

A hand is shown pointing at a computer keyboard. Several bright, glowing lines of light intersect at the point where the finger is touching the keys, creating a starburst effect. The background is dark, and the overall image has a high-tech, digital feel.

stress testing for  
risk control under  
**Basel II**

Dimitris N. Chorafas



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# Stress Testing for Risk Control under Basel II

*Dimitris N. Chorafas*



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Butterworth-Heinemann is an imprint of Elsevier  
Linacre House, Jordan Hill, Oxford OX2 8D  
30 Corporate Drive, Suite 400, Burlington, MA 01803, USA

First edition 2007

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#### British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

#### Library of Congress Cataloguing in Publication Data

A catalogue record for this book is available from the Library of Congress

ISBN-13: 978-0-7506-8305-0

ISBN-10: 0-7506-8305-8

For information on all Butterworth-Heinemann publications  
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Printed and bound in Great Britain

07 08 09 10 11 10 9 8 7 6 5 4 3 2 1

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# Preface

Starting with the 1996 Market Risk Amendment to Basel I, and following up with the 2006 Basel II's New Capital Adequacy Framework, the Basel Committee on Banking Supervision institutionalized the control of risk through models and testing methodologies. For the financial industry, however, risk management – and, most specifically, advanced testing – is not just a regulatory requirement; it is also a major:

- Operational,
- Cultural, and
- Technological challenge.

To help the reader face the risk management challenge, this book addresses the cultural and technological issues connected to an advanced methodology, and most particularly *stress testing*, which is a fairly recent development. A crucial question with new methods and tools is how they should be learned and applied in an environment of complex exposures, as in that of banks, which can suffer simultaneously through:

- Corporate bankruptcies,
- Derivatives exposure, and
- A shrinking value of investments.

More precisely, which factors should be taken into account in computing exposure, how the different types of risk should be combined into an aggregate picture, which critical limits could or should be applied and where, how one institution can be compared against another in terms of risk being assumed, and how stress testing can make these risks reveal their secrets.

This text is written for banking and, more generally, financial industry professionals and managers, who are not mathematicians, but need to deal with new regulations, models and advanced tests, for compliance with regulatory authorities and to keep ahead of the competition. Sixteen chapters provide the necessary background to understand:

- What is involved in using financial simulation and experimentation, and
- What kind of contribution technology can make to risk control, by means of stress testing.

Part 1 explains why an advanced testing methodology protects the bank from the unknowns that always exist in risks being assumed. Chapter 1 brings to the reader's attention the high impact of extreme events that are not being always accounted for, pays attention to the contribution of confidence intervals (a new theme in banking), and explains what is meant by an advanced testing methodology for risk management.

It has been a deliberate choice to leave the definition of risk and of risk appetite until Chapter 2, to allow a broader look at testing methodology and the way in which it should be implemented to gain competitive advantages. For the same reason, the task of explaining the dynamics of stress testing within the framework of enterprise risk management has been assigned to Chapter 3.

The tools of stress analysis are the theme of Chapter 4. These range from scenarios to sensitivities, and the use of statistical inference, including the methodology that should characterize the use of advanced tools. Chapter 5 presents case studies on worst case analysis, including drills for a meltdown and the concept of a ‘bad bank’.

Because an advanced testing methodology cannot be effectively implemented without the appropriate technological infrastructure, Chapter 6 has been added to Part 1 to outline and document what is involved in a successful technology effort. This text also includes the technical requirements for projecting and implementing an enterprise architecture, a ‘must’ for enterprise-wide risk management.

Part 2 addresses the stress testing of expected losses. This includes the stress probability of default (SPD), stress loss given default (SLGD), stress exposure at default (SEAD), and the prerequisites to be fulfilled to proceed successfully with SPD, SLGD and SEAD studies. Chapter 7 explains the need for including and studying the contribution of volatility patterns in connection with stress testing, and what kind of improvements need to be made to volatility models to improve their deliverables.

