Risk Management in Banking

THIRD EDITION

JOËL BESSIS

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Risk Management in Banking

"Highly recommended to professionals, risk managers and students in risk management who look for a relevant comprehensive view of how risk management expands and evolves towards greater sophistication."
Alain Canac, former Senior Credit Officer at Banque Paribas and IXIS Corporate & Investment Bank

"The recent global financial crisis has highlighted the need for all participants in the banking system to understand and intelligently utilize risk management. Updated and expanded, the new edition of Bessis's Risk Management in Banking *is the best overall guide to the concepts and tools needed to avoid the next banking crisis. Bessis reveals his roots as both academic and practitioner by his combination of intellectual rigor and pragmatic application. Concisely integrating a wide body of work within a comprehensive analytic framework, the careful exposition as well as practical illustrations will be appreciated by students and bankers alike. Highly recommended!"*
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David R. Koenig, Chief Executive Officer, The Governance Fund, LLC and Past Chair, Board of Directors, Professional Risk Managers' International Association (PRMIA)

Risk Management in Banking

THIRD EDITION

Joël Bessis

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About the Author

Joël Bessis is Professor of Finance at HEC, the leading French business school, where he conducts training in risk management throughout Europe, the US and Asia. Over the course of his career Joël has developed a dual expertise – as an academic and as a practitioner, holding permanent consulting assignments in corporations and later, in banks. Joël worked for over fifteen years in risk management departments of financial institutions – as a consultant to the risk departments of several banking institutions in Europe, including the Banque Paribas and the European Bank for Development (EIB). Joël took a leave of absence from HEC Paris between 2000 and 2005 where he held positions as Director of Research at Fitch, and Head of Risk Analytics and Model Validation in the Risk Department of IXIS, a Paris based investment bank. Joël graduated as an Engineer from École Centrale in Paris, before earning a Masters in Business Administration from Columbia University in New York, and a PhD in Finance from the Université Paris-Dauphine. As an academic, Joël has published various papers and books in the fields of corporate finance, industrial economics, and financial markets.

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Introduction

Risk management in banks became "the" hot topic after the 2008 financial crisis. The crisis appears as the most important one in the modern period. It is systemic in nature, in that it involves the entire financial system, from capital markets, to banks, funds and insurance companies, and all financial firms. Addressing risk management in this context is challenging given that the magnitude of the crisis suggests that risk management was inefficient, that risk models were inadequate and that regulations failed to meet their goal of avoiding a major crisis. Indeed, it is ironic that the crisis started when the new Basel 2 regulations were enforced in Europe.

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1 BASIC POSTULATES OF THIS TEXT

This book does not address the financial crisis directly, but does not bypass it either. The very first chapter addresses the issue of "what went wrong" in the development of the crisis, starting from the 2007 so-called "sub-prime" crisis and culminating in 2008 into an unprecedented halt of the financial system, a system that was precisely under regulations aiming at avoiding such systemic crisis.

1.1 The Financial Crisis

Some simple facts deserve to be mentioned as a starting point. Criticisms of financial firms, of regulators and regulations, of rating agencies, of governance practices, of short-sighted appetite for profitability, of improper behavior of supervising authorities, of risk models, became commonplace and are seen as major causes of the 2008 crisis. Even financial models, which are supposed to have scientific foundations, are widely blamed today, perhaps because they have been pushed too far, for example by plugging in unreliable data.

In the end, the development of the crisis, as explained in the very first chapter of this text, refers to simple mechanisms that could have been anticipated, some of them being well-known and others resulting from relatively simple adverse effects that were not beyond common sense, but emerged through interactions of new regulations. Presumably critics are right in explaining the crisis by such factors.

This fact supports the positive view that inspires this text. It postulates that there is a major distinction between practices and techniques that are economically sound and the use that financial firms make of these techniques. The financial crisis seems to be an example of what should not be done and strongly reinforces the need for sound practices and sound economics of financial firms, and an enhanced governance of financial firms.

Some implications follow. Risk management is made up from practices and tools, including risk models. Those are extremely different factors. Practices are subject to discretionary judgments and policies, to business development goals, as long as they comply with existing regulations. Technical tools and models are not.

Risk management techniques have made a lot of progress since the best practices were defined by various think-tanks and regulatory bodies. Does the crisis mean that all such progress is useless? Presumably, this is not so. It rather suggests that actual risk practices diverged from best practices, that governance has probably not been up to the standards of sound management policies, and that the growth of the financial sector, with increased risk and appetite for profitability, increased beyond what the financial system can sustain under current rules regulating the industry.

1.2 Scope and Goals of this Text

This introduction reminds one of some basic principles of risk management and explains how this text is positioned within a considerable range of financial literature. Loosely speaking, financial risks designate any uncertainty that might trigger losses.

