



**HAL**  
open science

## Combining objects with rules to represent aggregation knowledge in data warehouse and OLAP systems

Nicolas Prat, Isabelle Comyn-Wattiau, Jacky Akoka

### ► To cite this version:

Nicolas Prat, Isabelle Comyn-Wattiau, Jacky Akoka. Combining objects with rules to represent aggregation knowledge in data warehouse and OLAP systems. [Research Report] DR 09014, ESSEC Business School, Document de Recherche ESSEC / ISSN: 1291-9616. 2009. hal-00551866

**HAL Id: hal-00551866**

**<https://essec.hal.science/hal-00551866v1>**

Submitted on 4 Jan 2011

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

CENTRE DE RECHERCHE

DR 09014



COMBINING OBJECTS WITH RULES TO REPRESENT  
AGGREGATION KNOWLEDGE IN DATA WAREHOUSE  
AND OLAP SYSTEMS

---

NICOLAS PRAT  
ISABELLE COMYN-WATTIAU  
JACKY AKOKA

DECEMBER 2009

**ESSEC**

---

BUSINESS SCHOOL  
PARIS-SINGAPORE

*Il est interdit de reproduire ce document ou d'en citer des extraits  
sans l'autorisation écrite des auteurs.  
It is forbidden to quote all or part of this document without the written consent of the authors.*

- DR 09014 -

## **Combining Objects with Rules to Represent Aggregation Knowledge in Data Warehouse and OLAP Systems**

*Nicolas PRAT, Isabelle COMYN-WATTIAU, Jacky AKOKA*

December 2009

# Combining Objects with Rules to Represent Aggregation Knowledge in Data Warehouse and OLAP Systems

## **ABSTRACT:**

Data warehouses are based on multidimensional modeling. Using On-Line Analytical Processing (OLAP) tools, decision makers navigate through and analyze multidimensional data. Typically, users need to analyze data at different aggregation levels (using roll-up and drill-down functions). Therefore, aggregation knowledge should be adequately represented in conceptual multidimensional models, and mapped in subsequent logical and physical models. However, current conceptual multidimensional models poorly represent aggregation knowledge, which (1) has a complex structure and dynamics and (2) is highly contextual. In order to account for the characteristics of this knowledge, we propose to represent it with objects (UML class diagrams) and rules in Production Rule Representation (PRR) language. Static aggregation knowledge is represented in the class diagrams, while rules represent the dynamics (i.e. how aggregation may be performed depending on context). We present the class diagrams, and a typology and examples of associated rules. We argue that this representation of aggregation knowledge allows an early modeling of user requirements in a data warehouse project.

## **Key-Words:**

- Aggregation
- Conceptual Multidimensional Model
- Data Warehouse
- On-line Analytical Processing (OLAP)
- Production Rule
- UML

## **RESUME :**

Les entrepôts de données reposent sur la modélisation multidimensionnelle. A l'aide d'outils OLAP, les décideurs analysent les données à différents niveaux d'agrégation. Il est donc nécessaire de représenter les connaissances d'agrégation dans les modèles conceptuels multidimensionnels, puis de les traduire dans les modèles logiques et physiques. Cependant, les modèles conceptuels multidimensionnels actuels représentent imparfaitement les connaissances d'agrégation, qui (1) ont une structure et une dynamique complexes et (2) sont fortement contextuelles. Afin de prendre en compte les caractéristiques de ces connaissances, nous proposons de les représenter avec des objets (diagrammes de classes UML) et des règles en langage PRR (Production Rule Representation). Les connaissances d'agrégation statiques sont représentées dans les diagrammes de classes, tandis que les règles représentent la dynamique (c'est-à-dire comment l'agrégation peut être effectuée en fonction du contexte). Nous présentons les diagrammes de classes, ainsi qu'une typologie et des exemples de règles associées.

## **Mots-clés :**

- Agrégation
- Entrepôt de données
- Modèle conceptuel multidimensionnel
- OLAP
- Règle de production
- UML

*JEL classification : M15, C88*

# Combining Objects with Rules to Represent Aggregation Knowledge in Data Warehouse and OLAP Systems

Nicolas Prat<sup>1</sup>, Isabelle Comyn-Wattiau<sup>2</sup>, Jacky Akoka<sup>3</sup>

<sup>1</sup>ESSEC Business School, avenue Bernard Hirsch, BP 50105, 95021 CERGY Cedex, France  
[prat@essec.fr](mailto:prat@essec.fr)

<sup>2</sup>CEDRIC-CNAM & ESSEC Business School, 292 rue St Martin, 75141 PARIS Cedex 03, France  
[wattiau@cnam.fr](mailto:wattiau@cnam.fr)

<sup>3</sup>CEDRIC-CNAM & TMSP, 292 rue St Martin, 75141 PARIS Cedex 03, France  
[akoka@cnam.fr](mailto:akoka@cnam.fr)

**Abstract.** Data warehouses are based on multidimensional modeling. Using On-Line Analytical Processing (OLAP) tools, decision makers navigate through and analyze multidimensional data. Typically, users need to analyze data at different aggregation levels (using roll-up and drill-down functions). Therefore, aggregation knowledge should be adequately represented in conceptual multidimensional models, and mapped in subsequent logical and physical models. However, current conceptual multidimensional models poorly represent aggregation knowledge, which (1) has a complex structure and dynamics and (2) is highly contextual. In order to account for the characteristics of this knowledge, we propose to represent it with objects (UML class diagrams) and rules in Production Rule Representation (PRR) language. Static aggregation knowledge is represented in the class diagrams, while rules represent the dynamics (i.e. how aggregation may be performed depending on context). We present the class diagrams, and a typology and examples of associated rules. We argue that this representation of aggregation knowledge allows an early modeling of user requirements in a data warehouse project.

