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CDOs – Risks, Challenges and Market Outlook

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"History doesn't repeat itself... but it does rhyme."

Mark Twain

BRIEF HISTORICAL RECAP

Asset securitisation – a modern success story

Despite public headlines blaming asset securitisation for the 2007 financial crisis, such securitisation is hardly a new phenomenon. The mortgage market was transformed in 1970 when the US Government National Mortgage Association (popularly known as Ginnie Mae) first guaranteed mortgage pass-through securities. In the words of Ginnie Mae's website, "In a single step, the issuance of Ginnie Mae mortgage-backed securities converts individual mortgages into safe, liquid securities for investors around the world." By making broad diversified exposure to residential mortgage credit easy to acquire and to liquidate, this innovation attracted significant new sources of investable funds into the housing finance market. Pension funds, fixed income mutual funds, insurance companies and individuals now had a means of participating in this market without the prohibitive cost and operational details of acquiring whole loans. This is one of the great success stories of financial innovation but it was largely forgotten (or wilfully ignored) by the popular press amid the upheavals in the sub-prime CDO market during 2007.

Furthermore, the introduction of differing tranches with greater or lesser exposure to prepayment and/or default risk is a long-standing innovation. This type of structure has been a standard feature of asset-backed securities since the mid-1980s when the US Tax Reform Act of 1986 authorised real estate mortgage investment conduits (or REMICs). In many ways, this innovation was as significant as the original creation of mortgage-backed securities themselves. By structuring a variety of cashflow streams with different types and degrees of uncertainty, it was possible to attract a wider range of investors with distinctly different risk/reward preferences and different legal constraints on the types of investment they were allowed to make.

During the sub-prime mortgage crisis of 2007, some claimed it was impossible to create investment grade securities out of distinctly sub-investment grade underlying credits. In fact, nothing could be further from the truth. This simplistic claim ignores the role of diversification and the protection afforded by subordinated tranches in a structured security. Arguably a well diversified portfolio of double-B-rated securities has less risk (in the sense of uncertainty about its future fair value) than a highly concentrated portfolio of triple-B-rated securities. Furthermore, subordinated tranches clearly afford risk reduction benefits to more senior tranches by absorbing all losses up to a stated threshold. A more serious question is whether traditional corporate debt ratings are an appropriate metric for assessing the risk of various tranches. In addition, CDOs based on sub-prime mortgage obligations present a unique source of risk stemming from the limited historical role of such loans. These issues will be addressed in more detail later in this chapter.

Credit derivatives and their antecedents

Like so much of what we take for granted today, the origin of interest rate and currency swaps is shrouded in the mist of time. It is generally argued, however, that these contracts first appeared in the early 1980s.[1] Two independent, but highly significant, technological developments occurred around this time. The first was the introduction of the IBM personal computer in 1981 followed some two years later by the introduction of spreadsheet software.[2] These innovations put both computing power and a simplified software development tool directly into the hands of end-users. It proved to be the ideal environment to support the early development of financial derivatives (interest rate and foreign exchange swaps as well as FX and equity options). These developments in technology combined with theory, in the form of the Black–Scholes–Merton option pricing model published in 1973, producing the beginning of a derivatives market whose dramatic growth continues to this day. By the early 1990s, derivatives had become an important contributor to the earnings of many money-centre banks that made markets in these contracts.

Also in the early 1990s, banks were becoming increasingly aware of the value of diversifying their credit exposure. At that time, whole-loan sales were the primary method for achieving such diversification. This approach carried the unfortunate side effect, however, of straining customer relations. Many borrowers were uncomfortable with their loans being held by third parties at a time when relationship banking was still the norm. This stimulated a desire on the part of banks for an anonymous means of diversifying credit exposures without undermining customer relationships that often had been developed and cultivated over many years. One approach to tackling this problem was the development of asset swaps. By using the already well-developed Libor (London Interbank Offered Rate) swap market to hedge out the interest rate risk of a credit risky asset, these represented the first step toward a more liquid credit spread market. The main innovation driving the credit markets in the past fifteen years, however, has been the emergence of credit derivatives as a whole; first pushed by the development of credit default swaps (CDSs) and then by the standardisation of synthetic CDO tranches.

Early credit derivatives took the form of either total return swaps or CDSs.[3] The payments on the floating side of a total return swap (TRS) were based on the combination of interest payments made on a reference bond plus the increase (or minus the decrease) in its market value during a payment period. Thus, the total return payer was effectively being insured against loss-in-value, since its “payment” could be negative if the price of the reference bond declined; meaning it was a net receiver of cash in that case. While this type of contract provided protection against credit deterioration of the issuer of the underlying bond, it failed to gain wide acceptance. The problem was that a bond's value could fall for reasons other than impairment of the issuer's credit standing. Rising interest rates and liquidity issues would both have an impact on the underlying exposure of the TRS. CDSs rapidly swept the field because they effectively isolated the specific credit risk of a particular legal entity without entangling other extraneous risks in the process.

A CDS structure provides the main advantage of freeing the derivative product from the need to reference specific bond cash-flows, even when the underlying credit default reference is a bond, and allows these transactions to reflect the general credit standing of the underlying reference entity.[4] By doing so, however, it needs to incorporate legally defined events, ie, "defaults", rather than purely observable market events such as credit spreads. Nevertheless, the relationship to market observed variables remains tight since there is an arbitrage relationship between the expected loss from default and the term structure of credit spreads on an entity's debt. Originally the relationship ran from observed credit spreads on benchmark debt instruments to the price of CDSs. Bond yields, however, reflect idiosyncratic characteristics such as the size of a given issue, its coupon relative to current market rates, call features, relative seniority and so forth. This creates a basis risk between specific bond spreads and those implied by CDS prices. As the CDS market developed, these instruments became more liquid, with more regular quotations, than most individual bonds. As a result, in recent years the CDS market has become the primary source of price discovery, with bond spreads adjusting to CDS prices.

Collateralised debt obligations

The current state of the CDO market has roots in both the asset-backed securities and credit derivative markets. In one sense, cash CDOs are a direct extension to corporate debt of well-established asset-backed security (ABS) concepts. In many ways they play much the same role as traditional ABSs. By packaging a fairly liquid palette of the risks and returns of a commercial debt portfolio, CDOs allow investors to select tranches consistent with their preferences, thus reducing the transaction cost of acquiring desired exposure diversification. CDOs (specifically collateralised loan obligations or CLOs) became a standard means for banks to shift loans off their books and into the portfolios of permanent investors such as pension funds, endowments, foundations and insurance companies. CDO transactions are generally structured using a special purpose vehicle (SPV) so that they do not need to remain on a bank's balance sheet. The bank that issues the product generally plays the role of the underwriter of the transaction but does not take direct responsibility for processing incoming payments and distributing them to investors. A separate SPV is created for each new transaction to isolate the performance of any one pool from the performance of others.

It was not long before market makers naturally started to structure CDOs synthetically as they were using the increasingly liquid CDS market to hedge their books. This avoided the cost of assembling and administering a physical pool of underlying bonds and actually made the resulting structure more generic by avoiding the idiosyncrasies of specific issues. Lower operational cost, the absence of physical constraints related to the volume of available bonds and the link to the increasingly liquid CDS market for hedging have contributed to the remarkable growth of synthetic CDOs.