Risk management designates the entire spectrum of risk management processes and risk models that allow banks to implement risk-based policies and practices. It covers all techniques and management processes required for monitoring and controlling risks, and the required risk models. The spectrum of processes and models extends to all financial risks, the main ones being credit risk, market risk, interest rate risk and liquidity risk. Operational risk, however, is not addressed in this text, essentially because it is a non-financial risk.

The risk prospective differs strongly from the business prospective. Business units focus on development and profit. Risk managers focus on risk control and limits, on potential losses rather than profit. While the former think "profit," the latter think "worst case" situations. The main goal of risk policies and practices is viewed as controlling risk without impairing profitability, or "optimizing" the risk–return trade-off that all financial firms face.

If there were a single key priority to re-emphasize today, it would be risk oversight by bank professionals, supervisors and standards setters. Risk oversight implies awareness of risks embedded in the balance sheets and off the balance sheets of banks. Risk oversight also implies a minimum understanding of risk models and techniques, at least with respect to a sound usage of those, without going as far as turning all professionals into risk modelers.

Buzzwords such as "bank-wide risk management," suggest that risk oversight across giant banks is widely shared and managed consistently across their wide array of business lines. Indeed, models and techniques have been designed for achieving such a goal. But the financial crisis also suggests that risk oversight was not well shared within banks or by other financial firms and regulators. Risk oversight implies knowledge of risks, a forward view on adverse events, plus the capability of enforcing risk controls and limits when risks drift away from guidelines making up banks' policies.

Risk oversight and risk controlling is theoretically and practically feasible today because risk processes, techniques, and models are developed continuously for reaching this goal. Such a postulate is often challenged today in view of the wide underestimation of the magnitude of the crisis.

Last but not least, while risk management techniques have expanded for individual firms, the techniques for early detection of risk at the system-wide level remained nearly nonexistent, with an over-reliance on self-management and self-regulations by firms. It is striking that the target of risk regulations, system-wide risk, is not measured in any way, and that regulations focused on individual specific risk of financial firms. Measuring system-wide risk is a conceptual and practical challenge. Recognition of such a "regulation hole" now finally seems to emerge in current financial reforms.

2 POSITIONING OF THE TEXT

The positioning of this text in the literature should help readers to identify how it complements the multitude of texts and articles that relate to risk and to risk management.

2.1 The "Model Divide"

Current risks are tomorrow's potential losses. Unfortunately, they are not as tangible as revenues and costs, thereby making risk modeling a conceptual and a practical challenge. Risk models and techniques have continuously expanded in recent years, enhancing the ability to monitor and control risk and to develop business activities without a myopic view on profitability. This is the "bright side" of risk models. The "dark side" is that, perhaps, the usage of risk models remained in the hands of a small group of "quants", who used them without caring too much about explaining model risk to non-specialists. This is not a good enough reason to throw everything to the trash can. The modeling effort was productive and a necessary step in the development of better risk practices.

The gap between the technicality of the literature and the capability of risk professionals, who are not model experts, to integrate the complexity of models in their own practices is damaging. Presumably, such a gap exists, and grew through time as the 2008 crisis seems to suggest.

It is noticeable that, instead of a dissemination of model expertise across the entire industry, modeling techniques tended to concentrate in a smaller core of experts. Such a concentration

might explain the persisting and growing gaps between "model experts" and practitioners. Experts are "embedded" in banks, but being "embedded" does not imply that expertise is shared.

The book does not take harsh positions against models, even though it is relatively easy to pinpoint some model glitches[1] that were the sources of the financial crisis. Instead, it capitalizes on progress achieved that should allow banks to implement truly efficient risk management. It addresses risk processes and risk models, hoping to narrow the gap between specialists of quantitative finance and risk managers. It builds on a long experience in the risk department of banks and on academic knowledge.

Modelers will find here some reminders on classical finance models, which are pre-requisites to risk models, because there is no need for expanding such finance models beyond the essentials required for understanding risk models. However, risk models are expanded, explaining the rationale of models and illustrating them with examples. The text should help increasing transparency across the technicalities of risk management. It is balanced rather than technical, with a minimal background on risk modeling and an emphasis on how to assemble risk models in a consistent way, and on techniques and processes for making bank-wide risk management achievable.

As a consequence, an important goal of this book, as in previous editions, remains to address the "model divide" between model designers and risk professionals. Experts will find that some of the introductory essentials on modeling are fairly basic in this text. On the other hand, the larger mass of practitioners and students of risk management should find the text helpful because it is largely self-contained and integrated.

2.2 Risk Management versus Risk Instruments

Many risk management texts heavily focus on hedging instruments, mainly derivatives. Jumping to instruments for managing risk without prior knowledge of the source of risks bypasses the risk oversight principle. There is a major distinction between the usage of hedging instruments and the knowledge of what should be hedged in the first place.

