End-of-the-World Trade

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Last November, I spent several days in the skyscrapers of Canary Wharf, in banks' headquarters in the City and in the pale wood and glass of a hedge fund's St James's office trying to understand the credit crisis that had erupted over the previous four months. I became intrigued by an oddity that I came to think of as the end-of-the-world trade. The trade is the purchase of insurance against what would in effect be the failure of the modern capitalist system. It would take a cataclysm – around a third of the leading investment-grade corporations in Europe or half those in North America going bankrupt and defaulting on their debt – for the insurance to be paid out.

I asked one investment banker what might cause half of North America's top corporations to default. No ordinary economic recession or natural disaster short of an asteroid strike could do it: no hurricane, for example, and not even 'the big one', a catastrophic earthquake devastating California. All he could think of was 'a revolutionary Marxist government in Washington'. That's not a likely scenario, yet the cost of insuring against it had shot up ten-fold. Normally one can buy $10 million of end-of-the-world insurance for between two and three thousand dollars a year. By early last November, the prices quoted were between twenty and thirty thousand, and even then it was difficult to buy in quantity – at least, said the banker, 'not from anyone you trusted'.

Of course, the credit crisis has increased the risk of systemic economic failure. But the existence and rising price of the end-of-the-world trade indicate something beyond that. The crisis isn't just about the bursting of the US housing bubble and dodgy sub-prime lending. Nor is it merely a reflection of the perennial cycle in which greed trumps fear to create a euphoric disregard of risk, only for fear to reassert itself as the risk becomes too great. What is revealed by the end-of-the-world trade is that the current crisis concerns the collapse of public fact.

A price or an interest rate quoted by one person or firm to another and agreed between them is a private fact. That isn't good enough for many purposes. Even purely bilateral transactions are facilitated if there is a public fact, in this example a known and credible 'market price' or 'market interest rate', that can be consulted to check whether a quoted price or rate is fair. Trustworthy public estimates of borrowers' creditworthiness make debt markets far more liquid than they would be if borrowers' capacity to meet their obligations had to be investigated from scratch. Believable bank balance sheets encourage banks to lend to each other; it was the suspension of such lending that undid Northern Rock. As the American sociologists Bruce Carruthers and Arthur Stinchcombe pointed out in the journal *Theory and Society* in 1999, market liquidity – plentiful borrowing and lending, or buying and selling – 'is, among other things, an issue in the sociology of knowledge'. Believable market prices, valuations, credit ratings and balance sheets encourage lending, active trading, competition and keen pricing. If credibility is lost, then everyone becomes wary of lending, deals aren't done, and an increased proportion of sellers are the desperate, who have to accept fire-sale prices.

At the core of the current crisis is a set of mechanisms for the transfer of credit risk (the risk that borrowers default), in particular collateralised debt obligations (CDOs). The first CDOs were created in 1996-97 by banks that wished to pay others to take on the risks of the loans they had made. From 1999 onwards, CDOs were also pursued simply as money-making opportunities, and hedge funds as well as banks started to set them up.

CDOs come in many varieties, but one way for a bank or hedge fund to set one up is to create a separate legal entity known as a special purpose vehicle (typically registered in the Cayman Islands). The vehicle then buys assets such as corporate bonds, loans and bonds backed by mortgages, either from the parent bank – if, for example, the motive for the CDO is to reduce the risk of its loan portfolio – or on the open market.

To raise the money that's needed for these purchases and to create the opportunity for profit, the vehicle sells a hierarchically structured set of investments backed ('collateralised') by the pool of assets the CDO has bought. At the bottom of the hierarchy is the 'equity' tranche. Losses caused by default of the assets in the pool are absorbed in the first place by investors in this tranche, who in compensation receive the highest rates of return, often as high as 15-20 per cent. Next in the hierarchy is the mezzanine tranche or tranches, the investors in which incur a loss only if defaults are sufficiently bad to wipe out the equity tranche completely. Above the mezzanine is the senior tranche, and above that the super-senior. Because the buffer of the equity and mezzanine tranches stand between it and any losses, the senior tranche is usually regarded as very safe (equivalent to a corporate bond with the highest rating, AAA), and super-senior as even safer than that. Correspondingly, investors in these tranches have to accept rates of return substantially lower than those in the equity and mezzanine tranches.

