

"INTEGRATING CASE BASED AND RULE BASED  
REASONING: THE POSSIBILISTIC  
CONNECTION"

by

Soumitra DUTTA\*  
and  
Piero BONISSONE\*\*

N° 90/45/TM

\* Assistant Professor of Information Systems, Technology Management  
Area, INSEAD, Boulevard de Constance, Fontainebleau 77305 Cedex,  
France

\*\* Artificial Intelligence Program, General Electric Corporate Research  
and Development, Schenectady, New York 12301, U.S.A.

# Integrating Case Based And Rule Based Reasoning: The Possibilistic Connection

Soumitra Dutta

INSEAD, Fontainebleau  
France 77305

and

Piero P. Bonissone

Artificial Intelligence Program  
General Electric Corporate Research and Development  
Schenectady, New York 12301

E-mail: Dutta%Freiba51.bitnet  
Bonissone@crd.ge.com

## Abstract

Rule based reasoning (RBR) and case based reasoning (CBR) have emerged as two important and complementary reasoning methodologies in artificial intelligence (AI). For problem solving in complex, real world situations, it is useful to integrate RBR and CBR. This paper presents an approach to achieve a compact and seamless integration of RBR and CBR within the base architecture of rules. The paper focuses on the possibilistic nature of the approximate reasoning methodology common to both CBR and RBR. In CBR, the concept of similarity is casted as the complement of the distance between cases. In RBR the transitivity of similarity is the basis for the approximate deductions based on the generalized *modus ponens*. It is shown that the integration of CBR and RBR is possible without altering the inference engine of RBR.

This integration is illustrated in the financial domain of mergers and acquisitions. These ideas have been implemented in a prototype system, called MARS.

## 1 Introduction

In this section, we introduce rule based and case based reasoning methodologies, describe their treatment of uncertain information, emphasize the need for their integration and outline the focus and structure of the paper.

### 1.1 Rule Based and Case Based Reasoning

Rule based reasoning (RBR) [BG84] is one of the most popular reasoning paradigms used in artificial intelligence (AI). The reasoning architecture of rule based systems has two major components: the *knowledge base* (usually consisting of a set of "IF...THEN..." rules representing domain knowledge) and the *inference engine* (usually containing some domain independent inference mechanisms, such as forward/backward chaining).

Case based reasoning (or analogical reasoning), though common and extremely important in human cognition, has only recently emerged as a major reasoning methodology. Case based reasoning (CBR) involves solving new problems by identifying and adapting *similar* problems stored in a library of past experiences/problems. The reasoning architecture of CBR consists of a *case library* (stored representations of previous experiences/problems solved) and an *inference cycle*. The important steps in the inference cycle of CBR are to *find* and *retrieve* cases from the case library which are most relevant to the problem at hand (input) and to *adapt* the retrieved cases to the current input. Within this broad framework, two major classes of CBR can be identified [RS89b]: *problem solving CBR* and *precedent based CBR*. In problem solving CBR, the emphasis is on adapting the retrieved cases to find a plan or a course of action to solve the input problem (such as in industrial design and planning [BM88]). In contrast, the focus in precedent based CBR is to use the retrieved cases to justify/explain an action/solution (common in legal reasoning [AR88]).

## 1.2 Uncertainty in the Reasoning Systems

Uncertainty is pervasive in the reasoning cycle of deductive (rule-based) and analogical (case-based) reasoning systems.

In Rule-Based Reasoning (RBR), uncertainty is present in the knowledge used in the task. Rules elicited from domain experts are usually *plausible* rather than *categorical* in nature. The partial degree of belief entailed by these rules is propagated through the inference network to determine the degree of confirmation and refutation of the various conclusions.

In CBR, uncertainty is present in the semantics of *abstract features* used to index the cases, in the evaluation and (hierarchical) aggregation of the *similarity measures* computed across these features, in the determination of *relevancy and saliency* of the similar cases, and in the solution adaptation phase.

In Section 2.2 we will show how most of this uncertainty can be modeled by using fuzzy predicates and plausible rules to derive abstract features from the surface features. Similarity measures can be defined as the complement of metrics between fuzzy-sets (cases). The similarity measure can be aggregated or chained (using the transitivity of similarity) according to well-defined operators (Triangular norms.)

## 1.3 Integration of Reasoning Methodologies

The need to integrate diverse reasoning techniques for effectively solving complex real world problems has been recently recognized by the AI community. This is represented in the works of Carbonell and Velose [CV88] (integration of CBR and classical search problem solvers), Hammond and Hurwitz [HH88] (integrating CBR and explanation based reasoning) and Rissland and Skalak [RS89b] (integrating RBR and CBR).

RBR and CBR are largely *complementary* reasoning methodologies. RBR can better represent specialized domain knowledge in a modular, declarative fashion, while CBR can better represent past experiences and domain complexity [RS89a]. Significant benefits are possible by combining RBR and CBR. For example, CBR can directly enhance RBR by providing a context for screening the knowledge base and by extending the coverage of rules by representing exceptions (to the rule) in the form of cases. Going the other direction, RBR can enhance CBR by expressing domain knowledge to dynamically help determining the contextually dependent relevance of a feature set (or attributes of a case) to a given goal and to dynamically select the best similarity/relevancy measure to use for case retrieval. There are numerous domains in which it is important to combine RBR and CBR, e.g., the legal domain (see Section 3.2 for an example).

## 1.4 Focus and Structure of Paper

This paper is concerned with the integration of RBR and CBR in an uncertain and dynamic world. Rather than “patching together” two different types of representational and reasoning frameworks, we have chosen to attempt the integration within one architectural framework, namely that of RBR. As shown in later sections, it is possible to achieve a compact, seamless integration of the two reasoning methodologies without changing the inference engine of RBR. This has, as discussed later, some advantages over other architectures (e.g., the one of Rissland and Skalak [RS89b]). The incorporation of uncertainty into the reasoning framework gives the system added power in handling real world situations, which are almost invariably uncertain and dynamic. It also leads to a more accurate treatment of CBR, as it is inherently a non-deductive form of approximate reasoning in which there is significant uncertainty and imprecision, e.g., in the semantics of the case features and in determining the similarity/relevancy of prior cases to the input problem/goal. The significance of our work arises from the fact that though RBR and CBR are two extremely important reasoning methodologies, there has been very little research in combining the two.

The domain chosen for the illustration of our ideas is the financial domain of mergers and acquisitions (M&A). M&A represent a real world situation, which is complex, uncertain, dynamic and relevant for business today. The ideas and technical approach detailed in this paper have been implemented in a prototype system, called MARS [BD90].

This paper contains four other sections. Section 2 illustrates the role of approximate reasoning techniques and contrast probabilistic and possibilistic reasoning systems. A brief introduction to the domain of M&A is provided in Section 3. The need for integrating RBR and CBR in this domain is also explained in that section. Section 4 provides an overview of MARS, illustrates the nature of possibilistic reasoning in MAS, and then describes the integration of RBR and CBR in MARS. Section 5 compares our work with related research and concludes the paper by describing the contributions and limitations of this research.

## 2 Approximate Reasoning Systems

The task of a reasoning system is to determine the *truth value* of statements describing the state or the behavior of a real world system. However, this hypothesis evaluation requires complete and certain information, which is typically not available. Therefore, approximate reasoning techniques are used to determine a *set of possible worlds* that are logically consistent with the available information. These possible worlds are characterized by a set of propositional variables and their associated values. As it is generally impractical to describe these possible worlds to an acceptable level of detail, approximate reasoning techniques seek to determine some properties of the set of possible solutions or some constraints on the values of such properties [Rus90b].<sup>1</sup>

A large number of approximate reasoning techniques have been developed over the past decade to provide these solutions. (See references [Bon87a], [Pea88] for a survey). These techniques can be roughly subdivided into two basic categories according to their *quantitative* or *qualitative* characterizations of uncertainty. Among the quantitative approaches, we find two types of reasoning that differ in the semantics of their numerical representation. One is the *probabilistic reasoning* approach, based on probability theory. The other one is the *possibilistic reasoning* approach, based on the semantics of many-valued logics. We will briefly contrast these two types of quantitative representations and focus our discussion on possibilistic reasoning systems.

---

<sup>1</sup>The authors want to acknowledge Enrique Ruspini's private communication, which is the basis for the content of this section. The interested reader should consult reference [Rus87], [Rus97], [Rus90b] for a further elaboration of this topic.

## 2.1 Probabilistic and Possibilistic Reasoning Systems

Probability-based reasoning, or *probabilistic reasoning* seeks to describe the constraints on the variables that characterize the possible worlds with conditional probability distributions based on the evidence in hand. Their supporting formalisms are based on the concept of *set-measures*, additive real functions defined over certain subsets of some space.

These methods focus on chance of occurrence and relative likelihood. They are oriented primarily toward the choice of decisions that are optimal in the *long-run*, as they measure the *tendency* or *propensity* of truth of a proposition without assuring its actual validity. Thus, probabilistic reasoning estimates the frequency of the truth of a hypothesis as determined by prior observation (objectivist interpretation) or a degree of gamble based on the actual truth of the hypothesis (subjectivist interpretation).

Possibilistic reasoning, which is rooted in fuzzy set theory [Zad65] and many-valued logics, seeks to describe the constraints on the possible worlds in terms of their *similarity* to other sets of possible worlds.

These methods focus on *single* situations and cases. Rather than measuring the tendency of the given proposition to be valid, they seek to find another proposition that resembles (according to some measure of similarity) the hypothesis of interest but that is valid. Thus, possibilistic reasoning asserts that a related, similar (and usually less specific) hypothesis is true.

## 2.2 Possibilistic Reasoning

Given the purpose and characteristics of probabilistic and possibilistic reasoning, it is clear that these technologies ought to be regarded as being complementary rather than competitive.

The single-case orientation of possibilistic techniques makes them particularly suitable for case-based reasoning. In CBR, it is typically the case that the problem in hand (probe) has never been encountered before. The inference in CBR is based on the existence of cases *similar enough* (i.e. close enough) to the probe to justify the adaptability of their solution to the current problem.

