Chapter 11
Drifting into Failure:
Complexity Theory and the Management of Risk

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ABSTRACT

The Gaussian copula, an equation first published by David Li in 2000, was a beautiful thing—in isolation. Its intention was to price collaterized debt obligations, and work out whether they were moving in the same direction. The copula was an enabler of mortgaging the most hopeless of homeowner prospects. Millions of securities could be traded on the back of a single number (a security is something that shows ownership, or right of ownership of stocks or bonds, or the right to ownership connected with derivatives that get their value from some underlying asset). As more and more webs of interactions and relationships and interdependencies and feedback loops started growing around it, however, it became part of a complex system. The copula became the trigger of a recession that swelled the number of homeless families in the US by 30% inside of two years (Associated Press, 2010). It ended up bringing global lending to a virtual standstill, triggering a worldwide financial crisis and a deep recession. How did a once good idea like this drift into failure, and how can such a risk of collapse be managed? That is what this chapter is about.

INTRODUCTION

In a Crisis, All Correlations Go to 1

The copula is about probabilities, and whether they are associated with other probabilities. By putting in different bonds the Gaussian copula function produced a single number that became easily manipulable and traceable by the world of quantitative finance. It could show correlations between bonds that might default and bonds that might not.

$$\Pr[T_A<1, T_B<1] = \Phi_2(\Phi^{-1}(F_A(1)), \Phi^{-1}(F_B(1)), \gamma) \quad (1)$$

In the Gaussian copula (see Equation (1)), probability Pr is a joint default probability, the likelihood that any two members of a pool (A and B, each of which might contain hundreds or even thousands of mortgages, for example) will both default. This is what investors are looking, and the rest of the copula provides the answer. Φ_2 is the copula: it couples (hence the Latin copula) the individual probabilities associated with pools

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A and B to come up with a single number. Errors here can massively increase the risk of the whole equation producing garbage. Survival times (T_A and T_B) represent the amount of time between now and when A and B can be expected to default (i.e. fail to repay). Li was inspired in this by actuarial science, which has a similar concept for what happens to somebody's life expectancy when their spouse dies. Distribution functions F_A and F_B represent the probabilities of how long A and B are likely to survive. These are not certainties, so small misassessments or miscalculations here can lead to a much greater production or risk than the formula would have you believe. The idea about equality (=) between the copula and probability of default might be a dangerously misleading concept in this formula, as it suggests that there is no room for error, and is a short notation that says "is" or "equals" or "is equal to," which muffles the role of real-world uncertainty, fuzziness, and precariousness. The gamma γ at the end is the all-powerful correlation parameter, which reduces correlation to a single constant. This, in this context, is something that should be highly improbable, if not impossible. It was, however, the part that really made Li's idea irresistible and pervasive.

In isolation it looked elegant, and it worked well. But the world in which the Gaussian copula was released was the world of collaterized debt obligations, growing exponentially in size and complexity from the 1990's onward. Collaterized debt obligations, an invention from the late 1980's, are a type of synthetic asset-backed security. Some sort of corporate entity needs to be constructed to hold assets as collateral (say, somebody's house), and then collect interest which can be sold as packages of cash flow to investors. Collaterized debt obligations can either come from a special purpose entity that acquires a portfolio of underlying assets such as mortgage-backed securities, commercial real estate bonds and corporate loans. Or the special purpose entity issues bonds (those collaterized debt obligations) in what are called different tranches (levels of risk), from which the proceeds are then used to purchase a portfolio of underlying assets.

The risk and return for somebody who has invested in a debt obligation (often without really knowing it, by the way) depends on how the obligations and their tranches are defined (and this may not be communicated very clearly or get lost in the various layers of buying, selling and reselling), and only indirectly on the underlying assets. So in effect, the investment depends on the assumptions and methods used to define the risk and return of the tranches. Like all asset-backed securities, debt obligations enable the originators of the underlying assets to pass credit risk to a variety of other institutions or chop it up and distribute it to an immeasurable number of individual investors, who in turn might resell it. Risk is distributed and sold into invisibility. With the multiplying layers of players involved in the bond market in sending this money (or debts) around, risks were chopped up and scattered into oblivion.

The use and increasing opacity of financial instruments like debt obligations expanded dramatically on the back of a growing number of asset managers and investors. There was no intelligent design behind this, no single smart designer who had it all figured out beforehand, or could figure it all out even while things were playing out. The growth of asset management was in part a response to—and source for—a growing need for stock market investments and mortgages. From the 1990's onward, an increasing set of players in modern society (from private individuals to government pension funds to sovereign nations) turned to stock markets for financial returns and presumed future security. It intersected with the realization in many developed nations of impending pension fund depletions and sovereign debt obligations that would need to be met at some point. Many countries embarked an aggressive strategies to get people to invest in their own future pensions. At the same time, the call of home ownership as route to establishing independent