For a structure as complicated as a CDO to be attractive to investors, facts about it need to be created: ratings, crucially, awarded to its tranches by firms such as Standard & Poor's, Moody's and Fitch. Traditionally, the core business of these rating agencies is to grade bonds issued by corporations. They divide these between 'investment-grade' and 'speculative' (colloquially, 'junk'), and there are multiple categories indicating how high in investment grade, or how low in speculative grade, a bond is. Standard & Poor's, for example, has ten categories of investment grade, ranging from AAA down to BBB–. Recently, however, a large part of what rating agencies have done is to grade CDO tranches. Many investment institutions are strongly guided by ratings, and some are allowed to invest only in investment-grade products. The success of CDOs has rested on the way they can be set so that the mezzanine and senior tranches can achieve investment-grade ratings while offering higher rates of return than equivalently rated corporate or government bonds.

To award a rating, or more generally to work out the value of a CDO, requires one to take three main things into account. First is the risk of default on each of the debt instruments in the asset pool. Past data are useful here – the rating agencies have kept records of corporate defaults for decades – and the market's current view of such risk can be worked out, either from the yield of the bond involved (a risky bond has to offer a higher yield before investors will buy it) or from the cost of credit default swaps. Like CDOs, these swaps are 'credit derivatives' – products built on the

underlying market for bonds and loans – and they too have grown rapidly over the past decade. They are insurance, essentially, against the risk of an individual company defaulting. Under normal circumstances, credit default swaps are actively traded (far more often than a company's underlying bonds or loans), and thus have a credible market price.

A second issue is 'recovery rates': the amounts that creditors will get back when borrowers default. Though these rates vary, it's common in CDO valuation simply to assume a recovery rate of 40 per cent. Third, one needs to take into account the extent to which defaults by different borrowers are likely to cluster. Some defaults are the result of idiosyncratic problems causing the bankruptcy of a single corporation, but others reflect systemic factors such as poor conditions in the economy as a whole. If the latter, then one corporation's default is likely to be accompanied by others.

The extent to which default risks are linked is known in the world of credit derivatives as 'correlation'. If correlation is low, defaults aren't likely to cluster much, and only the equity tranche of a typical CDO would normally be thought of as carrying significant risk of loss. If, on the other hand, correlation is high and defaults tend to come in clumps, then the mezzanine and conceivably even the senior tranches can be hit.

Correlation is by far the trickiest issue in valuing a CDO. Indeed, it is difficult to be precise about what correlation actually means: in practice, its determination is a task of mathematical modelling. Over the past ten years, a model known as the 'single-factor Gaussian copula' has become standard. 'Single-factor' means that the degree of correlation is assumed to reflect the varying extent to which fortunes of each debt-issuer depend on a single underlying variable, which one can interpret as the health of the economy. 'Copula' indicates that the mathematical issue being addressed is the connectedness of default risks, and 'Gaussian' refers to the use of a multi-dimensional variant of the statistician's standard bell-shaped curve to model this connectedness.

The single-factor Gaussian copula is far from perfect: even before the crisis hit, I wasn't able to get a single insider to express complete confidence in it. Nevertheless, it became a market Esperanto, allowing people in different institutions to discuss CDO valuation in a mutually intelligible way. But having a standard model is only part of the task of understanding correlation. Historical data are much less useful here. Defaults are rare events, and producing a plausible statistical estimate of the extent of the correlation between, say, the risk of default by Ford and by General Motors is difficult or impossible. So as CDOs gained popularity in the late 1990s and early years of this decade, often the best one could do was simply to employ a uniform, standard figure such as 30 per cent correlation, or use the correlation between two corporations' stock prices as a proxy for their default correlations.

However imperfect the modelling of CDOs was, the results were regarded by the rating agencies as facts solid enough to allow them to grade CDO tranches. Indeed, the agencies made the models they used public knowledge in the credit markets: Standard & Poor's, for example, was prepared to supply participants with copies of its 'CDO Evaluator' software package. A bank or hedge fund setting up a standard CDO could therefore be confident of the ratings it would achieve. Creators of CDOs liked that it was then possible to offer attractive returns to investors – which are normally

banks, hedge funds, insurance companies, pension funds and the like, not private individuals – while retaining enough of the cash-flow from the asset pool to make the effort worthwhile. As markets recovered from the bursting of the dotcom and telecom bubble in 2000-2, the returns from traditional assets – including the premium for holding risky assets – fell sharply. (The effectiveness of CDOs and other credit derivatives in allowing banks to shed credit risk meant that they generally survived the end of the bubble without significant financial distress.) By early 2007, market conditions had been benign for nearly five years, and central bankers were beginning to talk of the 'Great Stability'. In it, CDOs flourished.

