

**A REGIONAL COOPERATION TO SUPPORT
FINANCIAL CRISIS MANAGEMENT
AND PREVENTION: AN APPLICATION
OF A MODEL WITH UNCERTAINTY
AND FEEDBACK INFLUENCES**

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Managing financial sector under a liberalized system is always difficult; it faces a risk of financial crisis. Financial managers in most emerging markets, be it in the corporate, banking or public sector, have experienced such a challenge, and those in East Asia have learned the hard lesson during the 1997–98 financial crisis. Although efforts have been made to restructure the domestic financial sector by imposing a better risk analysis, in a world of free capital flows there is no guarantee that the system can be totally impervious to a crisis. This implies that financial managers will continue to face a major challenge in terms of how to manage and prevent a financial catastrophe. They have given a particular attention to a possible cooperation with one another. In the case of East Asia, this will lead to the formation of a Regional Financial Arrangement (RFA). This study analyzes this process by focusing on the search for a particular form of RFA that would enable financial managers to better deal with the challenge of a crisis and prevent it whenever possible. Given the fact that the issue and the process of forming a regional cooperation/arrangement involves not only economic considerations but also political factors and other intangibles, a specific model known as the Analytic Network Process (ANP) is employed. It is revealed that financial managers and policy makers alike should not only consider the benefits and costs of each alternative form of RFA, but also the possible risks and opportunities

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that may arise. The extent to which financial managers will be able to cope with the challenge of a financial crisis depends on all these factors.

Keywords: Regional financial arrangement, Uncertainty, Managing crisis, Network, Feedback, Ratio scale, Analytic hierarchy process

A new regionalism in East Asia has been marked by the proliferation of formal regional economic arrangements. Compared to the more market-driven and informal arrangements of the past, the recent ones are more formal covering issues beyond preferential tariffs, removal of tariffs, and elimination of other trade regulations, to include standards, investment and finance. Various developments have impelled this new regionalism. The slow progress of WTO, the China factor, and the growing sense of community combined with a strong interest among business communities to access foreign markets and capital are among the important reasons. But the most important event that triggered the heightened interest among financial managers and policy makers alike for a closer regional cooperation was the 1997/98 financial crisis. There has been a strong desire to develop a regional self-help financial networking.¹

Realizing the strong need to stabilize financial sector and the exchange rate—e.g., defending local currency should it be under a speculative attack, on May 2000 political leaders and public and private financial managers in the region declared a new initiative known as the *Chiang Mai Initiative* (CMI). It includes ASEAN countries plus Japan, People's Republic of China (PRC), and Korea (hence the term “ASEAN+3”). The CMI goes beyond just expanding the common and bilateral swap arrangements. Focusing on a closer cooperation and aspiring for a concrete regional financial arrangement, it also stipulates the need for cooperation in regional surveillance and monitoring, particularly of capital flows.

The emerging question is: what would be the preferred form of cooperation? More specifically, what form of *Regional Financial Arrangement* (RFA) would be most suitable for achieving the stability of financial sector and for coping with the challenge of a financial crisis? Obviously, this involves a complex decision that includes not just economic rationales but also political and other considerations.

This paper focuses on the efforts of the region's financial managers and policy makers alike to establish a regional financial arrangement by exploring various issues and factors that need to be considered in the establishment of such an arrangement. By employing a specific decision making model, attempts are subsequently made to demonstrate how the complex interrelations among those factors are synthesized. The next Section discusses the model.

¹The early proposal initiated by Japan to set up an *Asian Monetary Fund* (AMF) was shelved because of strong rejection from the United States and the IMF, both of which argued that such an arrangement would create a double standard and worsen the moral hazard problem. Hitherto, however, regional arrangements similar to AMF exist elsewhere, e.g., the *Latin American Reserve Fund* (LARG) established in 1991, and the *Arab Monetary Fund* set up after the first oil boom in 1970s. The episode, however, did not stop the region from pursuing its efforts to strengthen the cooperation.

Decision Making Models: From Hierarchy to Network

Decision making is a process involving complex interrelations in ill-structured situations, possessing multiple (usually competing) objectives and uncertainty concerning outcomes. The intent of the decision making process is to provide decision makers with insight into their preferences as they relate to the relative priority they place among objectives, criteria, a set of sub—criteria, constraints, and alternative policies.

Four major stages are involved in the process: (1) structuring the problems; (2) selecting an appropriate approach or model to deal with the structured problems; (3) synthesizing outcomes generated by the model; and (4) exploring the uncertainty in the computed results of stage 2 through sensitivity analysis. In stage 2, the focus is on developing prescriptive model (endogenizing policy variables), among others through elicitation techniques. This is intended not only to enhance human judgment but also to improve the quality of the decision itself. The multi-dimensional nature of decision making necessitates decision makers to apply techniques rooted in other disciplines to enhance the robustness of the model and the model development process, including brainstorming techniques that have their intellectual roots in the psychological and business administration literature.

One of the most difficult facts in dealing with decision making problems is the presence of uncertainty concerning events and people's perceptions. Indeed, the ability to address uncertainty is an essential tenet of decision making. Analysts' response to such a challenge is usually to undertake a sensitivity analysis through an iterative process.² But uncertainty is also often associated with intangibles, e.g., political, psychological, and emotional factors. This suggests that an appropriate decision making model should ideally be capable of incorporating those intangibles in an explicit and quantitative manner so that the tradeoffs that will arise can be analyzed in a more concrete way.

Hierarchy

A good decision making model does not just easily place and populate variables (or elements) with statistical data, but also ensures that those variables represent decision makers' objectives and that the key variables affecting outcomes with respect to those objectives captures the critical relationships among all other relevant variables. One way to structure such relationships is by placing all variables in a hierarchy, in which objectives determine criteria and criteria determine policies. A decision maker will probe for these relationships and select a tool that is consistent with the prevailing conditions.