The rapid growth of the CDO market supported the creation of the standardised indexes iTraxx and CDX, now both managed by Markit.com and owned by a consortium of investment banks. These, in turn, have themselves contributed to further development and standardisation of the market. Index trading now represents almost half of the credit derivatives trading volume.

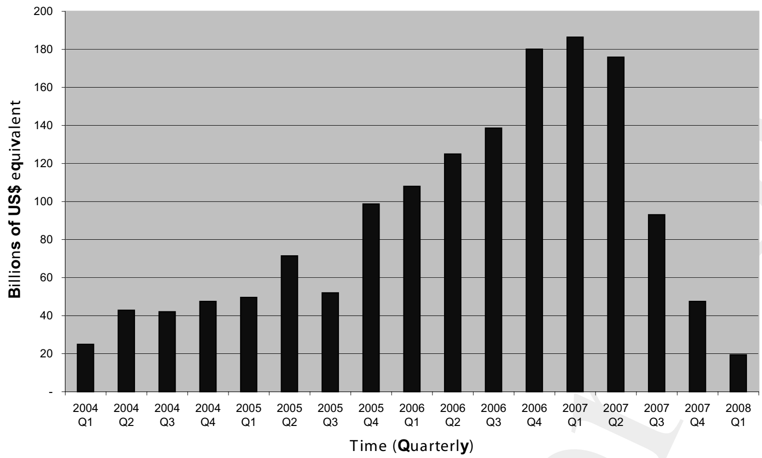
Overall, the CDO market grew at the staggering average rate of 95% per year from 2004 Q1 to 2007 Q1 and reached a total new issuance of US$550 billion in 2006. After holding up well in the first half of 2007, quarterly issuance plummeted by almost 90% from 2007 Q2 to 2008 Q1, as can be seen in Figure 23.1. This clearly shows that the "sub-prime mortgage crisis" is not just a local problem affecting only the property lending market. Its impact on the entire CDO market, and anecdotally on the broader credit markets as well, has been dramatic.

TECHNOLOGY AND DERIVATIVES

Symbiosis at work

As noted earlier, a cursory review of financial market history since 1980 clearly indicates that derivative markets and advances in

Figure 23.1 Global CDO market issuance (US$ million)



Source: Thompson Financial as published by the Securities Industry and Finance Markets Association

computing technology have been highly symbiotic developments. Introduction of the IBM PC in 1981 made computing power available in machines costing no more than many pieces of office equipment. The subsequent introduction of spreadsheets empowered end-users to create appropriate software directly. The democratisation of computing power and software burst forth with amazing speed. As some traditional information technology professionals quipped – only half in jest, "The users are revolting, in both senses of the word".

These developments were the essential enabling factors that made the emergence and the subsequent explosive growth in derivative markets possible. As computing power continued to double approximately every two years, new and more complex derivative products appeared that would have been impractical even 12 months earlier. This process of innovation was driven by continued intense competition. In time, the originally esoteric concepts involved in careful pricing of over-the-counter interest rate swaps became widely understood. Standard software emerged to support the pricing and life-cycle processing of such products.

This, in turn, allowed entry of more providers which narrowed bid–offer spreads.

The squeeze on bid–offer spreads encouraged further innovation, as new products offered temporary relief from the pressure on margins. This process inevitably led to some firms creating new structured deals before client requirements were clearly defined. Quite often the reduced transparency that regularly accompanies greater complexity works in favour of sophisticated market-makers at the expense of some less knowledgeable or less well-equipped customers. This cycle played out in the early 1990s in the interest rate derivative market and the same pattern was evident in the structured credit products market as the first decade of the new millennium unfolded.

Risk technology lags product innovation

Despite the powerful enabling impact of technology, another recurring pattern is that human imagination easily outpaces the growth in technological capabilities. Traders are always pushing the envelope relative to existing technology. This creates particular problems for risk systems and the effectiveness of risk estimation. The fundamental computational requirements for pricing and hedging complex derivatives are substantially smaller than those required for risk simulation. Products that significantly stretch the available computational resources of the front office easily overwhelm the resources of risk analysis. This can leave an institution with only dim and partial insight into both the market and credit risk it is incurring on such cutting edge transactions.

While excessive complexity relative to available computing power is a problem in itself, lack of a stable statistical relationship to structural factors can present even bigger problems. When there is sufficient liquidity, it is possible to trade and price things even if the underlying determinants of price behaviour cannot be isolated and modelled reliably. Pricing models in such situations are effectively descriptive without being genuinely explanatory. To an important extent this is what happened in the sub-prime CDO market. This generally works fine until liquidity evaporates. Then the lack of a structural arbitrage-based link with factors that are still observable in the market becomes a critical weakness. Without some kind of matrix-pricing framework, such as that which is commonly used to value thinly traded bonds, lack of liquidity destroys the one objective basis for determining fair value.

This creates:

- operational conflicts over appropriate levels of collateral;
- uneasiness and outright conflicts of interest around forcing customers to liquidate positions to meet margin requirements; and
- uncertainty surrounding the objectivity of financial reporting.

VALUATION AND RISK ASSESSMENT

Size of the problem

Assessing the challenge of CDO pricing and management requires taking a look at the details of a representative structure. In late 2007, a typical CDO depends on 100–150 names,[5] and is generally structured around five tranches, from the most risky (the equity tranche) to the most secure (the super-senior tranche). The detachment points for different tranches generally conform to the structure of one of the two widely traded indexes as shown in Table 23.1.

Table 23.1 CDS index detachment points

	iTraxx tranches (%)	CDX tranches (%)
Equity	0–3	0–3
Junior mezzanine	3–6	3–7
Junior	6–9	7–10
Senior	9–12	10–15
Super-senior	12–22	15–30

A typical bid–offer spread of an investment grade CDS, in "normal" market liquidity conditions, is about 10 to 50bp for a one million US dollar trade. It is then easy to understand the tremendous cost that the re-hedging of a CDO book would generate, knowing that the average size of a CDO transaction is around half a billion US dollars.

One consequence of this growth in complexity has been a steady increase in operating cost. A more significant development, however, has been rising uncertainty about the reliability of risk quantification due to the number of parameters and uncertainty surrounding their stability.

Operational issues

As the volume and complexity of CDO transactions has increased, a number of operational issues have emerged. The most common of these is a lack of clarity on default triggers, especially when it comes to debt restructuring. As noted earlier, despite all their attractive characteristics, CDSs introduced a legally defined event at the heart of the counterparties' respective rights and obligations. In several cases, banks have sued each other on disputes following a transfer of ownership of the obligor's stock.[6] A number of rules have been set up by ISDA (International Swaps and Derivatives Association) and market professionals in order to clarify what action should be taken in case of restructuring. The initial rule has been modified a number of times leading to "Modified Restructuring", "Modified Modified Restructuring" and "No Restructuring", each reflecting a different approach to the treatment of debt-restructuring events.

Another operational issue is the monitoring of effective default and how to link this information with operations and payment processing. No standard has yet emerged but a number of companies[7] have recognised the need and are starting to provide such information. The huge size of an average CDO also creates significant challenges in terms of payment processing, in particular for the holder of the underlying credit basket, with significant operational risk of overestimated or missing payments. The same idea applies to the administration of underlying securities when default occurs and a replacement needs to be processed.