The notion of similarity is based on the concept of *metric* or distance, as opposed to that of set measure. Distances are functions which assign a number greater than zero to pairs of elements of some set (for sake of simplicity, we will assume the range of this function to be the interval  $[0,1]$ ). Distances are *reflexive*, *commutative*, and *transitive*. Similarity can be defined as the complement of distance, i.e.:

$$S(A, B) = 1 - d(A, B)$$

The basic structural characteristics of the similarity functions is an extended notion of transitivity that allows the computation of bounds on the similarity between two objects A and B on the basis of knowledge of their similarities to a third object C:

$$S(A, B) \geq T(S(A, C), S(B, C)),$$

where T is a Triangular-norm [BD86], [Bon87b]. Any continuous triangular norm  $T(A, B)$  falls in the interval  $Max(0, A + B - 1) \leq T(A, B) \leq Min(A, B)$ . Thus, we can observe that if we use the lower bound of the range of T-norms in the expression describing the transitivity of similarity, we obtain the triangular inequality for distances. If we use the upper bound, we obtain the ultrametric inequality.

This similarity notion is a direct extension of the notion of *accessibility relation* that is of fundamental importance in modal logics. This notion is further described by Ruspini in these proceedings [Rus90a]. In summarizing Ruspini's results, we can observe that the notion of accessibility captures the idea that whatever is true in some world  $w$ , is true, but in a modified sense, in another  $w'$  that is

accessible from it. When considering multiple levels of accessibility (indexed by a number between 0 and 1), this relation, measuring the resemblance between two worlds, may be used to express the extent by which considerations applicable in one world may be extended to another world.

The basic inferential mechanism, underlying the *generalized modus-ponens* [Zad79], makes use of inferential chains and the properties of a similarity function to relate the state of affairs in the two worlds that are at the extremes of an inferential chain.

We have briefly summarized the semantics of possibilistic reasoning, its role in determining the similarity between possible worlds (cases), and its mechanism to propagate similarities through a reasoning chain (rule chain). On this basis, we have established a common ground upon which we can build the integration of CBR and RBR. Before proceeding to describe such an integration, we need to justify the reasons for integrating these two methodologies. This motivation will be provided by the description of the problem domain of Mergers and Acquisition (M&A), which is used to test the integration.

### 3 Mergers & Acquisitions (M&A)

This section introduces the domain of M&A and emphasizes the need for integrating RBR and CBR in M&A.

#### 3.1 Introduction and Overview

The structure of corporate USA has been changed dramatically by the flood of mergers and acquisitions witnessed over the past years. Today, a flurry of mergers are sweeping through European industry as it prepares for 1992. Annually, these deals total more than a few billions of US dollars. The average M&A deal is enormously complex and involves sophisticated reasoning and planning on the part of several parties. To lend some useful conceptual abstraction, we can consider two players of interest in simple M&A deals: the *raider* (who usually initiates a take-over attempt) and the *target* (which is the company of interest to the raider). Another player of interest who is outside the structure of the actual M&A deal, but has a keen interest in the entire process is the *professional arbitrageur*. While the actions of each of these players vary from deal to deal, it is possible to identify certain basic actions associated with their individual roles. For example, some of the representative actions of a raider are: *target monitoring, evaluation and selection; attack strategy selection; target's response evaluation and attack strategy adaptation*. Even in simple M&A deals, other complicating factors, such as multiple bidders and legal complications, often arise. The reader may consult the references [Fer87], [Mic86], [Roc87] for more details on various aspects of M&A.

#### 3.2 The Anti-trust Defense

Usually, when a raider launches a hostile takeover attempt, the target has to devise an elaborate defense strategy. Michel and Shaked [Mic86] note that "*anti-trust arguments are one of the most frequently used forms of merger defense*". The laws governing anti-trust cases depend on several merger guide-lines (e.g., the 1982 and 1984 guide-lines) issued by the Department of Justice (DOJ) (in the USA). Much of the reasoning involved in the interpretation and application of guide-lines regarding anti-trust laws can be expressed by rules. For example, the 1982 guide-lines specified that markets where the post merger HHI (a mathematical measure of market concentration) was above 1800 were *highly concentrated* and if the post merger HHI was between 1000 and 1800, then the market was *moderately concentrated* and so on. However, such rules by themselves are not enough as [Mic86] "*it is not possible to remove the exercise of judgement from the evaluation of mergers under*

*the anti-trust laws*". This exercise of judgement is predominant in resolving issues like definition and measurement of market, efficiency arguments and treatment of foreign competition. This is where CBR can help and is used extensively.

For example, consider the \$5.1 billion attempt by Mobil to takeover Marathon on Nov. 1, 1981. Marathon began the takeover defense by filing an anti-trust lawsuit against Mobil (if successful, Mobil would then become the largest marketer of gasoline in the USA with an estimated 10% market share). The key issue here was whether section 7 of the Clayton Act (which provides that "*no person .. shall acquire .. stock .. where, in any line of commerce .. in any section of the country, the effect of such acquisition may be substantially to lessen competition*") was being violated by the merger. Judge J. M. Manos of the Ohio Court ruled against Mobil and in his ruling [Mic86] "*referred to past cases similar to the Mobil-Marathon situation. In the 1962 case of Brown Shoe Company, the combined market share of Brown Shoe and G.R. Kinney Co. was found to exceed 5% nationwide, rising to 57% in some cities. In the 1966 case of Pabst Brewing Company, the merged firm would have had a combined market share of 4.49% in the USA and up to 23.95% in Wisconsin.*" In all these three cases, section 7 of the Clayton Act was found to be violated.

This brief example illustrates the important role that cases and rules have in the M&A domain and stresses the need for their integration.

## 4 MARS: A Mergers & Acquisitions Reasoning System

In this section, we first provide a quick overview of MARS and then focus on the integration of RBR and CBR within MARS.

### 4.1 Overview of MARS

MARS [BD90] is a prototype AI reasoning system that both simulates and provides expert advice regarding the actions of the raider, the target and the arbitrageur. The general software architecture of MARS is as shown in Figure 1. There are four independent simulators. The global simulator provides a simulation of the variations of the macro-economic variables affecting the M&A deal (e.g., the interest rate and the T-Bill price). The three other simulators simulate the reasoning and planning strategies of the raider, target and the arbitrageur respectively. There is a fusion of different reasoning techniques in all four simulators and each of them is independently capable of integrated reasoning and planning with uncertain, incomplete and time varying information.

MARS is implemented in Common LISP using KEE and Reasoning with Uncertainty Module (RUM) [BGD87], and runs on the Symbolics. The knowledge base of MARS is frame based and consists of approximately 550 KEE units. Figure 2 shows the user interface for MARS. More details on the structure, implementation and use of MARS can be found in [BD90].

### 4.2 Possibilistic Reasoning in MARS

The *generalized modus ponens* and its associated possibilistic approach has been implemented in RUM, a reasoning shell described in [BGD87] and [BW89]. For the reader's convenience it is briefly summarized in this section.

Uncertainty in RUM is represented in both facts and rules. Facts are qualified by a degree of confirmation and a degree of refutation. For a fact  $A$ , the lower bound of the confirmation and the lower bound of the refutation are denoted by  $L(A)$  and  $L(\neg A)$  respectively. As in the case of Dempster's [Dem67] lower and upper probability bounds, the following identity holds:  $L(\neg A) = 1 - U(A)$ , where  $U(A)$  denotes the upper bound of the uncertainty in  $A$  and is interpreted as the

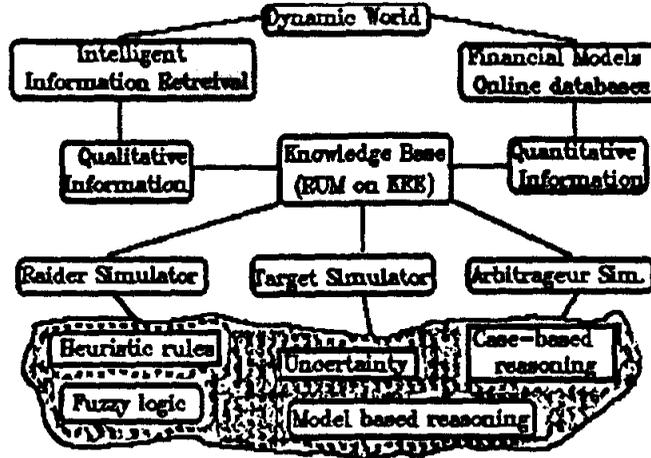


Figure 1: MARS Software Architecture

amount of failure to refute  $A$ . Note that  $L(A) + L(\neg A)$ , need not necessarily be equal to 1, as there may be some ignorance about  $A$  which is given by  $(1 - L(A) - L(\neg A))$ . The degree of confirmation and refutation for the proposition  $A$  can be written as the interval  $[L(A), U(A)]$ .

RUM provides a natural representation for plausible rules. Rules are discounted by *sufficiency* ( $s$ ), indicating the strength with which the antecedent implies the consequent and *necessity* ( $n$ ), indicating the degree to which a failed antecedent implies a negated consequent. Note that conventional strict implication rules are special cases of plausible rules with  $S = 1$  and  $N = 0$ . RUM's inference layer is built on a set of five Triangular norms (T-norms) based calculi [Bon87b]. T-norms and T-conorms are two-place functions from  $[0,1] \times [0,1]$  to  $[0,1]$  that are monotonic, commutative and associative. They are the most general families of binary functions which satisfy the requirements of the conjunction and disjunction operators respectively. Their corresponding boundary conditions satisfy the truth tables of the logical AND and OR operators. Five uncertainty calculi based on the following five T-norms are used in RUM:

$$T_1(a, b) = \max(0, a + b - 1)$$

$$T_{1.5}(a, b) = \begin{cases} (a^{0.5} + b^{0.5} - 1)^2 & \text{if } (a^{0.5} + b^{0.5}) \geq 1 \\ 0 & \text{otherwise} \end{cases}$$

$$T_2(a, b) = ab$$

$$T_{2.5}(a, b) = (a^{-1} + b^{-1} - 1)^{-1}$$

$$T_3(a, b) = \min(a, b)$$

Their corresponding DeMorgan dual T-conorms, denoted by  $S_i(a, b)$ , are defined as

$$S_i(a, b) = 1 - T_i(1 - a, 1 - b)$$

These five calculi provide the user with an ability to choose the desired uncertainty calculus starting from the most conservative ( $T_1$ ) to the most liberal ( $T_3$ ).  $T_1$  ( $T_3$ ) is the most conservative

