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Credit securitisation, information, and system stability

Roger Bowden*

Institute of Finance
Faculty of Mathematics and Economics
Ulm University, Germany;
Kiwicap Research Ltd
Wellington, New Zealand

Dawn Lorimer*

Victoria International Applied Finance Programme
Victoria University of Wellington
New Zealand

The leveraging of credit that precipitated the subprime crisis was vectored via a proliferation of investment vehicles and credit derivatives, driven in part by competitive pressures to enhance returns by economising on economic capital. Theoretically, this should have spread risk and improved economic efficiency, but in practice it exposed the system to a meltdown. Critical points for system stability are the certification of credit equivalence required by decentralised information trading, and the portfolio equivalence of credit default swaps and the physical loan book. Regulatory implications encompass the trade off between collateral and economic capital in liability recognition for credit default swaps; enhanced tests for fiduciary duty; managerial reward regimes; and periodic regulator advisories as to state dependence of credit ratings.

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1. Introduction

The subprime crisis, and the credit crunch that resulted, were in the first instance an outcome from the extensive securitisation of credit that gathered momentum over the years 2002-2006. Credit default swaps (CDS) had by that time become the vanilla flavour. Also on the menu were products such as credit spread options, swaptions, variance swaps, credit-linked notes, collateralised debt and loan obligations (CDO's and CDO², CLO's), synthetic CDOs with different capital structures, basket products, full and tranching index trades, equity default swaps, credit contingent swaps, constant maturity swaps, and CPPI. In face value terms, the volume of such 'alternative risk transfer' instruments substantially exceeded the underlying debt that constituted the ultimate physical. The securitisation of credit itself reflected the needs of the originators of special investment vehicles (SIV's) and special purpose vehicles (SPV's) constructed to hold tranches of mortgage backed securities, asset backed securities, or CDO's. In turn, these were driven by managerial yield enhancement pressures as interest rates dropped, and as regulatory reforms for banks necessitated more effective use of economic capital ('regulatory arbitrage'). For credit itself was profitable, especially if it could be separated from interest rate risk in the form of a pure credit spread, in effect a zero capital portfolio enhancement.

Much has since been written on the cause and consequences of the crisis, including the investment structures that helped to precipitate the liquidity crisis. But as recriminations fade, and litigation runs its course, the task begins of redesigning the system to minimise the chances of it all happening again. In principle, a well designed structure should function without extensive regulatory oversight and prescription. It has been argued, for instance, that if all CDS had to be routed through a central clearing house, posted collateral would be equivalent to economic capital under an external regulatory regime such as Basle II, with much less administrative expense and less temptation to engage in regulatory arbitrage. Whichever path is followed – system design, external oversight, or a combination – the task is how to minimise systematic risk, and the systemic risk it can generate.

Information plays a critical economic role in this respect. If the credit risk of any particular entity is going to be separated from the underlying physical debt and traded by an international clientele, then a mechanism must exist for information about the physical to become public knowledge. That role was played by the credit rating agencies, which in effect certified the debt. Apparently authoritative certification provided comfort to investors in SIV's, or to the funders of the commercial bills that sustained them. It also meant that a bank running a trading book in CDS could rely on certification to control for counterparty risk, for without

either certification or collateral the bank would have to research the entire portfolio of exposures of the counterparty from which it has bought credit protection. In that sense, the credit ratings amounted to metrics that played the role of sufficient statistics. System regulators could allow banks or other financial institutions to fall back on recognised credit ratings of their assets, as in the Standardised Approach of the Basle II regime.

The role of the ratings agencies in this respect has received much recent attention¹, including litigation, for if their models have deficiencies of one kind or another, then statistical sufficiency fails. This can be referred to as the problem of metric insufficiency. It becomes an additional source of risk (model risk), which can be systematic in nature where risks thought to be independent are in fact correlated (Coval *et al* 2009a,b). Where banks are concerned, systematic risk can pass easily into systemic risk. Two aspects are highlighted in the present review, though there is also some discussion of the moral hazard and adverse selection problems.

The first is the match between model methodology and model use. Credit models come in two generic forms, the ‘historical’ versus ‘structural’ approaches. The first is based on historical ‘over the cycle’ data and the second on modelling asset value and predicting conditional probabilities of default, as in the Merton options model of corporate spreads. Under the Basle Standardised Approach, banks could use ratings based on the historical model for their own capital adequacy; and the SIVs they set up were likewise tuned to the historical approach. So the issue becomes one as to whether this was an adequate safeguard, given that the economic state vector at the time was clearly signalling hazards ahead. The econometric issue is whether the ratings, of whatever philosophy, are statistically sufficient metrics, given the available information; and the policy issue is what to do if they are not.

A second aspect refers to absolute versus relative credit equivalence. There is tacit recognition by the regulators that ratings are not absolute but depend upon debt categories, which means that the ratings scale as a whole is not mathematically complete. Thus the Committee of European Banking Supervisors (CEBS) in their *Guidelines* (2006) distinguish between public finance, commercial entities, and structured finance, and the Basle II weightings also distinguish between corporate, bank, and sovereign debt. An AAA rating of a senior MBS tranche is evidently not equivalent to a US Government or World Bank security, a distinction that might have surprised the average SIV investor – before the crunch, when it mattered. But probabilities (of default or downgrade) are ordinal measures, not cardinal. If they are treated only as ordinal then on the face of it, there must something wrong with the model that maps estimated probabilities into ratings. However, the issue is really one of fitness for the intended purpose.

Taken together with statistical insufficiency, all this suggests that ways must be found to lessen the regulatory reliance on credit ratings.

The general theme of systematic risk has been mentioned in connection with model risk. In fact, there are reasons to think that decentralised trading of credit is exposed in more general ways to systematic risk. As already noted, a bank holding even a single name CDS in its trading book becomes exposed to an entire portfolio of names through counterparty relationships. In addition, the deconstruction of traditional lending into a base risk free asset + a pure credit spread is not necessarily portfolio equivalent to the original relationship lending model of bank lending. The pure credit component has the character of a put option, and is more sensitive to adverse states of the world; the nonlinear delta property. Moreover, the separation leads to informational exposures that create fresh sources of systematic risk. Investors who might otherwise have been limited to the local economy can now invest in credit globally, or hedge global exposures on other assets. But in doing so they are more reliant on the ratings agencies and system regulators for the certification process. Model risk therefore becomes an internationally systematic pricing factor. And to the extent that an organised market develops (as in CDX, ABX, or Itraxx), the information sets of investors adjust to encompass the public information about what others think, just as the no trade theorem says they should (Duffie and Manso 2007). A diverse set of views about credit status of a loan or portfolio become more homogenous and is also priced in terms of the common market factor, which can thereby be more affected by contagion and bubbles.

A number of regulatory implications are explored. These include more attention to the economic capital required for credit default swaps, which are arguably de facto guarantees. Under a Basle type external oversight, the full liability should be recognised, as distinct from market risk, which currently applies only if the swap is in the money. But also relevant is a current debate as to whether increased transparency of OTC counterparty concentrations would be enhanced with a formal clearing house, in which collateral has to be posted, playing the role of economic capital.

The metric insufficiency of credit ratings, and their periodic state dependence on unusual or hazardous circumstances, calls for a more activist regulator early warning system (‘hazard warnings’), to the effect that probabilities calibrated off historical ‘over the cycle’ models may not necessarily apply at this point in time. Enhanced legal tests for prudential duty on the part of financial managers might include paying attention to such signals.

Likewise, regularity scope should be extended to encompass exposures or predispositions resulting from managerial remuneration structures. Managerial bonus schemes have attracted

much media and political opprobrium, but this has tended to obscure some important points of economic principle, notably a reversal of long established conventions regarding risk shifting as between managers and shareholders. Because of the way that credit default swaps are structured, rewarding managers on the basis of early cash flows frontloads risk on to the shareholders; managers are in effect getting a free ride on their bonuses. A better arrangement would be to backload the managerial rewards to the later periods of the swap, at which time the swap coupons more than compensate for the fast sinking time value of the swap. One way to do this is via a sinking fund that is amortised over a designated period. Turning managers into creditors aligns their interests more closely with bond holders as well as stock holders.

So far as rescues are concerned, moral hazard is pretty much unavoidable, but its effects can nonetheless be diminished by the design of rescue packages. This might include more stringent tests of just who should be rescued, and recognition that rescue endows a real option to continue in business, for which the rescuer needs to be compensated.

The scheme of the rest of the paper is as follows. Section 2 examines the critical importance of information certification, in particular that offered by the credit rating agencies. Two important dimensions are metric sufficiency and credit equivalence. Section 3 turns to the issue of portfolio equivalence, and the systemic risk posed by credit derivatives. Section 4 examines the policy implications, with the conclusions of the paper cast in terms of system design and regulatory oversight.