A direct consequence of increased operational risk is the additional cost that puts more pressure on margins for issuers with a stronger incentive not to discount such risk.

Simple models and complex reality

One striking feature of contemporary credit analysis is the deep division between top-down and bottom-up approaches. Traditional credit analysis was almost exclusively micro-oriented. It focused on such things as financial performance, management's track record, technological threats, competitive market conditions and barriers to entry. Analysis and pricing of CDOs, on the other hand, focuses on high-level models of co-variation in the performance of component companies and movements in credit spreads. The reasonable presumption is that credit spreads are a reflection of credit quality and embody a consensus view of company fundamentals. The treatment of co-variation, however, is another matter.

The market standard Gaussian copula model with "base correlation" (see below for a more detailed explanation) is universally understood to be not only weakly explanatory but internally inconsistent across observed market prices. To match market prices across all tranches of a CDO requires conflicting assumptions for the same underlying correlation parameters. This is usually dismissed on the basis that the model is primarily a market quoting and communication tool and not a structural explanation of co-variation in credit quality. Much the same can be said for the Black–Scholes–Merton model, which requires inconsistent market volatility assumptions to match option prices across the full range of observed strike values. In the case of the option volatility smile, however, we know that the basic issue is the existence of fat-tailed distributions for prices of the underlying assets and risk aversion relative to being short volatility when experiencing a discontinuous change in market prices. In the same fashion, there is a strong aversion in the market to being exposed to correlation instability when spreads widen and liquidity evaporates. Because of the large number of underlying variables, however, it is far less clear what stochastic dynamic explains the correlation smile.

Complexity and the limits of human comprehension

Credit default modelling involves numerous parameters and requires data that can be hard to access. To circumvent the issue, a number of assumptions have to be made; some being more critical than others. Generally, there is no access to the full term-structure of CDS spreads for all underlying names, so most models assume a single spread per name. Models also generally focus on a single time horizon. In addition, correlation is generally assumed to be identical for all company pairs and to be constant over time.

Numerous extensions of this simplified approach have been suggested. See Chapters 10 and 15 for a detailed discussion of these extensions such as random factor loading and the introduction of new parameters such as the volatility of correlation and/or recovery rates. Inevitably, these extensions will further complicate the problem, making access to all the necessary data and reliable model calibration even more difficult.

The human brain is capable of handling a limited number of parameters simultaneously. With that in mind, in a single organisation, you will generally find that one person will understand very well the mechanics of a model, another will understand market equilibrium and have a view on a particular market while a third will have a global view on the portfolio but will be unable to understand the specifics. Each will try to simplify the problem by ignoring the factors that are external to his or her scope of understanding. It is similar to a large number of people building an edifice without using an architect, each knowing and performing specific tasks while ignoring how others might influence or affect the eventual outcome.

For example, a "quant" will understand how the correlation level affects the spread sensitivity of a CDO tranche and a trader might use this to calculate an appropriate hedge (that would probably be expressed in terms of cross-gamma sensitivity to underlying names) without realising that the effectiveness of the hedge will be highly sensitive to correlation. The trader's position would thus be vulnerable to a sudden unanticipated change in the correlation parameter.

Nassim N. Taleb argues in his book *The Black Swan* that we all have a tendency to "tunnel". By this, he means that when looking at a specific problem, we tend to focus on the aspects we know well and ignore alternate routes or scenarios. Also, because the problem is so vast, CDOs being influenced by the credit quality of the individual underlying names, the correlation structure, recovery rates, spread volatilities and interest rates behaviour, we tend to simplify it as much as we can. This naturally leads to a very sketchy representation of the "real world" and the effect of our own mistakes is increased because most of us fail to take full account of the distinction between the model and the reality it describes.

Valuation models and their discontents

All models are attempts to capture the essential dynamics of a highly complex multidimensional reality in simplified form. Developing such models is crucial to the advance of human understanding of both our physical and social environments. William of Ockham, a 14^{th} Century English Franciscan and logician, famously posited what has become known as Occum's Razor or, more descriptively, the Law of Parsimony. A stylised characterisation of the idea is that a good theory is one that explains the most with the simplest and fewest basic assumptions. Of course, it is mathematically impossible to maximise and minimise simultaneously. One thing can be maximised (say explanatory power) subject to an upper bound on something else (complexity of the theory). Alternatively, something can be minimised (complexity of the theory) subject to a floor on something else (explanatory power). In the end, there is always an uneasy and contentious balance between complexity and explanatory power. The right balance is more difficult when trying to model the behaviour of social systems than is true for physical systems. This is one of the dangers in the uncritical application of analysis borrowed from the physical sciences to problems in the social sciences.

In *The Black Swan*, Taleb coined the term "ludic fallacy". Based on the Latin word for "play", it means falling into the trap of believing that social systems behave according to the type of structured randomness that characterises games such as dice or roulette. In finance and the social sciences more broadly defined, this takes the form of confusing the structure of an explanatory model with the structure of the underlying reality it is attempting to represent. The seductive aspect of the situation is that well over 99% of the time this belief can seem quite realistic. When market movements are dominated by millions of largely independent decisions, models from the physical sciences work quite well. Only on those rare occasions that Taleb calls Black Swans are such models pushed to the potential breaking point. It is then that falling into the ludic fallacy can prove especially costly.

Richard Libby, Chief Credit Officer of Barclay's Global Investors, recently outlined an interesting perspective on models. He argues that bad models are not the key problem. Those kinds of model usually disappear quickly by failing to capture important structural considerations. A bigger problem, Libby argues, can flow from good, even great, models that "expose themselves to the paradox of self-reference by way of their universal adoption by the market". Libby goes on to say that, "Truly great models change the nature of the marketplace they were designed to model and therefore contain an element of self-referential paradox" that can lead to model failure. Applying human intelligence to market behaviour leads to more and more detailed analysis. Such analysis, however, can change the behaviour being examined in a kind of Heisenberg Principle of finance. Taleb, however, points out one very significant difference. The original Heisenberg Principle in physics applies at the extreme sub-atomic level. It does not destroy the influence of the central limit theorem at the scale of normal human experience. In financial markets we are not always so lucky. Excessive reliance on a "market standard" model can lead to self-reinforcing behaviour. Some argue that the stock market crash of October 1987 was exacerbated by program-trading models that failed to take appropriate recognition of the volatility smile in estimating the value of out-of-the-money options. Similarly the Gaussian Copula model of co-variation across the tranches of CDOs induced some to excessive confidence in the stability of the implied correlation sensitivities across these tranches. This led many hedge funds to take aggressively leveraged long/short positions across tranches of differing seniority, which in return resulted in significant losses in 2005 when these implied correlations changed abruptly and many hedge funds found themselves not nearly as hedged as they believed themselves to be. In effect, the positions that were established based on the implications of a model had pushed the market beyond the range of that model's applicability. See Chapter 8 for a discussion on the one-factor Gaussian copula model and 2005 correlation meltdown and Chapter 22 on model validation.