The focal point of Chapter 8 is stress testing the counterparty’s creditworthiness. The text includes the contribution of power curves, as well as problems posed by unwillingness to perform. The text is enriched with case studies. Stress probability of default and the way it is estimated is the subject of Chapter 9, including probability of default buckets, errors in stress probability of default estimates and the contribution of benchmarking.

Chapter 10 concentrates on the challenge of computing stress loss given default, and stress exposure at default (SEAD). It also presents the way in which legal risk and other operational risks impact negatively on SEAD losses. Part 2 concludes with the themes covered in Chapter 11: counterparty credit risk (as distinct from straight credit risk), ways and means for credit risk mitigation, and wrong-way risk in case of double default.

Part 3 presents the most important background factors behind expected and unexpected losses, as well as their after effects and algorithms associated with their computation. Chapter 12 concentrates on stress testing expected losses, and how the results of tests for tier-one, hybrid tier-one, tier-two and tier-three capital impact on regulatory requirements. Strengths and weaknesses of credit risk models are examined, and their implementation is evaluated from a holistic risk control perspective.

Because the analysis of reasons for unexpected losses should definitely involve the impact of macroeconomic developments, significant attention is paid to this in Chapter 13. The text includes stress testing macroeconomic risks, stress testing interest rates and stress testing losses from business risk. Economic capital allocation and algorithms for stress testing unexpected losses are the subjects of Chapter 14. They have been included to provide the reader with a comprehensive approach to the management of unexpected losses.

Closely associated with the subject of unexpected losses, and their impact on the banking industry, is the exposure taken with leveraged and volatile financial assets.

Chapter 15 starts with a brief overview of hedge funds, which manage such assets, then explains the need for stress testing the worth of highly leveraged institutions. Chapter 16 concludes this book by explaining through practical examples why stress testing is a means for better governance. The text also emphasizes the contribution of Pillar 2 and Pillar 3 of Basel II in better governance.

Because, to a large extent, the assets of a bank are liabilities of other entities, stress tests should consider not only counterparty risk, but also the fair value of these assets. A comprehensive approach to exposure contributes greatly to better governance and, along timely management control, can be instrumental in improving the bank's staying power and, therefore, market edge. Advanced testing is broadening both management's mind and the range of options in pursuing business opportunities.

My debts go to a long list of knowledgeable people and their organizations, who contributed to the research that led to this text. Without their contributions this book would not have been possible. I am also indebted to several senior executives for constructive criticism and valuable suggestions during the preparation of the manuscript.

Let me take this opportunity to thank Karen Maloney for suggesting this project, Charlotte Pover for the editing work and Melissa Read for the production effort. To Eva-Maria Binder goes the credit for compiling the research results, typing the text and preparing the camera-ready artwork.

*Valmer and Vitznau*      Dr Dimitris N. Chorafas  
November, 2006

# Warning

## The Merger of EL and UL and the Weakening of Basel II

A first draft of *Basel II*, by the Basel Committee on Banking Supervision, was released in June 1999. This was a consultative paper (CP) containing general outlines of proposed regulation in connection to *credit risk* and *operational risk*. CP1 also included some very clear thinking about how to handle these two important exposures.

This new capital adequacy framework made several major contributions to risk measurement and risk control. One of them has been, for the first time ever, the institution of capital requirement for operational risk. Another crucial concept, which helped to restructure the thinking of bankers in respect to exposure, was the distinction between *expected losses* (EL) and *unexpected losses* (UL).

- Capital for expected losses, which is *regulatory capital*, buys the bank a license to operate.
- Capital for unexpected losses, a new concept, addresses the long leg of the loss distribution as well as its spikes.