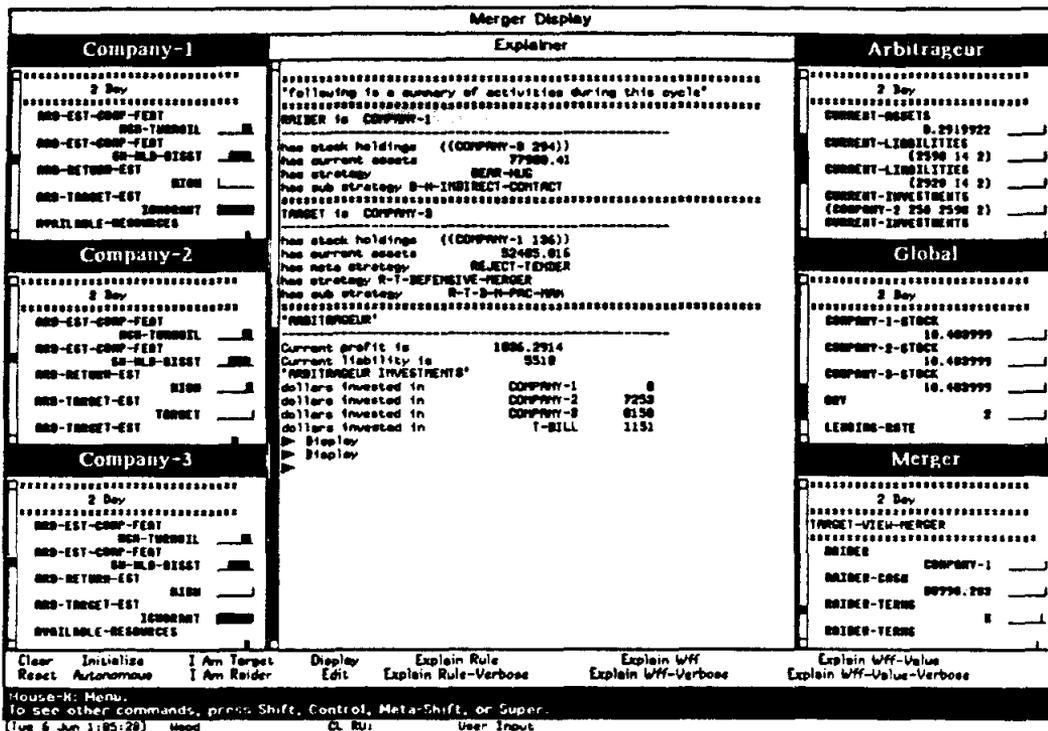


Figure 2: MARS User Interface

(liberal) T-norm in the sense that for the same input certainty ranges of facts and rule sufficiency and necessity measures,  $T_1$  ( $T_3$ ) shall yield the minimum (maximum) degree of confirmation of the conclusion. For each calculus (represented by the above five T-norms), the following four operations have been defined in RUM:

**Antecedent Evaluation.** To determine the aggregated certainty range  $[b, B]$  of the  $n$  clauses in the antecedent of a rule, when the certainty range of the  $i$ th clause is given by  $[b_i, B_i]$ :

$$[b, B] = [T_i(b_1, b_2, \dots, b_n), T_i(B_1, B_2, \dots, B_n)]$$

**Conclusion Detachment: Modus Ponens.** To determine the certainty range,  $[c, C]$  of the conclusion of a rule, given the aggregated certainty range,  $[b, B]$  of the rule premise and the rule sufficiency,  $s$  and rule necessity,  $n$ :

$$[c, C] = [T_i(s, b), 1 - (T_i(n, (1 - B)))]$$

**Conclusion Aggregation.** To determine the consolidated certainty range  $[d, D]$ , of a conclusion when it is supported by  $m$  ( $m > 1$ ) paths in the rule deduction graph, i.e., by  $m$  rule instances, each with the same conclusion aggregation T-norm operator. If  $[c_i, C_i]$  represents the certainty range of the same conclusion inferred by the  $i$ th proof path (rule instance), then

$$[d, D] = [S_i(c_1, c_2, \dots, c_m), 1 - S_i(C_1, C_2, \dots, C_m)]$$

**Source Consensus.** To determine the certainty range,  $[L_{tot}(A), U_{tot}(A)]$  of the same evidence,  $A$ , obtained by fusing the certainty ranges,  $[L_i(A), U_i(A)]$ , of the  $i$ th information source out of a total of  $n$  different possible information sources:

$$[L_{tot}(A), U_{tot}(A)] = [Max_{i=1, \dots, n} L_i(A), Min_{i=1, \dots, n} U_i(A)]$$

The theory of RUM is anchored on the semantics of many-valued logics [Bon87b]. Unlike other probabilistic systems, RUM's reasoning mechanism is possibilistic. References [Bon87b], [BGD87] describe a comparison of RUM with other reasoning with uncertainty systems, such as Modified Bayesian [DHN76], Certainty Factors [SB75], [Hec86], Dempster-Shafer [Dem67], [Sha76], and Fuzzy logic [Zad65].

### 4.3 Integrating RBR and CBR in MARS

#### 4.3.1 RBR in MARS

MARS is implemented using RUM [BGD87] and KEE. RUM is implemented on KEE but uses its own rule system (only the KEE data structure and graphical interface facilities are used by RUM). These rules are "plausible rules" rather than strict implications and incorporate a sophisticated uncertainty calculus, which is described in Section 4.2.

RUM offers both backward and forward processing. The expressiveness of RUM is enhanced by two other functionalities: the context mechanism and belief revision. The context represents the set of preconditions determining the rule's applicability to a given situation. This mechanism provides an efficient screening of the knowledge base by focusing the inference process on small rule subsets. The context of a rule forms an integral part of the RUM rule template. RUM's belief revision is essential to the dynamic aspect of the domain. The belief revision mechanism detects changes in the input, keeps track of the dependency of the intermediate and final conclusions on these inputs, and maintains the validity of these inferences. For any conclusions made by a rule, the mechanism monitors the changes in the certainty measures that constitute the conclusion's support. Rules in the MARS knowledge base are organized in hierarchical rule-classes. The reader is referred to [BGD87], [Bon87b] for more details on RUM and to [BD90] for details on the MARS rule base.

#### 4.3.2 CBR in MARS

We will now turn our attention to the CBR component in MARS. We will focus our discussion on four important issues related to CBR: representation & interpretation, need, matching & relevance, and integration.

- **Representation & Interpretation:** This issue is concerned with how the input problem/goal and the various cases in the case library are represented. Are they stored in an interpreted or uninterpreted (i.e., analyses of relevant features and event sequences are required) format? Is the representation complete or is it partial (i.e., some learning/non-monotonic reasoning is required)? What is the data/memory structure (rules/frames/MOPS [RS89a]) used?
- **Need:** This issue refers to determining whether the use of CBR is required for solving the input problem/goal. It follows from the observation that CBR is relevant only for certain kinds of problems/goals, e.g., in the domain of M&A, it is most relevant for the legal and tax aspects of the deal.

- **Matching & Relevance:** This issue is concerned with finding cases (from the case library) which are most similar to the input and determining which case is most relevant to solving/justifying the input problem/goal.
- **Integration:** How well can CBR be integrated into the overall problem solving structure? Until recently, this issue has been of little concern as most research in CBR has been done in isolation from other reasoning methodologies.

A review of the literature reveals that the issues of *representation & interpretation* and *matching & relevance* have received more discussion than the other two equally important issues of *need and integration*. We explain below how each of these issues has been addressed in MARS.

**Representation and Interpretation.** Given our intention to integrate RBR and CBR within the common architecture of rules, we have decided to represent individual cases in the MARS case library as RUM rules. The stored representation of cases consists of RUM rule templates. For example, the part of the Mobil-Marathon case elaborated upon in Section 3.2 would be represented in the following (pseudo English & Lisp) form:

```
IF (similar-industry ?raider ?target) AND (Ti)
   (large-merged-national-market ?raider ?target) AND (Ti)
   (significant-local-dominance ?raider ?target)
THEN significant chance (sufficiency)
   (anti-trust-success ?raider ?target) ;(CASE 1)
```

where (Ti) is the particular T-norm operator chosen for conjunction of the three rule premises. Each premise (here) is a call to a procedure which returns an interval valued certainty measure (see Section 4.3.1) when the variables *?raider* and *?target* have been instantiated to a particular raider and target. The sufficiency measure, *significant chance*, gives the degree to which the conjunction of the three premises is relevant to determining the success of the anti-trust suit in this case. (The necessity measure has been omitted for clarity). It should also be noted that Mobil and Marathon have been replaced by the role variables *?raider* and *?target* respectively.

The Mobil-Marathon case shall have many other such RUM rule templates to represent various aspects and events. A case library shall also have descriptions (rule templates) for other cases (e.g., the Brown Shoe and Kinney Co. case). In MARS a hierarchical structure is imposed on the case library containing various RUM rule templates. For example, the case library can have at the top level two divisions, one containing cases pertaining to *defensive* strategies and the other related to attack strategies. Within the defensive strategies category, we can have sub-categories for cases related to different types of defensive strategies (e.g., *pac-man*, *greenmail* and *anti-trust*). Going further down the sub- category for anti-trust defensive strategy cases, we can have sub-sub-categories for cases related to *market dominance*, *efficiency* and *foreign competition*. The example rule template, CASE 1, (described above) would be contained in the market dominance category.

Recall that a RUM rule (Section 4.3.1) has a context which keeps track of the environment in which that rule is activated. The context of rules used for RBR is used to efficiently index into the hierarchical structure imposed on the case library. For example, if the rule context indicates that anti-trust success is being evaluated, only related cases shall be retrieved. This shall become clearer below in the next few sub-sections. Rule templates representing cases also have contexts

(not shown in CASE 1) and these are useful in determining the relevance of the cases to the input problem/goal.

To summarize, cases are stored in an interpreted, rule template format with a hierarchical, functional structure imposed on the case library. The uncertainty mechanism of RUM is utilized in two ways: first to represent the relative importance of the premises for the conclusion (by the choice of  $T_i$ ) and second to represent the relevance of the premises to the conclusion (via the sufficiency and necessity measures). It is of course important to consider means to obtain the interpreted rule templates from available data. This is possible in the domain under consideration. Consider the ruling of Judge Manos in the Mobil- Marthon case which outlined detailed reasons for the judgement. An intelligent information retrieval system should be able to analyze such natural language data and extract the reasons (interpretations) for events and actions. SCISOR [JR90] is an intelligent natural language system which can perform this function. Reference [BD90] outlines this integration of SCISOR and MARS. In the absence of such recorded descriptions of events/actions and their interpretations, some inductive learning programs shall have to used to obtain the interpreted rule templates.