**Keywords:** Data warehouse, On-line Analytical Processing (OLAP), Conceptual multidimensional model, aggregation, UML, Production rule.

## 1 Introduction

Data warehouses are the cornerstone of data-driven decision support systems (DSS) [11]. They rely on a multidimensional model, providing users with a business-oriented view of data. Using On-Line Analytical Processing (OLAP) tools, decision makers may then navigate through and analyze multidimensional data. Typically, users need to analyze data at different aggregation levels, which is achieved by means of the roll-up operator (and its converse operator, the drill-down operator). Therefore, in order to ensure correct and flexible aggregation, aggregation knowledge should be

adequately represented in conceptual multidimensional models, and mapped in subsequent logical and physical models. This aggregation knowledge pertains to aggregation functions that can be applied, as well as to hierarchies along which they are applicable, etc.

Several authors have studied how data may be aggregated along hierarchies (a.k.a. summarizability), and several conceptual multidimensional models incorporate aggregation knowledge [2,6,9,14]. [2] includes summarizability constraints. [5] develops a taxonomy of the additive nature of measures (non-, semi-, fully-additive). [9] introduces non-additivity and semi-additivity as constraints on measures. Based on the typology of aggregation functions presented in [13], [6] defines aggregations using 4 restriction levels. For example, level 3 only allows COUNT operations on measures. [4] uses intentional rules to define exceptions in aggregation hierarchies; this paper illustrates the applicability of rules to model aggregation knowledge, but does not consider aggregation functions. Finally, [7] defines three necessary conditions for summarizability: disjointness, completeness of category attributes, and temporal specific conditions.

Despite the contributions of previous research, aggregation knowledge is still poorly or inadequately represented in current conceptual multidimensional models. Aggregation knowledge is difficult to represent in a simple way [15]. This knowledge (1) has a complex structure and dynamics and (2) is highly contextual in nature (e.g. the aggregation functions that may be applied at a given time may depend on the functions applied previously). In order to account for the characteristics of aggregation knowledge, we propose to represent it with objects (UML class diagrams [12]) and rules (in Production Rule Representation language [12]). Static aggregation knowledge is represented in the UML class diagrams, combined with PRR rules which represent the dynamics (i.e. how aggregation may be performed depending on context).

The rest of the paper is organized as follows. Section 2 focuses on the representation of static aggregation knowledge, using UML class diagrams. Section 3 proposes a typology of rules to represent dynamic aggregation knowledge, and illustrates how these rules may be represented and organized in the PRR formalism. Section 4 concludes and points to further research.

## **2 Representing Static Aggregation Knowledge: UML Class Diagrams**

A conceptual multidimensional model should clearly distinguish between structure (schema) and content (instances) [15]. In our approach, this distinction is crucial, since aggregations (roll-ups) will be performed at the instance level. We therefore distinguish between the core conceptual multidimensional model (used for the conceptual representation of a data warehouse), and the data cube model. A data cube is a user view on multidimensional data (like the core conceptual multidimensional model, the data cube model is represented at the conceptual level, i.e. independently of any OLAP implementation). Aggregations operate on and result in data cubes.

The UML class diagram of Figure 1 represents the static view of the core conceptual multidimensional model. This model draws on earlier work [3,14] and focuses more specifically on concepts related to aggregation. A conceptual multidimensional schema is composed of facts and dimensions. Facts are composed of measures and dimensions are composed of hierarchies. Hierarchies are built upon rollup relationships between dimension levels. The roles of rollup relationships are characterized by their multiplicity. For example, when the lower multiplicity of the source role is 0, we have an asymmetric hierarchy [10]; when the upper multiplicity of the target role is \* (i.e. the target is plural), we have a non-strict hierarchy [10], which requires the definition of a coefficient [3]. The model enables the data warehouse designer to specify some applicable aggregation functions; however, this is not compulsory since PRR rules (described in Section 3) are specifically aimed at representing dynamic aggregation knowledge, including applicable aggregation functions.