One of such hierarchical models, known as the *Analytic Hierarchy Process* (AHP), uses relative measurements, particularly ratio scales, which are derived

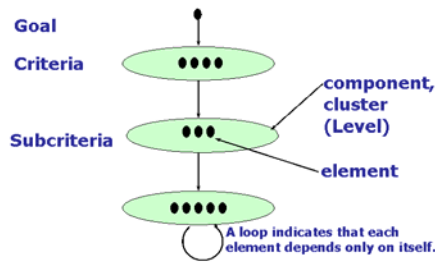
²Outcomes and insights obtained from sensitivity analysis might cause decision makers to reassess their value judgments; likewise, disciplined thinking about norms, values and excluded factors might stimulate the identification of new criteria, constraints and alternatives.

from paired comparisons.³ The basic specification of AHP is described in the Appendix.

Network

A hierarchical model does not recognize two-way dependence relationships that exist among variables, or how to compensate for those conditions in a decision making model. Consequently, an alternative model that allows one to deal systematically with *dependence* and *feedback* (i.e., counterpart of the influence diagram in statistical decision analysis based on Bayes theorem) is needed.⁴

Figure 1
Linear Hierarchy



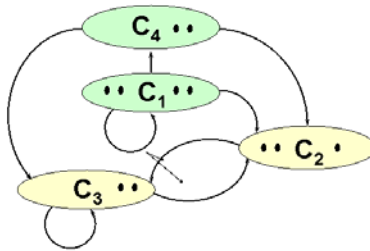
With feedback, the alternatives can depend on the criteria as in a hierarchy but they may also depend on each other. The criteria themselves can depend on the alternatives and on each other as well. Hence, it involves a network rather than a hierarchy. With such a feature, it is expected that the results from a network model is more stable because one can consider the influence on and survival in the face of other influences.

Figures 1 and 2 show the difference between a hierarchy and a network. Note that the term “level” is to be substituted by “cluster” in a network, and the terms “elements” and “nodes” are interchangeable. In Figure 2 the parent node or *element* and the nodes to be compared can be in different *clusters*; e.g., a directed link appears from the parent node cluster C4 to the other clusters (C2 and C3). This is the case of *outer dependence*. In other cases, the parent node and the nodes to be compared can be in the same cluster, in which case the cluster is linked to itself and a loop link appears. This is called *inner dependence*.

³Ratio scales are a fundamental kind of number amenable to performing the basic arithmetic operations of addition and subtraction within the same scale, multiplication and division of different scales, and combining the two operations by meaningfully weighting and adding different scales to obtain a unidimensional scale. Hence they are very useful to capture perceptions in a decision making model (Azis, 1990; Azis & Isard, 1996).

⁴Feedback is desirable because it enables people to factor the future and likely impact into the present event in expressing their perceptions to determine what to do and what course of action to take to attain a desired future.

Figure 2
Feedback Network



While in AHP a set of pairwise comparison matrices are used, the presence of feedback influences in a network model requires a large matrix known as *supermatrix* containing a set of sub—matrices. This supermatrix should capture the influence of elements in a network on other elements in that network. Denoting a cluster by C_h , $h = 1, \dots, m$, and assuming that it has n_h elements $e_{h1}, e_{h2}, e_{h3}, \dots, e_{hn_h}$, Figure 3 shows the supermatrix of such a hierarchy:

Figure 3
Supermatrix of a Hierarchy

$$W = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_{N-2} & C_{N-1} & C_N \end{matrix} \\ \begin{matrix} C_1 \\ \vdots \\ C_2 \\ \vdots \\ \vdots \\ \vdots \\ C_N \end{matrix} & \begin{bmatrix} \begin{matrix} c_{11} & \dots & c_{1n_1} & c_{21} & \dots & c_{2n_2} \\ \vdots & & \vdots & \vdots & & \vdots \\ 0 & 0 & & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ W_{21} & 0 & & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & W_{32} & & \dots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & & \dots & W_{n-1, n-2} & 0 \\ 0 & 0 & & \dots & 0 & W_{n, n-1} & I \end{matrix} \end{bmatrix} \end{matrix}$$

When the bottom level affects the top level of the hierarchy, a form of network known as *holarchy* is formed, the supermatrix of which will look like the one displayed in Figure 4.

Notice that the entry in the last row and column of the supermatrix in Figure 3 is the identity matrix I corresponding to a loop at the bottom level of the hierarchy. This is a necessary aspect of a hierarchy viewed within the context of the supermatrix. On the other hand, the entry in the first row and last column of a

hierarchy in Figure 4 is nonzero, indicating that the top level depends on the bottom level.⁵

Figure 4
Supermatrix of a Hierarchy

$$W = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_{N-2} & C_{N-1} & C_N \end{matrix} \\ \begin{matrix} C_1 \\ \vdots \\ C_2 \\ \vdots \\ \vdots \\ \vdots \\ C_N \end{matrix} & \begin{bmatrix} \begin{matrix} e_{11} & \dots & e_{1n_1} & e_{21} & \dots & e_{2n_2} & \dots & e_{(N-2)1} & \dots & e_{(N-2)n_{N-2}} & \dots & e_{(N-1)1} & \dots & e_{(N-1)n_{N-1}} & \dots & e_{N1} & \dots & e_{Nn_N} \end{matrix} \\ \begin{matrix} 0 & 0 & \dots & 0 & 0 & W_{1,n} \end{matrix} \\ \begin{matrix} W_{21} & 0 & \dots & 0 & 0 & 0 \end{matrix} \\ \begin{matrix} 0 & W_{32} & \dots & 0 & 0 & 0 \end{matrix} \\ \vdots \\ \begin{matrix} 0 & 0 & \dots & W_{n-1, n-2} & 0 & 0 \end{matrix} \\ \begin{matrix} 0 & 0 & \dots & 0 & W_{n, n-1} & 0 \end{matrix} \end{bmatrix} \end{matrix}$$

