60 to 1 today. For further discussion of this equality issue, the reader is referred to Gosta Esping-Andersen (1990), David Landes (1998), and Nancy Birdsall (1995). Michael Bruno, Martin Avallion, and Lyn Squires (3) have analyzed and interpreted large amounts of data related to the effects of inequality in several areas of the world. Another study of inequality focusing on East Asia has been done by Nancy Birdsall, David Ross, and Richard Sabot (4) of the World Bank.

Globalization requires liberalization on the part of less developed countries. This, in turn, puts a fiscal squeeze on these countries either in the form of difficulty in raising revenues or increase in need for public spending, or both (Grunberg, 1998). The globalization and transnationalization of feeble economies in alliance with a limited democracy has made countries more vulnerable to economic cycles. When the impact of this association is detrimental enough, countries sunk in massive layoffs, salary reductions, increase of marginality, and other sequels that reduce and channel social expression through violent forms of actions. Ethan Kapstein (1996) has studied this impact of globalization on wage inequality, income distribution, and unemployment. For a discussion of convergency, i.e., whether poor countries are catching up to their rich counterparts, the reader is referred to Jeffrey Williamson (1996) and Lant Pritchett (1996). An analysis of current reform status of China's state-owned enterprises is presented in great detail by Aimin Chen (1998). Most firms seem to be reluctant to accept the challenges of the market forces and to change the fundamentals of socialist enterprises. The potential risks of layoff of 15

**Figure 8. Relationship between Factors and Dysfunctions**



million of 76 million workers that state enterprises employ in the metamorphosed China, is analyzed by Neil Hughes (1998).

Ethnic and religious turmoil is becoming, increasingly, a factor of social risk in many countries, especially in traditional societies undergoing political and/or economic troubles. A classic introduction and contemporary issues related to the study of ethnic conflicts, genocidal wars, tribal, and religious struggle can be found in the works of Donald Horowitz (1985), Ted Robert Gurr (1995), and Neal Ascherson (1995). An account of government terrorism in Algeria is elucidated by Lahouari Addi (1998). A thorough academic analysis and personal observations on a whole range of topics and problems that modern India confronts, e.g., caste, religion, and economics, is presented by Shashi Tharoor (1997). A study on Latin American societies with lives of their own, rich in contradictions and conflicts, can be found in Mark Falcoff (1998). Projections of macro-societal factors unfolded in future scenarios that ponder instabilities, overpopulation, widening wage disparities, and rising religious intolerance, are developed by Eugene Linden (1998).

## MACRO-GOVERNMENTAL FACTORS

These attributes represent the quality of government of a country as well as the style, orientation, and effectiveness of its administration. It comprises of governmental/political measures such as repatriation restrictions, exchange controls, embargoes/international boycotts, border conflicts, conventional or nuclear war and, more recently, financial-banking crimes among others. As macro-societal factors express dysfunction among different sectors of society, in the same manner this form of government-related attributes reflects, in most cases, extreme utterances of dysfunction among the different political/economic sectors (Figure 8).

Financial-banking crime is an attribute that has played an important role in recent crisis and developments. It is distinctive of bank-dominated financial systems where markets for equity and debt are small and, in consequence, it creates a high potential for systematic under-pricing of loans. Eventually, politicians influence the patterns of bank lending, encouraging excessive borrowing of non-performing loans by firms with preferred access to credit as is the case of state-owned firms in China, the Chaebol in South Korea, those with government connections in Indonesia and Thailand. It is suspected that losses due to fraud, corruption, and other lending irregularities in Chinese banks may be similar to, or worse than, those under Indonesia's former government or in the illegal lending practice South Korean banks used, to funnel hundreds of millions of dollars into politician's pockets.

The common elements leading to financial-banking crime are inadequate central bank independence and lax regulation of commercial banks. Another important characteristic worth considering is the crucial linkage between real estate and the financial system. Countries such as Thailand, where 8 out of 10 loans at most banks are backed by real estate, or Hong Kong where the fastest growing stocks are property based, illustrate well this form of financial-banking deformities. In Malaysia, a country that exhibits the same negative linkage between real estate and

financial systems, slowing construction is causing a spike in unemployment. In most of the Asian countries, the real estate bubble has yet to deflate fully. Peter Hatcher (1998) has presented a broad account of current crises in Japan's financial system. "The East Asian Miracle" from World Bank (1993) explains the financial and real estate structure of the most export-push Asian economies. An excellent description of China's emerging market and its impact on land and housing development is provided by Conghua Li and Pat Lonconto (1998) and, also, perspectives of Chinese transition are presented by Cheng Li Lanham (1997), Nicholas Lardy (1998), and Joshua Cooper Ramo (1998).