Ratings aside, however, the world of CDOs remained primarily one of private facts. Each CDO is normally different from every other, and the prices at which tranches are sold to investors are not usually publicly known. So credible market prices did not exist. The problem was compounded by one of the repercussions of the Enron scandal. A trader who has done a derivatives deal wants to be able to 'book' the profits immediately, in other words have them recognised straightaway in his employer's accounts and thus in the bonus that he is awarded that year. Enron and its traders had been doing this on the basis of questionable assumptions, and accounting regulators and auditors – the latter mindful of the way in which the giant auditing firm Arthur Andersen collapsed having been prosecuted for its role in the Enron episode – began to clamp down, insisting on the use of facts (observable market values) rather than mere assumptions in 'booking' derivatives. That credit correlation was not observable thus became much more of a problem.

From 2003 to 2004, however, the leading dealers in the credit-derivatives market set up fact-generating mechanisms that alleviated these difficulties: credit indices. These resemble CDOs, but do not involve the purchase of assets and, crucially, are standard in their construction. For example, the European and the North American investment-grade indices (the iTraxx and CDX IG) cover set lists of 125 investment-grade corporations. In the terminology of the market, you can 'buy protection' or 'sell protection' on either an index as a whole or on standard tranches of it. A protection seller receives fees from the buyer, but has to pay out if one or more defaults hit the index or tranche in question.

The fluctuating price of protection on an index as a whole, which is publicly known, provides a snapshot of market perceptions of credit conditions, while the trading of index tranches made correlation into something apparently observable and even tradeable. The Gaussian copula or a similar model can be applied 'backwards' to work out the level of correlation implied by the cost of protection on a tranche, which again is publicly known. That helped to satisfy auditors and to facilitate the booking of profits. A new breed of 'correlation traders' emerged, who trade index tranches as a way of taking a position on shifts in credit correlation.

Indices and other tranches quickly became a huge-volume, liquid market. They facilitated the creation not just of standard CDOs but of bespoke products such as CDO-like structures that consist only of mezzanine tranches (which offer combinations of returns and ratings that many investors found especially attractive). Products of this kind leave their creators heavily exposed to changes in credit-market conditions, but the index market permitted them to hedge (that is, offset) this exposure.

All this activity explains the attractiveness of the end-of-the-world trade. The trade is the buying and selling of protection on the safest, super-senior tranches of the investment-grade indices. No one buys protection on these tranches because they are looking for a big pay-out if capitalism crumbles: if nothing else, they have no reason to expect that the institution that sold them protection would survive the carnage and be able to make the pay-out. Instead, they are looking to hedge their exposure to movements in the credit market, especially in correlation. Traders need to demonstrate they've done this before they're allowed to book the profits on their deals, so from their viewpoint it's worth buying protection, for example from 'monolines' (bond insurers), even if the latter would almost certainly be insolvent well before any pay-out on the protection was due.

With problems such as the non-observability of correlation apparently adequately solved by the development of indices, the credit-derivatives market, which emerged little more than a decade ago, had grown by June 2007 to an aggregate total of outstanding contracts of $51 trillion, the equivalent of $7,700 for every person on the planet. It is perhaps the most sophisticated sector of the global financial markets, and a fertile source of employment for mathematicians, whose skills are needed to develop models better than the single-factor Gaussian copula.

The credit market is also one of the most computationally intensive activities in the modern world. An investment bank with a big presence in the market will have thousands of positions in credit default swaps, CDOs, indices and similar products. The calculations needed to understand and hedge the exposure of this portfolio to market movements are run, often overnight, on grids of several hundred interconnected computers. The banks' modellers would love to add as many extra computers as possible to the grids, but often they can't do so because of the limits imposed by the capacity of air-conditioning systems to remove heat from computer rooms. In the City, the strain put on electricity-supply networks can also be a problem. Those who sell computer hardware to investment banks are now sharply aware that 'performance per watt' is part of what they have to deliver.

The boom in credit derivatives had wider effects, in particular increasing the appetite for low-grade debt. A typical CDO, if it is to offer an attractive enough return to investors, has either to purchase risky (and thus high-yielding) bonds or loans in significant quantity, or to sell protection on such bonds and loans via credit default swaps. This fuelled the growth in private equity groups, which buy companies by borrowing very heavily, often by issuing large quantities of bonds. Because of the riskiness of heavily-indebted enterprises these bonds can achieve only junk ratings, but were attractive nonetheless to the creators of CDOs.