2. Certification, credit equivalence and model risk

Guessing whether an otherwise sound company can make more money is a matter of judgement on which many investors are willing to chance their hand. Assessing the precise credit status of a company, on the other hand, requires a detailed look inside the company and its accounts, backed up by some serious expertise in assigning a metric outcome. The exponential growth of credit securitisation meant that the credit status of a company or SPV could be spun off and traded by investors who might have little knowledge of the company or its accounts; certainly not the kind of knowledge that would be acquired from relationship banking and other traditional vehicles for extending credit. In other words, ratings help to resolve informational asymmetry as between originators and investors (Sy (2009)). Indeed, in the case of a market maker in CDS, the informational gap might indirectly extend even to what reference entities it is exposed to, an aspect considered in section 3.1. Credit securitisation therefore required credit certification. For example, AIG was not required to post collateral on its CDS trades because of its AAA rating, so

that the rating was treated by its counterparties as metrically sufficient (see below). The problem is that credit certification in itself entails a form of risk, namely model risk.

Certification has always been vital to the debt markets, and the immediate custodians of certification have by common acceptance been the credit rating agencies. The ratings assigned to company debt by the three major agencies, in particular – Moody's, Standard and Poor's, and Fitch's – are significant pricing factors when debt is issued, or traded on the secondary market. The ratings early acquired administrative force in the form of restrictions on the investment grade allowable in company or fund articles: for instance, trust funds are not permitted to invest in bonds of sub investment grade (BBB- for Fitch and S&P, Baa3 for Moody). Certification is by no means limited to the three majors. In addition to a host of smaller credit rating agencies, drawn by the lucrative returns in recent years, there are special purpose agencies, notably those that specialise in rating people rather than firms. The most important of these is the US FICO index, originated by Fair Isaacs & Co, which assigns scores between 300 and 850 based on personal credit history and debt capacity. The median pre-credit crisis was 720, and the dividing line between prime and subprime borrowers was set at 700.

The certifying role of the three major credit rating agencies ('the majors') was given de facto official standing under the Basle Capital Adequacy, to which most OECD banking regulatory systems are now aligned, although there are some differences in specific aspects. Other rating companies are also free to apply for certification, and there are formal guidelines² for this, but the three majors are widely regarded as the benchmark. The Basle II regime gives banks the choice of a Standardised Approach or an approved internal model³. Under the Standardised Approach, the amount of economic capital that a bank has to hold against corporate debt and other assets depends upon the ratings assigned by accredited agencies. This extends to mortgage backed securities (MBS) or collateralised debt obligations (CDO). In this respect, an AAA rated tranche would have required 8% according to the original Basle convention. This was halved to 4% in the 1996 revision of Basle I, and further reduced to 1.6% in the Basle II Standardised Approach, which became operative from 2006.

The upshot was that the ratings of the majors had acquired official recognition. This extended to their respective national implementations. For example, the Financial Services Authority (FSA) in the UK also approved external rating agencies for institutions that use the Standard Approach to measuring credit risk. The Committee of European Banking Supervisors (CEBS) published in January 2006 a set of guidelines for recognition of External Credit Assessment Institutions (ECAIs) under the Capital Requirements Directive. Some system regulators not formally part of the Basle group followed suit. Given the systemic importance of

the ratings, it could therefore be claimed that a corresponding responsibility devolved upon the BIS and national central banks or regulatory authorities⁴, to assure themselves that the underlying credit models and assumptions behind the ratings were sound and fit for the intended purpose. *Quis custodiet ipsos custodes* could thus be adapted to ‘who certifies the certifiers’?

In the event, the credit rating agencies came under heavy fire following the 2007-8 meltdown (for a review, see Brunnemeier 2008)). What follows is a review of some of the problems that were raised and others that should be raised, cast in an economic framework. A more or less common theme is that of model adequacy and fitness for the intended purpose. If the system is going to rely as heavily as it did upon ratings, then the latter acquire the force of metric sufficiency, which amounts to statistical sufficiency⁵ with respect to the available information set. In practice, this turned out not to be the case.

2.1 Models and adverse selection

The task of model certification is going to be more onerous if the certified agencies all use different models for the same general purposes. In that case, the issue would have to arise as to which was the best model to use, for in an ideal world, a regulator could hardly approve a variety of models, some or all of which gave quite a different answer to the same purpose. One of them must be more correct or more appropriate to the intended use than the others. Or if capital adequacy is to be based on some weighted average of multiple metrics, the question would simply be recast as to how one should determine the weights, and whether they are constant over time. The best system outcome would be model convergence, so that all the agencies and the BIS itself use the same sort of model for the same sort of purpose. In addition, the model should rate highly on statistical validity: the probability that the model had predicted or signalled a credit event should be high, given that such an event in fact did occur. In regulatory guidelines this is referred to as ‘back testing’.

Moral hazard and related party problems have attracted considerable attention in the post credit crunch debate, for this can also lead to multiple models. From the informational point of view, an implied economic agency relationship exists between the raters and the investors. But it was the originators that paid for the ratings, for it was imperative that an SIV or SPV attain a very good rating for its senior tranches, in order to fund them through the commercial paper market. At the height, a huge amount of ratings business was being generated by structured finance products; indeed a major part of their corporate earnings originated in this way. The general thrust of the criticism and litigation was that this might have induced the rating agencies to relax their standards in order to acquire or keep such a lucrative relationship with the originating investment banks, or that providers could simply shop around for the best rating

(Skreta et al (2008)). Mahlmann (2008) makes a related point concerning strategic disclosure of ratings. A counterargument, aired by the Basle Committee itself, was that any perverse distortions of the rating models or their results would have impacted negatively on the agency's professional reputation, leading to loss of credibility among investors or regulators, and therefore loss of business.

Selection biases can also arise as a result of model type, or their empirical frame of reference. Thus suppose that two models have exactly the same mean of their respective sampling distributions for metrics (scores) that are monotonically related to the probability of default (the higher the score, the higher the chance of default over the given horizon). However, the philosophies of the two models differ. Model A adopts a long run or stationary frame of reference; model B pays more attention to changes in states the world, so that its predicted default probability reflects conditional information. Suppose also that in more uncertain or volatile times, model B has a higher sampling variance for its estimated score. Under client selection, what is the outcome? The client would reject model B in favour of A in the right hand tail (indicating high default probability) and reject A in favour of B in the left hand tail. Both models can survive, but the outcome ('fmin') is a censored distribution that is no longer unbiased; in fact, the mean of the censored distribution, as adopted by the client, has now shifted to the left, with a left hand skew, wrongly indicating lower expected default probability (see figure 1).

The generic problem is one of strategic self selection, in which the results of measurement depend upon the interests of either the measurer or the measured, in other words, a statistical game (Bowden 1988). The net result is an equilibrium in which multiple models can coexist, driven in part by adverse selection and in part by moral hazard. Unsuitable or even bad models can survive alongside good models. Natural selection is failing to ensure the survival of the fittest, at least from society's point of view. Yet another resolution of the model problem is one in which the same agency will produce several different scores, one for each type of model, or specific to different forecasting horizons. This is a more up front solution, but it vitiates the principle that ratings should be single valued functions usable for bank capital adequacy regulation and similar purposes.

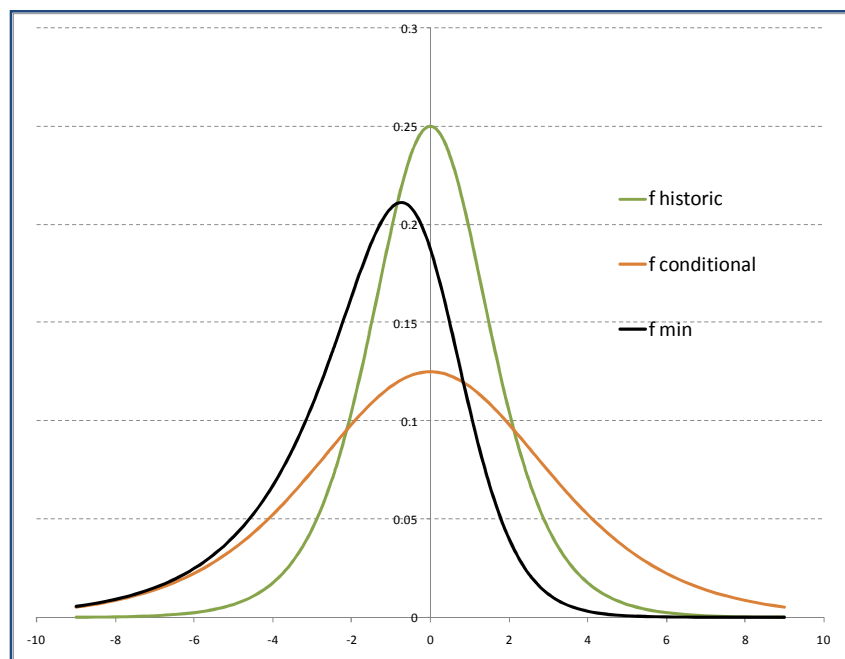


Figure 1: Adverse selection and default score densities

A related point concerns the less than arms length working relationship necessitated by the complexity of creating structured products, which requires feedback between the SIV writers and the ratings agencies (Mason and Rosner (2007)). Ishikawa (2009) has pointed out what is, in effect, an instance. From about 2005, investment banks and SPV's originated a credit instrument, based on a CDS portfolio as the underlying investment, that guaranteed only 10% of the investor's initial capital. These were called CPDO's (Constant Proportion Debt Obligations). Their philosophy was the polar opposite of portfolio insurance: they bought more of the underlying investment when the latter had done badly, and sold it when it had done well. The models underlying the pricing and rating of these CPDO's were based on mean reversion, the idea that sooner or later the price of such a fund would revert from either highs or lows back to a normal path reflecting the long run average cost of investor capital. Over the longer run, the CPDO's returned at least 8% in 99% of scenarios, and there was only the minutest probability of losses down to the 10% initial equity. With the results of the simulation model to hand, the ratings agencies obliged by giving the CPDO's an AAA rating. At the time they were returning LIBOR +2% , compared with +0.5% for other AAA instruments, and more than even investments rated BBB -. But in many, if not most cases, mean reversion models are more a reflection of econometric convenience than any deeper understanding of the economic structure