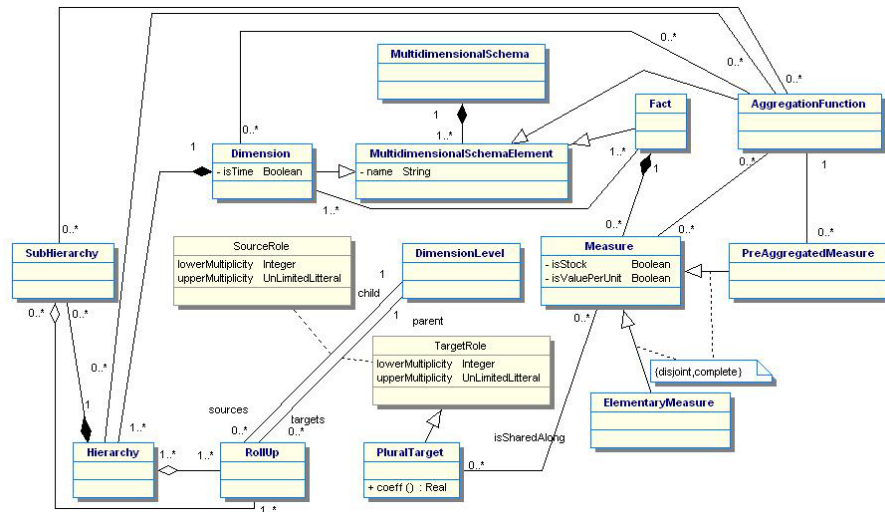


Fig. 1. Core Conceptual Multidimensional Model (MM): static view

Figure 2 represents the static view of a data cube (“MM” refers to classes of the core conceptual multidimensional model). A data cube is composed of cells and axes. Each axis has a default hierarchy (the default hierarchy used for rollup, as proposed in the Common Warehouse Metamodel [12]). A cell is composed of cell values (one value for each measure). Cell values may be base cell values or aggregated cell values (i.e. cell values resulting from previous rollups).

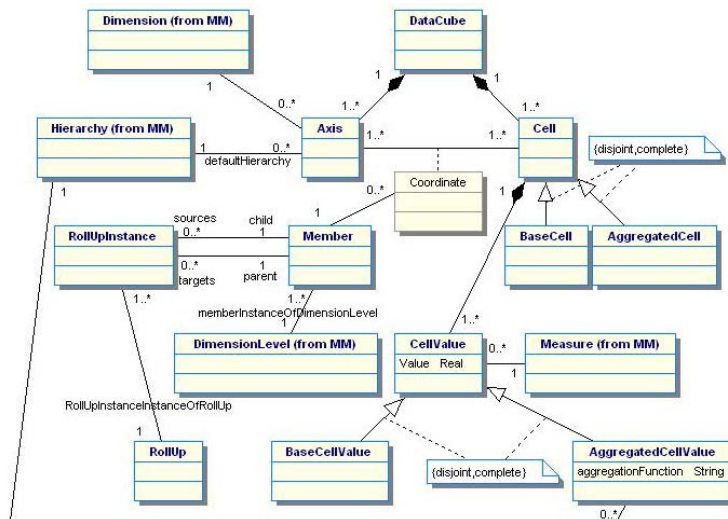


Fig. 2. Data cube model: static view

### 3 Representing Dynamic Aggregation Knowledge: PRR Rules

In order to completely represent aggregation knowledge, we must specify how, in a given context, aggregation may be performed on a given data cube (i.e. how to choose the aggregation function, and how to perform the aggregation once the aggregation function has been chosen). Since this knowledge is complex and highly contextual (depending on the data cube, the user preferences...), it is appropriately represented with rules. Rules also enable us to explain why a particular aggregation function has been chosen in a given context and how it has been applied.

To represent aggregation rules, we have chosen the Production Rule Representation language, complying with our choice of UML for representing the conceptual multidimensional model. The Production Rule Representation language enables the representation of rules related to the UML class diagrams presented in section 2, independently of subsequent implementations.

#### 3.1 The Production Rule Representation Language (PRR)

The Production Rule Representation language (PRR) [12] has been proposed by OMG for high-level (tool-independent) representation of rules.

PRR rules are grouped into rulesets. A ruleset is a collection of rules with a particular mode of execution (sequential or inferencing). When inferencing is chosen



as a mode of execution, priorities may be defined to constrain the order in which rules will be executed. PRR currently supports forward chaining only.

A production rule is typically represented as *if [condition] then [action-list]*. For example, an action may be the invocation of an operation associated with a class, or the assertion (creation) of a new object.

Variables may be defined at the ruleset level or the rule level. Rules variables are used for binding.

PRR rules can be represented formally, based on an extension of the Object Constraint Language (OCL) [12].

### 3.2 Typology and Examples of Rules

We distinguish the following types of aggregation rules:

- *Semantic aggregation rules*, which are based on the semantics of elements of the conceptual multidimensional model (e.g. semantics of dimensions, measures, aggregation functions).
- *Syntactic aggregation rules*, which express the mathematical properties of aggregation functions (e.g. commutativity, related to the concept of distributivity [8]).
- *User preferences* (e.g. “The aggregation function SUM should be used preferably to other aggregation functions.”).
- *Aggregation execution rules*.

Semantic and syntactic aggregation rules indicate which aggregations are correct; user preferences indicate which aggregations are preferable (in case several candidate aggregation functions are applicable). Finally, aggregation execution rules indicate how a particular aggregation function should be executed once it has been chosen (e.g. how to perform aggregation along a non-strict [10] hierarchy).

We give illustrations for each category of rules.

#### **Semantic aggregation rules**

These rules are complex and may depend, among other things, on the semantics of measures, dimensions and hierarchies. By representing aggregation knowledge as rules, we enable easy update of semantic aggregation knowledge (new rules are added as new semantic aggregation knowledge is acquired).