The correlation fallacy

The last big thing within the credit quantitative community was how to model correlation, and most of the recent literature has related to this subject. This interest can easily be explained by the fact that credit risk is heavily influenced by concentration and what is feared the most is not one default but the contagion effect that could follow an isolated failure, especially when issuing or investing in "multi-name" credit products. More quantitatively, to model global default risk you need a way to express joint loss distributions of multiple names, as opposed to individual marginal loss distributions. This is where abstract estimates of co-variation are required to model joint behaviour and joint losses. Such estimates are indeed very abstract, as there are many different ways to measure the co-variation of default.

The credit modelling paradigm is rather different from, and less tractable than, the traditional approach to market risk or pricing. A credit event is binary and is also non-reversible, as opposed to market values that can fluctuate over time. As a first natural approach, actuaries and risk managers traditionally modelled default as a jump event. Progressively this evolved to a more dynamic approach using factor modelling (Merton 1974, Longstaff and Schwartz 1995). The factor approach defines default as an event related to the market value of a firm's assets dropping below a threshold determined by the magnitude and, to some extent, the composition of the firm's liabilities. These models have the advantage of being highly tractable but are computationally intensive and can be difficult to calibrate, especially when evaluating the potential for short-term default.

The growth and increasing liquidity of the CDS market stimulated development of new pricing models such as the reduced form models (Duffie and Singleton 1999; Jarrow and Turnbull 1995). The comparative simplicity and ease of use these approaches offer transformed a market that was once considered highly exotic to becoming increasingly "plain vanilla". These models, in turn, accelerated the development of the CDS market and contributed to exponential growth in volume and liquidity over the past several years.

When basket credit derivatives started to appear, as a consequence of the increased liquidity in the underlying single-name market, the focus turned naturally to joint-default modelling; examining how the different names composing the basket are related to each other. David Li (2000) was the first to publish the idea of using copulas to model joint defaults, in contrast to the discrete event approaches (Lucas 1995) which were traditionally used in credit risk modelling. For more details see David Li's Chapter 3 on correlation approaches.

Responding, in part, to the perception of most investors that the CDO market was very obscure due to the complexity of the modelling, JP Morgan's Lee McGinty (2004) proposed a new concept that turned the copula idea on its head. Instead of assuming that correlation was a known number, as in previous discussions, he proposed implying it from the market price of CDO tranches. This idea gave birth to implied tranche correlations and, more generally, implied base correlations. The latter are the implied correlations of a [0%, *X*%] tranche. Initially, this was designed as a marketing tool to assist the bank's clients in understanding quotes for CDO tranches more easily. Implied correlation calculations using a normal copula model very quickly became the market standard and soon generated considerable literature of its own. It gave rise to what is known as "the correlation smile", based on an analogy with the volatility smile in option prices. The correlation smile refers to the differences in underlying implied correlations across tranches of different seniority in a CDO.

Extensive additional literature has been produced on copulas and default correlations in general. Some quantitative authors have been very prolific around this subject, generally seeking a means to eliminate the nagging inconsistency implicit in the correlation smile. Correlation clustering (Gregory and Laurent 2003), random factor loadings (Andersen *et al* 2003), changing the copula model and semi-analytical approaches (Hull and White 2004) have been proposed among other innovative ideas. Some approaches simplify the problem to improve computation; others add new parameters to achieve a better fit to available market data, which could be at the expense of performance or stability.

Most of the research and literature was then around this "smile" and how to explain it, or how to build more consistent models of co-variation that reduce the differences in implied correlation across tranches. The main difficulty around the smile is that it demonstrates the weakness of Gaussian copula models and that we cannot explain complex credit dependencies using a single co-variation parameter for the behaviour of all the underlying credits in a portfolio.

"Good" model parameters can easily and consistently be calibrated to market prices, are relatively stable (at least over the investment horizon) and can be hedged if non-constant. This is not the case for correlation parameters. Correlation is difficult to calibrate as it does not theoretically consist of one number if we want to represent dependencies realistically. Additionally, it is not stable and tends to be especially volatile following any announcement or market disruption. Finally, it cannot be easily or reliably hedged. As we mentioned previously, implied correlations have questionable structural meaning and their values cannot be derived from simple and liquid instruments, especially for bespoke portfolios.

The potentially attractive idea of being able to hedge co-variation risk may be a noble objective but it might not be achievable through simple modelling and realistic computation. Furthermore, the only fairly liquid instruments available are the iTraxx and CDX tranches, which are quite useful to hedge systemic credit risk but fall short when applied to specific risks such as sector, country or industry concentrations. Also, the way market-makers are hedging their books, especially for synthetic CDO tranches, is by using the most liquid and obvious instruments, namely the underlying single name default swaps. Correlation is embedded in the so-called "cross-gamma" measures in the hedge ratios that represent the potential change of a particular name's sensitivity, ie, its "delta", due to a change in the other name's spreads. To calculate cross-gammas, we need to rely on a model that has some embedded representation of credit dependencies. Either we treat correlations as constant in our model, but have to adjust our hedge at some cost if correlation changes or we choose to model correlations as a stochastic parameter, but then we need to hedge our portfolio against this parameter. How to do this? The problem is a bit like a snake that bites its own tail – there is no simple answer to this question. A similar problem occurred in the equity and FX option market when stochastic volatility models were implemented. The difference here is that these markets were generally liquid enough to allow hedging against volatility changes using other options (such as barrier options) or volatility swaps. Unfortunately this is not the case with correlation where such liquid instruments are far from being readily available to market participants. Even with some liquid instruments, a position can only hedge against the index implied correlation; it still remains exposed to some sector/industry/country correlations. See Chapters 17 and 18 for detailed discussion on hedging CDOs.

Depending on the modelling choice (factor models or reduced-form), correlation can be interpreted in different ways. In the factor model, the correlation factor measures the co-variations of obligors' creditworthiness (distance to default approach), whereas in a reduced-form model it represents the chance of defaulting around the same time (time to default approach). As a direct consequence, calibrating or measuring correlation has to be done in a very different manner depending on the modelling choice. For instance, using historical time series of spreads or stock prices makes sense in the factor model but is highly questionable in the reduced-form approach.

One thing about correlation is that it models co-dependencies, but generally ignores concentration effects. Concentration means that a single default can have a knock-on effect on the rating, the spread level and the liquidity of many other names. The difference with the way correlation is generally represented is that obligors that were "*a priori*" independent from the defaulting name can be affected due to market stress effects. This is referred to as "correlation clustering" similar to the observed volatility clustering of most market securities. The traditional academic way to treat credit correlation by sector and country can prove to be ineffective in such stress events. Even if no related defaults materialise, the theoretical mark-to-market of a CDO tranche can drop significantly following a single default.

Also, the 2007 crisis has shown us that, following a few unexpected events, liquidity can evaporate very quickly. This may be because no one wants to affect the market further or does not want to realise losses that potentially can materialise due to absence of market interest. Such an evaporation of liquidity can result in a sudden crisis in confidence. In this particular context, a single correlation measure to allow efficient pricing is destined to fail as a hedging tool. Implied correlation is totally dependent on liquidity to establish its prevailing value. Trying to model it in the absence of liquidity is like trying to live in a vacuum. Market liquidity is the very breath of life for implied correlations; without liquidity, meaningful estimates of implied correlations are impossible.

Implications for risk estimation

Consistent with the above discussion, Robert Jarrow of Cornell University and colleagues at Kamakura Corporation point to three critical simplifying assumptions that undermine the accuracy of

CDO prices based on the Gaussian copula model (see Chapter 16). These are:

(1) a single period modelling framework;
(2) constant default probabilities that fail to account for cyclical economic influences;
(3) highly simplified assumptions about the nature of correlations in default events.