Figure 5
Supermatrix of a Network

$$W = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_N \end{matrix} \\ \begin{matrix} C_1 \\ \vdots \\ C_2 \\ \vdots \\ \vdots \\ \vdots \\ C_N \end{matrix} & \begin{bmatrix} \begin{matrix} e_{11} & e_{12} & \dots & e_{1n_1} & \dots & e_{21} & e_{22} & \dots & e_{2n_2} & \dots & e_{N1} & e_{N2} & \dots & e_{Nn_N} \end{matrix} \\ \begin{matrix} W_{11} & W_{12} & \dots & W_{1N} \end{matrix} \\ \begin{matrix} W_{21} & W_{22} & \dots & W_{2N} \end{matrix} \\ \vdots \\ \begin{matrix} W_{N1} & W_{N2} & \dots & W_{NN} \end{matrix} \end{bmatrix} \end{matrix}$$

The entries of sub—matrices in W_{ij} are the ratio scales derived from paired comparisons performed on the elements within the clusters themselves according to their influence on each element in another cluster (outer dependence) or

⁵ In general, when feedback influences are present as in Figure 2, the supermatrix is formed by laying out all the clusters and all the elements in each cluster both vertically on the left and horizontally at the top as in Figure 5.

elements in their own cluster (inner dependence).⁶ The resulting *unweighted supermatrix* is then transformed into a matrix each of whose columns sums to unity to generate a stochastic supermatrix. The derived weights are used to weight the elements of the corresponding column blocks (cluster) of the supermatrix, resulting in a *weighted supermatrix* which is also stochastic. The stochastic nature is required for the reasons described below.

The typical entry of the Figure 5 supermatrix is:

Figure 6
Entry in the Supermatrix of a Network

$$W_{ij} = \begin{bmatrix} W_{i1}^{(j_1)} & W_{i1}^{(j_2)} & \dots & W_{i1}^{(j_{n_j})} \\ W_{i2}^{(j_1)} & W_{i2}^{(j_2)} & \dots & W_{i2}^{(j_{n_j})} \\ \vdots & \vdots & \ddots & \vdots \\ W_{in_i}^{(j_1)} & W_{in_i}^{(j_2)} & \dots & W_{in_i}^{(j_{n_j})} \end{bmatrix}$$

Since an element can influence the second element directly and indirectly through its influence on some third element and then by the influence of the latter on the second, every such possibility of a third element must be considered. This is captured by squaring the weighted matrix. But the third element also influences the fourth, which in turn influences the second. These influences can be obtained from the cubic power of the weighted supermatrix. As the process is performed continuously, one will have an infinite sequence of influence matrices denoted by W^k , $k = 1, 2, \dots$. The question is, if one takes the limit of the average of a sequence of N of these powers of the supermatrix, will the result converge, and, is the limit unique?

It has been shown that such a limit exists given the stochastic nature of the weighted supermatrix (Saaty, 2001). There are 3 cases to consider in deriving W^k : (1) $\lambda_{max} = 1$ is a simple root and there are no other roots of unity in which case given the nonnegative matrix W is *primitive*, we have $\lim_{k \rightarrow \infty} W^k = we^T$, implying that it is sufficient to raise the primitive stochastic matrix W to large powers to yield the limit outcome; (2) there are other roots of unity that cause cycling, in

⁶If the clusters influence and be influenced by other clusters, paired comparisons on the clusters are to be made as well. Like AHP, in a network model judgments are also elicited, from which ratio scales are derived.

which case Cesaro sum is applied⁷; and (3) $\lambda_{max} = 1$ is a multiple root, in which case the Sylvester's formula with $\lambda_{max} = 1$ is applied.⁸

In practice, however, one simply needs to raise the stochastic supermatrix to large powers to read off the final priorities in which all the columns of the matrix are identical and each gives the relative priorities of the elements from which the priorities of the elements in each cluster are normalized to one. The powers of the supermatrix do not converge unless it is stochastic, because then its largest eigenvalue is one. When a convergence is failed to achieve (a cyclic case) the average of the successive matrices of the entire cycle gives the final priorities (Cesaro sum), in which the limit cycles in blocks and the different limits are summed and averaged and again normalized to one for each cluster.⁹ At any rate, raising the stochastic supermatrix to large powers gives what is known as *limiting supermatrix*.

Hence, there are 3 supermatrices to be used: (1) the original unweighted supermatrix of column eigenvectors obtained from pair wise comparison matrices of elements; (2) the weighted supermatrix in which each block of column eigenvectors belonging to a cluster is weighted by the priority of influence of that cluster, rendering the weighted supermatrix column stochastic; and (3) the limiting supermatrix obtained by raising the weighted supermatrix to large powers.

Searching For a Regional Financial Arrangement

The overall objectives of establishing RFA are: (1) to minimize the exchange rate volatility (*ER Stability*), (2) *Strengthening Financial Sector*; and (3) to *Avoid Contagion*. In scrutinizing the various factors affecting RFA, the specific goals are: *Crisis Prevention* and *Crisis Management*, and the three alternative forms of RFA to be explored are: (1) RFA with common exchange rate basket system (*RFA—CommER*), (2) RFA without common basket system (*RFA—NoCommER*), and (3) RFA that neither specifies nor targets an exchange rate regime (*RFA—NoER*).

Each of those RFA forms needs to be evaluated based on its BOCR, i.e., benefits (B) and opportunities (O) it can create, as well as the costs (C) and risks (R). Hence, our task is to identify the elements under each component of BOCR.

Benefits and Opportunities

We begin with the benefit (B) component. In the search for RFA, a real fundamental question to ask is: why does the region need another arrangement, especially given the fact that the IMF has been functioning as a lender of last resort

⁷Cesaro' Summability basically stipulates that if a sequence converges then the sequence of arithmetic means formed from that sequence also converges to the same limit as the sequence (see Saaty, 2001)

⁸James Joseph Sylvester (1814–1897), who was an English poet and great creators of terms in mathematics, developed a mathematical formula that allows limit priorities to be obtained from a *reducible* stochastic matrix W with $\lambda_{max} = 1$ being a multiple root.