*Example R1: Measures of type stock are not additive along temporal dimensions [7].*

*Example R2: Ratios are not additive along any dimension [7].*

*Example R3: For a non-elementary (i.e. pre-aggregated) measure of type COUNT, along certain dimensions, aggregation may be incorrect from a certain dimension level, or a change in aggregation function may be necessary.*

As an illustration of rule R3, consider the number of credits of a module (i.e. the number of credits that the student will get in the module if he passes). Suppose we have the hierarchy module  $\rightarrow$  diploma  $\rightarrow$  institution. When rolling up from module to diploma, it makes sense to use the aggregation function SUM (total number of credits for the diploma). However, totaling the number of credits for the different diplomas of an institution does not make sense. Other aggregation functions may be used instead, e.g. MIN.

### **Syntactic aggregation rules**

These rules indicate the correct sequencing of aggregation functions, within a given dimension (intra-dimension syntactic aggregation rules), or between different dimensions (inter-dimension syntactic aggregation rules, sometimes referred to as commutativity).

*Example R4 (intra-dimension rule): For a given measure, for a given dimension, making the sum of averages does not make sense.*

### **User preferences**

These rules enable the representation of preferences for a given user, a profile of users, or for all users.

*Example R5: If applicable aggregation functions are specified in the core conceptual multidimensional model, these functions should be applied in priority.*

*Example R6: SUM should be applied preferably to all other aggregation functions [13].*

*Example R7: AVG, MIN or MAX should be applied preferably to COUNT [13].*

*Example R8: For a given measure, the same aggregation function should be applied to all dimensions along all hierarchies.*

*Example R9: For a given measure and a given hierarchy, the same aggregation function should be applied along all levels of the hierarchy.*

*Example R10: Aggregation should be stopped when null values are obtained. (Null values may be obtained when aggregating measures along asymmetric hierarchies [10] for example).*

### **Aggregation execution rules**

These rules are needed, in particular, to deal with non-standard (e.g. non-strict or asymmetric) hierarchies. They may also explicit how null values are taken into account in computing aggregation, which is crucial in OLAP applications [8].

*Example R11: Sums along non-strict hierarchies are performed by consider null values as 0.*

### 3.3 PRR rules organization and examples

The context of aggregation consists in a triple  $\langle \text{data cube}, \text{measure}, \text{axis} \rangle$ . *Data cube* is the active data cube, *measure* is the measure that the user wants to aggregate, and *axis* is the axis along which the user wants to perform the aggregation. We define a first ruleset for choosing the aggregation function. Inside the ruleset, the candidate aggregation functions are determined by means of the semantic and syntactic aggregation rules, and user preferences. These rules add or delete aggregation functions in the list of candidate aggregation functions. Ultimately, a unique aggregation function is chosen. (We illustrate a few examples of the rules described in section 3.2.)

```
RuleSet chooseAggregationFunction
  (in currentDataCube: DataCube, currentMeasure:
   Measure, currentAxis: Axis,
   out chosenAggregation: String)
```

**Variable:**

```
candidateAggregationFunctions: Set =
  Set{'SUM', 'AVG', 'MIN', 'MAX', 'COUNT'}
```

**Rule** R1\_stockNotAdditiveTime

**Condition:**

```
candidateAggregationFunctions->includes('SUM') and
currentMeasure.isStock=true and
currentAxis.dimension.isTime=true
```

**Action:**

```
candidateAggregationFunctions =
candidateAggregationFunctions->excluding('SUM')
```

**Rule** R4\_intraDimensionNotSumAfterAvg

**RuleVariable:**

```
?cell: Cell = currentDataCube.cells->any
  (c:Cell|currentDataCube.cells->first()==c)
?cellValues: Set = ?cell.cellValues->select
  (cv:CellValue|
  cv.oclIsTypeOf('AggregatedCellValue') and
  cv.measure=currentMeasure and
  cv.hierarchy.dimension=currentAxis.dimension and
  cv.aggregationFunction='AVG')
```

**Condition:**

```
candidateAggregationFunctions->includes('SUM') and
?cellValues->notEmpty()
```

**Action:**

```
candidateAggregationFunctions =
candidateAggregationFunctions->excluding('SUM')
```

**Rule** R6\_sumPreferableAggregation

**Condition:**

```
candidateAggregationFunctions->includes('SUM') and
candidateAggregationFunctions->size()>1
```

**Action:**

```
candidateAggregationFunctions=Set{'SUM'}
```

Once a unique aggregation function has been chosen, aggregation execution rules are used to perform the aggregation. For this purpose, we define a second ruleset. (In the sequel, we assume, for the sake of brevity, that there is only one measure, one axis, and no non-strict hierarchies). The first 3 rules are always executed, while the last rule implements rule r11 presented above.