Because derivatives are privileged instruments for controlling risks, they are introduced in a dedicated section of this book. But they are not the main focus of this book, because we know, in general, how to hedge a risk exposure once it has been properly identified. Financial institutions develop their business through an ever-changing innovation process of products. Innovation made it feasible to customize products for matching investors' needs. It also allowed both financial and corporate entities to hedge their risks with derivatives. The need for investors to take exposures and, for those holding exposures, to hedge them provided business for both risk takers and risk hedgers.

Did that solve risk management issues in financial institutions? It did not because two basic pre-requisites of a risk management system, risk oversight and tracing risks back to risk drivers, are different issues to understanding how derivatives work. Hence, the gap remains between derivatives that makes risk management feasible and financial firms' risk management focusing on risk oversight, the prerequisite for controlling risks with proper instruments.

1 We refer here to unreliable inputs of default correlations in credit portfolio models and, presumably, a lack of stress-testing of valuation models (see the chapters in Section 9 "Dependencies" and Chapter 51 on portfolio modeling).

2.3 Reverting to Better Risk Practices and Lessons of the Crisis

This text proceeds step by step in developing the building blocks of a sound risk management scheme, with the postulate that a sound usage of risk models and techniques is a tangible advance and that the sources of the current issues have to be looked for elsewhere, in the drift of practices and policies away from "best practices," rather than flaws of techniques, even though such flaws are pointed out throughout the text.

Some of the regulatory changes that emerge from the lessons of the crisis are ongoing, and some reforms have already been identified. But it is too early to foresee how regulatory changes will be implemented. A brief overview of future reforms being considered at the time of writing concludes the book. In between, we address risk management from a technical perspective, and maintain that sound risk processes and risk models have to be re-emphasized.

Moreover, the response to the crisis by financial authorities demonstrated that a major crisis implies that gains remain private while losses become publicly shared through massive government injections of cash and capital in ailing giant banks. Such responses, with the unique choices being either the "improvised" dismantling of failing financial firms or facing a financial collapse is unsustainable in the medium and long-term. It reinforces the critical need for sound risk practices and risk models for all financial firms, plus system-wide risk oversight.

3 BOOK STRUCTURE

The structure of the book is in 16 sections, each divided into several chapters. This structure facilitates a clear distinction between related subjects, with each chapter being dedicated to a specific topic. The benefit is that it is possible to move across chapters without necessarily following a sequential process throughout the book. Each chapter, or section introduction, provides a synthesis of the topics that will subsequently be expanded, allowing the reader to get an overview of each one and how it relates to the neighboring context.

The book outline is summarized by the list of sections, each of them divided into a number of different chapters dedicated to the related topics.

1 The Financial Crisis (2007–2008)
2 Business Lines, Risks and Risk Management
3 Financial Products
4 Valuation
5 Risk Modeling
6 Regulations
7 Asset Liability Management (ALM)
8 Fund Transfer Pricing Systems
9 Dependencies and Portfolio Risk
10 Market Risk
11 Credit Risk: Standalone
12 Credit Portfolio Risk
13 Capital Allocation
14 Risk-adjusted Performance
15 Credit Portfolio Management
16 Conclusion

The book addresses risk management in nine core blocks dedicated, respectively, to:

- Bank-wide risk management
- Asset liability management (mismatch risks)
- Risk regulations and accounting standards
- Market risk models
- Credit risk models
- Dependencies modeling
- Credit portfolio models
- Capital allocation
- Risk-adjusted performance
- Credit portfolio management

In between such core blocks are sections of three types. Some are here for providing a minimum background to subsequent issues. Others address parallel issues, many gathered in Sections 1 to 4 on the financial crisis, risk management principles and financial products. Others also provide parallel technical topics with the same purpose. Among other subjects, these sections provide the basics of derivatives, of main distribution functions of random variables, and of valuation. Note that valuation is a topic addressed in a considerable volume of literature whose purpose is to address pricing models, which is not the focus in this book. Rather, what is needed here is a minimum understanding on how to model potential losses and values (Section 4), summarizing some basic principles for valuation of risky assets, and providing minimal links with the pricing literature.

The extensive section on modeling dependencies, which is the foundation of diversification modeling within portfolios, is a transversal building block that applies to all portfolio models. The dependency topic is viewed from several angles, from traditional approaches as correlations and factor models up to the modern copula approach. Dependencies are addressed by keeping the focus on the essentials and on examples throughout a sequence of chapters.

We found that textbooks rarely address risk management in banking and in financial institutions in a comprehensive manner. We have tried to compensate for such gaps, by making a compromise between technicalities and simplicity, without sacrificing scope. Readers will realize that a balanced coverage of major risk models and practices is a goal that has inspired the entire volume.