## AN ILLUSTRATION

### Socio-Political Assessment

In order to assess the socio-political environment of a country, we should estimate the risk of revolution, nationalization, cross-national war, etc., as well as to consider each of the other sub-factors depicted in Figure 7. The user needs to provide a series of answers relating to these sub-factors by indicating whether existence of the sub-factor is low, medium, high, or unknown. The system will ascertain risk level for each factor based on the answers given for each sub-factor using the expert knowledge (Figure 9). For example,

*If strikes/boycotts/protests are occurring at a level Medium*

*And Union activism in the country is High*

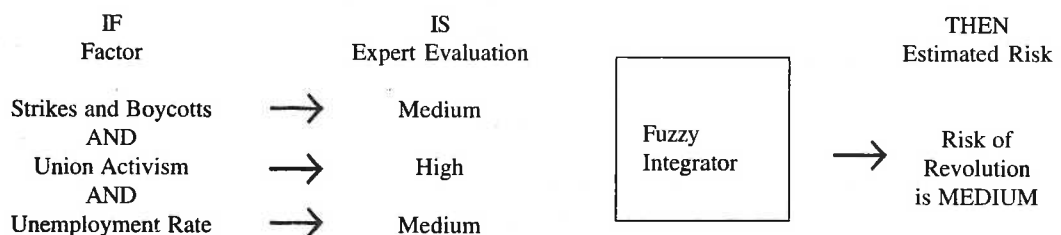
*And the unemployment rate is Medium*

*Then the risk of revolution is Medium*

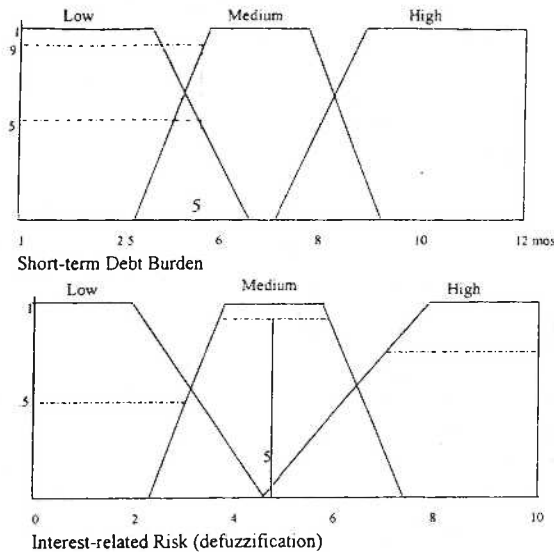
*Then the risk of revolution is Medium*

Once the values of each factor (revolution, nationalization, cross national war, large-scale/nuclear war, etc.) is ascertained, further processing takes place in the same manner as in the economic assessment example that follows.

**Figure 9. Expert System Logic of Socio-Political Risk Assessment**





**Figure 10. Membership Values of Some Factors**

### ***Economic Assessment***

The two variables - short-term debt burden (STDB) and import coverage (IMCO) determine the import-related risk (IRR). Assume that the user provides following inputs for the two variables: (STDB) = 5 months and (IMCO) = 4 months.

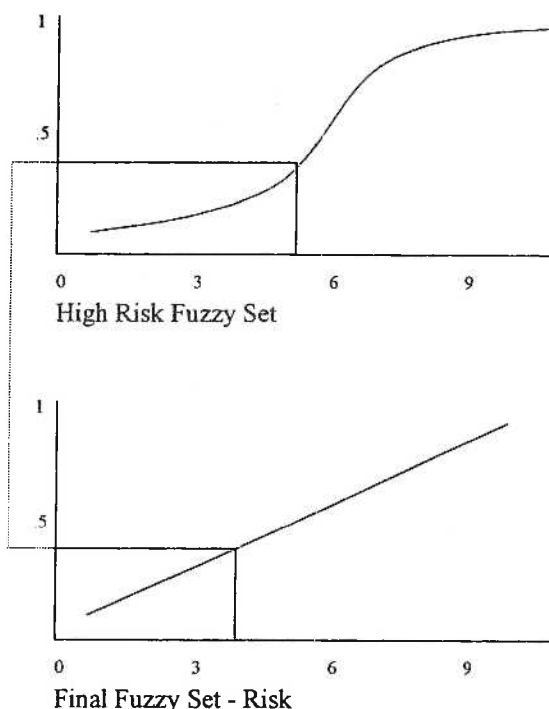
I	II	III	IV	V
Input Variable	Variable Value	Fuzzy Value (Using Figure 10)	Resultant Value for Risk category	Defuzzified Value for Risk category
(STDB) Short-term Debt burden	5 months	medium (.45)		
(IMCO) Import Coverage	4 months	medium (.4)	medium (.45)	is 5

Column IV is obtained using Rules (RI1) to (RI6) and the min-max principle.  
Column V is determined using composite maximum defuzzification method.