**Need for CBR.** It is important to recognize two points. First, CBR is important only for certain problems and goals. It is not useful to always consider CBR. For example, in the domain of M&A, CBR is useful primarily for structuring the legal and tax aspects of the deal. For some other aspects, such as use of statistical financial models, it makes little sense to include CBR. Second, CBR may be only one approach (proof path) to the solution of a goal/problem. There are (usually) other approaches (or proof paths) to the same goal/problem and it is important to consider the contributions of all paths, proportional to their relative importance. This aspect is significant, as most research in CBR has considered it in isolation till now. In MARS, the inference process can be considered as the traversal of paths in a rule graph. Premises, qualified by certainty intervals, combine (using RUM's uncertainty calculi) to generate conclusions (also qualified by certainty intervals) which either again act as premises for other rules or generate final conclusions. A simple rule graph is shown in Figure 3. Since CBR is just one path for proving a certain goal, a rule to

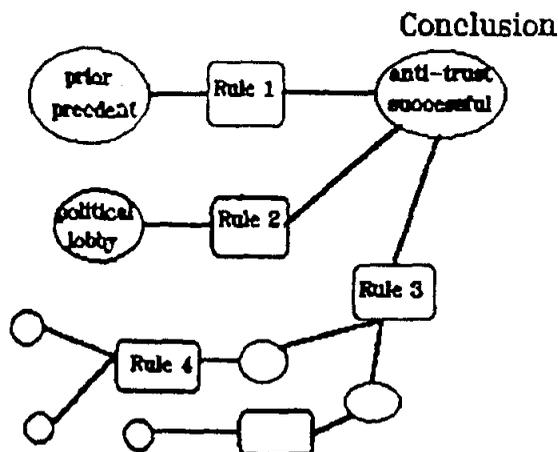


Figure 3: Example of a Simple Rule Graph

this effect is included in the rule structure whenever the expert feels that CBR is important for the

present goal. For example, consider a hypothetical M&A deal, M1, being analyzed by MARS. In the evaluation of the possibility of success of an anti-trust suit in M1, a rule would be added:

```
IF similar anti-trust precedent exists ; (RULE 1)
THEN high chance (sufficiency)
    anti-trust successful in M1
```

It should be noted that there shall be other rules (proof paths) also that either confirm/disconfirm the current goal under consideration. For example, there might be a rule:

```
IF target has strong political lobby ; (RULE 2)
THEN it is likely (sufficiency)
    anti-trust successful in M1
```

The above rules represent two different proof paths, each contributing to the determination of the goal "*anti-trust successful in M1*" (see Figure 3). The *conclusion aggregation* and *source consensus* operations (see 3.2.2) determine the relative contributions of RULE-1 and RULE-2 to the final conclusion of "*anti-trust successful in M1*".

**Matching and Relevance.** The matching and relevance process is operationalized by instantiating the case rule templates in the case library to the situation of the current world, M1. This process converts the rule templates to RUM rules which can be used in the reasoning process of M1 and at the same time determines the degree of relevance of the previous cases to M1. Thus if case 1 (rule template) were instantiated to M1 world conditions, the variables *?raider* and *?target* would be instantiated to the raider and target respectively in M1, and each of the three premises shall be evaluated to yield certainty ranges which give the degree to which the premises of the case are true in the current M1 world. If they are not relevant (true), a very low confirmation for the premises shall be obtained and vice versa. Using the uncertainty calculi of RUM, case 1 shall yield a conclusion with a certainty range which is the degree to which that case is relevant to M1. As there shall be many cases for the same conclusion (e.g., successful anti-trust cases) in the case library, an aggregated value of the relevance of all the previous cases can be obtained using the conclusion aggregation and source consensus operations of RUM's uncertainty calculi. The node labelled "*anti-trust success*" represents the aggregated contribution of various cases for determining the success of an anti-trust suit in M1.

This process of matching can be alternatively understood by noting that the *necessity measure*  $N(p | d)$  represents the degree of semantic entailment of a pattern descriptor  $p$  given a datum  $d$ . The *possibility measure*  $P(p | d)$  represents the degree of intersection between the same pattern and datum. Thus, the interval defined by  $[N(p | d), P(p | d)]$  represents the lower and upper bounds on the degree of matching between such pattern and data. This interval is the same as the interval valued certainty ranges obtained when premises of case rule templates are instantiated to the current world conditions.

**Integration.** The above sub-sections have outlined the details of the integration of RBR and CBR in MARS. The last detail in the integration process is observing that the node labelled

"Prior Precedent" in Figure 3 is automatically expanded by the backward chainer of the RBR when evaluating the truth value of the node "Anti-trust Success" (Figure 4). This expansion is shown in Figure 4.

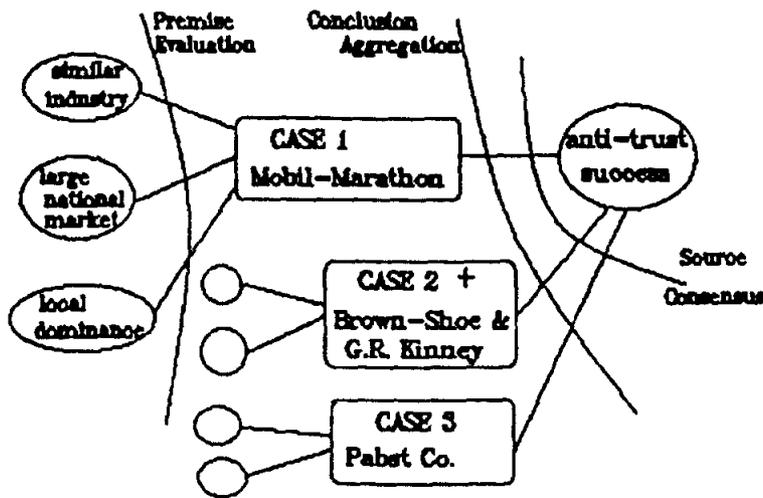


Figure 4: Expansion of Rule Graph

Thus to summarize the process briefly:

- Cases are stored as rule templates (CASE 1).
- If CBR is important, a rule to this effect (RULE 1) is added.
- Case rule templates are instantiated automatically while evaluating the premise of rules like (RULE 1). Rule contexts are used for indexing into the hierarchical structure of the case library.
- Instantiation of case rule templates (CASE 1) automatically determines relevance and matching using the T-norm based uncertainty calculi of RUM.

Finally, we would like to emphasize the seamless and compact integration of RBR and CBR. No changes need to be made in the inference engine of either RUM or MARS (which remains the same whether CBR is used or not).

## 5 Conclusion

### 5.1 Comparisons with Related Research

As mentioned earlier, there has been very little research in combining RBR and CBR. The only work in this area that the authors are aware of is that of Rissland and Skalak [RS89b]. Their approach however, is very different. While working in the legal domain of *statutory interpretation*, they have built a system called CABARET, whose architecture consists of two co-equal reasoners, one a RBR and the other a CBR, with a separate agenda based controller. The central controller contains heuristics to direct and interleave the two modes of reasoning and to post and prioritize tasks for each controller. This effort should be credited for being the first in addressing such an

important issue. However, we feel that it is difficult to choose the right heuristics for the controller and to design it to perform correctly and adequately in different, complex domains. Our approach to integrating RBR and CBR also provides a treatment of uncertainty and approximate matching between input and cases, which is not available in CABARET.

### **5.1.1 Contributions and Limitations**

We feel that the primary contribution of this paper has been to illustrate the compact and seamless integration of RBR and CBR as implemented in MARS. Both RBR and CBR are very important reasoning methodologies and it is surprising that there has been such little prior work in integrating the two. We hope that this paper represents a major effort in that direction. Both RBR and CBR are required for solving complex real world problems. By choosing RBR as the base architecture for integration, we have illustrated a method for adding more power to rule based systems, i.e., expanding their inference capabilities. Our architecture treats the contributions of CBR and RBR simultaneously and proportionately (according to their relative importance) as separate proof paths to a conclusion. This does not require the use of any special heuristics or agendas. As shown, no changes have to be made to the inference engine of RBR to accommodate CBR. Furthermore, this seamless integration is anchored on common possibilistic semantics for both CBR and RBR. The methodology presented in this paper is general and also applies to RBR without uncertainty (where rules and facts are special cases of RUM rules and facts) and to both problem solving CBR and precedent based CBR (as long as the base architecture is rule based).

We will conclude our discussion by noting some of the limitations of the methodology described in this paper and by proposing future efforts aimed at strengthening this approach. The case library consists of interpreted rule templates (cases). The process of interpretation of data to obtain such rule templates, though possible, is non-trivial. We are looking into the use of SCISOR [JR90] for such purposes. Also, the case library at present has to be necessarily incomplete (as it is not possible to represent all possible reasons for all possible events/actions). Currently, we have chosen to represent only important events/actions in a case. We are now investigating the use of machine learning and non-monotonic reasoning techniques for handling this incompleteness. A possibility in this connection, is to have a system such as SCISOR "lazily" interpreting case data on demand. This approach, however requires a more thorough treatment of issues related to dynamic analysis of cases, efficiency, etc. All these issues will be the focus of our research goals for the forthcoming future.

## **Acknowledgement**

The support and help given by General Electric and various members of the AI program at GE Corporate R&D is gratefully acknowledged.