The text develops many numerical examples, while restricting the analytics to the essentials. Simple examples help in illustrating the essentials better than formal descriptions. Of course, simple examples are no substitutes to full-blown models.

Finally, there is a balance to strike between concepts, analytics and applications. The goal of risk management is to use risk models for instrumental purposes and enriching the risk processes. This principle inspired this text by making it implementation focused. From a risk management prospective, it is important to understand which are the basic data required to model risk, the guidelines for implementing models, what are their outputs and how these should feed risk processes. For example, sample reports useful for management purposes, such as ALM or credit portfolio risk reporting, are included.

4 THE THIRD EDITION

The third edition of this book adds major and voluminous extensions to the previous edition.

The very first chapter deals with the financial crisis, which could not be a better introduction to the challenges of risk management in financial firms. The overview of risk management and risk models has been extended. The financial products section is also a full addition to the previous edition. The valuation section is entirely changed and expanded. The dependency section has been fully expanded to cover all approaches to dependencies, from the traditional techniques and up to the modern, more involved, techniques. The regulations section comprehensively covers the Basel 2 regulations using, as building blocks, the various approaches and sub-approaches. It now includes some essential features of accounting standards. Excerpts of Basel 2 are scattered in different chapters, notably in presenting cash products. Some of the analytics underlying the Basel 2 formulas are expanded in the credit sections.

Note that regulations are not the starting point of this text because these rely on risk management topics and issues. Risk management topics are introduced gradually without distortions between rule-based regulations and risk economics. Regulations are addressed in a dedicated section as they should, as regulatory application of risk models and risk processes.

As it is, the text sticks to the principle that sound models and sound implementation of risk management techniques remain the reference, and that the crisis is a massive evidence of absence of compliance with otherwise sound practices, governance and models. Therefore, the text has no negative view of risk models and practices, which tend to expand today, as expected in times of a major crisis.

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SECTION I

The Financial Crisis

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I

The 2007–2008 Financial Crisis

The crisis of 2007 and 2008 was a system-wide crisis whose amplitude is unprecedented in modern finance. It is systemic, in that it extends to the entire financial system. The sub-prime crisis should have been contained within the small segment of sub-prime mortgages. Financial risks of regulated firms are subject to strict regulations, whose purpose is precisely to avoid systemic, or "system-wide," crisis. Instead, it extended to the entire financial system and triggered economic contagion. Why did regulations fail? What went wrong?

The crisis expanded through "traditional" contagions, the contaminations of other segments of the system by a local event, and through procyclical effects. Procyclicality refers to the magnification of the amplitude of cycles. Moreover contagion and procyclical effects interacted with each other, revealing unexpected and interconnected effects, as seen in the various papers and official documents[1] used as a starting point for defining reforms of the overall regulation system.

Contagion and procyclicality are joint effects, which make them difficult to segregate. Many contagion effects detailed hereafter contribute to procyclicality and the reverse is also true. In this introductory chapter on the crisis, they are sometimes isolated for convenience.

Accordingly, this chapter starts with a brief overview of the sub-prime market, the classical contagion mechanisms, the financial risks, and the basics of risk regulations and of accounting regulations. The next sections address new contagion effects that emerged from the crisis. Those include adverse effects of accounting standards, the dissemination of risks through securitization, the liquidity crunch and its mechanical contagion effect, the procyclicality resulting from regulations and financial firms' behaviors, the role of lagged rating adjustments, the adverse effects of collateral-based leverage. Although the governance of banks is an issue in this context, we focus on the above effects.

1 The Financial Stability Forum [28] focuses on procyclicality, and the White Paper of the White House [79] addresses other aspect of the crisis and proposes reforms. Both are reviewed in the concluding chapter, Chapter 60.

This preliminary chapter also provides an overview of the financial system and regulations, which are subsequently detailed throughout several dedicated chapters on risk, regulations, banks' practices and risk models.

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1.1 THE SUB-PRIME CRISIS

By mid-2007, housing prices in the US began to decline. In previous years, the mortgage industry was flourishing and the sub-prime market developed significantly. Sub-prime loans are simply loans that would not be granted to borrowers under normal standards. They are, as other mortgages, collateralized by real estate property, and rely on the expectation that house prices going up would make the collateral more valuable and transform a sub-prime loan in a prime mortgage. Collateralization is traditionally measured by the "Loan-to-Value" ratio, the ratio of the value of the collateral to the debt contracted, or "LTV." The LTV ratio is below one for mortgages. It was above standards for sub-prime loans.

In earlier years the capital markets performed well and all financial institutions were expanding profitably. Furthermore, the financial system was regulated. The so-called "Basel 2" regulations[2] for banking credit risk were enforced in 2008 in Europe. In the US, banks refrained from full compliance to the new rules, except international banks. But, in both regions, the market risk was under scrutiny by the supervisors.