driving the time series. They are generally too mechanistic to cope with structural breakdowns, or even to adequately measure the current state of the system. And the hazards multiply when the system becomes highly levered through securitisation. Mean reversion, in other words, was an unsound conceptual basis for default scenarios.

Scenario analyses were in fact quite widely used at the time, typically in banks' internal ratings systems under Basle II, which requires back testing as a supplement to the formal model. Scenarios, in general, are alternative possible path histories into the future. The general idea is to identify path histories that depend upon a set of alternative contingencies acting as switches between alternative future paths. The dimensionality of a set of scenarios could be characterised in terms of the number of independent switch events. Probabilities can be attached to different scenarios by assessing the likelihood of the generating set of switches. Thus a simple version might depend upon a one dimensional switch between alternative values of GDP growth, which becomes the primary driver setting all subsequent switch points. The recent US Treasury stress testing of US banks is of this variety. In such a framework, one could decide on scenario probabilities by assessing the probability of a recession next year, as e.g. zero, mild or severe.

Assessments of this sort are evidently based on the current state of the world. The state vector, in other words, becomes of prime importance, and this extends not just to the state of the firm but to that of the economic environment in which it operates: the economic state vector. But if this is seen as necessary, why is such an approach not built into the credit rating process itself?

2.2 Model assumptions: state dependence and the nesting problem

As earlier mentioned, credit ratings can follow different models and methodologies. The ratings as they appear in the Basle II Standardised Approach are based on the 'scoring approach' or the 'historical model', because the ratings are calibrated off historical frequencies of bond defaults. The agencies commonly claim that these ratings are intended to apply not to the 'here and now', but to average behaviour over the long run of the economic cycle. In other words, the probabilities estimated are effectively unconditional and not conditional with respect to the current state of the world. To be sure, the scoring approach does measure current firm-specific variables such as leverage or liquidity ratios, and adjusts the logit scores for probabilities of default accordingly. But what comes out is a credit rating that is calibrated off the historical probability of a bond 'over the cycle'. Thus a probability of AAA in Fitch refers to the 10 year probability of default of 0.19%, or 0.02% annualised; for BBB-, the corresponding figures are 7.26% and 0.75%.

Even within a more or less stationary historical frame of reference, the probabilities have been questioned. Coval *et al* point out that even minor mis-estimations in the correlation of

defaults among the assets in any given CDO pool can seriously affect the ratings of the tranches constructed out of the pool. They consider a pool of otherwise undifferentiated credits that is divided into three tranches, the junior, mezzanine and senior according to the default sequence, so that the default losses start to impact on more senior tranches once the more junior tranches have borne a designated proportion, perhaps entirely wiped out. If the default correlations in the underlying pool increase to just 20%, even the senior AAA rated claims can quickly turn into BBB-, and the effect is more marked if the CDO structure is itself compound as CDO² (CDO's written on CDO's).

Exercises of the above kind could alternatively be regarded as parametric interpretations of changing conditional probabilities generated by underlying structures or circumstances that are observable, but which the credit modeller might not have factored in. What may look like a correlation with respect to one information filtration may just be conditional means with respect to another. Thus suppose returns on a set of n securities are generated by

$$r_i = \mu_i + \beta_i s + \epsilon_i; 1 = 1, 2, \dots, n,$$

where s is a zero mean signal that is observable to individual C but not to individual H. The idiosyncratic disturbances ϵ_i are uncorrelated with respect to either information filtration. Hence:

$$E_H[r_i] = \mu_i; \text{Cov}_H[r_i, r_j] = \beta_i \beta_j \sigma_s^2; \text{ but}$$

$$E_C[r_i] = \mu_i + \beta_i s; \text{Cov}_C[r_i, r_j] = 0.$$

To individual H (for historical) there appears to be systematic correlation, but not to individual C (for conditional).

This raises a more fundamental issue, as to the type of model being used, for the historical approach is not the only way to model default probabilities. An alternative 'structural' approach is based on a dynamic model of the asset value of the firm and locating default as the event where the debt to asset value ratio falls below some critical point. The Merton options model of corporate bond pricing is based on this sort of model⁶. The probability of default, sometimes called in this context the 'expected default frequency' (EDF), now explicitly refers to the coming interval of time (in this context, the value at risk horizon), with drift and volatility terms that can both be variable. The difference has analogies with that in biometrics between a survival probability and a hazard function. The historical approach could be regarded as providing the survival probability over a longer time frame, while the structural approach refers to the probability of 'death' over the coming time interval, given the firm is still currently 'alive'.

In the present context, the precise nesting between the two is unclear; for there should be such, if only to elucidate the circumstances under which the historical approach can afford to ignore initial conditions. At times of exceptional economic stress, the probability of survival (default) over the next 10 years is surely diminished, for any given values of firm's financial ratios. Loeffler (2007) has suggested that the results from different methodologies could themselves be combined into a single index that best predicts future default over designated horizons. If this or a similar mixture distribution path is to be followed, the weights or nesting should ideally be linked to the economic state vector itself. In more normal times the distribution would resemble the historical or stationary distribution, while at times of economic stress, the distribution would come to resemble more the conditional EDF approach.

Even within the structural framework, questions have been raised about the way that other variables can impact on structural probabilities; thus Liao *et al* (2009) explore the effect of agency and asymmetric information in raising estimated default probabilities. But a major problem that impacted so adversely on the current crisis was the difficulty in capturing changes in the ambient economic environment that can affect many credits at the same time. This can apply not just to changed correlations between the credits in a portfolio, but to expected outcomes conditional upon current information.

The subprime mortgage crisis provides chapter and verse for the need to condition on current information, including current financial structures. In the US a huge volume of loans were written in the form of option adjustable rate mortgages (ARM's) that carried an option to pay a lesser interest rate for a defined period, the foregone payment being added on to the loan balance. A 2006 article⁷ in *Business Week* describes the potential threat to stability, noting that by 2004-5 more than a fifth of the adjustable rate mortgages were in negative equity as a result of accumulating mortgage balance. The resulting accumulation of negative owner equity predisposed to house price instability if there was any kind of economic shock, or even a slowdown. Without ARM's the adjustment path is more stable and preserves positive homeowner equity. With ARM's, the adjustment path is steeper downwards as more houses are dumped on to the market ('jingle mail', because the keys were posted to the bank). A common economic stimulus that adversely impacts on employment or incomes becomes a systematic risk that increases correlation across the whole pool of loans. Relatively benign ARM's can generate path histories that are predisposed to default by even straight mortgagors, as the next tranche up.

The common denominator of all the above is that there are hidden sources of systematic risk that are deeply rooted in the current situation and the scenarios that can emerge as a consequence. Influences of this kind may not be encompassed in the historical scoring approach

to credit modelling, and modelling them may be difficult even within the structural approach. In any dynamic system there may be hidden or latent variables that from time to time surface as shocks to the ambient economic state vector. In the present history, it could be argued that the existence of such economic shocks, or the threat of such, was known to market participants by 2005, manifested as high oil prices together with higher interest rates. Further elements of the economic state vector might have included inventory accumulation in the US auto industry, as a major employer. By 2006, the hazard state vector might have included loan to value ratios and other measures of mortgagor stress or housing market overheating. The publicly available information set had arguably changed to an orange light, if not a red light. This is not a matter of correlations from a more or less stationary distribution. It concerns conditional distributions, given the current information sets available to participants; the economic state vector.