## References

- [AR88] Kevin Ashley and Edwina Rissland. Dynamic Assessment of Relevancy in a Case-based Reasoner. *IEEE Expert*, 1988.
- [BD86] Piero P. Bonissone and Keith S. Decker. Selecting Uncertainty Calculi and Granularity: An Experiment in Trading-off Precision and Complexity. In L. Kanal and J. Lemmer, editors, *Uncertainty in Artificial Intelligence*, pages 217–247. North-Holland, Amsterdam, 1986.
- [BD90] Piero Bonissone and Sumitra Dutta. Mars: A Mergers & Acquisitions Reasoning System. In *Computer Science in Economics and Management*, page Forthcoming. Kluwer Academic Publishers, Holland, 1990.
- [BG84] B.G. Buchanan and E.H. Shortliffe. *Rule-Based Expert Systems*. Addison-Wesley, Reading, MA, 1984.
- [BGD87] Piero P. Bonissone, Stephen Gans, and Keith S. Decker. RUM: A Layered Architecture for Reasoning with Uncertainty. In *Proceedings of the 10th International Joint Conference on Artificial Intelligence*, pages 891–898. AAAI, August 1987.
- [BM88] R. Barletta and W. Mark. Explanation-based Indexing of Cases. In *Proceedings of the AAAI-88*, San Mateo, CA, 1988. Morgan Kaufmann Publishers, Inc.
- [Bon87a] Piero P. Bonissone. Plausible Reasoning: Coping with Uncertainty in Expert Systems. In Stuart Shapiro, editor, *Encyclopedia of Artificial Intelligence*, pages 854–863. John Wiley and Sons Co., New York, 1987.
- [Bon87b] Piero P. Bonissone. Summarizing and Propagating Uncertain Information with Triangular Norms. *International Journal of Approximate Reasoning*, 1(1):71–101, January 1987.
- [BW89] Piero P. Bonissone and Nancy C. Wood. T-norm Based Reasoning in Situation Assessment Applications. In L. Kanal, T. Levitt, and J. Lemmer, editors, *Uncertainty in Artificial Intelligence 3*, pages 241–256. North-Holland, Amsterdam, 1989.
- [CV88] Jamie Carbonell and Manuela Veloso. Integrating Derivational Analogy into a General Problem Solving Architecture. In *Proceedings of the Case-based Reasoning Workshop*, pages 104–124, San Mateo, CA, May 1988. Morgan Kaufmann Publishers, Inc.
- [Dem67] A.P. Dempster. Upper and Lower Probabilities Induced by a Multivalued Mapping. *Annals of Mathematical Statistics*, 38:325–339, 1967.
- [DHN76] R.O. Duda, P.E. Hart, and N.J. Nilsson. Subjective Bayesian Methods for Rule-based Inference Systems. In *Proc. AFIPS 45*, pages 1075–1082, New York, 1976. AFIPS Press.
- [Fer87] R.C. Ferrara. *Mergers and Acquisitions in the 1980s : attack and survival*. (Series title: Corporate law and practice course handbook series; no. 558). Practising Law Institute, 810 7th Ave., New York, New York 10019, 1987.
- [Hec86] D. Heckerman. Probabilistic Interpretations for MYCIN Certainty Factors. In L.N. Kanal and J.F. Lemmer, editors, *Uncertainty in Artificial Intelligence*, pages 167–196. North-Holland, Amsterdam, 1986.

- [HH88] Kristian Hammond and Neil Hurwitz. Extracting Diagnostic Features from Explanations. In *Proceedings of the Case-based Reasoning Workshop*, pages 169–178, San Mateo, CA, May 1988. Morgan Kaufmann Publishers, Inc.
- [JR90] P. Jacobs and L. Rau. Scisor: A system for extracting information from financial news. *CACM (forthcoming)*, 1990.
- [Mic86] Michel, A. and Shaked, I. *Takeover Madness*. John Wiley, 1986.
- [Pea88] Judea Pearl. Evidential Reasoning Under Uncertainty. In Howard E. Shrobe, editor, *Exploring Artificial Intelligence*, pages 381–418. Morgan Kaufmann, San Mateo, CA, 1988.
- [Roc87] Milton L. Rock. *The Mergers and Acquisitions Handbook*. McGraw-Hill., NY, 1987.
- [RS89a] C.K. Riesbeck and R. C. Schank. *Inside Case-Based Reasoning*. Lawrence Erlbaum Associates Inc., NJ, 1989.
- [RS89b] Edwina L. Rissland and David B. Skalak. Combining Case-based and Rule-based Reasoning: A Heuristic Approach. In *Proceedings of the Eleventh Joint Conference on Artificial Intelligence*, San Mateo, CA, August 1989. Morgan Kaufmann Publishers, Inc.
- [Rus87] E.H. Ruspini. The Logical Foundations of Evidential Reasoning. Technical Note 408, Artificial Intelligence Center, SRI International, Menlo Park, California, 1987.
- [Rus90a] E.H. Ruspini. Possibility as Similarity: The Semantics of Fuzzy Logic. In *Proceedings 1990 AAAI Uncertainty Workshop*, Cambridge, MA, 1990.
- [Rus90b] Enrique Ruspini. The Semantics of Vague Knowledge. *Revue de Systemique*, forthcoming 1990.
- [Rus97] E.H. Ruspini. On the Semantics of Fuzzy Logic. Technical Note 475, Artificial Intelligence Center, SRI International, Menlo Park, California, 19897.
- [SB75] E.H. Shortliffe and B. Buchanan. A Model Of Inexact Reasoning in Medicine. *Mathematical Biosciences*, 23:351–379, 1975.
- [Sha76] G. Shafer. *A Mathematical Theory of Evidence*. Princeton University Press, Princeton, New Jersey, 1976.
- [Zad65] L.A. Zadeh. Fuzzy Sets. *Information and Control*, 8:338–353, 1965.
- [Zad79] L.A. Zadeh. A Theory of Approximate Reasoning. In P. Hayes, D. Michie, and L.I. Mikulich, editors, *Machine Intelligence*, pages 149–194. Halstead Press, New York, 1979.

INSEAD WORKING PAPERS SERIES

1986

- |       |  |  |       |   |  |
|-------|--|--|-------|---|--|
| 86/01 | Arnoud DE MEYER  | "The R & D/Production interface".  | 86/16 | B. Espen ECKBO and<br>Herwig M. LANGOHR   | "Les primes des offres publiques, la note<br>d'information et le marché des transferts de<br>contrôle des sociétés". |
| 86/02 | Philippe A. NAERT<br>Marcel WEVERBERGH<br>and Guido VERSWIJVEL         | "Subjective estimation in integrating<br>communication budget and allocation<br>decisions: a case study", January 1986.                    | 86/17 | David B. JEMISON  | "Strategic capability transfer in acquisition<br>integration", May 1986.   |
| 86/03 | Michael BRIMM  | "Sponsorship and the diffusion of<br>organizational innovation: a preliminary view".   | 86/18 | James TEBOUL<br>and V. MALLERET   | "Towards an operational definition of<br>services", 1986.  |
| 86/04 | Spyros MAKRIDAKIS<br>and Michèle HIBON                                 | "Confidence intervals: an empirical<br>investigation for the series in the M-<br>Competition" .  | 86/19 | Rob R. WEITZ  | "Nostradamus: a knowledge-based forecasting<br>advisor".   |
| 86/05 | Charles A. WYPLOSZ   | "A note on the reduction of the workweek",<br>July 1985.   | 86/20 | Albert CORHAY,<br>Gabriel HAWAWINI<br>and Pierre A. MICHEL                      | "The pricing of equity on the London stock<br>exchange: seasonality and size premium",<br>June 1986.                 |
| 86/06 | Francesco GIAVAZZI,<br>Jeff R. SHEEN and<br>Charles A. WYPLOSZ         | "The real exchange rate and the fiscal<br>aspects of a natural resource discovery",<br>Revised version: February 1986.                     | 86/21 | Albert CORHAY,<br>Gabriel A. HAWAWINI<br>and Pierre A. MICHEL                   | "Risk-premia seasonality in U.S. and European<br>equity markets", February 1986.                                     |
| 86/07 | Douglas L. MacLACHLAN<br>and Spyros MAKRIDAKIS                         | "Judgmental biases in sales forecasting",<br>February 1986.  | 86/22 | Albert CORHAY,<br>Gabriel A. HAWAWINI<br>and Pierre A. MICHEL                   | "Seasonality in the risk-return relationships<br>some international evidence", July 1986.                            |
| 86/08 | José de la TORRE and<br>David H. NECKAR                                | "Forecasting political risks for<br>international operations", Second Draft:<br>March 3, 1986.   | 86/23 | Arnoud DE MEYER   | "An exploratory study on the integration of<br>information systems in manufacturing",<br>July 1986.                  |
| 86/09 | Philippe C. HASPELAGH  | "Conceptualizing the strategic process in<br>diversified firms: the role and nature of the<br>corporate influence process", February 1986. | 86/24 | David GAUTSCHI<br>and Vithala R. RAO  | "A methodology for specification and<br>aggregation in product concept testing",<br>July 1986.                       |
| 86/10 | R. MOENART,<br>Arnoud DE MEYER,<br>J. BARBE and<br>D. DESCHOOLMEESTER. | "Analysing the issues concerning<br>technological de-maturity".  | 86/25 | H. Peter GRAY<br>and Ingo WALTER  | "Protection", August 1986.   |
| 86/11 | Philippe A. NAERT<br>and Alain BULTEZ                                  | "From "Lydiametry" to "Pinkhamization":<br>misspecifying advertising dynamics rarely<br>affects profitability".                            | 86/26 | Barry EICHENGREEN<br>and Charles WYPLOSZ  | "The economic consequences of the Franc<br>Poincare", September 1986.  |
| 86/12 | Roger BETANCOURT<br>and David GAUTSCHI                                 | "The economics of retail firms", Revised<br>April 1986.  | 86/27 | Karel COOL<br>and Ingemar DIERICKX  | "Negative risk-return relationships in<br>business strategy: paradox or truism?",<br>October 1986.                   |
| 86/13 | S.P. ANDERSON<br>and Damien J. NEVEN                                   | "Spatial competition à la Cournot".  | 86/28 | Manfred KETS DE<br>VRIES and Danny MILLER                                       | "Interpreting organizational texts.  |
| 86/14 | Charles WALDMAN  | "Comparaison internationale des marges brutes<br>du commerce", June 1985.  | 86/29 | Manfred KETS DE VRIES   | "Why follow the leader?".  |
| 86/15 | Hihkel TOMBAK and<br>Arnoud DE MEYER                                   | "How the managerial attitudes of firms with<br>FMS differ from other manufacturing firms:<br>survey results", June 1986.                   | 86/30 | Manfred KETS DE VRIES   | "The succession game: the real story.  |
|       |  |  | 86/31 | Arnoud DE MEYER   | "Flexibility: the next competitive battle",<br>October 1986.   |
|       |  |  | 86/31 | Arnoud DE MEYER,<br>Jinichiro NAKANE,<br>Jeffrey G. MILLER<br>and Kasra FERDOWS | "Flexibility: the next competitive battle",<br>Revised Version: March 1987   |
|       |  |  | 86/32 | Karel COOL<br>and Dan SCHENDEL  | Performance differences among strategic group<br>members", October 1986.   |