**RuleSet** executeAggregation

```
(in currentDataCube: DataCube, currentMeasure:
Measure, currentAxis: Axis,
chosenAggregation: String)
```

**Variable:**

```
newDataCube: DataCube
theAggregatedCell: AggregatedCell
theMembers: Set = Set{}
```

**Rule** R0a\_initializeNewDataCube (priority = 3)

**Action:**

```
newDataCube = assert DataCube
assert Axis (dimension = currentAxis.dimension ;
hierarchy = currentAxis.hierarchy)
```

**Rule** R0b\_findParentMembers (priority = 2)

**RuleVariable:**

```
?cell: Cell = currentDataCube.cells->any()
?coordinate: Coordinate = ?cell.coordinate-> any
(c: Coordinate|c.axis=currentAxis)
?rollUpInstance: RollUpInstance =
?coordinate.member.sources->any
(r:RollUpInstance|r.rollUp.hierarchies->
includes(currentAxis.hierarchy))
```

**Condition:**

```
theMembers->excludes(?rollUpInstance.parent)
```

**Action:**

```
theMembers = theMembers->
including(?rollUpInstance.parent)
```

**Rule** R0c\_initializeCellsAndCellValues (priority = 1)

**RuleVariable:**

```
?parentMember: Member= theMembers->any()
```

**Action:**

```
theAggregatedCell = assert AggregatedCell
(dataCube=newDataCube)
assert Coordinate(axis = currentAxis; cell =
theAggregatedCell; member = ?parentMember)
assert AggregatedCellValue
(cell = theAggregatedCell; hierarchy =
currentAxis.hierarchy; aggregationFunction =
chosenAggregation; measure = currentMeasure;
value = 0)
```

**Rule** R11\_executeSum<sup>1</sup>. (priority = 0)

**RuleVariable:**

```
?aggregatedCell: AggregatedCell =
    newDataCube.cells->any()
?aggregatedCellValue: AggregatedCellValue =
    ?aggregatedCell.cellValues->any()
?parentMember: Member =
    ?aggregatedCell.coordinate->any()
?rollUpInstance: RollUpInstance =
    ?parentMember.targets->any
    (r:RollupInstance|r.rollUp.hierarchies
    ->includes(currentAxis.hierarchy))
?sourceCell: Cell = currentDataCube.cells->any
    (c:Cell|c.coordinate.member=
    ?rollUpInstance.child)
?sourceCellValue: CellValue =
    ?sourceCell.cellValues->any()
```

**Condition:**

```
?sourceCellValue.value<>1
```

**Action:**

```
?aggregatedCellValue.value =
    ?aggregatedCellValue.value +
    ?sourceCellValue.value
```

## 4 Conclusion and Further Research

The aggregation concept is of central concern in data warehouse design and multidimensional modeling. However, it is generally poorly represented, due to the fact that multidimensional models mainly focus on static knowledge representation. To overcome this limitation, we proposed in this paper to use Production Rule Representation to enrich UML class diagrams with dynamic aggregation knowledge. The literature mentions approaches which mainly represent information on aggregation hierarchies. We go beyond by proposing PRR as a means to incorporate dynamic aggregation knowledge in the multidimensional model. In order to achieve this objective, we extended PRR allowing us to define variables representing collection types as in standard OCL. The main contributions of this paper are in i) collecting knowledge on aggregation in the literature, ii) classifying it into semantic rules, syntactic rules, user-preference rules, and execution rules, iii) homogenizing the description of these rules in a unique formalism using PRR language, and iv) demonstrating the expressive power of PRR language. Beyond the examples of PRR

rules as illustrated in this paper, we plan to perform larger experiments based on a prototype. The next step of our research will consist of the definition of mapping rules to transform PRR aggregation rules into commands that could be executed by an OLAP tool. The typology of aggregation rules can also be refined and used to define rule execution strategies. Finally, sequence diagrams could be used to combine rulesets, as proposed in [1].

## References

1. Abdullah, M., Benest, I., Paige, R., Kimble, C.: Using Unified Modeling Language for conceptual modeling of Knowledge-Based Systems, Proc. ER 2007, Auckland, New Zealand, November 2007
2. Abello, A., Samos, J., Saltor, F.: YAM<sup>2</sup>: a multidimensional conceptual model extending UML, Information Systems, 31 (6), September 2006
3. Akoka, J., Comyn-Wattiau, I., Prat, N.: Dimension hierarchies design from UML generalizations and aggregations, Proc. ER 2001, Yokohama, Japan, November 2001
4. Espil, M.M., Vaisman, A.: Revising aggregation hierarchies in OLAP: a rule-based approach, Data & Knowledge Engineering, 45 (2), May 2003
5. Horner, J., Song, I.-Y., Chen, P.: An analysis of additivity in OLAP systems, Proc. DOLAP'04, Washington, DC, USA, November 2004
6. Hüsemann, B., Lechtenböcker, J., Vossen, G.: Conceptual data warehouse design, Proc. DMDW 2000, Stockholm, Sweden, June 2000
7. Lenz, H.-J., Shoshani, A.: Summarizability in OLAP and statistical data bases, Proc. SSDBM'97, Olympia, Washington, USA, August 1997
8. Lenz, H.-J., Thalheim, B.: OLAP databases and aggregation functions, Proc. SSDBM 2001, Fairfax, Virginia, USA, July 2001
9. Lujan-Mora, S., Trujillo, J., Song, I.-Y.: A UML profile for multidimensional modeling in data warehouses, Data & Knowledge Engineering, 59 (3), December 2006
10. Malinowski, E., Zimanyi, E.: Hierarchies in a multidimensional model: from conceptual modeling to logical representation, Data & Knowledge Engineering, 59 (2), November 2006
11. March, S., Hevner, A.: Integrated decision support systems: a data warehousing perspective, Decision Support Systems, 43 (3), April 2007
12. Object Management Group: OMG specifications, available at [http://www.omg.org/technology/documents/spec\\_summary.htm](http://www.omg.org/technology/documents/spec_summary.htm)
13. Pedersen, T., Jensen, C.: Multidimensional data modeling for complex data, Proc. ICDE'99, Sydney, Australia, March 1999
14. Prat, N., Akoka, J., Comyn-Wattiau, I.: A UML-based data warehouse design method, Decision Support Systems, 42 (3), December 2006
15. Torlone, R.: Conceptual multidimensional models. In M. Rafanelli (ed), Multidimensional databases: problems and solutions, Idea Group, 2003