⁹In other words, one has to compute the limit priorities of the stochastic supermatrix according to whether it is irreducible (primitive or imprimitive [cyclic]) or it is reducible with one being a simple or a multiple root and whether the system is cyclic or not.

through its *Supplementary Reserve Facility* (SRF) and *Contingent Credit Line* (CCL)?¹⁰ The severity of a crisis such as the one in 1997–98 would require a fast disbursement of a large amount of liquidity. This puts a serious constraint on the IMF to act in a timely manner with sufficient financial resources. This is in addition to the inappropriateness of IMF-recommended policies: while the 1997–98 episode was a capital account crisis, the policies suggested by the IMF were those appropriate for a current account crisis (Azis, 2002). The IMF's global mandate is to provide financial assistance at any time to many member countries, not specifically to countries in a particular region. From this perspective, *Regional-Focus* and *Quick Disbursement* should be among the important criteria. To facilitate quick disbursement when needed without risking moral hazard, soft conditionalities, and low repayment capacity, a system of prequalification is needed (Azis & Woo, 2003).¹¹

The next BOCR component is opportunity (O). The proposal to set up a new RFA provides a set of opportunities. The event in 1997–98 clearly shows that the region's pre-crisis macroeconomic fundamentals were not weak; the fragility was mainly in the financial sector. Unlike the IMF's mandate in overseeing all macroeconomic issues including financial matters, the proposed new arrangement is expected to concentrate only on financial issues. Many of the problems in the financial sector are too complex to be addressed collectively with other macroeconomic issues. The financial sector-oriented nature of the regional arrangement would serve the purpose well; it will provide an opportunity for the member countries to coordinate more intensively activities in this sector, suggesting that *Financial-Focus* to be one of the elements within the opportunity cluster.

There is also an opportunity for the region to conduct a more effective surveillance mechanism and to monitor the development of financial sector (e.g., monitoring capital flows) once a specific RFA is established. Therefore, *Surveillance* element is included in the opportunity cluster. This element is not only necessary for crisis prevention but also commensurate with conditionalities that must be imposed when some members need to get hold of financial resources through the swap mechanism under the new arrangement.

Having RFA would also enable member countries to utilize foreign reserves in a more productive way (hence, *Foreign Reserves* element in the opportunity cluster). It is a basic rule for governments to maintain a level of foreign reserves that exceeds the amount of its outstanding external short-term debt. On the other hand, excessive accumulation of foreign reserves is a waste of valuable financial resources since it involves high opportunity costs (i.e., low US Treasury bonds'

¹⁰This is precisely the issue raised by those opposing the AMF concept in 1998. Can't the stated objectives be acquired by simply making the necessary adjustments to the existing global institutions such as the IMF? Even if a new institution is justified, why shouldn't it be global, not regional, in its focus?

¹¹The merit of a regional-oriented cooperation was evident from the far too small supplementary support from other countries in the region to the IMF program in Thailand and Indonesia in 1997–98 when such a cooperation did not exist.

interest rate compared with high rate of return to domestic capital). RFA could considerably reduce such a waste of resources.

Costs and Risks

The first and perhaps most immediate cost is *Complex Bureaucracy*. This could always arise when a new institution is established. The problem could be aggravated by the fact that the region is heterogeneous. As the experience of other regional cooperation suggests, the problem of bureaucracy will be clearly manifested in *Difficult Coordination* among member countries. Unless clear and concrete cooperative mechanisms are laid out, there will certainly be a serious coordination adjustment problem.

For a more concrete format of financial arrangement, badly needed is a specified target, both on the item and on the deadline for achievement (*Target Specification*). It is very difficult for a new arrangement to be credible if at this stage no specific targets are set. Unfortunately, the region--particularly ASEAN countries--does not have exemplary points in this regard. The principle of non-interference (should the target is not met) may deter the need to designate specific targets. The recovery process, albeit slowly and varies between countries, and the greater interest towards regional trade rather than financial arrangement can have some influence on this matter as well. Uncertainties and fears of failure may also prevent member countries to come forward with certain targets. Last but certainly not least, the "Asian values" glorifying consensus and informality could stand in contrast with explicit target setting.

All the above "costs" can seriously undermine the efforts to meet the original goals. But perhaps the most important cost that could significantly forestall the process is the large amount of financial resources required to make the swap arrangement credible or taken seriously by the financial market (in the model this is labeled *Limited FinResources*). While Japan may be more willing to commit greater amount of resources, the PRC would not necessarily support such a move since it could be viewed as jeopardizing Beijing desire to become the major player in the region. Other member countries such as Singapore and Brunei may also be reluctant to increase the committed amount since they are aware of their position being more of a swap provider than direct beneficiaries in the arrangement.

Indeed, it has been very difficult to raise the amount of swap facility. Even if commitments among the swap providing countries can be strengthened, effectively raises the upper limit of available liquidity, the objection from the IMF remains a serious obstacle (Eichengreen & Bayoumi, 1996). The current *Bilateral Swap Arrangement* (BSA) only allows an immediate disbursement of up to 10 percent of the maximum amount, providing the swap providing countries can agree. Above that amount, the swap requesting countries are required to agree on the IMF program.

There are also some risks involved in the creation of RFA. Obviously, different forms of RFA pose different risks. One of the serious risks is the potential conflict arising due to the fact that some governments have to abide the existing arrangements they had made with other international organizations such as the IMF. The RFA may contain some features not in line with those arrangements. Capital

controls and bail-in program discussed earlier are the noted examples. Given the gap in financial technology and in the number of expertise, the aforementioned conflict could be difficult to avoid. The resulting outcome may be a worsening problem of coordination particularly in making RFA features consistent with those of other arrangements (this risk is labeled *DomCoordination* in the model).

There are also risks of failures due to deep suspicions among member countries. This could arise because of the *Heterogeneity* factor. However, many would agree that the most serious risk is the lack of a concrete political integration (*Political* element in the risks cluster). As long as there is no willingness to pool political sovereignty to make room for the creation of regional political institution with real power, any forms of RFA would not be effective. The absence of clear regional leadership and consensus only worsens the situation (related to Japan's feeble economy).