However, many financial players were considering mid-2007 with some worries because the house market prices stopped inflating and because the interest rates on sub-prime loans, low at inception (teaser rates), were expected to increase after the initial grace period. A crisis in the sub-prime compartment of the market should have had a limited impact. The sub-prime market is a small segment of the huge mortgage US market. Even if some expected some difficulties in this special compartment, nobody expected that it would trigger a system-wide crisis.

In fact, an unprecedented crisis in modern times developed by the end of 2007 and peaked with the failure of Lehman Brothers in the US in September 2008. At that time, it became obvious that the entire financial system was locked into its first systemic crisis of modern times. Bank failures, considered as a "thing of the past," became numerous and spectacular. Northern Rock

2 See Chapters 19 and 20 on regulations. Regulations guidelines are defined by the Bank of International Settlements (BIS) in Basel, Switzerland.

went under, an unprecedented event in the booming United Kingdom financial industry within the previous century. Failures extended to all players, funds, and insurance companies.

At first sight, this crisis looks like a puzzle. Indeed, it took some time to get a financial picture of what happened in a narrow time framework, to have a decent perception of the magnitude of expected losses by all financial players, to understand how drastic was the extent of the crisis, to realize that the financial landscape was undergoing a unprecedented shake up in modern times, and that the rules and the perceived "best practices" of governance and risk management proved inefficient.

How come the sub-prime market triggered such a contagion to all financial players and to all financial industries, triggering in turn an economic crisis? Why did regulations fail? How could the "systemic risk," feared by all, actually materialize at a time when regulations – whose purpose is precisely to eliminate it – developed and culminated in the enforcement of the Basel 2 Accord for banks, and with the final stage of the Solvency 2 regulations for the insurance industry?

The sub-prime market size was estimated in 2007 at around $600 billion of the $3 trillion mortgage market. Sub-prime loans are loans which would normally not be granted to borrowers because they have sub-standard credit quality. Sub-prime borrowers originally pay 200–300 basis points (2–3%) above prime mortgage rates ("spread") because they have higher credit risk and because they would not otherwise get a loan. Sub-prime borrowers often pay variable rates, with a grace period (2–3 years) before rates get higher. Such features make loans riskier if borrowers cannot sustain the hike of interest rates and/or if house values move down.

Defaults on loans don't occur in the early stages of a loan, right after inception, nor at a later stage when the loan is almost paid back. Rather, the peak of defaults occurs in between, with historical statistics on non sub-prime loans showing a peak at around 50 to 60 months after origination, and depending on various factors, such as economic conditions prevailing or the nature of interest paid, fixed or adjustable. For lenders, loss in the event of default is mitigated by the real estate property backing the loan.

Default risk, measured by the likelihood of default event and the magnitude of such losses under default, increased progressively. Interest rates started to increase from mid-2004. House prices began to fall from 2005–6 in the US. Both factors reduced the solvency of borrowers and a surge in mortgage defaults showed up in 2007 and accelerated in subsequent months. The potential losses directly related to such defaults, at the date of this writing, remained difficult to evaluate, with estimates ranging initially from $200 million to much bigger figures in 2008.

The specific features of sub-prime loans led to a concentration of reset dates to higher rates after the initial grace period with low rates for sub-prime borrowers. The peak of defaults was expected to occur more or less around the same period, in 2007–2008, given estimates on "normal seasoning," or time profile of mortgage defaults. The home price downturn became visible as early as 2006 and accelerated subsequently. The three factors concurrently increased the default rates in 2007–2008.

Higher defaults in the segment were expected, perhaps not with the magnitude observed, but were also expected to remain within the segment. But they were not. Instead, the segment problems triggered unprecedented numerous "contagions" and adverse effects within the system.

Those adverse effects included a capital market downturn; a liquidity "crunch" or a contraction of liquidity of the funding and the cost of funding for all financial players; a "credit crunch," or a drastic contraction of credit; and, finally, an adverse economic impact with the risk of a strong economic recession.

The summer 2007 crisis turned out to be a major financial crisis in 2008 with a series of bank failures, mergers, losses, and unprecedented intervention of financial authorities "injecting" liquidity in the system and up to nationalization of major institutions. When the crisis peaked, the US authorities set up a major, and unprecedented in modern finance, emergency plan in September 2008, intended to isolate so-called "toxic assets" from the balance sheets of banks and other financial players (insurance), and to avoid a global collapse of the financial system. In other countries, notably the UK, similar plans were implemented. At the same period, US authorities, faced with numerous failures of major institutions, supported some flamboyant Wall Street investment banks but let Lehman Brothers go under. The event seems to have considerably altered the trust in the financial system and brutally accelerated the plunge of the capital markets.