---

---

**LISTE DES DOCUMENTS DE RECHERCHE DU CENTRE DE RECHERCHE DE L'ESSEC**  
(Pour se procurer ces documents, s'adresser au CENTRE DE RECHERCHE DE L'ESSEC)

**LISTE OF ESSEC RESEARCH CENTER WORKING PAPERS**  
(Contact the ESSEC RESEARCH CENTER for information on how to obtain copies of these papers)

RESEARCH.CENTER@ESSEC.FR

---

---

## 2004

- 04001 BESANCENOT Damien, VRANCEANU Radu**  
Excessive Liability Dollarization in a Simple Signaling Model
- 04002 ALFANDARI Laurent**  
Choice Rules Size Constraints for Multiple Criteria Decision Making
- 04003 BOURGUIGNON Annick, JENKINS Alan**  
Management Accounting Change and the Construction of Coherence in Organisations: a Case Study
- 04004 CHARLETY Patricia, FAGART Marie-Cécile, SOUAM Saïd**  
Real Market Concentration through Partial Acquisitions
- 04005 CHOFFRAY Jean-Marie**  
La révolution Internet
- 04006 BARONI Michel, BARTHELEMY Fabrice, MOKRANE Mahdi**  
The Paris Residential Market: Driving Factors and Market Behaviour 1973-2001
- 04007 BARONI Michel, BARTHELEMY Fabrice, MOKRANE Mahdi**  
Physical Real Estate: A Paris Repeat Sales Residential Index
- 04008 BESANCENOT Damien, VRANCEANU Radu**  
The Information Limit to Honest Managerial Behavior
- 04009 BIZET Bernard**  
Public Property Privatization in France
- 04010 BIZET Bernard**  
Real Estate Taxation and Local Tax Policies in France
- 04011 CONTENSOU François**  
Legal Profit-Sharing: Shifting the Tax Burden in a Dual Economy
- 04012 CHAU Minh, CONTENSOU François**  
Profit-Sharing as Tax Saving and Incentive Device
- 04013 REZZOUK Med**  
Cartels globaux, riposte américaine. L'ère Empagran ?

## 2005

- 05001 VRANCEANU Radu**  
The Ethical Dimension of Economic Choices
- 05002 BARONI Michel, BARTHELEMY Fabrice, MOKRANE Mahdi**  
A PCA Factor Repeat Sales Index (1973-2001) to Forecast Apartment Prices in Paris (France)

- 05003 ALFANDARI Laurent**  
Improved Approximation of the General Soft-Capacitated Facility Location Problem
- 05004 JENKINS Alan**  
Performance Appraisal Research: A Critical Review of Work on “the Social Context and Politics of Appraisal”
- 05005 BESANCENOT Damien, VRANCEANU Radu**  
Socially Efficient Managerial Dishonesty
- 05006 BOARI Mircea**  
Biology & Political Science. Foundational Issues of Political Biology
- 05007 BIBARD Laurent**  
Biologie et politique
- 05008 BESANCENOT Damien, VRANCEANU Radu**  
Le financement public du secteur de la défense, une source d'inefficacité ?

## **2006**

- 06001 CAZAVAN-JENY Anne, JEANJEAN Thomas**  
Levels of Voluntary Disclosure in IPO prospectuses: An Empirical Analysis
- 06002 BARONI Michel, BARTHELEMY Fabrice, MOKRANE Mahdi**  
Monte Carlo Simulations versus DCF in Real Estate Portfolio Valuation
- 06003 BESANCENOT Damien, VRANCEANU Radu**  
Can Incentives for Research Harm Research? A Business Schools Tale
- 06004 FOURÇANS André, VRANCEANU Radu**  
Is the ECB so Special? A Qualitative and Quantitative Analysis
- 06005 NAIDITCH Claire, VRANCEANU Radu**  
Transferts des migrants et offre de travail dans un modèle de signalisation
- 06006 MOTTIS Nicolas**  
Bologna: Far from a Model, Just a Process for a While...
- 06007 LAMBERT Brice**  
Ambiance Factors, Emotions and Web User Behavior: A Model Integrating and Affective and Symbolical Approach
- 06008 BATISTA Catia, POTIN Jacques**  
Stages of Diversification and Capital Accumulation in an Heckscher-Ohlin World, 1975-1995
- 06009 TARONDEAU Jean-Claude**  
Strategy and Organization Improving Organizational Learning
- 06010 TIXIER Daniel**  
Teaching Management of Market Driven Business Units Using Internet Based Business Games
- 06011 COEURDACIER Nicolas**  
Do Trade Costs in Goods Market Lead to Home Bias in Equities?
- 06012 AVIAT Antonin, COEURDACIER Nicolas**  
The Geography of Trade in Goods and Asset Holdings
- 06013 COEURDACIER Nicolas, GUIBAUD Stéphane**  
International Portfolio Diversification Is Better Than You Think
- 06014 COEURDACIER Nicolas, GUIBAUD Stéphane**  
A Dynamic Equilibrium Model of Imperfectly Integrated Financial Markets
- 06015 DUAN Jin-Chuan, FULOP Andras**  
Estimating the Structural Credit Risk Model When Equity Prices Are Contaminated by Trading Noises
- 06016 FULOP Andras**  
Feedback Effects of Rating Downgrades