Until quite recently, provisioning for financial resources connected to unexpected losses has been made through *economic capital*, a non-regulatory funding. In its background is *Pillar 3* of Basel II. This active and transparent use of *market discipline* encourages monetary financial institutions (MFIs) to:

- Hold more capital than strictly required by regulators, and
- Allocate that capital to their business units, enabling them to face losses due to outliers and extreme events.<sup>1</sup>

Many market participants looked at UL provisions as *signalling capital*, telling the market that the bank has the resources to face exceptional shocks. This has been a neat approach with clear organizational guidelines, made by geniuses who also introduced *stress testing* concepts associated to UL:

- Stress probability of default (SPD)
- Stress loss given default (SLGD)
- Stress exposure at default (SEAD)

Over the last six years, *stress testing* proved to be one of the top contributions of Basel II, surpassing the two aforementioned original goals in terms of its potential to improve risk management policies and practices. Moreover, stress testing is a

necessary complement to the discipline of modelling. Ingeniously used, it can serve in exercising some control over *model risk*, which is always present.

Regulatory authorities look very favourably at commercial banks' expertise in stress testing. The Basel Committee on Banking Supervision is underlining that:

- Banks *must* do stress tests under *Pillar 2*, and
- Therefore, stress testing is now in the domain of national supervisors.

Pillar 2 is the steady review of capital adequacy, along with other criteria of prudential bank supervision exercised by national regulatory authorities. This mission for greater attention placed by national supervisors on stress testing, comes over and above other already existing duties.

The concept of placing stress testing under Pillar 2 is good. But there are two challenges which need to be addressed. One lies in the fact that not all national regulatory authorities employ *rocket scientists*, or have the skills necessary for controlling stress testing models and procedures of commercial banks. A basic management principle is that:

- *If* there is no control
- *Then* there is no way to assure compliance. Therefore, prudential supervision means nothing.

This leads to the second challenge: The need for global homogeneity in prudential regulation, which has been the Basel Committee's goal in the first place. Assigning stress testing responsibility to national supervisors will eventually see to it that there is a bifurcation in the sophistication of stress tests.

- The few national supervisors employing rocket scientists will be the *leading edge*, moving well ahead of the lot.
- But the majority of national supervisors lacking such skills, will fall behind and become Basel II's *bleeding edge*.

It is nobody's secret that many supervisory authorities are behind the commercial banks in their jurisdiction, in regard to technology and analytical skills. This is bad not only for supervisors but also for commercial banks, as it increases by an order of magnitude:

- The risk of conflicts of interest in modelling,
- The attention they should pay to model risk, and
- The expertise they should acquire in stress testing.

This book has been deliberately organized in a way to assist in the effort of stress testing for risk control – both for commercial banks and supervisory authorities.



It needs no explaining that *if* Basel II is to become effective, *then* supervisors should establish a most rigorous plan on how to move ahead of the curve in:

- Stress testing, and
- Model risk control.

\* \* \*

The state of business described in preceding paragraphs regarding gaps in high technology and analytical skills, is not extraordinary. Classically, national supervisors have been tooled for control of regulatory capital requirements which were linear, and much simpler than those now under *Pillar 1* and *Pillar 2* of Basel II. Pillar 1 specifies two methods for regulatory capital calculation regarding credit risk:

- The standardized approach, an upgraded version of Basel I, and
- Internal ratings-based (IRB) method, with two alternatives: F-IRB and A-IRB.

Originally, under Basel II, the computation of expected losses under either IRB approach was provided in an elegant, comprehensive manner, expressed through the algorithm:

$$EL = PD \cdot LGD \cdot EAD \quad (1)$$

On 10/11 October, 2003, this neat concept ceased being the model for expected losses. At that time, the Basel Committee met in Madrid to decide on over 200 responses and comments received on the third consultative paper (CP3), plus results from *quantitative impact studies*. (QIS 1 of 1999, QIS 2 and QIS 2.5 of 2001, and QIS 3 which was taking place that very month of 2003.)

In the course of that fatal Madrid meeting, the EL equation was dropped because responses to CP3 by commercial banks pressed the point they were already making reserves for expected losses, and formula (1) was a duplication. The Basel Committee accepted this thesis which, in my opinion, was not the right decision – and it has been, in a way, reversed (more on this later).