At this stage, it was clear to all that the financial system as a whole was on the verge of collapsing and that the financial landscape had drastically changed within weeks, with investment banks disappearing, trough mergers and failures, inclusive of the biggest ones, and up to the failure the biggest insurance company in the world, AIG.

After-the-fact, casual observation was enough to identify classical "contagion" mechanisms. More puzzling are other contagion mechanisms, which have become the focus of the new wave of regulations taking place today.

1.2 CLASSICAL CONTAGION MECHANISMS

A well-known contagion effect is the "domino effect." The failure of a large financial institution triggers failure in many others who have large exposure, through lending for example, to the ailing institution. The domino effect played a role in the crisis since so many financial organizations failed. It is the foundation of the "too big to fail" principle, which suggests that no large institution can be allowed to fail for fear of contagion to many others. It is noticeable that the principle was not fully implemented when US authorities let Lehman Brothers go under, although they seem to have done whatever they could in other similar cases (Bear Stearns acquired by J.P. Morgan with a Federal Reserve credit line). The domino effect is the effect rather than the cause of the crisis. In this chapter, we try to examine some of the main contagion effects, other than the "domino effect" and some procyclical mechanisms that were seen as the explanation of the amplitude of the crisis.

The capital market downturn was triggered by several well-known factors, which developed with a much larger magnitude than in the recent crises. The usual "flight to quality" is triggered by the fear of investors of further losses from the on-going downturn of markets. Investors sell risky assets and buy Treasury bills and bonds. Such sales further accelerate the capital market downturn.

"Fire sales" of assets were triggered for all funds and leveraged financial firms, by the lower value of their collateralized securities. All leveraged funds, using extensively debt ("leverage") for financing their assets, face a lower ratio of debt to the value of pledged assets. The gap between security values and debt is called the "haircut," and is subject to minimum values below which either debt has to be reduced or additional collateral posted ("margin calls"). In other words, financial debt is over-collateralized, a standard practice for financial players, because the collateral is made of securities of which value varies with market movements. When values of market instruments fall, the ratio falls, triggering a deficiency, making debt unsustainable. In order to comply with lenders' requirements, leveraged institutions have only one way out:

Fire sales of assets for reducing debt and bringing back asset value in line with LTV ratios, thereby adding to the market turmoil.

Banks' equity moved down because of huge markdowns of portfolios, due to the depreciated value of their assets, adding to fear of further losses and inadequate capital of banks. A bank's capital is the foundation of regulations. It is considered as the unique safety cushion capable of absorbing losses. Once capital is deteriorated by losses commensurate with capital size, the bank's solvency and credit standing strongly deteriorates.

All such mechanisms are usually triggered by a downturn of financial conditions. But their effect is usually of limited magnitude and never ended up in systemic risk. Moreover, the recent history of continuous growth of economies fueled by easy financing, have symmetric effects. In the expansive phase, the risk appetite for financially risky assets grows. The value of assets also increases and generates capital gains, rather than capital losses, which allows leveraged institutions to further increase their leverage. Banks' equity is up, fueled by profits. Combining favorable economic conditions with regulations supposed to limit the magnitude of adverse effect tends to make the financial industry more "resilient," as evidence was provided by several crises, which were all feared, such as the downturn in 2002, but ended up with a limited magnitude.

Wealth effects usually follow adverse financial conditions. Faced with reduced wealth, due to the decline of real estate property or of the value of financial assets, spending declines. A financial crisis has always an adverse economical impact, beyond the financial sphere. Consumer spending cannot rely anymore on refinancing mortgages, which is feasible when home values go up making it possible to get another loan extension within acceptable limits for lenders, secured by an increasing home value. Agents, with less wealth, become reluctant to spend. Wealth effect further slows down consumption and, consequently, investment. Consumption and revenue fall; saving rate becomes negative. Doubt on growth becomes stronger and expectations adjust accordingly. Expected recession materializes in lower growth. All economic entities, financial firms and non-financial firms, face lower growth prospects.

1.3 FINANCIAL RISKS

All classical adverse mechanisms are supposed to have limited magnitude because of risk regulations. Risk regulations address the main risks faced by financial players. Risk is defined as a combination of uncertainty and potential losses resulting from adverse scenarios. Major risks are subject to quantification imposed by Basel regulations.

Credit risk is the risk of losses due to borrowers' defaults or deterioration of credit standing. Market risk is the risk of losses due to adverse movements of the value of financial instruments (stocks, bonds, etc.) because of market movements for an horizon that depends on the required time to liquidate them, thereby avoiding further losses. Both risks are regulated in banks. Credit risk is now subject to Basel 2 rules. Market risk has been measured since the 1996–1997 Basel amendments for market risk either by capital charges allocated to each exposure, or the now common "value-at-risk" calculation[3]. Other risks are well defined and supervised, even though they do not require a capital charge.