They conclude that the Gaussian copula model seriously overstates the value of CDO tranches relative to a reduced-form model that accounts for business cycle influences. Of particular interest is their assertion that six to eleven million scenarios are required to achieve a level of price precision consistent with the typical bid–offer spread observed in more mature markets. Such computationally burdensome pricing calculations clearly present nearly insurmountable obstacles to effective risk estimation.

Beyond the challenge of massive computational demands, instability of relative sensitivities across the components of a portfolio presents more fundamental problems for the estimation of risk. It has been rightly said that markets can establish prices for things that cannot be modelled. Without either the ability to model something structurally or a significant volume of historical data with reasonably stable statistical properties, risk estimation is reduced to little more than guesswork. Even if the underlying reference entities of a derivative have a long history, instability in their co-variability strikes at the heart of effective risk estimation. When the underlying assets themselves are new and untested the problem is magnified significantly.

LEGAL AND SOCIO-ECONOMIC CONSIDERATIONS

Legal arbitrage and the sub-prime mortgage crisis

One of the consistent characteristics of free markets is to undermine artificial obstacles to competition. Most frequently these obstacles are rooted in legal restrictions of various kinds. In some cases these restrictions may be fatuous or motivated to protect special interests. In others they have a broadly accepted rationale. One of the latter is the restriction on certain types of funds to hold only "investment grade" securities.

Investment grade restrictions are generally applied to pension funds and similar entities with a fiduciary responsibility to assure a minimum retirement income for their beneficiaries. Until about 20 years ago such requirements prevented these entities from channelling any of their funds into financing non-investment grade assets. One motivation for structured securities has been to enable such conservative investors to participate in these markets that had previously been completely off-limits. This is accomplished, of course, by tiered loss absorption in which junior tranches provide significant default protection for more senior tranches, allowing the senior tranches to obtain an investment grade credit rating. By reducing the expected default losses of senior tranches relative to the total pool of underlying or reference assets, such structures can legitimately create investments appropriate for a conservative fund.

This type of market innovation does, however, have a downside. The legal constraint to invest only in "investment grade" securities embeds traditional corporate bond rating scales within the regulations. For fiduciaries to be allowed to invest in new types of securities these must be rated on the same basis. This raises an important question as to the suitability of traditional bond ratings for all such innovative types of claims. Typically bond ratings attempt to estimate a likelihood of default. When default occurs, however, attention shifts to the likely timing and amount of any recovery. In the case of a senior tranche of a CDO, the probability of 100% repayment can be considered. Compared to corporate bonds, however, losses are seen much more as a smoothly continuous proposition.

Another important consideration is the potential instability of a credit rating. Two securities can have the same expected probability of 100% repayment at a point in time even though one of them is subject to much greater uncertainty around the stability of that probability over time. Arguably the double-A rating for a regulated utility company can be expected to be fairly stable in the face of economic uncertainties. Most of the risk to such a rating is idiosyncratic to the particular company. An example would be a major power plant disaster. Even this uncertainly, because it is company specific, can be diversified away through a broad portfolio of bonds issued by many different utility companies. The rating of a senior tranche of a CDO, on the other hand, is vulnerable to an above-average default rate in the underlying portfolio that erodes the protective cushion of more junior tranches. For more on the aspect of rating CDOs, see Chapter 19.

Hidden concentration is another issue. It may appear that holding multiple senior tranches of many different CDOs offers the benefits of diversification. If the nature of the underlying assets is similar across all the multiple holdings, however, then they may all be subject to a common underlying uncertainty. This clearly applied to senior and super senior tranches of sub-prime CDOs, all of which were vulnerable to a decline in house prices. When this contingency materialised in 2007, the apparent diversification of such investments proved to be illusory.

The need to satisfy a narrow and rigid legal definition of "investment grade securities" meant that the quality of innovative instruments had to be assessed using a framework created for a far different era. It has become clear that over-reliance on traditional credit ratings to assess the safety of innovative new instruments can produce very unpleasant surprises. Expanding the assessment framework to reflect broader considerations and subtler nuances would be worthwhile. This is unlikely to happen, however, as long as a traditional credit quality metric is enshrined in legal and regulatory restrictions.

To some extent it may be possible to blame this crisis on a failure of the enterprise risk management infrastructure. Few firms are able to consolidate their risks effectively at the enterprise level and even fewer are able to perform "what-if" exercised with any genuine confidence. Beyond that, however, the sub-prime crisis involved more than just a failure of analysis. Mortgage underwriting standards had been slipping for well over a year before the crisis struck. This even spawned a derisive term "NINJA" (no income, no job or assets) loans. Clearly the value of assets built on this foundation was highly dependent on a continued increase in house prices. Such dependence cannot have been a deep secret within the affected organisations. To a significant degree, the crisis was a failure of discipline and a failure of will as much as a failure of analysis.

Socio-economic aspects of financial innovation

The socio-economic impact of financial markets and financial innovation is an important issue. In the long run, financial markets must support social and economic advance if they are to prosper. Despite a deep human longing for harmony and cooperation, experience shows that the turbulent and often uncomfortable pressures of competition provide the most effective assurance of continued progress. Attempts to control economic activity by political means inevitably stifle the essential process of creative destruction that leads to progress. The huge economic disparity between the West and the nations that emerged from the Soviet Bloc after 1989 offers striking confirmation of the failure of administered economies. Nevertheless, open competition is prone to short-term distortions from periodic bouts of "irrational exuberance". The excesses produced by such exuberance are frequently unwound in painful corrections. Such corrections tend to undermine public support for the very idea of open competition itself. In this context, it is worth considering how financial innovation affects not just investment banks and other financial institutions but also non-financial businesses, individuals and the global economy in general.

We should always remember that the central contribution of financial markets is to channel society's savings to the most productive forms of investment. They do this by forcing those wishing to make different investments to compete for the limited pool of savings by offering attractive risk-adjusted returns. Such returns may take many forms. Some are fixed in monetary terms, subject only to the outright default of the obligor. Others may be indexed for general inflation. Still others entail substantial risk to the investors' capital in exchange for significant upside potential. Much of the revolution in modern finance entails structuring ever more complex forms of risk and reward in the effort to attract investable funds.

Three important concepts stand at the heart of financial market activities, namely; diversification, liquidity and insurance:

(1) diversification is the key to improving the trade-off between risk and return;
(2) liquidity allows investors to alter their positions and risk profiles in response to unexpected changes in their circumstances.

As such, it provides valuable flexibility in exchange for which investors are willing to accept a somewhat lower risk-adjusted return;

(3) insurance offers investors a way to meet their sensible desire to bear a small expected cost in exchange for protection against a possible (although unlikely) catastrophic loss.

Most financial market innovations are designed to provide easier access to diversification, greater liquidity, protection against extreme adverse events or a combination of these qualities. Examples include ABSs and CDOs (cheaper access to diversification and a more comprehensive menu of risk and return possibilities) repos and secured loans (provision of liquidity) and options (insurance).