Sometime after October 2003, two events worth recording took place: one was QIS 4, and the other was the advancement of an UL formula based on stress testing. (Prior to this there were a couple of UL equations, an excellent one advanced by the Deutsche Bundesbank.) The stress testing formula is:

$$UL = SPD \cdot SLGD \cdot SEAD \quad (2)$$

QIS 4 has been the last quantitative impact study in which American regulators participated: Federal Reserve, Office of the Controller of the Currency (OCC) and Federal Deposit Insurance Corporation (FDIC). From what is known from US Congress hearings:

- OCC and FDIC do not subscribe to precommitment on regulatory capital made by commercial banks by means of models.
- Sometimes marking to model is like marking to myth, says Warren Buffett, the well-known investor.

FDIC and OCC would like to see *as a minimum* 8 per cent regulatory capital for credit risk, as prescribed by Basel I – no matter what the models say. To be at the side of prudence, since regulatory capital is a proxy for avoidance of systemic risk, American regulators:

- Will follow their way, and
- Conduct their own quantitative impact studies.

By contrast, other central banks in the Basel Committee proceeded with QIS 5, as explained in the main text of this book. American regulators contributed to this QIS 5 study QIS 4 results. QIS 4 was conducted only one year earlier than QIS 5, but among G10 countries it was restricted to the US and Germany. Therefore:

- The Basel Committee considered the results of QIS 4 and QIS 5 comparable, and
- Selected data from QIS 4 was included in the QIS 5 analysis.<sup>2</sup>

With QIS 5, EL has also come back to life. According to the Basel Committee's *International Convergence of Capital Measurement and Capital Standards*, of June 2006, a potential difference between total EL and total eligible provisions – known as *regulatory calculation* difference – will be deducted from regulatory capital.<sup>3</sup>

Now comes the surprise. QIS 5 targeted UL, though unexpected losses are covered by economic capital. UL has never been a regulatory capital requirement under the original A-IRB and F-IRB of Basel II. By contrast, with QIS 5 the IRB approaches are calibrated on *UL only* (emphasis added). I don't think this is the right decision because it destroys the very neat concept of a line dividing:

- *Expected losses*, which every well-managed bank knows how to handle.
- From *unexpected losses* which, as their name implies, hold many unknowns and surprises – for commercial bankers and regulators alike.

Anything that unsettles the clarity of an important issue is the enemy of good governance. Moreover, technically speaking, the characteristics of EL and UL are totally different. Precisely this fact made the person who invented this distinction between EL and UL a genius:

- *Expected losses have a fairly common pattern*,
- To the contrary, every financial institution has *its own risk appetite* – and, therefore, *its own pattern of unexpected losses*.

The fact that EL and UL have totally different risk distributions – the first characterized by high frequency low impact (HF/LI) events, the second by low frequency high impact (LF/HI) events – should have been enough to keep them separate. Every junior high school student knows that they should not add together apples and grapefruits, even if both are round.

Mixing up EL and UL by basing regulatory capital on UL (God forbid) has self-evident contradictions. Unexpected losses are, by definition, outliers. If not, they would have been expected losses. Beyond the minimal doubt, every credit institution's *own pattern* of extreme events must be studied at much higher level of sophistication than expected losses.

- Minimum capital requirements computed by summing up EL and UL – without stress factors – *mean nothing*.

Both the weeding out of the aftermath of extreme events in UL and the inclusion of UL into regulatory capital, make me feel very uncomfortable – which explains the reason for this *Warning*. Its aim is to bring to the reader's attention these worries. Also, to comment on what seems a low level of capital requirements for credit institutions revealed by QIS 5. Gaming the regulatory system is done through:

- Correlation coefficients, and
- Risk weighted assets (RWAs).

QIS 5 has demonstrated that a fairly significant reduction in regulatory capital requirements takes place in spite of a shrinkage of equity capital (Tier 1), already made because of Hybrid T-1, Hybrid T-2, deferred tax assets (DTAs), and other fuzzy reasons. Also, in spite of the inclusion into QIS 5 capital requirements for credit risk, of:

- Operational risk, and
- *Market risk* (curiously enough).