Another important risk is the possibility of a serious *Moral Hazard*. The problem of moral hazard is not only related to the behavior of borrowers (swap recipients), but also to the questionable representation of government officials in power whose interest may be inconsistent with broader interests of the citizens of the country concerned. This classical "principal/agent problem" could be severe when citizens do not fully understand or appreciate the consequences of decisions on complex issues--such as financial matters--that are made in their name. There is also a possible risk of financial support not being repaid. The moral hazard issue in this respect could be related to a situation whereby the financial support was given and used for reasons other than the agreed criteria. There is no question that the moral hazard problem poses a serious risk. On the other hand, some may question whether the RFA's moral hazard would be any more severe than that implied in the context of the IMF presence. What it suggests is, the formulation and enforcement of conditionalities will have to be a critical part of the swap arrangement.

Up to this point I have laid-out all the relevant clusters and elements in the system. Our next task is now applying the ANP model to the system. Figure 7 displays the basic model framework.

The three major objectives of establishing RFA are first pairwise compared. The resulting priority ranking is: *Strengthening Financial Sector* (.72), *ER Stability* (.21), and *Avoid Contagion* (.07). Clearly, the penultimate objective of all the efforts to establish RFA is to strengthen the region's financial sector (see Azis, 2003).

There are three clusters in each component of BOCR: goals cluster, criteria cluster, and alternatives cluster. The element inside the criteria cluster and those within the goals cluster are interdependent. Figures 8 to 11 display the clusters and elements in the network for the benefits, opportunities, costs, and risks.

Similarly, in comparing the alternative forms of RFA with respect to each of the criteria, there is also a feedback effect.

Figure 7
Basic Model Framework

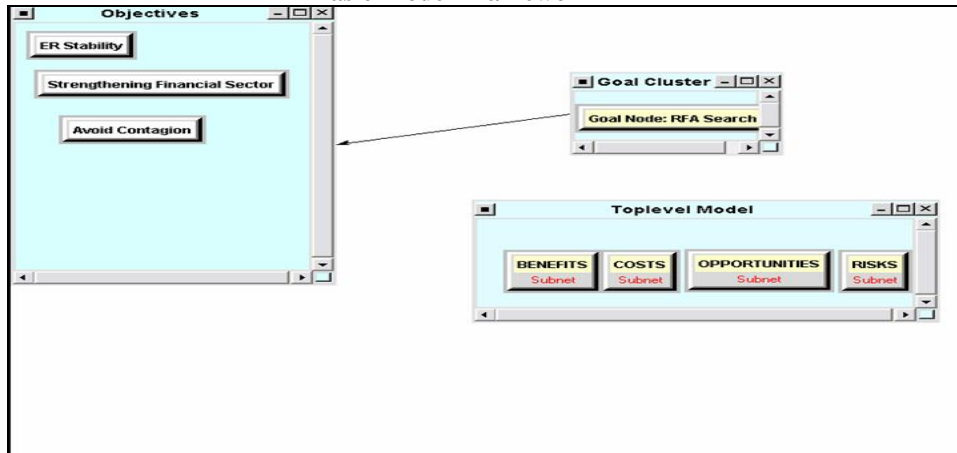
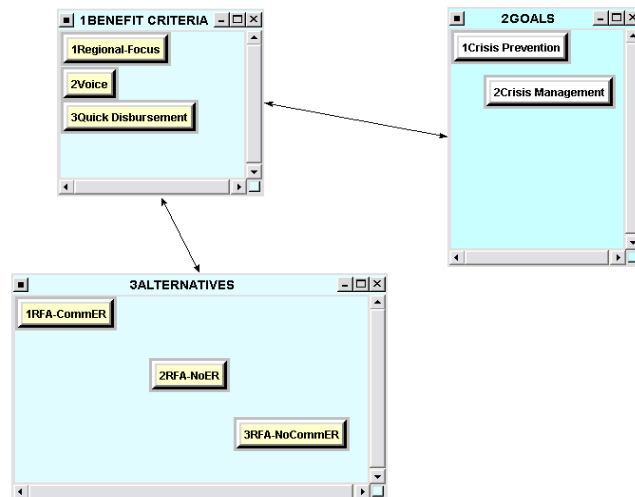


Figure 8
Network of Benefits Cluster



Synthesis

Combining the prioritization results from linking the three clusters yields the relevant weighted and unweighted supermatrices, based upon which the limiting supermatrix is derived (Tables 1 to 4).

Table 1
Limiting Supermatrix for Benefit Cluster

Matrix	1	2	3	4	5	6	7	8
1	.20	.20	.20	.20	.20	.20	.20	.20
2	.06	.06	.06	.06	.06	.06	.06	.06
3	.24	.24	.24	.24	.24	.24	.24	.24
4	.07	.07	.07	.07	.07	.07	.07	.07
5	.18	.18	.18	.18	.18	.18	.18	.18
6	.11	.11	.11	.11	.11	.11	.11	.11
7	.03	.03	.03	.03	.03	.03	.03	.03
8	.11	.11	.11	.11	.11	.11	.11	.11

Note: 1 = Regional-Focus, 2 = Voice, 3 = Quick Disbursement, 4 = Crisis Prevention, 5 = Crisis Management, 6 = RFA-Comm ER, 7 = RFA-No ER, and 8 = RFA-No Comm ER