By providing a richer array of investment alternatives, financial innovation offers investors a greater opportunity to shape the risk reward profiles that best suit their individual situations and preferences. From this perspective, such innovations represent genuine economic value added. Quite clearly the development of both cash and synthetic ABSs has resulted in credit risk being more widely dispersed and more effectively managed. In the process it has increased competition in many parts of the credit market by opening access to new investors who were previously subject to insurmountable legal and operational constraints. This has allowed greater diversification of specific risk from exposure to individual obligors. Perhaps even more importantly, it has enabled firms to diversify their exposure to systemic risk factors such as regional and industrial concentrations.

Needless to say, however, these larger social benefits are generally not the immediate motivations behind the creation of new financial products. Such innovations are driven primarily by the temporarily wider margins they provide in a fast paced and ever more competitive marketplace. Quite naturally, such new products offer an immediate top-line return that prospective investors find attractive. Surrounding that return, however, is an inevitable web of complexity with risk implications that many investors are not equipped to analyse fully. This has led to a situation where more and more financial institutions are holding products with underlying risks that are dimly understood at best. This has drawn the attention of regulators and increased concern about an uncertain degree of global systemic risk. The intense competitive pressures that drive financial innovation also tend to induce behaviour that increases the risk of potentially damaging consequences.

Ideally the right technology (computing power, efficient programming, and accurate models) should be in place to process and manage these innovations before they become widespread. In the far from ideal real world, however, pressure on margins and short-term profit motivation push firms to start booking contracts before the appropriate technology is fully ready. Indeed, the much needed investments in technology are nearly impossible to justify until it becomes clear that product volumes warrant the cost. Thus there is an ever recurring cycle of innovation forging ahead with technology and operations scrambling to catch up after the fact.

Sometimes innovation surges too far ahead of both supporting technology and investors' ability to assess the risk. Volume and leverage grow and spreads narrow to unsustainable levels. Often this expansive phase unfolds in an environment where market returns have fallen and investors feel driven to "reach for yield". One way to raise expected returns is through the use of leverage. It is almost as if investors have a target desired yield and, at least in the euphoric expansion phase, they are willing to assume greater risk to achieve this target.

At some point a mishap, or perhaps a slowly accumulating awareness that the process has become unsustainable, triggers a correction. The severity of such corrections tends to be magnified by the amount of leverage and the impact of psychological contagion. During expansions market sentiment is dominated by greed and the thirst for higher returns. Once a correction is triggered, the dominant market sentiment turns to fear which produces an over-reaction. Only the savviest investors with the deepest pockets are in a position to counter the momentum of such market fear, however irrational it may be. Those without significant staying power may suffer unacceptable losses before market balance is restored.

The severity of such corrections can be magnified by a number of circumstances in addition to the increase in leverage mentioned earlier. One of these is a situation where the previous market euphoria focused on a new and previously untested type of security. To a degree this happened in the US after the initial introduction and surging popularity of Real Estate Investment Trusts. A similar reaction affected high-yield bonds in the early 1990s after they had been immensely popular throughout the 1980s. Much the same can be said about the shares of Internet start-up companies in 2000–2001. Needless to say, the most recent example is CDOs backed by sub-prime residential mortgages.

As mentioned earlier, one characteristic of new and untested types of security is uncertainty around valuation methods. Increases in the use of leverage to strive for a target yield means that the earnings impact of valuation modelling errors is correspondingly magnified. This can aggravate a fear-driven withdrawal from the market and produce a significant liquidity shortage. The absence of liquidity casts doubt on the reliability of asset prices that had been heavily dependent on such liquidity to provide the inputs for valuation models. This further increases market fears of the unknown and aggravates the vicious cycle of retrenchment.

Interdependence and moral hazard can also play a role. If investors have taken a hit from loss of confidence in a new and innovative security, their broker dealers are normally incentivised to force them to liquidate holdings to meet margin calls. The brokers, however, are often significant holders of such assets on their own books. Forcing a counterparty to liquidate its holdings of the same asset class can put pressure on prices, especially in the face of limited liquidity. This can create a significant disincentive for the broker dealer to enforce a margin call given the adverse secondary impact on its own asset values that such an action could cause.

To a degree "sustainability" has become an overused term, but it does have a certain relevance to financial markets. Legal, social and political conditions have a profound influence on the role and effectiveness of financial markets. Public confidence that financial markets are fair and open and make a positive contribution to improved economic well-being is crucial to their continued success. In most western countries there is broad acceptance, albeit accompanied by limited understanding, of the important economic contribution that financial markets make to effective investment allocation. This acceptance can sustain periodic financial market crises even if they have a wider negative impact on the general economy, provided that such crises are not too frequent and their impact is not too severe. It is in the long-term interest of financial institutions themselves to establish the necessary analytical systems and, more importantly, the institutional standards and discipline to assure that the damage from these inevitable market upheavals remains within socially acceptable bounds.

MARKET OUTLOOK

Events through early 2008

At the time of writing, the end of 2007, the market is experiencing a major credit and liquidity crisis. The situation has been triggered by a confidence crisis in the mortgage market in the US, owing to a sharp rise in "sub-prime" lending. We might wonder why a consequential but relatively small market (compared to the global capital market) could have such a devastating effect on the credit market as a whole. The question might be answered by looking at dependencies between borrowers, lenders and final investors. The borrowers were mostly composed of low-income households buying their main residence with 100% loan-to-value mortgages, and sometimes with the need to remortgage due to their incapacity to cover the annuities with their current income. They were offered these loans largely on the belief that house prices would carry on rising at the same pace as in previous years and that the loan exposure would be well covered by the appreciating property value. Unfortunately, when house prices softened in 2007, defaults on the underlying assets began to rise and the lack of an equity cushion at origination implied materially greater loss given default than has been typical on prime loans. In addition, prime mortgage loans rely on a borrower's income as the primary means of repayment. The fact that borrowers derive their incomes from a variety of regions and industries provides a degree of diversification for a portfolio of such loans. With sub-prime loans, however, the collateral value of the houses being financed is the primary source of repayment and this is subject to highly correlated declines when the housing market slows.

A good explanation why these defaults propagated to the whole market was the way these loans were being securitised and structured into "secured" CDO tranches. Many investors (pension funds, hedge funds, insurance companies) were pulled into this market because of the "attractive" package presented to them:

(1) high returns;
(2) long-term investment;
(3) underlying mortgage loans (supposedly secured);
(4) senior tranches not directly affected by first defaults.

When the first defaults occurred, the mark-to-market value of these CDO tranches dropped significantly because some investors began to recognise the lack of diversification and started to worry that even their senior tranche investments would be affected. This had a significant impact on the confidence that these investors were putting in other CDO tranches (even those not invested in property mortgages) and subsequently on the whole credit market. Also, some hedge funds started to experience difficulties refinancing their books as banks themselves had the same issue. To meet margin calls, hedge funds often found it necessary to sell those assets where reasonable market liquidity still existed, putting pressure on prices in those markets as well.

Through the use of credit derivatives, banks and investors now have access to fairly liquid diversification and hedging tools to reduce their specific exposures. Arguably, however, systemic risk has increased due to the magnifying effect of leverage and the interdependency between investors and banks. This interdependency can be compared to the "prisoner's dilemma" used in game theory. Basically, this concept applies when multiple actors have different choices to make (in our context it would mean holding or selling) but know that one choice can affect others' decisions. Everyone knows that everybody holding their positions is the best solution but each holder fears that others will not make that choice. The result is that no one is making the optimal choice and it goes some way to explaining the psychology behind massive sell-offs or liquidity crises.