In terms of the tranching model of asset backed securities, the effect of conditionality is to materially enhance the probability of default across the board, extending to the higher AAA rated tranches. The Coval *et al* structure earlier could be described as *ex post* tranching, because the underlying assets that enter the respective tranches are known only after the event of default. In *ex ante* tranching, the tranches (high, medium, low) are assembled according to initial credit status such as FICO scores. Conditionality now means that an economic shock can expose even strong *ex ante* credits, so that following an economic shock, the bad credits drag down the good ones.

The 2006 *Business Week* article earlier quoted was written *before* the meltdown. So a further issue is whether the available information was being used efficiently on the part of most market participants and on the part of the regulators. A minority of perceptive individuals⁸, using just the same publicly available information set, evidently came to quite different conclusions about the sustainability of the ABS pyramid. Either they stopped writing more ABS, or else sold short the ABX index, even to the extent of bearing the burden of paying on the underlying credit default swaps. A third alternative, among those well informed, was to simply continue to write up more SPV structures, fully aware that the whole house of cards could collapse, but determined to make money in the meantime. In other words, information could be used efficiently from the private point of view, but not from the social perspective. This raises the issue of accountability assurance (see section 4).

2.4 Absolute and relative credit equivalence

As the preceding example suggests, the ambient situation is also going to be important in driving the probabilities of default. A home mortgage credit tranche rated AAA on historical grounds becomes anything but when it is exposed to falling house prices triggered by structural

deficiencies in the mortgage origination industry. The best that could be said of the historical approach is that it might provide an ordinal ranking of default probabilities, applicable even to state dependent contingencies of the kind earlier noted. In the above example this would be true of within-category differences. Thus a prime borrower (Fico score of 700+) with a conventional mortgage would certainly rate higher than a subprime borrower with an ARM mortgage. Likewise, if a company or government is placed on credit watch, this refers to the possibility of a downward change in credit rankings, without specifying anything more precise.

Unfortunately this falls far short of what is required of a comprehensive comparison system across different categories of financial instrument, issuers or industries. It does not mean, for instance, that an AAA rating from an ABS structured finance tranche is necessarily the same as an AAA rating from the World Bank or the US Government, which might be much less affected by exceptional times. In technical terms, the ordering or preference relation is far from complete. The industry has tacitly accepted this for some time. It is implicit in the Basle credit weightings: for instance, an AA rated corporate loan requires 20% economic capital, but an AA rated sovereign debt requires none. Likewise, the CEBS *Guidelines* (2006) distinguish three main market segments: public finance, commercial entities, and structured finance.

A sanguine view is that this would amount to ‘relative’ credit equivalence: relative, that is, to the class of asset (e.g. corporate bonds, or government bonds). The average investor, however, would think in terms of ‘absolute’ credit equivalence, according to which an AAA rated SIV credit tranche has the same default risk as a US government liability. The methodological framing of the ratings in terms of historical probabilities of default might well justify such an interpretation. For probabilities of default are a cardinal measure, not an ordinal. If the models do correctly predict probabilities of default, why should government debt be treated any differently from ABS securities in structured finance? Or if they are, at just what point is an equivalence to be established between the two scales? After all, that is just what Basle II does in allocating economic capital, as in the above example. So if a basis exists to do this, then investors at large should have access to just the same methodology via the credit rating agencies.

Even with relative credit ratings, there is a lack of both consistency and completeness. Under relative equivalence, it is difficult to decide just where the asset class boundaries should be drawn. Even for the same company, agencies such as Moody’s might prepare a number of different ratings scores, depending upon the type of rating methodology or the type of liability. At any given time, the scores can vary quite widely from one methodology to another and be of quite different success in predicting default probabilities. To some extent, the heterogeneity might itself be a transitional problem as rating methodologies themselves develop as a result of

future technical advances. In the meantime, credit ratings are evidently not single valued, but for any given company and liability, at any given time, the ‘true’ credit rating is inherently fuzzy, in the sense of Zadeh (1965). This is the more so as one tries to compare ratings across different classes of liability, and as the ambient economic environment changes.

Ultimately, the whole issue of relative versus absolute credit ratings comes back to model fitness for the intended purpose, and whether the latter is appropriate and clearly understood. Probabilities are simply weights defined on a specific measure space, and there may or may not be an associated frequentist interpretation. The problems arise when the measure space is not what investors or regulators think it is, or has changed in some way. The issue of what to do about this is revisited in section 4.3.

3. Portfolio equivalence and credit disintermediation

Credit default swaps were initially seen as a way to distribute default or downgrade risk to those willing to bear a share of the burden in exchange for a periodic fixed payment; loosely, the ‘coupon’, by analogy with interest rate swaps. However, as single name CDS liquidity and the range of associated index products evolved, user horizons expanded. By 2006, banks and a growing number of other market players were holding extensive portfolios of CDS’s along with a proliferation of other credit driven derivatives. The monoline insurers were in fact only a minor part of the total market for credit derivatives by volume, though their systemic importance turned out to be disproportionately high.

Bank holdings were at first predominantly in their trading books, driven by market making and by arbitrages between asset swaps and CDS. This usage remained important, especially in the light of subsequent events. As time went on, the banks were also holding large amounts in their loan book, partly to hedge existing loans, but partly also as complement or even substitute for physical loans. And in addition to a growing appetite from hedge funds, ‘real money’ and other fund managers were also using CDS as substitutes for a cash loan book. In what follows we look at both motivations, the trading book and the loan book.

3.1 The trading book

Almost by definition, the trading book should be roughly balanced over all except very temporary horizons as between short positions (taken here as credit protection seller) and long (credit protection buyer). However this does not imply safety, for absent stringent collateral requirements, the bank is now exposed to an upstream network of counterparties and in turn, to an entire portfolio of reference entities.

Thus suppose that a given CDS on the short side refers to a single reference entity (i.e. a single name CDS). To protect its exposure as a credit protection seller, the bank does a corresponding swap on the long side written on the same underlying reference entity. If the reference entity defaults or downgrades, then the bank has recourse to its counterparty. But the counterparty must itself not default on its obligation under the swap. Thus our bank has on the long side an effective call option against the counterparty that pays off if two things happen: (i) the reference entity defaults; and (ii) the counterparty does not default. Now consider, in turn, the counterparty. This might itself hold a portfolio of CDS, which may or may not be protected in the same way as that of our bank (AIG appears not to have been hedged, i.e. a primary risk bearer). If not, the network has reached a terminal node, and the counterparty has simple exposures to a set of its portfolio reference entities. But in turn this means that our bank, in buying a single name CDS, has indirectly inherited an exposure to an entire portfolio of names. Things are not very different if the counterparty has in turn protected itself with long CDS positions. Sooner or later, a terminal node is reached and our bank is indirectly exposed to the reference entity names on all its upstream links.

How can the bank know all these indirect exposures? The practical answer is that it cannot. For that informational role it has to rely on the credit rating agencies. The metrics of the latter become sufficient statistics for unobservable information. If in fact metric insufficiency holds then the bank is to that extent exposed to model risk.

3.2 The loan book

In the early years CDS were used to hedge existing exposures in the loan book, but while this usage remained, an additional agenda gained ground, that of a synthetic loan book. By combining government bonds and credit default swaps on CDO's, managers could reconstruct a portfolio of physical corporate loans, but free up some of the economic capital otherwise needed to do so. In doing so, a bank or fund manager could hope to effectively create a portfolio of corporate bonds of any desired credit profile, both as to margins or ratings and as to the industrial composition of the exposures, one could also be tailored for any stance on market risk factors such as interest rate risk. Moreover, it could do so without the transaction, monitoring, and administrative costs of 'live' client relationships, convenient for new entrant banks without an established local client base. CDS offered a potential flexibility advantage relative to standard commercial loans: there is no locking in effect, so that it is easier to switch in or out of industries or credit classes according to changed perception or policy priorities. The maturity composition of a CDS portfolio could be adjusted by buying or selling swaps closer to maturity. And taking the portfolio idea to a logical conclusion, the portfolio proportions could be adjusted more or less

at will. In the terminology of portfolio enhancement (Bowden 2003), the CDS portfolio could be structured as a zero capital enhancement overlay, with respect to a base or benchmark portfolio of AAA rated government bonds or the equivalent; a swap for instance is technically a zero capital instrument at inception (regulatory requirements aside). One could go short as well as long in the enhancement portfolio. Negative basis trades were an instance. Bank loan managers could also use CDS indices as a hedge against the credit spread on their physical loan book. Investors at large could, and did, buy credit default swaps as an alternative to going short in the stock of a company, or even in combination for an aggressively levered short position.

The above deconstructions could be described as a form of portfolio equivalence. A portfolio of commercial or residential loans is separated out into the underlying high grade base and the pure credit component, which can be repackaged and sold separately. Doing so would theoretically improve the pricing and trading of risk because its flexibility allowed many more counterparties to share in the risk, including those with a specific risk appetite such as hedge funds. All in all, it was an attractive idea, not least because by 2002, most international investment banks with trading desks were showing up to 300 names on individual CDS's. Correspondingly the volume of CDS exploded worldwide, not just from bank holdings but those of synthetic SPV's⁹ and other holders.

