Computational Risk Management

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Mapping Financial Stability

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Work is more fun than fun

—Noel Coward

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Frankfurt, January 31, 2014 Peter Sarlin

Contents

Acronyms

AANN	Auto-Associative Neural Network
AE	Advanced Economy
AI	Artificial Intelligence
ANN	Artificial Neural Network
AUC	Area Under the Curve
BIS	Bank for International Settlements
BMU	Best-Matching Unit
BSC	Banking Supervision Committee
CCA	Curvilinear Component Analysis
CCE	Coordinated Compilation Exercise
CCF	Correct Classification Frontier
CDA	Curvilinear Distance Analysis
CDS	Credit Default Swap
CHAPS	Clearing House Automated Payment System
CISS	Composite Indicator of Systemic Stress
CRISP-DM	Cross Industry Standard Process for Data Mining
DA	Discriminant Analysis
DDR	Data-Dimension Reduction
DQRS	Data Quality Reference Site
ECB	European Central Bank
EDA	Exploratory Data Analysis
EME	Emerging Market Economy
EU	European Union
FCM	Fuzzy C-Means
FDI	Financial Distress Index
FSI	Financial Soundness Indicator
FSOM	Feedback SOM
GA	Genetic Algorithm
GDDS	General Data Dissemination System
GDP	Gross Domestic Product
GFSM	Global Financial Stability Map
GTM	Generative Topographic Mapping
IA	Intelligence Amplification
IMF	International Monetary Fund

IS	Information Systems
IT	Information Technology
KD	Knowledge Discovery
KDD	Knowledge Discovery in Databases
LE	Laplacian Eigenmaps
LLE	Locally Linear Embedding
LMDS	Local MDS
MDS	Multidimensional Scaling
MPI	Macro-Prudential Indicator
MSOM	Merge SOM
MVU	Maximum Variance Unfolding
NG	Neuro-Genetic
OECD	Organisation for Economic Co-operation and Development
PCA	Principal Component Analysis
QE	Quantization Error
RecSOM	Recursive SOM
RO	Research Objective
ROC	Receiver Operating Characteristics
RQ	Research Question
RSOM	Recurrent SOM
RT	Research Theme
SDDS	Special Data Dissemination Standard
SIFI	Systemically Important Financial Institutions
SNA	System of National Accounts
SOFSM	Self-Organizing Financial Stability Map
SOM	Self-Organizing Map
SOMSD	SOM for Structured Data
SOTM	Self-Organizing Time Map
TARGET	Trans-European Automated Real-time Gross Settlement Express Transfer System
TPM	Transition Probability Matrix
t-SNE	t-Distributed Stochastic Neighbor Embedding
TSOM	Temporal SOM
UK	United Kingdom
US	United States
VQ	Vector Quantization
XOM	Exploration Observation Machine

Summary

The ongoing global financial crisis has demonstrated the importance of a systemwide, or macroprudential, approach to safeguarding financial stability. An essential part of macroprudential oversight concerns the tasks of early identification and assessment of risks and vulnerabilities that eventually may lead to a systemic financial crisis. Thriving tools are crucial as they allow early policy actions to decrease or prevent further build-up of risks or to otherwise enhance the shock absorption capacity of the financial system. In the literature, three types of systemic risk can be identified: (i) build-up of widespread imbalances, (ii) exogenous aggregate shocks, and (iii) contagion. Accordingly, the systemic risks are matched by three categories of analytical methods for decision support: (i) early warning, (ii) macro stress-testing, and (iii) contagion models. Stimulated by the prolonged global financial crisis, today's toolbox of analytical methods includes a wide range of innovative solutions to the two tasks of risk identification and risk assessment. Yet, the literature lacks focus on the task of risk communication.

This book concerns macroprudential oversight from the viewpoint of all three tasks: Within analytical tools for *risk identification* and *risk assessment*, the focus concerns a tight integration of means for *risk communication*. Data and dimension reduction methods, and their combinations, hold promise for representing multivariate data structures in easily understandable formats. The overall task of the work in this book is to represent high-dimensional data concerning financial entities on low-dimensional displays. The low-dimensional representations have two subtasks: (i) to function as a display for individual data concerning entities and their time series, and (ii) to use the display as a basis to which additional information can be linked. The final nuance of the task is, however, set by the needs of the domain, data, and methods. The following five questions comprise subsequent steps addressed in this book:

1. What are the needs for macroprudential oversight?
2. What form do macroprudential data take?
3. Which data and dimension reduction methods hold most promise for the task?
4. How should the methods be extended and enhanced for the task?
5. How should the methods and their extensions be applied to the task?

Based upon the Self-Organizing Map (SOM), the work in this book not only creates the Self-Organizing Financial Stability Map (SOFSM), but also lays out a general framework for mapping the state of financial stability. The work in this book also introduces three extensions to the standard SOM for enhancing the visualization and extraction of information: (i) fuzzification, (ii) transition probabilities, and (iii) network analysis. Thus, the SOFSM functions as a display for risk identification, on top of which risk assessments can be illustrated. In addition, this book puts forward the Self-Organizing Time Map (SOTM) to provide means for visual dynamic clustering, which in the context of macroprudential oversight concerns the identification of cross-sectional changes in risks and vulnerabilities over time. Rather than automated analysis, the aim of visual means for identifying and assessing risks is to support disciplined and structured judgmental analysis based upon policymakers' experience and domain intelligence, as well as external risk communication.