- 06017** **LESCOURRET Laurence, ROBERT Christian Y.**  
 Preferencing, Internalization and Inventory Position
- 06018** **BOURGUIGNON Annick, SAULPIC Olivier, ZARLOWSKI Philippe**  
 Management Accounting Change in the Public Sector: A French Case Study and a New Institutional Perspective
- 06019** **de BEAUFORT Viviane**  
 One Share – One Vote, le nouveau Saint Graal ?
- 06020** **COEURDACIER Nicolas, MARTIN Philippe**  
 The Geography of Asset Trade and the Euro: Insiders and Outsiders
- 06021** **BESANCENOT Damien, HUYNH Kim, VRANCEANU Radu**  
 The "Read or Write" Dilemma in Academic Production: A European Perspective

## **2007**

- 07001** **NAIDITCH Claire, VRANCEANU Radu**  
 International Remittances and Residents' Labour Supply in a Signaling Model
- 07002** **VIENS G., LEVESQUE K., CHAHWAKILIAN P., EL HASNAOUI A., GAUDILLAT A., NICOL G., CROUZIER C.**  
 Évolution comparée de la consommation de médicaments dans 5 pays européens entre 2000 et 2004 : analyse de 7 classes pharmaco-thérapeutiques
- 07003** **de BEAUFORT Viviane**  
 La création d'entreprise au féminin dans le monde occidental
- 07004** **BOARI Mircea**  
 Rationalizing the Irrational. The Principle of Relative Maximization from Sociobiology to Economics and Its Implications for Ethics
- 07005** **BIBARD Laurent**  
 Sexualités et mondialisation
- 07006** **VRANCEANU Radu**  
 The Moral Layer of Contemporary Economics: A Virtue Ethics Perspective
- 07007** **LORINO Philippe**  
 Stylistic Creativity in the Utilization of Management Tools
- 07008** **BARONI Michel, BARTHELEMY Fabrice, MOKRANE Mahdi**  
 Optimal Holding Period for a Real Estate Portfolio
- 07009** **de BEAUFORT Viviane**  
 One Share - One Vote, the New Holy Graal?
- 07010** **DEMEESTERE René**  
 L'analyse des coûts : public ou privé ?
- 07011** **TIXIER Maud**  
 Appreciation of the Sustainability of the Tourism Industry in Cyprus
- 07012** **LORINO Philippe**  
 Competence-based Competence Management: a Pragmatic and Interpretive Approach. The Case of a Telecommunications Company
- 07013** **LORINO Philippe**  
 Process Based Management and the Central Role of Dialogical Collective Activity in Organizational Learning. The Case of Work Safety in the Building Industry
- 07014** **LORINO Philippe**  
 The Instrumental Genesis of Collective Activity. The Case of an ERP Implementation in a Large Electricity Producer
- 07015** **LORINO Philippe, GEHRKE Ingmar**  
 Coupling Performance Measurement and Collective Activity: The Semiotic Function of Management Systems. A Case Study

- 07016 SALLEZ Alain**  
Urbaphobie et désir d'urbain, au péril de la ville
- 07017 de CARLO Laurence**  
The Classroom as a Potential Space - Teaching Negotiation through Paradox
- 07019 ESPOSITO VINZI Vincenzo**  
Capturing and Treating Unobserved Heterogeneity by Response Based Segmentation in PLS Path Modeling. A Comparison of Alternative Methods by Computational Experiments
- 07020 CHEVILLON Guillaume, Christine RIFFLART**  
Physical Market Determinants of the Price of Crude Oil and the Market Premium
- 07021 CHEVILLON Guillaume**  
Inference in the Presence of Stochastic and Deterministic Trends
- 07023 COLSON Aurélien**  
The Ambassador, between Light and Shade. The Emergence of Secrecy as the Norm of International Negotiation
- 07024 GOMEZ Marie-Léandre**  
A Bourdieusian Perspective on Strategizing
- 07025 BESANCENOT Damien, VRANCEANU Radu**  
Multiple Equilibria in a Firing Game with Impartial Justice
- 07026 BARONI Michel, BARTHELEMY Fabrice, MOKRANE Madhi**  
Is It Possible to Construct Derivatives for the Paris Residential Market?