Fatally, the demand for risky debt – which arose not just from CDOs, but from the sharply reduced returns available from safer assets more generally – also encompassed bonds based on sub-prime mortgages: home loans that are risky, usually because the borrower has a blemished credit record, but also because the loan-to-value or loan-to-income ratio is high, documentation is poor, or it's a buy-to-let purchase or second mortgage. It is now well known that problems in the US sub-prime sector caused the credit market to turn in summer 2007 from boom to crisis.

It is important, however, to keep a sense of scale. Last autumn, the Bank of England calculated that bonds backed by US sub-prime mortgages totalled $0.7 trillion. That's a lot of money, but it makes up only 2.5 per cent of the total value of non-governmental bonds and corporate loans outstanding worldwide. Sub-prime's $0.7 trillion is, for example, dwarfed by the $11 trillion corporate bond market, of which $10.2 trillion is investment grade. Indeed, what is perhaps most striking about the credit crisis is that corporations outside the financial sector have remained generally in robust economic health, with bankruptcies and thus default rates at historic lows. Not a single investment-grade corporation has defaulted recently, and there haven't even been any recent large-scale speculative-grade corporate defaults.

Problems spilled over from sub-prime to sectors that hadn't been experiencing financial distress in good part because of damage to the credit market's fact-generating mechanisms. The rating agencies had graded products underpinned by sub-prime mortgages on the basis of previous experience of default rates and of the proceeds of the sale of repossessed properties, but had failed to take into account the effects of the bubble in housing prices in the US, the way in which the growth of mechanisms for transferring credit risk and the increased appetite for risky debt had altered the US mortgage market. Predatory and irresponsible lending by commission-hungry brokers had been encouraged by the way in which even the riskiest mortgages could so easily be packaged and sold on, leaving the original mortgage-lender free of losses in the event of default. Mortgage-backed products that the rating agencies had ranked as investment-grade started to incur major losses, and the agencies had to revise many ratings sharply downwards. To take an extreme but not wholly untypical case, Moody's downgraded the top tranche of one mortgage-backed CDO by 14 notches. When it was issued in April last year the tranche was rated Aaa, the top of investment grade; by November, it was rated B2, well down in junk.

The rating agencies are businesses, and the issuers of debt instruments pay the agencies to rate them. The potential conflict of interest has always been there, even in the days when the agencies mainly graded bonds, which generally they did quite sensibly. However, the way in which the crisis has thrust the conflict into the public eye has further threatened the credibility of ratings. 'In today's market, you really can't trust any ratings,' one money-market fund manager told *Bloomberg Markets* in October 2007. She was far from alone in that verdict, and the result was cognitive contagion. Most investors' 'knowledge' of the properties of CDOs and other structured products had been based chiefly on ratings, and the loss of confidence in them affected all such products, not just those based on sub-prime mortgages. Since last summer, it has been just about impossible to set up a new CDO.

Even more damagingly, the credit world's existing special purpose vehicles have found it harder and harder to obtain funds from the source that usually sustains them, the sale of 'commercial paper' (short-term debt). Consequently, some vehicles have had to sell assets – not just mortgage-backed securities, but corporate loans and corporate bonds – to raise cash.

The result of such forced selling, and the unwinding of positions in other sectors of the credit derivatives market, has been a sharply increased demand for protection, and much-diminished willingness to sell it. As a result, the cost of protection has soared across all sectors of the credit market. The safest instruments have been affected as

well as the riskiest ones, paradoxically sometimes to an even greater degree. For example, the returns from holding safe assets or selling protection on the safest index tranches were in the recent past paltry, so it was common for hedge funds and other market participants to finance such positions by borrowing, or by multiplying returns (and also potential losses) in other ways; this is called 'leverage'. A popular product, for example, has been 'leveraged super-senior', investors in which sell end-of-the-world insurance, but with returns and risks multiplied by about ten.

If you're levered up, even relatively modest market movements can force you to liquidate your positions in a hurry to stop your losses becoming catastrophic. Leveraged super-senior and similar products, for example, typically have specified 'unwind points': thresholds, such as loss levels, at which the deal has to be unwound by buying protection equivalent to the protection one has sold. With what Jon Gregory of Barclays Capital estimates in *Risk* magazine to be around $100 billion of leveraged super-senior protection having been sold, even the fear of approaching unwind points can be deeply disturbing to the markets.

Processes of this kind – changes internal to the world of credit derivatives, not in the level of the risks being insured against – have meant that investment-grade indices sometimes move by up to 20 per cent in a single day. At times, the price of end-of-the-world insurance has corresponded to utterly implausible correlation levels in excess of 90 per cent: meaning, in effect, that if one investment-grade corporation were to default, almost all of them would.