\* \* \*

Allow me to open a parenthesis which helps to better appreciate the comments which follow. The Basel Committee's *Results of the Fifth Quantitative Impact Study (QIS 5)*, of June 16, 2006, states that this test took place in 31 countries among 51 Group 1<sup>4</sup> G-10 banks, 146 Group 2 G-10 banks, and 155 banks from other countries.

The sample is unquestionably statistically significant. This makes the results so much more worrying regarding *the huge shrinkage in regulatory capital requirements*; and hence, in relation to the stability of the global financial system. According to QIS 5, with A-IRB:

- Group 1 G-10 banks *will reduce* their capital requirements by 7.1 per cent (!)
- Group 2 G-10 banks *will reduce* their capital requirements by 26.7 per cent (!!)
- Other non-G-10 Group 1 banks *will reduce* their capital requirements by 29.0 per cent (!!!)

That's free lunch, and everybody is invited to the party. It is not funny, but it is still a laughing matter if for no other reason than because these hefty regulatory capital reductions are made courtesy of *unstable models*. To make matters much worse:

- This shrinking regulatory capital base is *supposed to cover credit risk, market risk, and operational risk*.
- Notice that operational risk was originally supposed to represent an additional 20 per cent, then 12.5 per cent, over and above credit risk.
- Moreover, market risk has been a subject of the 1996 Market Risk Amendment – not of Basel II (more on this later).

What the above mentioned capital reductions document is that Basel II has become *ultra light*. Given these horrendous figures, it would have been advisable to put Basel II, its procedures, and its models under a 5-year test in parallel to Basel I – until its many bugs and loopholes are weeded out.

\* \* \*

The careful reader will notice that, officially, these (–7.1 per cent, –26.7 per cent, –29.0 per cent) very superficial figures represent *the change in total minimum required capital – that is, including credit, market and operational risk*.

- Officially, it is said that this is the difference in regulatory capital between Basel II and Basel I.
- But such comparison is lopsided because the 1988 Basel I regarded only credit risk.

Such super reduction of regulatory capital happens at a time when it has been officially announced that derivative exposures currently stand at about \$330 *trillion*, in notional principal amount. Just three big institutions: JP Morgan Chase, Bank of America, and Citigroup, share among themselves \$110 trillion in derivatives exposure.

As explained in the body of this book, in terms of credit equivalence under stress conditions, the \$110 trillion in notional principal morph into \$22 trillion in *real money*. This corresponds to almost 2 years of the US gross national product (GDP) – a level of exposure which:

- Gives vertigo to bankers and regulators, and
- Increases most significantly the likelihood of systemic risk.

It is therefore a great disservice to the commercial banks themselves, at least to those who put survival ahead of yearly profits, to lump together all sorts of heterogeneous types of losses. And, having done so, to also decrease the level of regulatory capital. John Law, of Mississippi Bubble and Royal Bank fame, would have loved this kind of 'solution'.

The question these references pose to the Basel Committee and all national regulators is whether there is a plan to review and rethink UL, because of risks presented by the aforementioned capital reduction. Will commercial banks also keep their classical

credit risk reserves beyond UL? The answer I got is that banks will keep their credit risk reserves which are subject to national accounting rules, rather than the Basel II Framework. Is Basel II going to be further degraded?

Another question in connection to the theme under discussion, concerns the very foggy and utterly unsettled issue of *correlations* in finance and banking. While chairman of the Fed, Dr Alan Greenspan had said that the study of covariance in finance is still in its infancy. Moreover, a 2001 document by the Joint Forum of the Bank for International Settlements (BIS) states that:

The correlation between different risk types may be very difficult to measure.<sup>5</sup>

That's absolutely correct. With IRB, the correlation coefficient is set by the Basel Committee. Two big issues come up: the first is what sort of control, for instance through sampling, there exists to assure this is exactly the correlation coefficient the banks are using with IRB.