## **2008**

- 08001 BATISTA Catia, POTIN Jacques**  
International Specialization and the Return to Capital, 1976-2000
- 08002 BESANCENOT Damien, FARIA Joan Ricardo, VRANCEANU Radu**  
Why Business Schools Do So Much Research: a Signaling Explanation
- 08003 de BEAUFORT Viviane**  
D'un effet vertueux de l'art. 116 de la loi NRE en matière de RSE ? La problématique est posée à échelle de l'Union européenne
- 08004 MATHE Hervé**  
Greater Space Means More Service: Leveraging the Innovative Power of Architecture and Design
- 08005 MATHE Hervé**  
Leading in Service Innovation: Three perspectives on Service Value delivery in a European Context
- 08006 ROMANIUK Katarzyna, VRANCEANU Radu**  
Asset Prices and Asymmetries in the Fed's Interest Rate Rule: A Financial Approach
- 08007 MOTTIS Nicolas, WALTON Peter**  
Measuring Research Output across Borders - A Comment
- 08008 NAPPI-CHOULET Ingrid, MAURY Tristan-Pierre**  
A Spatiotemporal Autoregressive Price Index for the Paris Office Property Market
- 08009 METIU Anca, OBODARU Otilia**  
Women's Professional Identity Formation in the Free/Open Source Software Community
- 08010 SIBIEUDE Thierry, VIDAL Rodolphe**  
Le programme « Une grande école : pourquoi pas moi ? ® ». D'une action de responsabilité sociétale de l'ESSEC à la responsabilité sociétale des grandes écoles françaises
- 08011 SIBIEUDE Thierry, VIDAL Rodolphe**  
Enjeux et perspectives du sociétariat des groupes mutualistes complexes face aux stratégies de développement à l'échelle groupe : quelques enseignements du cas du groupeMACIF
- 08012 FOURÇANS André, VRANCEANU Radu**  
Money in the Inflation Equation: the Euro Area Evidence

- 08013 CAZAVAN-JENY Anne, JEANJEAN Thomas**  
Supply and Demand for European Accounting Research. Evidence from EAA Congresses
- 08014 FAYARD Anne-Laure, METIU Anca**  
Beyond Orality and Literacy: Letters and Organizational Communication
- 08015 CAZAVAN-JENY Anne, MISSONIER-PIERA Franck, MARGAINE J.**  
CEO Compensations in a Stakeholders' Regime: An Empirical Investigation with French Listed Companies
- 08016 METIU Anca, FAYARD Anne-Laure**  
Letters and Scientific Communities
- 08017 BESANCENOT Damien, VRANCEANU Radu**  
Migratory Policy in Developing Countries: How to Bring Best People Back?
- 08018 BESANCENOT Damien, VRANCEANU Radu**  
Financial Distress and Bank's Communication Policy in Crisis Time
- 08019 AGID Philippe, TARONDEAU Jean-Claude**  
Les performances des maisons d'Opéra : une explication statistique

## **2009**

- 09001 POTIN Jacques**  
The Selection Effect of Two-way Trade in the Melitz Model: An Alternative Approach
- 09002 NAIDITCH Claire, VRANCEANU Radu**  
Migratory Equilibria with Invested Remittances
- 09003 BARONI Michel, BARTHELEMY Fabrice, MOKRANE Mahdi**  
A Repeat Sales Index Robust to Small Datasets
- 09004 NAPPI-CHOULET Ingrid, MAURY Tristan-Pierre**  
A Spatial and Temporal Autoregressive Local Estimation for the Paris Housing Market
- 09005 BENCHIMOL Jonathan, FOURÇANS André**  
Money in a DSGE Framework with an Application to the Euro Zone
- 09006 VRANCEANU Radu**  
Four Myths and a Financial Crisis
- 09007 BESANCENOT Damien, VRANCEANU Radu**  
Banks' Risk Race: A Signaling Explanation
- 09008 BESANCENOT Damien, HUYNH Kim, VRANCEANU Radu**  
Desk Rejection in an Academic Publication Market Model with Matching Frictions
- 09009 BOUTY Isabelle, GOMEZ Marie-Léandre**  
Unpacking Knowing Integration: A Practice-based Study in Haute Cuisine
- 09010 GOMEZ Marie-Léandre, BOUTY Isabelle**  
The Social Dimensions of Idea Work in Haute Cuisine: A Bourdieusian Perspective
- 09011 GOMEZ Marie-Léandre**  
Knowledge Dynamics During Planning Practices
- 09012 GIRAUD Gaël, RENOUEAU Cécile**  
Relational Capability: An Indicator of Collective Empowerment
- 09013 MOTTIS Nicolas, PONSSARD Jean-Pierre**  
Création de valeur, 10 ans après...

Pour tous renseignements :

- **Centre de Recherche/Research Center**

Tél. 33 (0)1 34 43 30 91  
research.center@essec.fr

- **Visitez notre site**

**[www.essec.fr](http://www.essec.fr)**

ESSEC BUSINESS SCHOOL PARIS  
AVENUE BERNARD HIRSCH - BP 50105 CERGY  
95021 CERGY-PONTOISE CEDEX - FRANCE  
TÉL. +33 (0)1 34 43 30 00 - FAX +33 (0)1 34 43 30 01  
[www.essec.fr](http://www.essec.fr)

ESSEC EXECUTIVE EDUCATION  
CNIT - BP 230  
92053 PARIS LA DÉFENSE - FRANCE  
TÉL. +33 (0)1 46 92 49 00 - FAX +33 (0)1 46 92 49 90  
<http://formation.essec.fr>

ESSEC BUSINESS SCHOOL, SINGAPORE CAMPUS  
100 VICTORIA STREET - NATIONAL LIBRARY BUILDING #13-02  
SINGAPORE 188064  
TÉL. +65 6884 9780 - FAX +65 6884 9781  
[www.essec.edu](http://www.essec.edu)