- 86/33 Ernst BALTENSPERGER and Jean DERMINE "The role of public policy in insuring financial stability: a cross-country, comparative perspective", August 1986, Revised November 1986.
- 86/34 Philippe HASPELAGH and David JEMISON "Acquisitions: myths and reality", July 1986.
- 86/35 Jean DERMINE "Measuring the market value of a bank, a primer", November 1986.
- 86/36 Albert CORHAY and Gabriel HAWAWINI "Seasonality in the risk-return relationship: some international evidence", July 1986.
- 86/37 David GAUTSCHI and Roger BETANCOURT "The evolution of retailing: a suggested economic interpretation".
- 86/38 Gabriel HAWAWINI "Financial innovation and recent developments in the French capital markets", Updated: September 1986.
- 86/39 Gabriel HAWAWINI Pierre MICHEL and Albert CORHAY "The pricing of common stocks on the Brussels stock exchange: a re-examination of the evidence", November 1986.
- 86/40 Charles WYPLOSZ "Capital flows liberalization and the EMS, a French perspective", December 1986.
- 86/41 Kasra FERDOVS and Wickham SKINNER "Manufacturing in a new perspective", July 1986.
- 86/42 Kasra FERDOVS and Per LINDBERG "FMS as indicator of manufacturing strategy", December 1986.
- 86/43 Damien NEVEN "On the existence of equilibrium in hotelling's model", November 1986.
- 86/44 Ingemar DIERICKX Carmen MATUTES and Damien NEVEN "Value added tax and competition", December 1986.
- 1987
- 87/01 Manfred KETS DE VRIES "Prisoners of leadership".
- 87/02 Claude VIALLET "An empirical investigation of international asset pricing", November 1986.
- 87/03 David GAUTSCHI and Vithala RAO "A methodology for specification and aggregation in product concept testing", Revised Version: January 1987.
- 87/04 Sumantra GHOSHAL and Christopher BARTLETT "Organizing for innovations: case of the multinational corporation", February 1987.
- 87/05 Arnoud DE MEYER and Kasra FERDOVS "Managerial focal points in manufacturing strategy", February 1987.
- 87/06 Arun K. JAIN, Christian PINSON and Naresh K. MALHOTRA "Customer loyalty as a construct in the marketing of banking services", July 1986.
- 87/07 Rolf BANZ and Gabriel HAWAWINI "Equity pricing and stock market anomalies", February 1987.
- 87/08 Manfred KETS DE VRIES "Leaders who can't manage", February 1987.
- 87/09 Lister VICKERY, Mark PILKINGTON and Paul READ "Entrepreneurial activities of European MBAs", March 1987.
- 87/10 André LAURENT "A cultural view of organizational change", March 1987.
- 87/11 Robert FILDES and Spyros MAKRIDAKIS "Forecasting and loss functions", March 1987.
- 87/12 Fernando BARTOLOME and André LAURENT "The Janus Head: learning from the superior and subordinate faces of the manager's job", April 1987.
- 87/13 Sumantra GHOSHAL and Nitin NOHRIA "Multinational corporations as differentiated networks", April 1987.
- 87/14 Landis GABEL "Product Standards and Competitive Strategy: An Analysis of the Principles", May 1987.
- 87/15 Spyros MAKRIDAKIS "METAFORCASTING: Ways of improving Forecasting. Accuracy and Usefulness", May 1987.
- 87/16 Susan SCHNEIDER and Roger DUNBAR "Takeover attempts: what does the language tell us?", June 1987.
- 87/17 André LAURENT and Fernando BARTOLOME "Managers' cognitive maps for upward and downward relationships", June 1987.
- 87/18 Reinhard ANGELMAR and Christoph LIEBSCHER "Patents and the European biotechnology lag: a study of large European pharmaceutical firms", June 1987.
- 87/19 David BEGG and Charles WYPLOSZ "Why the EMS? Dynamic games and the equilibrium policy regime", May 1987.
- 87/20 Spyros MAKRIDAKIS "A new approach to statistical forecasting", June 1987.
- 87/21 Susan SCHNEIDER "Strategy formulation: the impact of national culture", Revised: July 1987.
- 87/22 Susan SCHNEIDER "Conflicting ideologies: structural and motivational consequences", August 1987.
- 87/23 Roger BETANCOURT David GAUTSCHI "The demand for retail products and the household production model: new views on complementarity and substitutability".

87/24	C.B. DERR and André LAURENT	"The internal and external careers: a theoretical and cross-cultural perspective", Spring 1987.	87/41	Gavriel HAWAVINI and Claude VIALLET	"Seasonality, size premium and the relationship between the risk and the return of French common stocks", November 1987
87/25	A. K. JAIN, N. K. MALHOTRA and Christian PINSON	"The robustness of MDS configurations in the face of incomplete data", March 1987, Revised: July 1987.	87/42	Damien NEVEN and Jacques-F. THISSE	"Combining horizontal and vertical differentiation: the principle of max-min differentiation", December 1987
87/26	Roger BETANCOURT and David GAUTSCHI	"Demand complementarities, household production and retail assortments", July 1987.	87/43	Jean GABSZEWICZ and Jacques-F. THISSE	"Location", December 1987
87/27	Michael BURDA	"Is there a capital shortage in Europe?", August 1987.	87/44	Jonathan HAMILTON, Jacques-F. THISSE and Anita WESKAMP	"Spatial discrimination: Bertrand vs. Cournot in a model of location choice", December 1987
87/28	Gabriel HAWAVINI	"Controlling the interest-rate risk of bonds: an introduction to duration analysis and immunization strategies", September 1987.	87/45	Karel COOL, David JEMISON and Ingemar DIERICKX	"Business strategy, market structure and risk- return relationships: a causal interpretation", December 1987.
87/29	Susan SCHNEIDER and Paul SHRIVASTAVA	"Interpreting strategic behavior: basic assumptions themes in organizations", September 1987	87/46	Ingemar DIERICKX and Karel COOL	"Asset stock accumulation and sustainability of competitive advantage", December 1987.
87/30	Jonathan HAMILTON W. Bentley MACLEOD and J. F. THISSE	"Spatial competition and the Core", August 1987.	<u>1988</u>		
87/31	Martine QUINZII and J. F. THISSE	"On the optimality of central places", September 1987.	88/01	Michael LAWRENCE and Spyros MAKRIDAKIS	"Factors affecting judgemental forecasts and confidence intervals", January 1988.
87/32	Arnoud DE MEYER	"German, French and British manufacturing strategies less different than one thinks", September 1987.	88/02	Spyros MAKRIDAKIS	"Predicting recessions and other turning points", January 1988.
87/33	Yves DOZ and Amy SHUEN	"A process framework for analyzing cooperation between firms", September 1987.	88/03	James TEBOUL	"De-industrialize service for quality", January 1988.
87/34	Kasra FERDOVS and Arnoud DE MEYER	"European manufacturers: the dangers of complacency. Insights from the 1987 European manufacturing futures survey, October 1987.	88/04	Susan SCHNEIDER	"National vs. corporate culture: implications for human resource management", January 1988.
87/35	P. J. LEDERER and J. F. THISSE	"Competitive location on networks under discriminatory pricing", September 1987.	88/05	Charles WYPLOSZ	"The swinging dollar: is Europe out of step?", January 1988.
87/36	Manfred KETS DE VRIES	"Prisoners of leadership", Revised version October 1987.	88/06	Reinhard ANGELMAR	"Les conflits dans les canaux de distribution", January 1988.
87/37	Landis GABEL	"Privatization: its motives and likely consequences", October 1987.	88/07	Ingemar DIERICKX and Karel COOL	"Competitive advantage: a resource based perspective", January 1988.
87/38	Susan SCHNEIDER	"Strategy formulation: the impact of national culture", October 1987.	88/08	Reinhard ANGELMAR and Susan SCHNEIDER	"Issues in the study of organizational cognition", February 1988.
87/39	Manfred KETS DE VRIES	"The dark side of CEO succession", November 1987	88/09	Bernard SINCLAIR- DESGAGNÉ	"Price formation and product design through bidding", February 1988.
87/40	Carmen MATUTES and Pierre REGIBEAU	"Product compatibility and the scope of entry", November 1987	88/10	Bernard SINCLAIR- DESGAGNÉ	"The robustness of some standard auction game forms", February 1988.
			88/11	Bernard SINCLAIR- DESGAGNÉ	"When stationary strategies are equilibrium bidding strategy: The single-crossing property", February 1988.