So how did portfolio equivalence stack up? *Ex post*, not at all well, at least from the stability point of view. One of the problems was that by this time, the major CDS indexes (CDX and Itraxx) had become settled in composition and well traded. The pricing of CDS's inevitably adjusted to the benchmarks, so that when the crisis started to unfold, most if not all individual CDS's plunged in value along with the indices, leading to large mark to market losses for holders of long (protection seller) positions. Market evolution therefore meant a much higher systematic component, and one that could change in value very quickly, relative to an old time portfolio of bank commercial loans. For an organised CDS market is essentially trading delta on an option that is critically dependent on the strike price (here, the default point). As the price of the underlying physical asset moves down towards the strike, the delta becomes more and more sensitive; unlike the price of an equity, say, which is exposed much more uniformly to upward as well as downward movements. Appendix A illustrates.

The economic problems with portfolio equivalence originate with informational differences that arise once a publicly traded market comes into existence. These might apply even to an otherwise identical portfolio of loans, and in the absence of any special relationships between bank and client. Thus imagine there is no formal CDS or securitised market for credit. Lenders rate each loan according to a Merton type options model, but their views of the effective

strike price (default point for asset value) differ; for in practice, the stress point is a matter for judgement. Thus each lender will have a different implied option value. Even for an individual investor faced with a single credit, the effective strike price might well be uncertain. With such a distribution of strike prices, the aggregate delta for the portfolio option value against changes in the portfolio asset value will be smaller in the neighbourhood of the average strike price. In this sense, informational dispersion among agents, or even individual uncertainty, constitutes a buffering factor.

But suppose that the same set of loans is opened up to exchange based CDS trading and to a market index for CDS. Traded prices now reveal public information, after the fashion of the no trade theorem. The result is likely to be convergence among agents' views (Bayesian posteriors), given their observations of the posted market prices; see also Duffie and Manso (2007). In the present context, this is likely to lead to a corresponding sharpening in the asset delta of the aggregate portfolio. The existence of a formal market offers less buffering against shocks to asset prices, which quickly become transmitted and incorporated into the common view. In addition, the public information filtration is from time to time a conduit for contagion effects, after the fashion of rational expectations models of market bubbles (Gallegati *et al* 2008).

A second effect arose (in the event) because of an extension of scope. An investor in credit was no longer constrained by his or her home market, but could now invest or trade in global credits, meaning those of large international companies, incorporating the views of investors in every time zone. If the object was to hedge local loan book exposures using traded trade credit derivatives, then basis risk could arise out of the extension of scope. Likewise, the pricing for the global portfolio of tradable credits was again based on a global reference portfolio, which might not coincide with that for the local institution's own operations and cost of capital.

A related problem for market stability was again informational in nature. To the extent that local institutions and investors turned to globally traded credit products, they were in most cases operating off a very slight idiosyncratic informational base. Virtually all their information was coming from the market prices, or common sources immediately captured in the international market. A dominant informational influence in the latter respect was the ratings of the major agencies. A bank loan portfolio manager would by that token be exposed to model risk and to model revisions, in common with every other investor in the market. Thus the rating downgrades by the majors in mid 2008 had a shattering effect on the global credit market. The concentration of information that accompanied an organised credit market was therefore exposure in common for every participant, and a source of systematic risk that operated faster

and more comprehensively than was the case for a traditional loan or debt book of the local bank or fund manager.

A cognate issue is one of the nature and purpose of banking business. There are two potential views of bank CDS portfolios, at least those in the loan book. One is that they are simply deconstructed commercial lending, as above. Another view is that by receiving on CDS (selling protection), the banks are in effect writing insurance, so that in this aspect there was little effective difference between them and the monoline insurers. The distinction is a fine one. But it ought perhaps to have bothered banking regulators more than it evidently did. Even if insurance was adjudged a permissible bank activity, CDS portfolios would not, by virtue of the strong systematic component, live up to the spreading of independent risks that is supposed to characterise traditional insurance activities. In this respect, it is just as though the bank is insuring against a single large adverse event – in effect, it is offering catastrophe insurance (Coval *et al* 2009). Put that way, a regulatory authority might have viewed member bank activities quite differently. The same point applies to insurance regulators. The risks that AIG were insuring by writing CDS turned out to be highly correlated, hardly the traditional insurance model.

A final point concerns the alleged role CDS in precipitating company collapse. Recent litigation in Canada and the US has highlighted the problem of major stakeholders refusing to allow company rescues, debt rescheduling, or other forms of restructuring, because they have hedged their own interest with CDS written on the company. Better to let the company die and collect on the CDS rather than have the CDS expire while argument is still going on.

4. The role of the regulator

Financial systems are commonly supposed to re-circulate savings, facilitate transactions, and enhance price discovery, including the pricing of risk. This is a generic efficient requirement. They are also supposed to be robust against collapse. This means that the system should be designed and regulated in such a way that it is proof against economic or financial shocks. But in spite of a huge and complex investment in regulation, nationally and internationally, the system did effectively collapse in 2008. To the prior costs of regulation has now to be added the even more massive costs of government rescues¹⁰, not to mention the moral hazard. Yet the system had, on the face of it, become more efficient. Securitisation on an international scale, and enhancements such as credit default swaps, technically meant that risks could be spread via a variety of vehicles to a wider clientele willing to bear a share of the risk in return for a reward. It could well be argued that the pricing of risk was not in fact correctly discovered, so this extent

the system was not efficient. Moreover, to the extent that the price discovery failed, there could be a predisposition to collapse, so that efficiency and stability are by no means disparate considerations. Yet in reviewing the kinds of securitisation structures that had evolved by late 2006, one is struck by just how clever some of the innovations actually were. The problem is how to preserve what was accomplished while proofing it against repeat episodes of the international credit crunch.

One thing that did become apparent was that the financial system had evolved into a financial network with a more extensive and diverse set of counterparty nodes and connections. As to networks in general, the standard result (e.g. Allen and Gale 2000) that more extensive networks are more stable, has to be revisited. In the light of experience, more extensive risk sharing can evidently mean more extensive exposures to common shocks, or a wider set of entry points for a system 'virus' that spreads such a shock. So we need to understand just how these exposures can rise, how to measure their potential extent, and how to prevent contagion spreading within the network; in short, how to characterise and construct a stable financial network. Such an understanding has to inform the rules and regulations that govern the system. In addition, the financial regulator is itself part of the system to be regulated, so that their's is a 'view from within', much as in the reflexive model of social statistics (Bowden 1988). In this respect, the regulatory arbitrage incentives created by the Basle conventions to economise on capital or redirect investments were earlier noted. An important issue is therefore whether structures can be devised that will obviate implicit reliance on centralised official regulatory supervision.

For to continue along the latter path will likely lead to even greater regulatory complexity and detail. In management jargon, the regulation will become more and more 'granular'. Thus in January-March 2009, the Basle Committee announced proposed revisions to the Basle II market risk framework, addressing the excessive leverage in bank trading books. Measures include the introduction of an incremental risk capital charge to cover elements of default and migration risk, and reduce incentives for regulatory arbitrage that had occurred between banks' trading and banking books. To further guard against risk in the trading books, the Committee proposed the introduction of an additional capital requirement to cover 'stressed value-at-risk' relating to previous periods of substantial losses, and acting as a countercyclical capital buffer. Also signalled was a move towards a more 'macro-prudential' approach focussing on the systemic components of financial markets.

As these and other proposed changes suggest, the 'granularity' of formal prudential regulation will become yet finer, and with it will go yet more administrative and monitoring

costs, which will ultimately be incident upon bank customers as higher bank fees or borrowing costs, or else upon the taxpayer to fund the regulatory bureaucracy that seems certain to develop. Nor is it at all clear that more detailed regulation will mean more effective control of systemic risks (Van Hoose, 2007). Instructive in this respect are the CEBS Guidelines for external credit certification, intended as the book of words for a 'common basis application pack'. *Guidelines* amounts to 40 pages of testing procedures, 'mappings', codes of conduct, with mention also of allowing for 'current conditions', an unspecified form of conditioning on the economic state vector. The document is dated 20 January 2006. Back testing, it seems, should be applied to the certifiers as well as the certified.

What follows is a review of some of these issues, with some suggestions as to how they might be addressed. It is not intended to be comprehensive; certain aspects such as moral hazard in certification are not covered because of the large amount of attention already devoted to the issue by the Basle Committee and the International Organisation of Securities Commissions (IOSCO). The institutional structure of regulatory responsibilities is also not covered, a topic of emerging debate in the US in particular¹¹.