Figure 9
Network of Costs Cluster

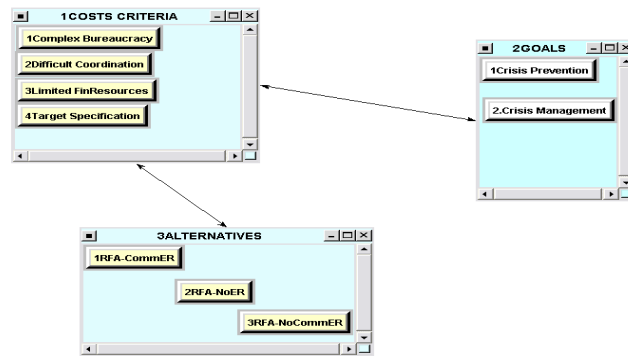


Table 2
Limiting Supermatrix for Cost Cluster

Matrix	1	2	3	4	5	6	7	8	9
1	.05	.05	.05	.05	.05	.05	.05	.05	.05
2	.09	.09	.09	.09	.09	.09	.09	.09	.09
3	.29	.29	.29	.29	.29	.29	.29	.29	.29
4	.07	.07	.07	.07	.07	.07	.07	.07	.07
5	.05	.05	.05	.05	.05	.05	.05	.05	.05
6	.20	.20	.20	.20	.20	.20	.20	.20	.20
7	.16	.16	.16	.16	.16	.16	.16	.16	.16
8	.03	.03	.03	.03	.03	.03	.03	.03	.03
9	.06	.06	.06	.06	.06	.06	.06	.06	.06

Note: 1 = Difficult Coord, 2 = Limited FinRes, 3 = Target Spec, 4 = Crisis Prevent, 5 = Crisis Mgt, 6 = RFA-CommER, 7 = RFA-NoER, and RFA-NoCommER

Table 3
Limiting Supermatrix for Opportunity Cluster

Matrix	1	2	3	4	5	6	7	8
1	.16	.16	.16	.16	.16	.16	.16	.16
2	.20	.20	.20	.20	.20	.20	.20	.20
3	.14	.14	.14	.14	.14	.14	.14	.14
4	.12	.12	.12	.12	.12	.12	.12	.12
5	.13	.13	.13	.13	.13	.13	.13	.13
6	.11	.11	.11	.11	.11	.11	.11	.11
7	.04	.04	.04	.04	.04	.04	.04	.04
8	.11	.11	.11	.11	.11	.11	.11	.11

Note: 1 = Financial-Focus, 2 = Foreign reserves, 3 = Surveillance, 4 = Crisis Prevention, 5 = Crisis Management, 6 = RFA-CommER, 7 = RFA-NoER, and 8 = RFA-NoCommER

Table 4
Limiting Supermatrix for Risk Cluster

Matrix	1	2	3	4	5	6	7	8	9
1	.13	.13	.13	.13	.13	.13	.13	.13	.13
2	.07	.07	.07	.07	.07	.07	.07	.07	.07
3	.18	.18	.18	.18	.18	.18	.18	.18	.18
4	.12	.12	.12	.12	.12	.12	.12	.12	.12
5	.12	.12	.12	.12	.12	.12	.12	.12	.12
6	.13	.13	.13	.13	.13	.13	.13	.13	.13
7	.16	.16	.16	.16	.16	.16	.16	.16	.16
8	.03	.03	.03	.03	.03	.03	.03	.03	.03
9	.06	.06	.06	.06	.06	.06	.06	.06	.06

Note: 1 = Dom Coordination, 2 = Heterogeneity, 3 = Moral Hazard, 4 = Political, 5 = Crisis Prevention, 6 = Crisis Management, 7 = RFA-Comm ER, 8 = RFA-No ER, and 9 = RFA-No Comm ER

The next step is to conduct the ratings for BOCR. This step is necessary because in real world the importance of each component of BOCR is often time weighted differently (Saaty, 1996). In some cases, the benefits and opportunities are assigned higher rating than the costs and risks, in others the opposite may be the case. If this step is not done, essentially implying that all components of BOCR are assumed to have same weights, the overall results show that RFA without a common currency basket (*RFA—NoCommER*) is the most suitable form of RFA. The weights of the other two alternative forms, *RFA—NoER* and *RFA—CommER*, are .30 and .27, respectively:




Graphic	Alternatives	Total	Normal	Ideal	Ranking
	1RFA—CommER	.50	.27	.63	3
	2RFA—NoER	.56	.30	.70	2
	3RFA— NoCommER	.80	.43	1.00	1

Figure 10
Network of Opportunities Cluster

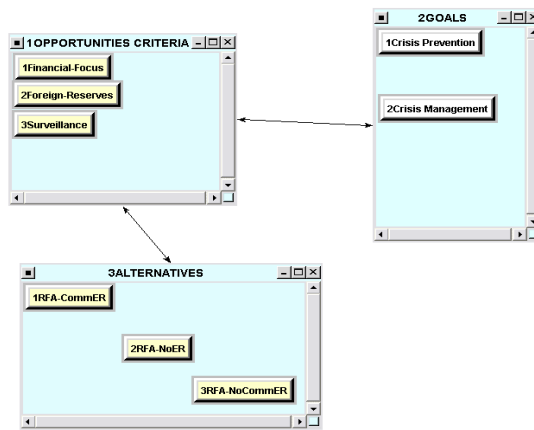
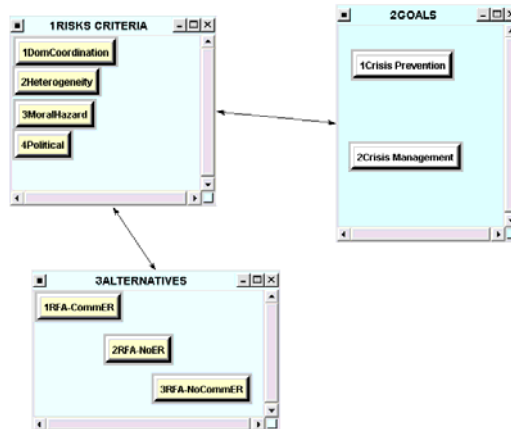









Figure 11
Network of Risks Cluster






What about if the components of BOCR are not equally weighted? Considering the development since the announcement of CMI and the recent financial reform throughout the region, a more likely rating for BOCR would be:

Graphic	Ratings Alternatives	Total	Ideal	Normal	Ranking
	Benefits	.95	1.00	.29	2
	Costs	.46	.48	.14	4
	Opportunities	.95	1.00	.29	3
	Risks	.95	1.00	0.29	1