- 88/12 Spyros MAKRIDAKIS "Business firms and managers in the 21st century", February 1988
- 88/13 Manfred KETS DE VRIES "Alexithymia in organizational life: the organization man revisited", February 1988.
- 88/14 Alain NOEL "The interpretation of strategies: a study of the impact of CEOs on the corporation", March 1988.
- 88/15 Anil DEOLALIKAR and Lars-Hendrik RÖLLER "The production of and returns from industrial innovation: an econometric analysis for a developing country", December 1987.
- 88/16 Gabriel HAWAVINI "Market efficiency and equity pricing: international evidence and implications for global investing", March 1988.
- 88/17 Michael BURDA "Monopolistic competition, costs of adjustment and the behavior of European employment", September 1987.
- 88/18 Michael BURDA "Reflections on "Wait Unemployment" in Europe", November 1987, revised February 1988.
- 88/19 M.J. LAWRENCE and Spyros MAKRIDAKIS "Individual bias in judgements of confidence", March 1988.
- 88/20 Jean DERMINE, Damien NEVEN and J.F. THISSE "Portfolio selection by mutual funds, an equilibrium model", March 1988.
- 88/21 James TEBOUL "De-industrialize service for quality", March 1988 (88/03 Revised).
- 88/22 Lars-Hendrik RÖLLER "Proper Quadratic Functions with an Application to AT&T", May 1987 (Revised March 1988).
- 88/23 Sjur Didrik FLAM and Georges ZACCOUR "Equilibres de Nash-Cournot dans le marché européen du gaz: un cas où les solutions en boucle ouverte et en feedback coïncident", Mars 1988
- 88/24 B. Espen ECKBO and Hervig LANGOHR "Information disclosure, means of payment, and takeover premia. Public and Private tender offers in France", July 1985, Sixth revision, April 1988.
- 88/25 Everette S. GARDNER and Spyros MAKRIDAKIS "The future of forecasting", April 1988.
- 88/26 Sjur Didrik FLAM and Georges ZACCOUR "Semi-competitive Cournot equilibrium in multistage oligopolies", April 1988.
- 88/27 Murugappa KRISHNAN and Lars-Hendrik RÖLLER "Entry game with resalable capacity", April 1988.
- 88/28 Sumantra GHOSHAL and C. A. BARTLETT "The multinational corporation as a network: perspectives from interorganizational theory", May 1988.
- 88/29 Naresh K. MALHOTRA, Christian PINSON and Arun K. JAIN "Consumer cognitive complexity and the dimensionality of multidimensional scaling configurations", May 1988.
- 88/30 Catherine C. ECKEL and Theo VERMAELEN "The financial fallout from Chernobyl: risk perceptions and regulatory response", May 1988.
- 88/31 Sumantra GHOSHAL and Christopher BARTLETT "Creation, adoption, and diffusion of innovations by subsidiaries of multinational corporations", June 1988.
- 88/32 Kasra FERDOVS and David SACKRIDER "International manufacturing: positioning plants for success", June 1988.
- 88/33 Mihkel M. TOMBAK "The importance of flexibility in manufacturing", June 1988.
- 88/34 Mihkel M. TOMBAK "Flexibility: an important dimension in manufacturing", June 1988.
- 88/35 Mihkel M. TOMBAK "A strategic analysis of investment in flexible manufacturing systems", July 1988.
- 88/36 Vikas TIBREWALA and Bruce BUCHANAN "A Predictive Test of the NBD Model that Controls for Non-stationarity", June 1988.
- 88/37 Murugappa KRISHNAN and Lars-Hendrik RÖLLER "Regulating Price-Liability Competition To Improve Welfare", July 1988.
- 88/38 Manfred KETS DE VRIES "The Motivating Role of Envy : A Forgotten Factor in Management", April 88.
- 88/39 Manfred KETS DE VRIES "The Leader as Mirror : Clinical Reflections", July 1988.
- 88/40 Josef LAKONISHOK and Theo VERMAELEN "Anomalous price behavior around repurchase tender offers", August 1988.
- 88/41 Charles WYPLOSZ "Assymetry in the EMS: intentional or systemic?", August 1988.
- 88/42 Paul EVANS "Organizational development in the transnational enterprise", June 1988.
- 88/43 B. SINCLAIR-DESGAGNE "Group decision support systems implement Bayesian rationality", September 1988.
- 88/44 Essam MAHMOUD and Spyros MAKRIDAKIS "The state of the art and future directions in combining forecasts", September 1988.
- 88/45 Robert KORAJCZYK and Claude VIALLET "An empirical investigation of international asset pricing", November 1986, revised August 1988.
- 88/46 Yves DOZ and Amy SHUEN "From intent to outcome: a process framework for partnerships", August 1988.

- 88/47 Alain BULTEZ, Els GIJSBRECHTS, Philippe NAERT and Piet VANDEN ABEELE "Asymmetric cannibalism between substitute items listed by retailers", September 1988.
- 88/48 Michael BURDA "Reflections on 'Wait unemployment' in Europe, II", April 1988 revised September 1988.
- 88/49 Nathalie DIERKENS "Information asymmetry and equity issues", September 1988.
- 88/50 Rob WEITZ and Arnoud DE MEYER "Managing expert systems: from inception through updating", October 1987.
- 88/51 Rob WEITZ "Technology, work, and the organization: the impact of expert systems", July 1988.
- 88/52 Susan SCHNEIDER and Reinhard ANGELMAR "Cognition and organizational analysis: who's minding the store?", September 1988.
- 88/53 Manfred KETS DE VRIES "Whatever happened to the philosopher-king: the leader's addiction to power", September 1988.
- 88/54 Lars-Hendrik RÖLLER and Mihkel M. TOMBAK "Strategic choice of flexible production technologies and welfare implications", October 1988
- 88/55 Peter BOSSAERTS and Pierre HILLION "Method of moments tests of contingent claims asset pricing models", October 1988.
- 88/56 Pierre HILLION "Size-sorted portfolios and the violation of the random walk hypothesis: Additional empirical evidence and implication for tests of asset pricing models", June 1988.
- 88/57 Wilfried VANHONACKER and Lydia PRICE "Data transferability: estimating the response effect of future events based on historical analogy", October 1988.
- 88/58 B. SINCLAIR-DESGAGNE and Mihkel M. TOMBAK "Assessing economic inequality", November 1988.
- 88/59 Martin KILDUFF "The interpersonal structure of decision making: a social comparison approach to organizational choice", November 1988.
- 88/60 Michael BURDA "Is mismatch really the problem? Some estimates of the Chelwood Gate II model with US data", September 1988.
- 88/61 Lars-Hendrik RÖLLER "Modelling cost structure: the Bell System revisited", November 1988.
- 88/62 Cynthia VAN HULLE, Theo VERMAELEN and Paul DE WOUTERS "Regulation, taxes and the market for corporate control in Belgium", September 1988.
- 88/63 Fernando NASCIMENTO and Wilfried R. VANHONACKER "Strategic pricing of differentiated consumer durables in a dynamic duopoly: a numerical analysis", October 1988.
- 88/64 Kasra FERDOWS "Charting strategic roles for international factories", December 1988.
- 88/65 Arnoud DE MEYER and Kasra FERDOWS "Quality up, technology down", October 1988.
- 88/66 Nathalie DIERKENS "A discussion of exact measures of information asymmetry: the example of Myers and Majluf model or the importance of the asset structure of the firm", December 1988.
- 88/67 Paul S. ADLER and Kasra FERDOWS "The chief technology officer", December 1988.
- 1989
- 89/01 Joyce K. BYRER and Tawfik JELASSI "The impact of language theories on DSS dialog", January 1989.
- 89/02 Louis A. LE BLANC and Tawfik JELASSI "DSS software selection: a multiple criteria decision methodology", January 1989.
- 89/03 Beth H. JONES and Tawfik JELASSI "Negotiation support: the effects of computer intervention and conflict level on bargaining outcome", January 1989.
- 89/04 Kasra FERDOWS and Arnoud DE MEYER "Lasting improvement in manufacturing performance: In search of a new theory", January 1989.
- 89/05 Martin KILDUFF and Reinhard ANGELMAR "Shared history or shared culture? The effects of time, culture, and performance on institutionalization in simulated organizations", January 1989.
- 89/06 Mihkel M. TOMBAK and B. SINCLAIR-DESGAGNE "Coordinating manufacturing and business strategies: I", February 1989.
- 89/07 Damien J. NEVEN "Structural adjustment in European retail banking. Some view from industrial organisation", January 1989.
- 89/08 Arnoud DE MEYER and Hellmut SCHÜTTE "Trends in the development of technology and their effects on the production structure in the European Community", January 1989.
- 89/09 Damien NEVEN, Carmen MATUTES and Marcel CORSTJENS "Brand proliferation and entry deterrence", February 1989.
- 89/10 Nathalie DIERKENS, Bruno GERARD and Pierre HILLION "A market based approach to the valuation of the assets in place and the growth opportunities of the firm", December 1988.

- 89/11 Manfred KETS DE VRIES and Alain NOEL "Understanding the leader-strategy interface: application of the strategic relationship interview method", February 1989.
- 89/12 Wilfried VANHONACKER "Estimating dynamic response models when the data are subject to different temporal aggregation", January 1989.
- 89/13 Manfred KETS DE VRIES "The impostor syndrome: a disquieting phenomenon in organizational life", February 1989.
- 89/14 Reinhard ANGELMAR "Product innovation: a tool for competitive advantage", March 1989.
- 89/15 Reinhard ANGELMAR "Evaluating a firm's product innovation performance", March 1989.
- 89/16 Wilfried VANHONACKER, Donald LEHMANN and Fareena SULTAN "Combining related and sparse data in linear regression models", February 1989.
- 89/17 Gilles AMADO, Claude FAUCHEUX and André LAURENT "Changement organisationnel et réalités culturelles: contrastes franco-américains", March 1989.
- 89/18 Srinivasan BALAK-RISHNAN and Mitchell KOZA "Information asymmetry, market failure and joint-ventures: theory and evidence", March 1989.
- 89/19 Wilfried VANHONACKER, Donald LEHMANN and Fareena SULTAN "Combining related and sparse data in linear regression models", Revised March 1989.
- 89/20 Wilfried VANHONACKER and Russell WINER "A rational random behavior model of choice", Revised March 1989.
- 89/21 Arnoud de MEYER and Kasra FERDOWS "Influence of manufacturing improvement programmes on performance", April 1989.
- 89/22 Manfred KETS DE VRIES and Sydney PERZOW "What is the role of character in psychoanalysis? April 1989.
- 89/23 Robert KORAJCZYK and Claude VIALLET "Equity risk premia and the pricing of foreign exchange risk" April 1989.
- 89/24 Martin KILDUFF and Mitchel ABOLAFIA "The social destruction of reality: Organisational conflict as social drama" April 1989.
- 89/25 Roger BETANCOURT and David GAUTSCHI "Two essential characteristics of retail markets and their economic consequences" March 1989.
- 89/26 Charles BEAN, Edmond MALINVAUD, Peter BERNHOLZ, Francesco GIAVAZZI and Charles WYPLOSZ "Macroeconomic policies for 1992: the transition and after", April 1989.
- 89/27 David KRACKHARDT and Martin KILDUFF "Friendship patterns and cultural attributions: the control of organizational diversity", April 1989.
- 89/28 Martin KILDUFF "The interpersonal structure of decision making: a social comparison approach to organizational choice", Revised April 1989.
- 89/29 Robert GOGEL and Jean-Claude LARRECHE "The battlefield for 1992: product strength and geographic coverage", May 1989.
- 89/30 Lars-Hendrik ROLLER and Mihkel M. TOMBAK "Competition and Investment in Flexible Technologies", May 1989.
- 89/31 Michael C. BURDA and Stefan GERLACH "Intertemporal prices and the US trade balance in durable goods", July 1989.
- 89/32 Peter HAUG and Tawfik JELASSI "Application and evaluation of a multi-criteria decision support system for the dynamic selection of U.S. manufacturing locations", May 1989.
- 89/33 Bernard SINCLAIR-DESGAGNE "Design flexibility in monopsonistic industries", May 1989.
- 89/34 Sumantra GHOSHAL and Nittin NOHRIA "Requisite variety versus shared values: managing corporate-division relationships in the M-Form organisation", May 1989.
- 89/35 Jean DERMINE and Pierre HILLION "Deposit rate ceilings and the market value of banks: The case of France 1971-1981", May 1989.
- 89/36 Martin KILDUFF "A dispositional approach to social networks: the case of organizational choice", May 1989.
- 89/37 Manfred KETS DE VRIES "The organisational fool: balancing a leader's hubris", May 1989.
- 89/38 Manfred KETS DE VRIES "The CEO blues", June 1989.
- 89/39 Robert KORAJCZYK and Claude VIALLET "An empirical investigation of international asset pricing", (Revised June 1989).
- 89/40 Balaji CHAKRAVARTHY "Management systems for innovation and productivity", June 1989.
- 89/41 B. SINCLAIR-DESGAGNE and Nathalie DIERKENS "The strategic supply of precisions", June 1989.
- 89/42 Robert ANSON and Tawfik JELASSI "A development framework for computer-supported conflict resolution", July 1989.
- 89/43 Michael BURDA "A note on firing costs and severance benefits in equilibrium unemployment", June 1989.
- 89/44 Balaji CHAKRAVARTHY and Peter LORANGE "Strategic adaptation in multi-business firms", June 1989.
- 89/45 Rob WEITZ and Arnoud DE MEYER "Managing expert systems: a framework and case study", June 1989.