A drop in long-term credit market liquidity can also affect short-term funding liquidity, as most banks prefer to refinance with shorter maturities when long-term credit is scarce and expensive. Even here there can be a problem, however, if banks fear that their peers may have hidden losses that have not yet been revealed. This fear of the unknown is widely regarded as the root cause of the evaporation of liquidity in the interbank money market in August 2007, a condition that central banks have had difficulty eliminating through the year-end.

A further source of concern is that the sub-prime mortgage problems unfolded in a market that was vulnerable on a broader front. Professor Ed Altman of New York University has pointed out that the proportion of high-yield bonds rated B- or worse at issue was historically high from 2004 through 2006. Under normal circumstances these bonds would be expected to experience rising default rates as they age.[8] Despite this, default rates have remained at historic lows all the way through 2007. Until recently this appears to have been because of the market's continuing appetite for absorbing additional high-yield debt, often packaged into corporate CDOs. This allowed companies facing fiscal stress to refinance their debt with comparative ease. Given the dramatic re-pricing of risk since mid-2007 and the far more constrained appetite for highly risky investments in the face of massive bank write-downs, such refinancing seems certain to become far more difficult in 2008 and 2009, with a corresponding rise in aggregate corporate default rates. In early December, Moody's predicted that the global speculative grade default rate would rise from its historic low of 1% over the past 12 months to over 4% in 2008. If the US economy actually falls into recession, Moody's estimates that such default rates could increase as high as 10%.

Future prospects

Events such as the sub-prime mortgage crisis of 2007 inevitably raise a variety of questions about the future outlook. Needless to say, as this is written at the end of March 2008, the answers to these questions are speculative at best. Nevertheless, we offer some thoughts on potential future scenarios related to four issues.

How much damage will be caused by these events both to financial institutions and the general economy?

Indications are that fall-out from the credit market upheaval will continue into 2008. Fortunately the capital base of banks in the industrial countries has been strengthened considerably over the past two decades. The Basel I regime took effect in 1988. After exactly 20 years it was superseded by Basel II in the EU as of January 1, 2008. Major money centre banks in the US will follow suit on January 1, 2009. There is much to criticise about the Basel I regime but it has been successful in its primary objective, namely increasing capital/asset ratios in the global banking system. This ample capital cushion is playing its intended role in absorbing the widely publicised losses reported by major banks during this crisis. If there is no failure of a major commercial bank as a result of these events, which is still a plausible possibility as of early 2008, Basel I can claim a significant part of the credit.[9]

This does not imply that the impact of the credit market crisis on general economic activity will be minimal. Clearly a major re-pricing of credit risk has occurred and that will not be reversed quickly. Weak companies that have issued a significant volume of single-B rated debt in the past four years will find it much harder to restructure or refinance their obligations in this harsher environment. Bankruptcies appear set to rise significantly, albeit from historically low levels.

These continuing consequences of the credit crisis are bound to slow real economic growth. Whether the impact tips the US and other industrial countries into an outright recession is still too close to call at this point in late March of 2008. The depth and duration of any recession will be critically influenced by new surprises that may emerge over the next year. Equally important will be how well governments manage the painful but necessary adjustments that need to take place. Government efforts to postpone or avoid such adjustments arguably prolonged the 1974–5 recession that was triggered by the first Arab oil embargo. It also led to prolonged stagnation in Japan beginning in the early 1990s.

One factor bolstering prospects for the economy is the broad range of new innovations in electronics, communications, agriculture, biogenetics and other fields. Introduction and application of these many exciting advances will play an important role in improving standards of living and will contribute to measured growth in real GDP throughout the world over the next several years.

How should businesses respond?

To some degree it is clear that a failure of senior management at financial institutions to strike an appropriate strategic balance between risk and return is at the heart of the 2007 credit crisis. There are theoretical arguments to support the idea that sound risk management contributes to higher shareholder value. As is always the case, however, harsh experience is a far more cogent teacher than economic or financial theory. The huge and well-publicised losses that occurred with uncomfortable frequency from the mid-1980s to the mid-1990s effectively stimulated the development of financial risk management as a self-conscious profession. Out of this experience emerged the concept of a Chief Risk Officer and the sense that risk management needed a seat at the executive committee level in order to assure an institution's long-term financial success. Memories fade, however, and periodic painful reminders are required to maintain a proper balance between the aggressive pursuit of higher earnings and protecting against serious losses in a crisis.

It is likely that the events of 2007 will renew senior executives' emphasis on risk management and increase resources devoted to the production of accurate and timely risk information. The trick will be to prevent this new focus from degenerating into routine processes that produce plenty of reports but do not actually influence strategic decisions. Special attention is required at the enterprise-wide level. Few firms can legitimately claim to have effective enterprise-wide data consolidation and associated analytic capabilities. Without this, senior management is seriously handicapped in assessing downside risks effectively. It is likely that some firms will weigh the huge write-offs they have experienced in 2007 against the cost of more effective enterprise risk management systems and will allocate the necessary resources to make significant improvements. This certainly will empower their firms to make more effective strategic risk decisions in the future.

How should financial regulators respond?

The risk in terms of regulation is the potential for over-reaction. Crises always put pressure on politicians to do something. Unfortunately the urge to act often outweighs the need for careful deliberation. The result tends to be ill-considered requirements that need to be revised or reversed later. That said, one area where regulators could make a constructive contribution is in demanding better operational control. Part of the story of this latest crisis is a failure to maintain effective life-cycle processing capabilities. As products become more complicated and volumes grow, sustaining operational capabilities at an acceptable level should be as important a focus for regulators as assuring adequate capital. This also would ease the task of consolidating data at the enterprise level as described previously.

Will unfolding structural changes in financial markets be slowed or even reversed?

Some have argued that the events of 2007 will trigger a reversal of the long migration from an originate-and-hold model of banking to an originate-and-distribute model. This seems to be highly unlikely. The diversification benefits and improved liquidity that these changes have created are valuable contributions to more stable financial markets. The fact that the collapse of the dot-com boom in 2001 and 2002 did not threaten a single major commercial or investment bank with failure is important evidence for the value of these changes.

Despite this, the unbridled pursuit of complexity for its own sake is a worrisome trend. It is hard to see what fundamental customer need is met by CDO^2 or CDO^3 structures. The main result is to make the structure so complex that only highly sophisticated firms can hope to assess the underlying risks. One favourable result of this crisis would be for buy-side firms to adopt a policy that they will only invest in products where they can independently understand and evaluate the risk. This would remove much of the incentive for sell-side firms to create gratuitous complexity that hides the true underlying risk. To a degree, however, the problem is more fundamental. As noted previously, the pricing for complex credit products with tiered tranches is heavily, sometimes exclusively, dependent on market liquidity. When liquidity dries up, the fragility of the underlying valuation models becomes apparent. The 2007 losses related to sub-prime CDOs occurred at several highly sophisticated firms with state-of-the-art quantitative staff and supporting analytical tools. Clearly, the products had become too complex for even the most advanced firms to assess the potential risks effectively.