Why aren't such mispricings being corrected by savvy investors, eager to seize the opportunities for profit they create? Why, for example, have people not been selling end-of-the-world insurance when the returns from doing so have jumped ten-fold while the risk of having to pay out remains small? A crucial part of the answer is that, paradoxically, a fact-generating mechanism is blocking the restoration of fact. The mechanism is 'marking-to-market', the compulsory revaluation of portfolios as market prices fluctuate. Its motivation is entirely sensible: for example, when regulators insist that banks mark-to-market, it should force them to disclose losses to their investors and creditors.

Unfortunately, however, marking-to-market makes market participants extremely sensitive to short-term price fluctuations. To sell end-of-the-world insurance, for example, is almost certainly an excellent long-term bet, but traders don't do it because of the fear that in the short run its price may increase even further, causing a mark-to-market loss. Although it would be a paper loss, it would have real consequences, damaging your bank's balance sheet and profits, threatening your bonus, and typically forcing you to transfer valuable collateral to the custody of the buyer of the insurance.

Over recent months, banks have frequently been accused of hiding their credit losses. The truth is scarier: such losses are extremely hard to measure credibly. Marking-to-market requires that there be plausible market prices to use in valuing a portfolio. But the issuing of CDOs has effectively stopped, liquidity has dried up in large sectors of the credit default swap market, and the credibility of the cost of protection in the index market has been damaged by processes of the kind I've been discussing.

How, for example, can one value a portfolio of mortgage-backed securities when trading in those securities has ceased? It has become common to use a set of credit indices, the ABX-HE (Asset Backed, Home Equity), as a proxy for the underlying mortgage market, which is now too illiquid for prices in it to be credible. However, the ABX-HE is itself affected by the processes that have undermined the robustness of the apparent facts produced by other sectors of the index market; in particular, the large demand for protection and reduced supply of it may mean the indices have often painted too uniformly dire a picture of the prospects for mortgage-backed securities. One trader told the *Financial Times* in April that the liquidity of the indices had become very poor: 'Trading is mostly happening on interdealer screens between eight or ten guys, and this means that prices can move wildly on very light volume.' Yet because the level of the ABX-HE indices is used by banks' accountants and auditors to value their multi-billion dollar portfolios of mortgage-backed securities, this esoteric market has considerable effects, since low valuations weaken banks' balance sheets, curtailing their capacity to lend and thus damaging the wider economy.

Josef Ackermann, the head of Deutsche Bank, has caused a stir by admitting 'I no longer believe in the market's self-healing power.' The state has had to stand between the market and the abyss. Had the British government not rescued Northern Rock, bank runs would have brought down other institutions and destroyed confidence in the UK's financial system. Had the Federal Reserve not bailed out Bear Stearns, at least one other major Wall Street bank would most likely have failed, and chaos might have ensued. With private lending having dried up, government-sponsored lenders now provide 90 per cent of the funding of new mortgages in the US.

Modern central banking, backed ultimately by the tax payer, can almost certainly prevent financial catastrophe on the scale of 1929. Restoring normality, which requires repairing the cognitive state of modern finance, is quite a different matter. As Carruthers and Stinchcombe note, market liquidity depends on facts. However, today's financial facts depend on liquidity. The credit markets remain stuck in a vicious circle.

There are some signs that repair might be possible. Pension funds, which are under less immediate pressure to mark-to-market, have started to sell end-of-the-world insurance, and if they do so on a larger scale, liquidity and thus credible prices may return to that part of the index market. The rescue of Bear Stearns persuaded many traders that the Federal Reserve will not allow any major US bank to collapse, and a $19 billion write-down (a reduction in the balance-sheet valuation of its portfolio) by the Swiss Bank UBS in early April was widely seen as a nadir, the valuation now so low that it was unlikely to fall much further.

But there have been false dawns before. In early October 2007, as US banks first started to report large write-downs of their credit portfolios, their share prices surprisingly soared. 'It seems that the more money you lose,' one banker told the *Financial Times*, 'the more your shares go up.' It had begun to seem as if the banks had the measure of the crisis, and facts were on the way to being restored. However, that impression quickly evaporated as within weeks the estimates of losses jumped upwards. For example, by 20 October Merrill Lynch had increased its estimate of its losses from $4.5 billion to $7.9 billion. That's the problem with facts. Once they fall apart, they are very difficult to put back together again.