89/46	Marcel CORSTJENS, Carmen MATUTES and Damien NEVEN	"Entry Encouragement", July 1989	89/64	Enver YUCESAN and (TM) Lee SCHRUBEN	"Complexity of simulation models: A graph theoretic approach", November 1989
89/47	Manfred KETS DE VRIES and Christine MEAD	"The global dimension in leadership and organization: issues and controversies", April 1989	89/65	Soumitra DUTTA and (TM, Piero BONISSONE AC, PIN)	"MARS: A mergers and acquisitions reasoning system", November 1989
89/48	Damien NEVEN and Lars-Hendrik ROLLER	"European integration and trade flows", August 1989	89/66	B. SINCLAIR-DESGAGNE (TM,EP)	"On the regulation of procurement bids", November 1989
89/49	Jean DERMINE	"Home country control and mutual recognition", July 1989	89/67	Peter BOSSAERTS and (PIN) Pierre HILLION	"Market microstructure effects of government intervention in the foreign exchange market", December 1989
89/50	Jean DERMINE	"The specialization of financial institutions, the EEC model", August 1989			
89/51	Spyros MAKRIDAKIS	"Sliding simulation: a new approach to time series forecasting", July 1989			
89/52	Arnoud DE MEYER	"Shortening development cycle times: a manufacturer's perspective", August 1989			
89/53	Spyros MAKRIDAKIS	"Why combining works?", July 1989			
89/54	S. BALAKRISHMAN and Mitchell KOZA	"Organisation costs and a theory of joint ventures", September 1989			
89/55	H. SCHUTTE	"Euro-Japanese cooperation in information technology", September 1989			
89/56	Wilfried VANHONACKER and Lydia PRICE	"On the practical usefulness of meta-analysis results", September 1989			
89/57	Taekvon KIM, Lars-Hendrik ROLLER and Mihkel TOMBAK	"Market growth and the diffusion of multiproduct technologies", September 1989			
89/58	Lars-Hendrik ROLLER (EP,TM) and Mihkel TOMBAK	"Strategic aspects of flexible production technologies", October 1989			
89/59	Manfred KETS DE VRIES, (OB) Daphna ZEVADI, Alain NOEL and Mihkel TOMBAK	"Locus of control and entrepreneurship: a three-country comparative study", October 1989			
89/60	Enver YUCESAN and (TM) Lee SCHRUBEN	"Simulation graphs for design and analysis of discrete event simulation models", October 1989			
89/61	Susan SCHNEIDER and (All) Arnoud DE MEYER	"Interpreting and responding to strategic issues: The impact of national culture", October 1989			
89/62	Arnoud DE MEYER (TM)	"Technology strategy and international R & D operations", October 1989			
89/63	Enver YUCESAN and (TM) Lee SCHRUBEN	"Equivalence of simulations: A graph theoretic approach", November 1989			

<u>1990</u>			90/16 FIN	Richard LEVICH and Ingo WALTER	"Tax-Driven Regulatory Drag: European Financial Centers in the 1990's", January 1990
90/01 TM/EP/AC	B. SINCLAIR-DESGAGNE	"Unavoidable Mechanisms", January 1990	90/17 FIN	Nathalie DIERKENS	"Information Asymmetry and Equity Issues", Revised January 1990
90/02 EP	Michael BURDA	"Monopolistic Competition, Costs of Adjustment, and the Behaviour of European Manufacturing Employment", January 1990	90/18 MKT	Wilfried VANBONACKER	"Managerial Decision Rules and the Estimation of Dynamic Sales Response Models", Revised January 1990
90/03 TM	Arnoud DE MEYER	"Management of Communication in International Research and Development", January 1990	90/19 TM	Beth JONES and Tawfik JELASSI	"The Effect of Computer Intervention and Task Structure on Bargaining Outcome", February 1990
90/04 FIN/EP	Gabriel HAVAVINI and Eric RAJENDRA	"The Transformation of the European Financial Services Industry: From Fragmentation to Integration", January 1990	90/20 TM	Tawfik JELASSI, Gregory KERSTEN and Stanley ZIONTS	"An Introduction to Group Decision and Negotiation Support", February 1990
90/05 FIN/EP	Gabriel HAVAVINI and Bertrand JACQUILLAT	"European Equity Markets: Toward 1992 and Beyond", January 1990	90/21 FIN	Roy SMITH and Ingo WALTER	"Reconfiguration of the Global Securities Industry in the 1990's", February 1990
90/06 FIN/EP	Gabriel HAVAVINI and Eric RAJENDRA	"Integration of European Equity Markets: Implications of Structural Change for Key Market Participants to and Beyond 1992", January 1990	90/22 FIN	Ingo WALTER	"European Financial Integration and Its Implications for the United States", February 1990
90/07 FIN/EP	Gabriel HAVAVINI	"Stock Market Anomalies and the Pricing of Equity on the Tokyo Stock Exchange", January 1990	90/23 EP/SM	Damien NEVEN	"EEC Integration towards 1992: Some Distributional Aspects", Revised December 1989
90/08 TM/EP	Tawfik JELASSI and B. SINCLAIR-DESGAGNE	"Modelling with MCDSS: What about Ethics?", January 1990	90/24 FIN/EP	Lars Tyge NIELSEN	"Positive Prices in CAPM", January 1990
90/09 EP/PIN	Alberto GIOVANNINI and Jae VON PARK	"Capital Controls and International Trade Finance", January 1990	90/25 FIN/EP	Lars Tyge NIELSEN	"Existence of Equilibrium in CAPM", January 1990
90/10 TM	Joyce BRYER and Tawfik JELASSI	"The Impact of Language Theories on DSS Dialog", January 1990	90/26 OB/BP	Charles KADUSHIN and Michael BRIMM	"Why networking Fails: Double Binds and the Limitations of Shadow Networks", February 1990
90/11 TM	Enver YUCESAN	"An Overview of Frequency Domain Methodology for Simulation Sensitivity Analysis", January 1990	90/27 TM	Abbas FOROUGH and Tawfik JELASSI	"NSS Solutions to Major Negotiation Stumbling Blocks", February 1990
90/12 EP	Michael BURDA	"Structural Change, Unemployment Benefits and High Unemployment: A U.S.-European Comparison", January 1990	90/28 TM	Arnoud DE MEYER	"The Manufacturing Contribution to Innovation", February 1990
90/13 TM	Soumitra DUTTA and Shashi SHEKHAR	"Approximate Reasoning about Temporal Constraints in Real Time Planning and Search", January 1990	90/29 FIN/AC	Nathalie DIERKENS	"A Discussion of Correct Measures of Information Asymmetry", January 1990
90/14 TM	Albert ANGEHRN and Hans-Jakob LÜTHI	"Visual Interactive Modelling and Intelligent DSS: Putting Theory Into Practice", January 1990	90/30 FIN/EP	Lars Tyge NIELSEN	"The Expected Utility of Portfolios of Assets", March 1990
90/15 TM	Arnoud DE MEYER, Dirk DESCHOOLMEESTER, Rudy MOENAERT and Jan BARBE	"The Internal Technological Renewal of a Business Unit with a Mature Technology", January 1990	90/31 MKT/EP	David GAUTSCHI and Roger BETANCOURT	"What Determines U.S. Retail Margins?", February 1990
			90/32 SM	Srinivasan BALAK- RISHNAN and Mitchell KOZA	"Information Asymmetry, Adverse Selection and Joint-Ventures: Theory and Evidence", Revised, January 1990
			90/33 OB	Caren SIEHL, David BOWEN and Christine PEARSON	"The Role of Rites of Integration in Service Delivery", March 1990

90/34 FIN/EP	Jean DERMINE	"The Gains from European Banking Integration, a Call for a Pro-Active Competition Policy", April 1990
90/35 EP	Jae Won PARK	"Changing Uncertainty and the Time-Varying Risk Premia in the Term Structure of Nominal Interest Rates", December 1988, Revised March 1990
90/36 TM	Arnoud DE MEYER	"An Empirical Investigation of Manufacturing Strategies in European Industry", April 1990
90/37 TM/OB/SM	William CATS-BARIL	"Executive Information Systems: Developing an Approach to Open the Possibles", April 1990
90/38 MKT	Wilfried VANHONACKER	"Managerial Decision Behaviour and the Estimation of Dynamic Sales Response Models", (Revised February 1990)
90/39 TM	Louis LE BLANC and Tawfik JELASSI	"An Evaluation and Selection Methodology for Expert System Shells", May 1990
90/40 OB	Manfred KETS DE VRIES	"Leaders on the Couch: The case of Roberto Calvi", April 1990
90/41 FIN/EP	Gabriel HAWAWINI, Itzhak SWARY and Ik HWAN JANG	"Capital Market Reaction to the Announcement of Interstate Banking Legislation", March 1990
90/42 MKT	Joel STECKEL and Wilfried VANHONACKER	"Cross-Validating Regression Models in Marketing Research", (Revised April 1990)
90/43 FIN	Robert KORAJCZYK and Claude VIALLET	"Equity Risk Premia and the Pricing of Foreign Exchange Risk", May 1990
90/44 OB	Gilles AMADO, Claude FAUCHEUX and André LAURENT	"Organisational Change and Cultural Realities: Franco-American Contrasts", April 1990