Note that while the benefits and opportunities are rated high, the risks also receive an equally high rating. The heterogeneity among member countries, including in the speed and coverage of the post-crisis financial reform, augments the importance of the risk factor. Notably, the risk of creating more suspicions related to the repayment capacity of swap receiving countries on the one hand and the enforcement of conditionalities on the other remains high. With the above BOCR rating, the resulting priority of RFA is as follows:

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	1RFA—CommER	.57	.30	.70	2
	2RFA—NoER	.52	.27	.63	3
	3RFA—NoCommER	.82	.43	1.00	1

Clearly, the dominance of *RFA—NoCommER* continues, suggesting that such a choice is fairly robust. However, unlike in the preceding case, RFA with common currency based on a basket system is now ranked higher than RFA without specifying exchange rate target and exchange rate regime; this is consistent with studies by Ito, Ogawa and Sasaki (1999); Kawai and Akiyama (1998); Kuroda, Haruhiko and Kawai. (2002). The relatively low rating for costs criteria implies that difficulties in coordination, the provision of large amount of pooled financial resources, target specification, and overcoming the bureaucracy when a common currency is adopted are not too significant. This is also evident from the results of a sensitivity analysis. When these costs and risks criteria are given a higher rating than the benefits and opportunities, the priority ranking of RFA changes:

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	1RFA—CommER	.07	.05	.09	3
	2RFA—NoER	.78	.53	1.00	1
	3RFA—NoCommER	.63	.42	.81	2

Discussions

Selecting alternatives is among the most important objectives of decision making models. Once the alternatives are identified, they need to be evaluated. Since the negative repercussions of a decision can be much larger than its positive impacts, the benefits of each identified decision are to be contrasted with the costs. In the process of selecting the suitable form of RFA, financial managers and policy makers also need to evaluate the risks and the opportunities of each alternative. The problem is, some of the elements are intangibles and likely to have feedback effects. The proposed model (ANP) is capable of dealing with this problem. It uses ratio scales to combine subjective judgments (intangibles) with statistical data (tangibles). Unlike models that use a hierarchy in which no feedback influence are captured, the ANP involves a network that allows feedback to capture both the outer dependence and the inner dependence.

Selecting the most suitable form of RFA is obviously a complex decision, having to include not just economic rationales but also political and other considerations. Considering the goals, the criteria and the alternatives, and taking into account the feedback influences among them, the results show that under the equal rating of benefits, opportunities, costs, and risks (BOCR), a regional arrangement without a common currency basket is the most suitable form for East Asia. When a more likely rating of BOCR is applied, the choice remains the same. Hence, the results are fairly robust. Only when the costs criteria are rated much higher than the other criteria the results show that it would be better off for the region to cooperate without targeting exchange rate stability and asset prices.

Implications for Management

Financial system is like the brain of the economy: it is a coordinating mechanism that allocates capital to various sources. No matter how advance the rules the regulations and the selection system are, occasionally financial managers make mistakes in allocating capital, and that could lead to a financial crisis. Neither hard work nor work ethic can compensate for a misallocation of capital. In a liberalized financial system, managing financial sector is tricky; it always has a risk of propagating a financial crisis. Therefore, financial managers and policy makers alike need to find ways to cooperate regionally through some sort of financial arrangement. In formulating the precise form of arrangement, it would be necessary for them to consider not just the immediate benefits and costs but also the potential opportunities and risks that may arise. The immediate benefit they will gain from an RFA is the greater possibility of a quick disbursement of

financial support should a crisis hit. In this way, the country's foreign reserves can be strengthened. On the other hand, financial managers should realize that any support from a regional arrangement will be subject to member countries' willingness to allocate financial resources. In addition, there is also a risk of complacency that may create moral hazard. Given the current stage of development and other circumstances surrounding the East Asian economy, it is shown in this study that financial managers and policy makers alike should work on important issues surrounding financial cooperation *without* attempting to alter the prevailing exchange rate system.

Directions for Future Research

While the immediate benefits and costs of financial cooperation/arrangement are reasonably clear, future research should explore the risks and opportunities in greater details. For example, one needs to have a more precise assessment as to the extent of moral hazard that a particular form of financial arrangement may create. The weight assigned to this risk factor in the current study is based on the perceptions of financial managers, experts, and financial policy makers with whom the author had interactions during his consulting work in 2001–2004 at the Asian Development Bank Institute (ADB–I). Obviously, analyzing this subject by using a wider range of financial experts in the individual countries as a sample would be worth to conduct. This may or may not alter the priority weight of each component in the risk cluster, and it may also add new component(s) in the cluster. Future research should also include a comparative study by looking at the experience of financial cooperation/arrangements in other emerging markets (e.g., Latin America, Europe).

Limitations

A perception-based survey is warranted for a study involving intangibles (e.g., political factor). However, unlike in a stochastic Bayesian model that uses secondary data or cardinal scales, it is difficult to verify the results of a perception-based non-Bayesian model that uses ratio scales. Although the results of the analysis in this paper largely conform to the actual events and the development in the region, it would be useful to compare them with the results obtained from the Bayesian models.

References

- Azis, I. J. (1990). Analytic hierarchy process in the benefits/cost framework: A post-evaluation of the trans-sumatera highway project. *European Journal of Operational Research*, 48 (1), 38–48
- Azis, I. J. & Isard, W. (1996), The use of the analytic hierarchy process in conflict analysis and an extension. *Peace Economics, Peace Science and Public Policy*, 3 (3), 15–7.
- Azis, I. J. (2002). What would have happened in Indonesia if different economic policies had been implemented when the crisis started? *Asian Economic Papers*, 1 (2), 75–103.
- Azis, I. J. (2003, October). From Chiang Mai initiative to regional financial arrangement. *Asia's new regionalism: ASEAN+3*. Symposium conducted at Center for East Asian and Pacific Studies, University of Illinois at Urban–Champaign.