4.1 Economic capital

Economics is supposed to be the science of using scarce resources efficiently. The securitisation explosion was effectively an application of the same principle to economic capital. Structured investment vehicles accomplished this by originating loans and taking them off the balance sheet of the parent bank. The problem was that there was an undertaking by the bank either to provide liquidity to their associated SIVs in the case the funding failed, or else to assure the credit rating by bringing underlying loans back on balance sheet, all of which duly happened. Common sense suggests that such arrangements (securitisation with recourse) were implicit guarantees, which should have required Basle capital. More conservative accounting regimes do in fact require all such contingent liabilities to be brought back on balance sheet. This was true in New Zealand, for instance. As a consequence, the system regulator (Reserve Bank of New Zealand) required full economic capital allocation for securitisation, which effectively stifled the market in that country. So this is one area in which we can expect official attention internationally, and indeed the US Treasury Secretary has already signalled this.

Credit default swaps are arguably enhancements rather than *de novo* securitisations, but the systemic exposures that result also call for explicit regulator attention. It is unclear that Basle II mentions very much about credit default swaps at all, at least so far as their essence is concerned. A CDS is a counterparty contract and if the CDS is in the money, then under Basle II market risk guidelines, capital has to be allocated in case the counterparty subsequently defaults

on its obligations; the amount of capital depends to an extent upon the volatility of the CDS market value. However, this is essentially a form of market risk. It is much less clear as to what the economic capital requirements are when the CDS is falling out of the money, so that there is potential default liability to the protection seller, in this case the bank. Commonsense suggests that a protection seller position on a CDS is an implicit bank guarantee against an asset, even if the latter refers to a loan on some other party's balance sheet. One has to look past the derivative (the CDS) to the underlying physical; to the substance, and not the form.

A cognate issue arises as to how much capital should be set aside to cover risk in the CDS trading book. As pointed in section 3.1, even where the bank has protected itself with an offsetting swap, residual liability remains, to indirect credit risk on an entire upstream portfolio and hence to systematic, or even systemic, risk. Credit ratings of counterparties have (in effect) been supposed to act as sufficient statistics in this respect; but as events have shown, further current information needs to be endogenised into market outcomes, and the results incorporated within the framework of capital adequacy. Differential economic capital weightings for clearing house versus private OTC swaps are one potential way of handling this, considered in section 4.2.

Liquidity risk has been another troublesome area. Maturity mismatches such as funding mortgages off commercial bills is arguably¹² a financial health hazard at the best of times, but became a near death experience in the credit crunch. The liability has already been mentioned in connection with SIV liquidity recourse. Even without special structures, funding large volumes of Australian or NZ home mortgages by rolling over very short term commercial paper offshore was always going to be a risk, one that was not cancelled out in the course of the associated cross currency interest rates swap transactions¹³. This raises the question of whether, and how much, economic capital should be allocated against this form of liquidity risk, or whether unprotected maturity mismatches of this nature should simply be proscribed¹⁴.

4.2 Concentration and collateral

In an ideal world, system architecture would make formal capital adequacy regimes superfluous. An idea that has been advocated by system regulators in the US in particular, is that all CDS trades would have to be routed through a central clearing house, which would take the role of the counterparty to each side. Initial and variation margin calls would be made according to the mark to market value of the call, or else in response to doubts about the credit status of its counterparties. Several such clearing houses are now either established or under way for the US and Europe¹⁵. Participating banks and other members would have to contribute towards the central guarantee fund as well as providing collateral against their own trades. The capital and

collateral could be regarded as economic capital that is structurally motivated, rather than being proscribed by a formal regulator. It is, however, dedicated to one particular use at the disposal of a third party (the clearing house), rather than being fungible over a range of risks at the option of the bank itself.

An organised clearing house for CDS is seen as one possible way of monitoring excessive exposures positions and detecting excessive concentrations of risk. As earlier indicated, losses of major proportions arose from bank trading books, either from arbitrage activities against asset swaps, or from market making activities. A bank might stand in the middle of a CDS, with (e.g.) AIG on one side as the credit protection seller. If AIG defaults, then the bank is left exposed. Thus when the US government bailed out AIG, the systemic intent was to bail out its US bank counterparties; though in the event, also foreign banks such as Deutschebank and Barclays – to the dismay of US legislators once counterparties were revealed!

The banks themselves were criticised for the concentration of their exposures to a single counterparty. A further criticism was that AIG was not asked to post collateral of any kind, a common practice even in private in OTC swap agreements, often called when the mark to market value is moving against the counterparty. Evidently, AIG's historical AAA credit rating preserved it from the indignity of being called for collateral, unlike some other market participants at the time.

There is debate over whether a clearing house requirement would really solve problems of concentration and information. By way of contrast, the general swap market has remained OTC over the years, in spite of attempts to establish either clearing house or exchange traded equivalents for even vanilla interest rate swaps. Nevertheless, it could be argued that CDS are inherently riskier than vanilla interest rate swaps, for the exposure is to the full amount of the face value of the contract.

So far as concentration itself is concerned, the economic issue is whether the risk can be diversified away or whether it is a risk in common. Thus suppose AIG has been split into 10 smaller entities, formally unrelated, but in fact all trading in the same kind of reference exposures, such as SIV credit tranches. Not much would change. The network would be more dispersed, but the effective concentration of risk would be the same. So concentration is a matter of looking past the veil of corporate identity to the underlying economic exposure. What is needed is in the first instance is a procedure for identifying and measuring the extent of common factors, analogous to factor analysis in statistics, or the APT and Fama-French models of risk premiums in finance.

A further benefit claimed by clearing house proponents is that the existence of concentrations of risk becomes public knowledge much faster than with a set of private OTC deals. Even if the privately cleared OTC deals survive, the existence of clearing house margin calls on a particular reference entity would itself act an informational signal for collateral calls on similar private OTC contracts. On the other hand, the precise extent of clearing house information revelation of any kind is as yet unclear, given also the requirements for confidentiality.

A final issue is the extent to which other kinds of OTC instruments involving counterparties could or should be brought under the same clearing house umbrella. Duffie and Zhu (2009) argue that overall netting of exposures would be improved if other kinds of swaps (e.g. interest rate swaps) were included. If a swap of one kind between two counterparties is taken over by the clearing house, but an offsetting swap of another kind remains a private contract, then the total exposure has in fact increased. On the other hand, vanilla interest rate swaps have much less exposure than do CDS, for the latter extends to the full face value. So it might be better to simply make sure that the real source of systemic trouble has been neutralised. If there are indeed systemic benefits from the centralised clearing and settlement of CDS, then this could be recognised in bank capital adequacy regimes, so that a clearing house CDS might require less regulatory economic capital than the equivalent private OTC. Banks would be free to hold or trade either form, e.g. for nonstandard swaps.

4.3 Certification and regulatory advisories (financial hazard warnings)

The more extensive the financial network, and the more structured the securitisations, the more important does certification become. Widely dispersed security holders may know little or nothing of the affairs of the corporates or vehicles whose risks they are implicitly underwriting. Credit certification is on the face of it, a private contract. I pay a credit rating agency to rate the debt I am issuing, or the structures I have created to sell to investors. But the impact concerns many more parties in the network of which I now become part. A social externality is therefore created by the actions of those who certify credit, and it requires a corresponding social solution. To some extent this has been found, in the form of the Basle II credit categories, stratified according to the ratings of the agencies. This is implicit social certification (in this case by the BIS) that the respective agency models are sound. The same point applies to the internal ratings based approach, under which banks with more advanced risk management systems can do their own ratings. That the agency models have evidently been found wanting is perhaps partly evolutionary: models are just models, and will always evolve in the light of experience and modelling methodology.

On the other hand, models can fail because of purposes to which they have inappropriately been put. If the agencies themselves claim that their ratings reflect some sort of stationary distribution of default probabilities, but on the other hand, current circumstances indicate exceptional times, or exceptional exposures, then market participants need to know. In other words, there needs to be an authoritative shadow risk rating system, along with that of the credit agencies, more responsive to current indications of potential trouble down the track. This would suggest a role for the national regulators in informing their respective financial institutions, and investors at large, that an AAA credit rating may not at the current point in time carry the long run meaning, either across the board or for specific classes of liability. Risk advisories of this nature would require the system regulator to examine exposures across the board, extending to bank counterparties. In turn, this would entail a more rigorous examination of the current state of the system and its possible exposures to economic and other shocks. Referring to earlier discussion, it remains a puzzle as to why US mortgage originators were permitted to continue to originate and package mortgages as demonstrably dangerous as high loan to value teasers and ARM's¹⁶. The mortgage funding practices of Australian and NZ banks mentioned in section 4.2 were arguably another instance.

It would remain open to financial institutions to ignore advisories of this kind. But in that case it should be made clear that their managers would face a risk of actions by their bond and equity holders, or even the regulator itself, for breach of fiduciary duty. Dereliction of duty has been seen as a possible remedy in the aftermath of the credit crunch¹⁷ but this is very much after the event, for by that time the horse has bolted. The threat of possible actions down the track for disregarding advisories from a national regulator, without good cause to do so, might help to close the stable door in advance.