Of course, any discussion of buy-side risk assessment raises the issue of the role of credit rating agencies in this process, (see Chapter 19 for a detailed discussion on rating agencies). The more advanced buy-side firms deploy their own selection criteria to supplement agency ratings. It appears, however, that an appreciable share of institutional investors have relied too heavily on official ratings in making decisions about suitable investments. Unfortunately the traditional bond rating scale was designed for an utterly different financial landscape than exists today. As noted earlier, agency ratings are embedded in legal requirements such as the constraint on certain types of fund to invest only in "investment grade" securities. The problem arises in that a traditional credit rating addresses only one important aspect of a security's appropriateness for a conservative investment portfolio, namely the probability of 100% repayment. Other issues such as the volatility of such an assessment and co-variation of such behaviour across assets and the implications of such behaviour for diversification and portfolio risk are not addressed. In effect we are attempting to assess the appropriateness of investments for conservative fiduciaries in the 21st Century with a metric from almost one hundred years ago.

Clearly some serious thought needs to be devoted to enriching the metrics produced by rating agencies and to incorporate such metrics in law and regulation. A first step might be to require that any agency rating be accompanied by a quality index that indicates the richness of the information base and the maturity of the analytics that underlie that rating.[10] If such a quality index ranged from 1 for the highest quality to 5 for the poorest quality, presumably corporate bond ratings would carry a quality index of 1. Ratings of sub-prime CDO tranches clearly should have carried a quality index of 5. At least this would have given a simple high-profile warning of the uncertainty around the reliability of the CDO tranche ratings. Restrictions on appropriate investments could then be augmented to say that only investment grade securities with a rating quality index of 3 or above are allowed. Alternatively, investment guidelines could, for example, put portfolio proportion limits on investments with rating quality indexes below 3. There still would be a question of conflict of interest within a system in which ratings are paid for by the issuers of securities being rated. Nevertheless, including the added dimension of an agency's assessment of the maturity of the methods underpinning a rating would seem to provide valuable and highly visible supplemental information for investors.

One important trend emerging from the current crisis is the significant increase in the equity of banks and other financial institutions held by sovereign-wealth funds. China, Singapore and Middle Eastern countries have taken advantage of the opportunity to acquire stakes at favourable prices in the midst of the huge write-downs in recent months. Forty years ago this would have been an unthinkable development. Whether these will remain passive investors or begin to exert management influence remains to be seen. Should they become active in attempting to influence the policies and lending practices of those institutions in which they have invested, this could create difficult political ramifications. This is an unprecedented development and could be one of the most explosive future consequences of the sub-prime mortgage crisis of 2007.

SUMMARY

Growth in the real economies of the G7 industrial countries appears destined to suffer some slowdown as a result of the unfolding credit crisis. Increased cost and limited availability of credit will prevail for some time. At the end of March 2008, the depth and duration of any economic slowdown remains highly uncertain and dependent on shocks that have yet to emerge.

In the aftermath of the current upheavals, financial executives are likely to take risk management more seriously for a number of years and may well allocate additional resources to improve enterprise-wide risk assessment. Regulators may accelerate this trend by an increased insistence on operational excellence both to control operational risk and to enhance availability of information for effective risk analysis.

It is unlikely that the trend toward an originate-and-distribute model of banking will be reversed by the unfolding credit crisis. Nevertheless, greater buy-side awareness of the dangers of depending blindly on agency credit ratings is likely to place a temporary restraint on the growth of excessive complexity. Improved awareness of and attention to diversification also is likely, especially relative to new and untested instruments. Enrichment of the nearly century-old credit rating scale to include additional considerations beyond the probability of 100% repayment is also possible, although less assured.

Perhaps the most enduring result of the sub-prime crisis will be increased equity holdings in western financial institutions by sovereign-wealth funds. How this situation will unfold is anybody's guess but it could have significant geopolitical implications.

Will future crises be avoided because market participants have learned their lesson? The short answer is "Dream on!" A somewhat tongue-in-cheek explanation of the Kondratiev Long-Wave in economic activity is that "Every generation must learn what its grandparents knew and its parents forgot". The accelerated pace of today's world seems to have shortened this cycle of forgetting and relearning. As an example, the latest splurge of gratuitous complexity is a recognisable echo of what occurred in the interest rate derivative market in the mid-1990s.[11]

Let there be no mistake, in another 10 or 15 years risk aversion will erode and new innovative instruments will emerge. These will cater to a voracious appetite for yield with little regard for the associated risks, especially when such risks are masked by gratuitous complexity. As Mark Twain famously said, "History doesn't repeat itself, but it does rhyme." Hopefully some who have suffered through the current crisis will emerge with an improved awareness of the rhymes of history. Those who do will have at least a fighting chance to avoid the worst consequences of the next round of irrational exuberance.

1 In 1981 The World Bank and IBM entered into a currency swap involving US dollar payments on one side in exchange for a combination of Deutschmark and Swiss franc payments on the other. In 1982 the Student Loan Marketing Association (Sallie Mae) swapped the payments on an issue of their intermediate-term fixed-rate debt for floating payments indexed to the three-month Treasury bill yield.

2 While VisiCalc is widely regarded as the first general function electronic spreadsheet, the later introduction of Lotus 123 for the IBM PC and Applix for Unix-based hardware made this technology far more widely available in the business world.

3 A more mundane, but probably more informative, name would be "credit default insurance contract". It is widely believed that "credit default swap" was chosen to avoid unwanted forms and sources of regulation.

4 The bond is generally used to define the loss (or recovery rate) in case of default, as it would be delivered against cash to the protection seller.

5 This was more in the range of 50–100 names in the earliest issues.

6 In March of 2001, UBS sued Deutsche Bank claiming that Deutsche defaulted on a CDS written on Armstrong World Industries. See URL: http://www.credit-deriv.com/crenews.htm#ubs_sues.

UBS sues Deutsche Bank for derivatives default

"Swiss bank UBS AG has sued Deutsche Bank AG for more than USD 10 million, according to documents filed with Britain's High Court of Justice. They show that UBS is alleging Deutsche is in default in a credit derivative deal designed to pay if U.S. building materials maker Armstrong World Industries Inc defaulted on its debt. UBS apparently entered into a credit default swap with Deutsche Bank for bonds of Armstrong, due in 2005. Armstrong has, in the meantime, altered its corporate structure and transferred ownership of its stock to its holding company. The holding company has filed for protection under Chapter 11 of the US bankruptcy code. The parties have possibly a legal duel on the technical wording of the swap agreement."

7 D&B provides company analysis for instance. Creditex has specialised in credit derivatives quotes and news.

8 Altman, Edward I., "*Are Historically Based Default and Recovery Models in the High-Yield and Distressed Debt Markets Still Relevant in Today's Credit Environment?*," New York University Salomon Center, Stern School of Business, October 2006; summarised in D. Rowe, *A Gathering Storm?, Risk* magazine, February 2007, p. 83.

9 Bear Sterns, of course, was not a commercial bank and was not subject to the Basel I capital requirements; nor did it have the liquidity backstop of the central bank to deal with a sudden loss of market confidence.

10 Michael Gordy of the Federal Reserve Board staff has suggested such a scheme. He emphasises, however, that this is his personal view and does not reflect an official FRB position.

11 See Rowe, D., *The Dangers of Complexity, Risk Magazine*, April 2005, p. 73.

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