Azis, I. J., & Woo, W. T. (2003, January). *Establishing a Regional Financial Institution for East Asia to Support the Chiang-Mai Initiative*. Research Report Asian Development Bank Institute, ADB-I, Tokyo: Japan.

Saaty, T. L. (1994). *Decision making in economics political, social and technological environments with the analytic hierarchy process 6*. Pittsburgh, PA: RWS Publications.

Saaty, T. L. (1996). *Fundamentals of decision making and priority theory with the analytic hierarchy process*. Pittsburgh, PA: RWS Publication.

Saaty, T. L., & Vargas, L. G. (1998). Diagnosis with dependent symptoms: Bayes theorem and the analytic hierarchy process. *Operations Research*, 46 (4), 491–502.

Saaty, T. L. (2001). *Decision making with dependence and feedback: The analytic network process*. Pittsburgh: RWS Publication.

Eichengreen, B. & Bayoumi, T. (1996). Is Asia an optimum currency area? Can it become one? *Working paper series C96-081*. Berkeley CA: University of California, Center for International and Development Economics Research.

Ito, T., Ogawa, E., & Sasaki, Y. (1999). A regional currency system in East Asia. *In Stabilization of Currencies and Financial Systems in East Asia and International Financial Cooperation*. Tokyo: Institute for International Monetary Affairs.

Kawai, M. & Akiyama, S. (1998). Roles of the world's major currencies in exchange rate arrangements. *Journal of the Japanese and International Economies* 12, 334–387.

Kuroda, H., & Kawai, M. (2002, April). *Strengthening regional financial cooperation in East Asia*. Paper presented to the seminar Regional Economic, Financial and Monetary Co-Operation: the European and Asian Experiences, Tokyo, Japan.

Appendix

Let $A_1, A_2, A_3, \dots, A_n$ be n elements in a matrix within a hierarchy. The pairwise comparisons on pairs of elements (A_i, A_j) that we have to make are represented by an n -by- n matrix $\mathbf{A} = (a_{ij})$, where $i, j = 1, 2, 3, \dots, n$. Define a set of numerical weights $w_1, w_2, w_3, \dots, w_n$ that reflects the recorded comparisons, so that we can write:

$$\mathbf{A} = \begin{matrix} & \begin{matrix} A_1 & A_2 & & A_n \end{matrix} \\ \begin{matrix} A_1 \\ \dots \\ A_n \end{matrix} & \begin{bmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ \dots & \dots & \dots & \dots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{bmatrix} \end{matrix}$$

The scales used in the pairwise comparisons are based on Saaty's scaling system (Saaty, 1994), i.e., from 1 to 9. By multiplying \mathbf{A} with the vector of weights \mathbf{w} ,¹²

$$\mathbf{Aw} = \mathbf{nw} \tag{1}$$

To recover the scale from the matrix ratios, the following system ought to be solved:

$$(\mathbf{A} - \mathbf{nI})\mathbf{w} = \mathbf{0} \tag{2}$$

¹²Since every row is a constant multiple of the first row, \mathbf{A} has a unit rank.

Clearly, a nontrivial solution can be obtained if and only if $\det(\mathbf{A}-n\mathbf{I})$ vanishes, i.e., the *characteristic equation* of \mathbf{A} . Hence, n is an *eigenvalue* and \mathbf{w} is an *eigenvector*, of \mathbf{A} . Given that \mathbf{A} has a unit rank, all its eigenvalues except one are zero. Thus, the *trace* of \mathbf{A} is equal to n .

If each entry in \mathbf{A} is denoted by a_{ij} , then $a_{ij} = 1/a_{ji}$ (reciprocal property) holds, and so does $a_{jk} = a_{ik} / a_{ij}$ (consistency property). By definition, $a_{ii} = a_{jj} = 1$ (when comparing two same elements). Therefore, if we are to rank n number of elements, i.e., \mathbf{A} is of the size n -by- n , the required number of inputs (from the paired comparison) is less than n^2 ; it is equal to only the number of entries of the sub-diagonal part of \mathbf{A} (see Saaty, 1994). Hence, if there are three elements in a particular level of a hierarchy, only three pairwise comparisons are required.

In general, however, the precise value of w_i/w_j is hardly known simply because the pairwise comparisons we made is only an estimate, suggesting that there are some perturbations. While the reciprocal property still holds, the consistency property does not. By taking the largest eigenvalue denoted by λ_{\max} ,

$$\mathbf{A}^P \mathbf{w}^P = \lambda_{\max} \cdot \mathbf{w}^P \quad (3)$$

where \mathbf{A}^P is the actual, or the given, matrix (perturbed from matrix \mathbf{A}). Although (1) and (3) are not identical, if \mathbf{w}^P is obtained by solving (3), the matrix whose entries are w_i/w_j is still a *consistent* matrix; it is a consistent estimate of \mathbf{A} , although \mathbf{A}^P itself does not need to be consistent. Note that \mathbf{A}^P will be consistent if and only if $\lambda_{\max} = n$. As long as the precise value of w_i/w_j cannot be given, which is common in a real case due to the bias in the comparisons, λ_{\max} is always greater than or equal to n (hence, a measure of consistency can be derived based on the deviation of λ_{\max} from n).

When more than two elements are compared, the notion of consistency can be associated with *transitivity* condition: if $A_1 > A_2$ and $A_2 > A_3$, then $A_1 > A_3$. It should be clear that in solving for \mathbf{w} , the *transitivity* assumption is not strictly required; the inputted comparisons do not have to reflect a full consistency. Yet, as shown above, the resulting matrix and the corresponding vector remain consistent. It is this consistent vector \mathbf{w} that reflects the priority ranking of the elements in each level. Hence, in a standard hierarchy with three levels (goals, criteria, and alternative policies), the elements in each level are pairwise compared with respect to elements in the level above it, and the resulting vector for the bottom level reflects the priority ranking of the alternative policies.

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Received: May 2005

Accepted after two revisions: March, 2006