The official answer seems to be that in QIS 5, banks provided input data for the Basel II risk-weighted functions which indeed include correlations set by the Committee. The results of QIS 5 therefore reflect the regulatory minimum capital requirements. This does not respond to the query about post-mortem control by Basel and/or national regulators.

- *If* the correlation coefficients given for A-IRB and F-IRB are sort of averages.
- *Then* the results being obtained are unreliable; correlations are the Achilles heel of Basel II.<sup>6</sup>

There is no evidence that during QIS 5 the Committee asked commercial banks to provide *their* internal correlation estimates, or economic capital figures. Officially it has been said that bank and market data had been taken into account in the original calibration of correlation coefficients. *Calibration?*

The question mark on calibration is in the background of yet another issue. Even if one accepts that RWAs and correlations based on averages are admissible with expected losses, which tend to be normally distributed, this can *never* be the case with unexpected losses, their outliers and their spikes.

As an American saying goes, thinking through averages is a state of mind which says that if you have your head in an oven and your feet in a freezer, on average you will feel alright. Averages will not do, even if they are properly computed, and steadily updated. Confidence *intervals* play both the freezer and oven roles.

- Rating agencies look at a 99.97 per cent level of significance when they give AA credit rating.
- It is an illusion to think that averages, the 50 per cent level, can satisfy regulatory capital requirements, in any serious approach to the control of systemic risk.

Taking everything into account, for the time being, a reliable computation of correlations remains the weakest link of every modelling approach to regulatory capital requirements. No two banks have the same type, magnitude and impact of exposures:

- Therefore, their correlations should enter into regulatory capital, *after* rigorous supervisory control.
- ‘Standard correlations’ for banks with hugely varied risk appetites and amounts of exposure, don’t really make sense.

Yet another weakness of current calculations made for regulatory capital reasons – whether EL, UL, both of them or something else – is the very short time frame of one year. With few exceptions, banks don’t fail in one year. The drift to default takes several years of mismanagement. Therefore, an extension to a 10-year time frame would have been a valuable improvement.

\* \* \*

In conclusion, the reader should retain the following points:

1. *Stress testing remains very important*, even if UL is no more the product of stress tests of EL factors.

Stress testing now comes under Pillar 2. Evaluation of stress test results is at the discretion of national supervisors.

2. Capital for unexpected losses has become a sort of regulatory requirement.

In fact, QIS 5 primarily addressed UL, not EL. By all evidence, IRB methods of Basel II are now targeting UL only; a questionable practice.

3. Correlation coefficients have been given, and will continue being given, by the Basel Committee.

In the preceding pages (and in the body of this book) I have expressed my reservations about using one-size correlations for institutions with most diverse exposure. It is time to scotch the myth that average correlations are serious business.

Last but not least, credit-risk-only reserves will be subject to national supervisory rules, rather than Basel II. This is a significant weakening of Basel II – but at the same time it increases the importance of stress tests, and of the stress testing methodology discussed in the text the reader has on hand.

## Notes

1. D.N. Chorafas, *Economic Capital Allocation with Basel II. Cost and Benefit Analysis*, Butterworth-Heinemann, London, 2004.
2. QIS 2 and 3 were conducted before the final Basel II Framework was published, and therefore the rules on which they were based were different. Additionally, macro-economic conditions prevailing at their time were not the same as those of QIS 5.

3. See paragraphs 43, 380, 383, 386 and 563 of Basel Committee for Banking Supervision *International Convergence of Capital Measurement and Capital Standards*, BIS, Basel, June 2006.
4. These are diversified, internationally active institutions, with capital in excess of Euro 3 billion (\$3.8 billion (£2 billion)).
5. The Joint Forum *Risk Management Practices and Regulatory Capital*, BIS, Basel, November 2001.
6. D.N. Chorafas *After Basel II. Assuring Compliance and Smoothing the Rough Edges*, Lafferty/VRL Publishing, London, 2005.

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