Using this information (Figure 10), it is determined that (STDB) is medium (.45) and (IMCO) is medium (.4). After applying Rules (R11) to (R16) and min-max principle, it is concluded that the fuzzy solution set for (IRR) is medium (.45) and thus the value for (IRR) is medium. Using composite maximum defuzzification method, the defuzzified value of risk is 5. This process will

be repeated for other categories of risks. The values determined during the first phase are as follows: (IRR) is 5, (ERR) is 3, (RRR) is 4, and (GRR) is 3. These values are mapped to a standard fuzzy set final risk using monotonic chaining (Figure 11).

**Figure 11. Monotonic Chaining Reasoning Method**



This step is necessary since the shape of each category risk may be slightly different. Once the mapping is performed, the risk is accumulated from each category to compute the composite risk, which will be on a scale of 4 to 40. In this example, the country risk or sensitivity is low; it is 15 out of a maximum of 40. Assuming relatively stable exchange rates and fairly stable political and social conditions in the country, let the exchange rate risk be .3, political risk be .4, and social risk be .3. The dynamic risk is given by the following fuzzy relation: exchange risk  $\vee$  (political risk  $\wedge$  social risk). Applying the fuzzy min and max will obtain the dynamic factors risk equal to .3. Using the matrix in Figure 12, the final prediction is that the country risk is low.

**Figure 12. Fuzzy Rule Base for Risk Prediction**

		1	.8	.6	.4	.2	0
Socio-Political Risk	Economic Risk	Increasing Rapidly	Increasing Slowly	Stable	Decreasing Slowly	Decreasing Rapidly	
	0	Very Low	Low	Low	Very Low	Very Low	Very Low
	.2	Low	Average	Average	Low	Low	Low
	.4	Average	High	Average	Average	Average	Average
	.6	High	Very High	Very High	High	High	High
	.8	Very High	Very High	Very High	Very High	Very High	Very High
	1						

### ***Validation Process***

One of the important steps in the design of a decision support tool is validation and verification. In the design of Country Risk Assessment system, validation and verification was given a high priority. At each step of the design, the authors went back and verified the logic used in the step several times. The authors also used a comprehensive approach to validation of this system. It included two major efforts as described below. First of all, the general framework of prediction using socio-political and economic factors was distributed to several experts in the industry and in major financial institutions and a review of factors was invited. Based on their reviews certain minor adjustments were made to the attributes and their weights.

Secondly, all the necessary data was collected regarding two important countries with concrete values - Argentina and China. Both countries exhibit different levels of uncertainty, ambiguity, and contradiction in data/knowledge representation, imprecision, and noise which makes them good candidates for the validation of this fuzzy model. Although the countries differ from each other substantially, same attributes could be used provided adjustments are made by using different sets of weights.

Argentina is in the process of a wholesale restructuring of its economy and the reforms have not yet transformed popular expectations for progress. As time elapses, the credibility of the reforms is eroding and the social unrest is increasing. On the other hand, Chinese leadership has also embarked on a daunting transition that has not yet found solution to the problems of money-losing state-owned enterprises, failing banks, and real estate bubbles. The reform program is fraught with risks due to the unprecedented unemployment rate and the external pressure to liberalization on his domestic financial markets. Moreover, the transition has unfavorable external conditions due to the drastic Asian financial crises that have affected countries with many of the same structural problems as those of China. Despite the \$225 billion received in foreign capital by the end of 1997, and its huge foreign exchange reserves large enough to finance a full year of imports, China still is considered volatile because of the common factors leading to fraud, corruption, political influence, and lax regulation of commercial banks.

The above discussed data relating to these two countries was then applied on the model to obtain specific assessment. The results of the model matched with the risk level predicted by the industry experts for the two countries.

## **CONCLUSIONS**

In this paper, the authors have developed a fuzzy logic model for assessment and prediction that uses static and dynamic factors and provides a systematic approach to analyzing a target country. The model includes an extensive framework that helps in acquiring relevant social, political and economic data that is essential for the analysis. Additionally, the model uses a methodology that provides guidance to information gathering and processing.

The major advantages of the approach discussed in this paper are evaluation of a vast array of factors from various significant areas of the target country's environment that includes eco-

conomic, political, and social indicators, and additionally, the ability of the model to handle both exact (crisp) and fuzzy data at the same time. Another major benefit of the model is its robustness. By a simple adjustment of weights, it can be applied to very distinct countries as well as for assessment in the short, medium, or long range.

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