4.4 Regulatory scope and limits

Although significant progress has been made in regulating other financial sectors, notably Solvency II for insurance companies and the European MIFID directive for financial traders, regulation of other sectors has by and large been left to the national regulators. Systemic problems arise first because of the international exposures, and secondly because the counterparty exposures typically extend well beyond specific regulatory fiefdoms to other sectors, notably the banking sector.

Problems of this kind rose to the surface in the credit crunch. To illustrate the interface aspect, by the end of 2007, AIG had built up a CDS exposure, largely arising out of London operations, to the value of US400 billion, substantially in excess of its reserves and of its market capitalisation; other monolines had significant exposures. The AIG exposure was to senior SIV

and similar ABS tranches that evidently carried AAA ratings, at least once the CDS were in place. Even so, under Basle II a bank would have had to find substantial economic capital against a potential exposure of this magnitude. But AIG was not a bank, though its default would have brought down many of its bank counterparties via a direct or indirect chain of relationships; for there was at that time no impediment to AIG as a counterparty from the point of view of a bank, or a commercial paper funder of SIV's. Nevertheless, AIG maintained its own AAA credit rating while in the process of building up the enormous CDS exposure, both for itself and for counterparty banks and other financial institutions around the world. So where then did regulatory responsibility reside? AIG was an American company operating also in London, with counterparties everywhere. Its ultimate bailout was by the US government, yet its activities impacted on many other national jurisdictions and across industrial boundaries.

A better early warning system for banks as to the changed conditional status of credit ratings, along the lines earlier considered, might have picked up some of the problems; for in the event, AIG's official AAA rating evidently persisted far too long. A matter for resolution would then be just which agency, in which country, should issue such warnings; and as to the warnings themselves, whether they are very general 'heads up's, or on the other hand directed at particular counterparty types or even individual institutions. An operational problem concerns the definition of the appropriate economic or financial state vector on the basis of which the hazard warning is to be issued. In this respect, existing risk indices such as VIX, Libor-OIS spread, Itraxx or ABX are arguably *ex post* in nature; what is needed is an early warning radar signalling potential trouble ahead, even if it never eventuates.

4.5 *Corporate and managerial accountability*

Much has been made by politicians and the media of misplaced or *ex post* awards of substantial bonuses to executives in apparent contradiction of their role in approving positions and policies that had precipitated their respective institutional failures and government bailouts. There is indeed anecdotal evidence that over 2006-7, many market players were concerned only to make as much money as they could and let the future look after itself, even when they had become resigned to the likely fallout for the system as whole. The helplessness felt by legislators derived from the perceived lack of legal recourse in removing those entitlements, which were contractual in nature. A partial defence of the bonus awards has been that some were made to managers whose actions were not those that precipitated the mess, but who achieved or exceeded targets for their own particular divisional operations. Another has been that bonus awards were made in the form of company stock options that lost substantial value, at least in the short run. Yet another possible defence is that managers felt pressured by their own share or unit holders to

achieve high returns. To go with the crowd on this was a dominant strategy; for a contrary investment policy could involve damaging opportunity costs, while if there was meltdown everyone was in it together. Risk aversion, in other words, applied less to the downside than the upside – the subprime build up was marked by inverted risk aversion.

Extenuating circumstances aside, to award bonuses along with blame is manifestly incongruous. To do so puts the law of contract in collision with the system imperative to avoid moral hazard. The only way to resolve the contradiction is to devise mechanisms for sheeting home executive responsibility for actions that were subsequently shown to be reckless in themselves, or in the failure to take reasonable steps to ensure that the decisions were fully informed. It may well be that the tests for fiduciary duty have to be tightened up, both in absolute terms and to make it clear that even lesser fiduciary blemishes are a ground for abrogating contractual entitlements to rewards. The difficulty is to devise such tests while offering managers comfort against *ex post* witch hunts that might have the *ex ante* effect of stifling managerial initiative and innovation. Ignoring financial hazard warnings of the kind discussed in section 4.3 could constitute a *prima facie* ground.

There are also issues of scope. Tests for fiduciary duty and reasonable care are obviously going to be different as between a bank or trust company on the one hand and a hedge fund on the other. Banks, in particular, are the cornerstone of the monetary clearing system, and there is to that extent an element of economic rent in a bank licence. One would therefore expect a higher standard of the duty of care, to extend to the public interest as well as to the bank shareholders. But as the LTCM episode showed us, a duty of public care exists even for hedge fund managers as part of the system. Given the public anger over accountability, it seems inevitable that national regulatory agencies will be reviewing the issue of just what does constitute a reasonable degree of care and prudence; and to whom is it owed, given that the taxpayer becomes an implicit third party via treasury or central bank funded bailouts.

4.6 Risk shifting and management reward structures

The traditional risk separation view of employment contracts is that entrepreneurs risk their own capital in the hope of large rewards if things do go right. Employees, on the other hand, trade off upside rewards with protection on the downside, so their income remains more stable on the downside though remaining more modest on the upside. In recent years, however, executives and senior managers reaped huge rewards on the upside¹⁸, easily outweighing any reputational or employment risk that might exist on the downside. They operated under the benefits of an established company name, so that in the formal sense they were not entrepreneurs risking their

own financial capital, beyond bonus shares. In effect, senior managers had been awarded a free call option on the company shares. The counterargument that this was paid for by accepting a lower base salary might have been applicable in one or two cases, but as general rule is unconvincing, given that the base salaries and/or remuneration guarantees were often multi-million dollar to begin with.

From the economic point of view, however, the bonus structures created adverse risk shifting as between managers and shareholders, entirely reversing the established separation of rewards and risk. A structured finance product such as a CDS is really a multi-period put option written by the credit protection seller in favour of the credit protection buyer. As with any option, the time value will decay only slowly in the first year of its tenor, but will speed up towards maturity. In the early years of its life, the swap coupon (fixed basis points payment) is compensating the protection seller for the considerable risk that remains of default or downgrade of the reference entity. Only later towards maturity does the coupon more than compensate for the then fast diminishing option value. But the problem was that managerial rewards were frontloaded to apply to the early coupons, as a reported profits element, the more so as the volume of new CDS was exploding. Shareholders were thus left bearing much of the early risk. A more suitable structure would have backloaded the managerial rewards out of the later cash flows of the swap.

In other product domains, annual bonuses were made not on terminal cash flows, but on reported company profits arising from mark to market or cash flows that were only progress, or even provisional. Thus for option ARMs, banks were actually permitted under accounting rules to accrue interest that was compounded into principal. *Ex post*, much of that accrued interest will never be realised. But the qualifying period for managers to cash in on bonus was often as short as a year. There was no scope for de-awarding option payoffs if they are not time consistent, for example where company profits are based on mark to market or cash flows from structured products that subsequently collapse down the track – by which time the originating managers might have left the company.

The general problem of risk frontloading could be resolved by turning managers themselves into creditors. Any form of supernumerary incentive reward, such as cash bonuses and stock options, would be placed into a sequestered account that becomes a liability of the firm. Over a designated period, say 5 years, the balance of the account would be amortised and paid out in ways consistent with the nature of the reward (e.g. options awarded at the original strike price), together with interest payments to compensate for the use value of money. The manager is free to leave the firm at any time, but the firm's liability remains in place. The

amortising arrangement itself is little different to what is now in place in many cases. But the liability is structured as a debt that could in principle even be sold on by a departing manager. It would be junior rather than senior, which would be a departure from established bankruptcy conventions as to employee priority. Managers would thereby acquire some of the perspectives of the firm's debt holders; they have more to lose, compared with the 'slash and burn' husbandry that has laid waste to bondholder value.

4.7 Rescues

It is not the purpose of the present paper to document the rescue packages that were implemented between late 2007 and early 2009. Noteworthy, however, was the almost complete absence of any evidence that the mechanics and scope of the rescue had been thought out in advance, something that appeared to be true no matter what the country concerned. Rescue policy was quite obviously being made on the fly and in a tearing hurry, with periodic revisions of considerable substance. How should the rescue packages be structured so that the taxpayer would have a chance of receiving a compensating reward down the track when things did recover? Should credit default swaps be paid out at full face value? If bank guarantees are to be extended, should this be at the retail level or the wholesale level, and what fees should be charged, if any, for a guarantee? Similar remarks could concern the scope of the rescues, as to whether non bank rescues should be confined to important bank counterparties or the whole financial sector, even where there were no counterparty risks to the payments system. And, of course, how to structure things to discourage moral hazard for the future.

To be sure, there were other considerations clouding the issue, for this was not merely a financial meltdown but a major threat to economic activity. Systemic rescues, in the narrow sense, are those concerned with preserving the monetary clearing and payment system. Economic rescues are those concerned with major threats to incomes and employment. The distinction is far from watertight, if only because both involve confidence, in the absence of which liquidity traps can arise and the flow of funds in the economy effectively seize up. In principle, however, one could imagine that systemic rescues would be the immediate preserve of the central bank, and economic rescues that of the government, with the government as ultimate guarantor of both.