Interest rate risk is the risk of losses due to adverse movements of interest rates, notably when cost of debt increases. Liquidity risk, or funding risk, refers to the availability of funds when

3 See related Chapters 19 and 20 on market risk regulations.

needed. It is the risk of not being able to raise funds at a reasonable cost, and it culminates when a financial entity cannot raise additional funds, with the ultimate stage being bank failure.

Both risks are related to mismatch risk. Mismatch risk results from the maturity of assets being often longer than maturity of financing. Lending or investing long and borrowing short is a common practice because it allows financial institutions to tap the lower rates of the highly liquid short-term market and to benefit from longer rates when lending (when the turn structure of interest rates is upward sloping). Maturity mismatch creates liquidity risk when financial players roll over their short-term debts. It creates as well interest rate risk since the rollover of short-term debts is at prevailing rates, which might increase. Mismatch risk is a common practice even in depository institutions, which benefits from short-term funds and lends for longer maturities. Since mismatch risk was the source of the failure of the saving and loans institutions in the US, when short-term interest rates jumped up when the Chairman of the Federal Reserve in the US, Paul Volcker, decided to increase interest rates to double digit levels for fighting inflation in 1979, it is still surprising that mismatch risk is left to direct control by banks, and entails no capital charge.

Obviously, financial players are aware of such risks and they prepare themselves for market disruptions. A common way of isolating a bank from market disruptions is to hold very liquid assets. Liquid assets are the easiest to sell without risk of significant losses. Short maturity risk-free assets are less exposed to value variations when interest rates increase. High credit quality assets are always in demand at time of uncertainty, when "flights to quality" occur. Assets meeting those two basic requirements are Treasury bills. Holding such assets allows one to rely on sales of such assets to obtain liquidity when market conditions deteriorate. Banks hold a varying fraction of their total assets in highly liquid assets. How much depends on the bank's exposure to such market disruptions and the bank's policies. Regulations do not provide minimum amounts although regulators normally monitor the situations of banks. The drawback for banks is the low return of such liquid assets, which creates a trade-off between the cushion against market disruptions and profitability.

Market liquidity risk is a price risk and refers to the capability of selling traded instruments at a "fair price." Market liquidity is directly related to the volume of trading in capital markets. As long as trading exists with some volume, selling assets without disrupting price remains relatively easy. The recent period demonstrated that market liquidity can dry up just as funding liquidity did.

The absence of stringent regulations on liquidity risk is the "liquidity hole" in regulations, as well as it is in the theory of finance. It proved to be a major weakness that turned a downturn of capital markets into a major liquidity crisis for both the markets and the financial system.

A review of financial reports of banks in various countries, referring to the end of 2006, showed that banks were apparently prepared for such risks. They disclosed the volumes of liquid assets; the mismatch between assets and liability maturities; the measures of regulatory capital; the excess capital buffer over minimum requirement; how they performed their value-at-risk calculations for market risk; and up to the assessment of "economic capital" for credit risk, based on economic assessment rather than regulatory rules. Such disclosures testify of the prevailing confidence in their risk management practices before the crisis.

1.4 REGULATIONS

There are two set of regulations that that apply to financial firms. Risk regulations are designed to prevent failure of individual financial firms by imposing minimum standards to the capital

base that are risk driven. Accounting standards affect the value assessment of financial assets and liabilities, and have a direct influence on capital base and the bottom line of the income statement.

1.4.1 Risk Regulations

Financial risks are precisely defined because they are regulated. Regulations impose a quantification of potential losses stemming from risks, and such potential losses are the foundation for determining the capital base of financial institutions. The regulations of the financial system are reviewed in Chapters 19 and 20 of this text. Only the basic principles are summarized here. The core concept of risk regulations is the "capital adequacy" principle, which imposes a capital base commensurate with risks to which each bank is exposed. The principle is sound and makes a lot of sense. Instead of "dos and don'ts"," banks simply need to have enough capital to make their risks sustainable[4].

The rationale of the principle is that lenders can always absorb "statistical losses," such as those that are measurable in retail banking where there are millions of commitments, through adequate provisions. Risk provisioning can go beyond with provisions for general factors, should banks feel that they are exposed to such factors in their portfolios. But what would happen for the first Euro or Dollar of loss beyond the provisions? In the absence of capital, there would be no further buffer for such "average" losses. The rationale of the capital buffer is that banks should have a capital capable of sustaining much higher than average losses. It sounds natural, for ensuring bank solvency, to impose a capital base in line with such unexpected losses. Of course unexpected losses are future and potential losses. They are not supposed to materialize in other than unexpected ways. And they depend on current risks taken by the bank. The challenge of regulators and of banks as well, is in measuring potential losses in line with current risks.

The capital adequacy principle was the starting point of the strong emergence of modern risk management because it requires translating risks, which appear, at first sight, as intangibles, into Euro or Dollar values. Risk quantification and modeling made tremendous advances under the impulse of capital regulations.

Guidelines are defined by a regulators meeting in Basel at the Bank of International Settlement (BIS), hence the name of "Basel" Accords. The sequence of Accords in Basel started 20 years ago with the Accord for credit risk, or Basel 1, which relied on the very simple Cooke ratio. The Cooke ratio stipulated that the capital charge for lending or credit risk in general should be 8% of risk-weighted assets. Risk-weighted assets are the amount at risk, subject to loss, weighted by a coefficient between 0% and 100%. Such values were supposed to match rough proxies of the likelihood of unexpected credit losses, after considering the diversification effect of lending portfolios. Since they were very few weights, the first capital accord was very easy to implement, which was the purpose of its simplicity.

The 1996–1997 amendments targeted market risk, and allowed to use a standard approach using risk weights and, for the first time, the internal model approach, or the value-at-risk model for market risk. The challenge for measuring potential losses is to turn intangible risks into quantified measures in monetary value. The conceptual solution to that challenge is the

4 Among others, important documents on risk regulations by the Basel Committee for Banking Supervision (BCBS) are for credit risk in sources [7] and [10] and [8] for market risk, supplemented by publications available on the Bank of International Settlements (BIS) website.

"value-at-risk" concept, which synthesizes risks into a Dollar or Euro value through risk models. Value-at-risk gained popularity because it measures in a single figure the potential losses, a measure imposed by the bank's supervisors. Value-at-risk is the potential loss that is not supposed to be exceeded in more than a very small fraction of all feasible scenarios. It has now a track record of around 10 years and is implemented in most banks as the basis for the calculation of the capital charge against market risk.

In January 2007, the Basel 2 Accord for credit risk was enforced in European counties and for major international banks. The Basel 2 Accord essentially differentiates the capital charge according to the credit risk of the borrowers, using as an intermediate step internal credit ratings assigned by banks to all borrowers (in approaches other than the simpler Standard approach).

Ratings are measures of the "credit standing" as a rank along a scale. For bonds, rating agency scales are widely used. Those are letter grades such as, in the simplified Moody's scale: Aaa, Aa, A, Baa, Ba, B. Detailed scales are also extensively used. Under Basel 2, any borrower from a bank (corporations, banks), should be assigned an internal credit rating, which drives the capital charge. For individuals, in retail banking, the large volume of data allows using statistical measures, or "scores," for measuring credit standing, already used by many banks. Some are nationwide such as the famous FICO (Fair Isaac Corporation) score in the US. Others are proprietary to banks, such as in Europe.

Regulations were stringent, but regulations "holes" remained. Mismatch risk is a case in point, since it is left mainly to the self-discipline of market players, and without any capital charge. In addition, the scope of regulations does not extend to the entire industry. Another case in point is that of hedge funds. Hedge funds use proprietary trading techniques for enhancing their return, providing alternate sources of returns to straight investments in securities. For doing so, they use various techniques, such as betting on convergence of market parameters of different regions, or stock prices, or using event-driven strategies, betting on the outcome of mergers or even elections for example. Creativity has no bounds. Regulations would make proprietary strategies more public than they are, removing the added value of hedge funds policies, as some argue. Head fund management was left to self-discipline as well, contrasting with standard mutual funds subject to stringent restrictions. Moreover, funds can be highly leveraged (using debt financing), posting as collateral the assets held. A well-known effect of debt financing is that, under favorable conditions, it enhances the returns to investors (and to the fund managers as well). This could be fine, except that funds rely a lot on market liquidity and on mismatch risk for enhancing return. As explained subsequently, hedge funds participated to the aggravation of the crisis because of rules applying to collateral-based financing and mismatch risk.

Other entities are supposed to follow a "code of conduct" enforced by the market. The case in point is that of rating agencies. The business model of rating agencies is assigning credit ratings which serve the investors. Since they help issuers of bonds to raise financing, they are paid by issuers. Self-discipline can be powerful enough to impose self-regulation because the reputation of agencies depends on how well they do. At least, this was the prevailing view, since no one regulated rating agencies. Once the role of rating agencies in monitoring risk was heavily criticized, it become a common perception that self-regulation was not enough, and that the "issuer paid" model might raise conflicts of interest for agencies rating issues.

The debate on regulations before the crisis was how to weight self-regulation, or self-discipline, versus rule-based regulations enforced over financial firms. Since the crisis, it became official that regulation could not depend any more on self-discipline or "codes of conduct." Rather, all official documents point to the deficiency of existing regulations, and universally