In the event, the blurring of the distinction did raise some problems, complicated further by additional agendas such as fairness. Thus one might consider rescuing AIG if its counterparty commitments would otherwise bring down the banking system, and the bailout option was cheaper than compensating or underwriting the banks themselves, just as LTCM was rescued a decade earlier. But in some countries, finance company bailouts were seen as avoiding

distortions or unfairness that would arise if only banks were to be rescued. This has proved to be expensive and probably unnecessary from the point of view of either system stability or economic activity. So one issue that has to be resolved is the scope of rescues: just who or what should receive public funding or guarantees, and who should be allowed to fail? The latter question is not as simple as the old doctrine of ‘too big to fail’. Given the extensive series of counterparty connections in the financial network, it might be that the failure of even quite minor players could open up fault lines that damage the system to the point of requiring rescue. Another issue concerns the nature of the signals for just when rescues need to be mounted. It has been suggested that mark to market valuation and associated accounting regimes give undue weight to price falls resulting from temporary liquidity or other market difficulties. Temporary suspension of such rules, and others such as economic capital adequacy, is seen as a way out. But this would constitute a dangerous precedent, on several grounds: the moral hazard problem, and the danger of falling into an even deeper hole if falling mark to market values do have signal validity for the danger of an eventual collapse.

Finally if rescues are to be mounted, then those rescued have in effect acquired a real option to continue in business. That being the case, existing shareholders and debt holders should be required to give up a substantial slice of the contingent value if the real option is in the money down the track. In the event, the financing structures embodying the rescues did converge to that view, making use of equity warrants attached to debt financing, or simply diluting the equity via the public shareholding. Another virtue of warrants, in particular, is that the costs of rescue can be distributed around to the investment community at large, as partners in the purchase of warrants. An incidental, but pleasing, virtue might be that those who have made money by correctly going short in the meltdown could be offered the chance to make more money by going long in the recovery.

Appendix A

Generalised delta for option type payoffs

Let x represent the physical price with risk neutral density $f(x)$ for the outcome values over the coming interval for pricing purposes. Denote by X the strike price of a put option written on x . The simplest case is a binary put option with payoff given by the 0-1 ramp function:

$$RF(x; X) = 1 \text{ if } X > x; = 0 \text{ otherwise .}$$

Apart from the discount factor, the binary option is valued at

$$E[X - x]_+ = \int_{-\infty}^{\infty} RF(x; X)f(x)dx.$$

Suppose now that one perturbs the density to give $\tilde{f}(x) = f(x + \lambda h(x))$ where λ is a scalar and the perturbation $h(x)$ is called a direction. The idea is that the old distribution is locally shifted horizontally by the perturbation, whose magnitude is controlled with the scalar λ . In order to preserve $\int_{-\infty}^{\infty} \tilde{f}(x) dx = 1$, we require the normalisation

$$(i) \quad \int_{-\infty}^{\infty} h(x) f'(x) dx = 0.$$

The sensitivity to shifts in f along direction h can be measured with the directional derivative

$$(ii) \quad \Delta_h \pi \triangleq \left[\frac{\partial}{\partial \lambda} \int_{-\infty}^{\infty} RF(x; X) f(x + \lambda h(x)) dx \right]_{\lambda=0}.$$

Integrating by parts and using (i) we get

$$(iii) \quad \Delta_h \pi = - \int_{-\infty}^X h(x) f'(x) dx.$$

Thus the sensitivity to any perturbation in the view of the underlying asset distribution is a matter of whether it occurs in the sensitive region for the density, and whether the latter is closer to the payoff zone for the option. If the perceived density alters in zones that are well out of the money with respect to X , then there will be little change to the value of the option. But if new information means that the density has shifted to the left ($h(x) < 0$) in a mass accumulation zone that is adjacent to the strike then the impact on option price will be much greater.

The result for a conventional put option with payoff $(X - x)_+ = \max(X - x, 0)$ is essentially an integrated version of (iii), namely $\Delta_h \pi = - \int_{-\infty}^X x dx \int_{-\infty}^x h(s) f'(s) ds$.

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Endnotes

¹ Sy (2009) provides a survey. On litigation, the California State Employees Pension Fund announced on July 16 2009 that it is suing the three major ratings agencies, *inter alia* for conflicts of interest and less than arms length relationships with the SIVs whose assets they were certifying.

² See CEBS: Committee for European Banking Supervisors (2006). Also relevant is the US Credit Rating Agency Reform Act of 2006 under which the SEC assumed responsibility for NRSRO's (Nationally Recognized Statistical Rating Organizations).

³ Under the Basle II Internal or Advanced Models, banks can choose to construct their own risk management systems and certifications, but satisfactory certification is again the required outcome. Ruthenberg and Landskroner (2008) have noted that the difference between the Internal and Standard models allows adverse selection under which high risk customers will tend to choose banks that have opted for the Standard Approach.

⁴ It could be remarked that the certification process extended to membership, or membership terms, of other parts of the financial network and the implied club of its members, not just commercial banks. Thus to deal in the traded credit default swap market (CDX and Itraxx) that developed, effectively administered by the originating investment banks, a credit downgrade could lead to penal margin calls that could effectively end participation by the downgraded party.

⁵ Given a probability density $f(x;g)$ with $x \in X$, a statistic m is sufficient with respect to X if $f(x|g,m)=f(x|m)$. Here g can be either a parameter, as in classical sufficiency, or a random variable, as in Bayesian sufficiency. A corollary in the latter case is predictive sufficiency: $f(g|x)=f(g|m)$. If this is not the case, then one has to allow for hidden variables to supplement m . (The definition is loose but hopefully sufficient.)

⁶ See e.g. Loeffler and Posch (2007).

⁷ *Nightmare Mortgages*, September 11, 2006 :

http://www.businessweek.com/magazine/content/06_37/b4000001.htm

⁸ See e.g. Michael Lewis 'The End of Wall's Street's Boom', *National Business News*, December 2008.

⁹ An arrangement in which investors' money is put partly into a secure asset such as government bonds, and the yield enhanced by receiving on CDS. The govt bond base provided the underlying security to meet default or downgrade calls on the CDS. In the event, charities, local councils and other investors lost a lot of money.

¹⁰ Faced with costs of this kind, it is unsurprising that calls in the US have resurfaced for a resurrection of the Glass-Steagall Act, which was itself historically set within the aftermath of the great depression of the 1930's and seen at the time as a way to safeguard against a further meltdown of the banking system. If SIV's, CDS's and other structured finance activities have caused all this trouble, then let's get back to basics and disallow securitisation activities by any monetary clearing bank. Ring fencing policies of this kind do have their attractions, but also their limitations. In practice, commercial banks have all sorts of counterparties for OTC products like interest rate or currency swaps, forwards and options. Is one to proscribe them along with credit default swaps? Achieving a watertight demarcation would be difficult. However, in January 2009, Citigroup announced a separation of its activities along lines reminiscent of a Glass-Steagall separation. Some investment banking activities, subprime mortgages, and consumer finance divisions are to be sold off, unwinding in part an earlier merger with the Travelers Group.

¹¹ The reforms announced by President Obama on June 17, 2009 do little to resolve the problem of split responsibilities. Indeed, the creation of two new quangos, the Financial Services Oversight Council and the Consumer Protection Agency, together with ambiguities as to just who controls banks and insurance companies (and who should), leads us to think that this cannot be a stable or effective solution. Split responsibilities are also awkward in the UK system, as between the FSA, the Bank of England and the Treasury.

¹² Although it has been suggested that the threat of not being able to refund might induce managerial responsibility, so to this extent the funding mismatch is incentive compatible with system stability.

¹³ In early November 2008 the commercial paper market dried up altogether in the general scare as to SIV funding, leaving the NZ banks high and dry for their mortgage funding. The NZ Government had to step in and guarantee the paper, following the earlier lead of Australia which had a similar problem

¹⁴ See the BIS paper, *Principles for Sound Liquidity Risk Management and Supervision*, September 2008, <http://www.bis.org/publ/bcbs144.htm>; also the RBNZ liquidity policy consultation paper October 2008: <http://www.rbnz.govt.nz/finstab/banking/3477458.pdf>

¹⁵ As an extension of the activities of the Intercontinental Exchange (ICE) in US and Europe; also the proposed new Clearing House Corporation (CCorp), which is a consortium of investment banks.

¹⁶ The proposed new Consumer Credit Protection Agency in the US is presumably to take over such a role, though it is as yet unclear as to whether its terms of reference will include systemic risk.

¹⁷ See for example the Feb. 10 2009 letter from New York Attorney General to the House Committee on Financial Services, announcing an enquiry as to 2008 bonus awards made by Merrill Lynch.

¹⁸ In 2006 the top 250 managers at UBS earned an average bonus of USD 1m. The 2008-9 bonus pool for Salomons is a reported USD 4.6 billion (BBC news, 16 July 2009).