Risk

*Banks have a variety of analytical tools at their disposal to allow them to create optimal collateralised debt obligation (CDO) portfolios and other structured products. One software company, however, believes it is able to outperform traditional methods for optimising CDOs by making use of Darwin's theory of evolution. By **Clive Davidson** reports*

The evolution will be analysed

One of the most crucial tasks in putting together a collateralised debt obligation (CDO) is choosing the underlying credits that will be included in the portfolio. Investors often express preferences on individual names, while there are likely to be rating constraints and industry concentration limits imposed by rating agencies. Given these various requirements, it's up to the structurer to optimise the portfolio and achieve the best possible spreads for investors.

A variety of analytical tools and rating models have been developed over the past few years to help banks construct optimal CDO portfolios. However, one UK-based software firm believes lessons can be learned from the natural world, and is applying evolutionary techniques espoused by Charles Darwin to construct optimal CDO portfolios.

In the natural world, life adapts to suit the particulars of its environment, from the microscopic thermophilic bacteria that can live in the cook-pot temperatures of deep-sea volcanic vents, to the giant redwoods and firs that tower through the mists of the west coast of North America. To adapt to a specific environment, a simple but extraordinarily powerful set of techniques are employed – sex, reproduction, mutation and survival of the fittest. In this way, nature explores the full range of possible structures to hone in on those that are most perfectly suited to the surroundings.

Creating a portfolio for a CDO can broadly be seen in similar ways. Given a certain set of constraints – the number of underlying credits, the notional for the credits, concentration limits and the weighted average rating factor – dealers need to be able to construct a portfolio that is best suited to the market environment. If the portfolio does not suit the conditions, it evolves so that only those with the best fit – in other words, those that deliver the best spread given the constraints – will survive. Many of the same techniques used in the natural world can be applied in this process.

Jeremy Mabbitt set up Codefarm, a Brighton, UK-based financial software company, in 2001 to bring evolutionary computing to real-world problems. Evolutionary computing has been a research area for more than 30 years, and has been studied in the context of robotics, hardware development and resource scheduling. But Mabbitt was

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convinced there were many other areas where evolutionary techniques could have an edge on man-made methods. Structured products – and CDO portfolios in particular – proved to be one of those areas.

Evolution is a transferable phenomenon because it works at the level of DNA. The characteristics of each individual – human or otherwise – are specified in the DNA of its chromosomes. Sex results in the mixing, or crossover, of chromosomes; mutation randomly changes an element, or elements, within the chromosome; and reproduction carries these changes in coding forward into a new generation. The new offspring is tested in the environment, with only the fittest surviving. And so the cycle continues until the creatures that are the embodiment of the chromosomes are finely tuned to their environment. The process works for bacteria, trees, humans and anything else that can be specified in code – including structured products.

Codefarm's Galapagos Structurer (named after the islands where Darwin gained his evolutionary insights) converts the specifications of a synthetic CDO portfolio into an artificial chromosome – basically, a string of computer code. For the evolutionary process to work, a population of potential portfolio structures is required so that the crossover and mutation techniques can operate. These portfolios can either be rough stabs at viable structures or carefully constructed versions that represent the best efforts of humans to find optimal solutions. The evolutionary process then begins: sex, mutation and reproduction occur to create a new generation, and the fitness test is applied – in this case, a pricing model. Portfolios with the optimal spreads survive; the rest are killed off. The process continues until the deal objectives have been realised and the structure converges on an optimal portfolio.

In head-to-head trials with 12 investment banks using traditional methods, Mabbitt says Galapagos Structurer has outperformed them all, typically by about 30 basis points. Codefarm claims it already has five of the top 10 leading CDO arrangers as clients – although Mabbitt would not name them.

While Galapagos Structurer has borrowed techniques that nature has spent millions of years perfecting, other inputs are also required to optimise portfolios. Precisely how the portfolios are coded, how the initial population is selected and how the operators (mutation, crossover, and so on) are defined all affect the performance of the system. "Evolutionary computing is still something of a black art," says Mabbitt.

Despite the fact that computers fast-forward the evolutionary process, the fitness test requires simulation-based pricing for each offspring portfolio (each candidate portfolio is evaluated thousands of times under various scenarios), which means it is a computationally intensive and potentially time-consuming process. By bringing sophisticated computing and financial expertise to the problem, the process can be compressed to a matter of hours.

One way Codefarm speeds up the calculations is to use a computer grid – a network of low-cost processors across which calculations can be distributed and computed in parallel. Using Galapagos Structurer's front-end on their desktops, users can define the specifications of their required portfolio and add any relevant market information, such as ratings, issuer and spread data. This is transmitted to Codefarm's computing grid, hosted by California-based computing company Hewlett-Packard in one of its global data centres, where the optimisation is performed and the results returned to the user.

To determine which portfolio is the best fit, Galapagos Structurer uses a pricing model from the Risk Analytics Platform for Credit Derivatives (Rap CD), a CDO valuation service from New York-based Derivative Fitch – although users can use their own model if they prefer. The system can be applied to a range of CDOs, including CDO-squareds and forward-starting tranches, and using base, blended base or compound correlation. User-controlled constraints can include notional for individual underlying credits, concentration limits and weighted average rating factor and spread.

No bank *Risk* approached would acknowledge on record that it is using Galapagos Structurer. Most say they use of a mix of proprietary and third-party tools in their structuring efforts. ABN Amro, for instance, uses genetic algorithms and other pattern search methods in its CDO portfolio construction. "However, some credit viewpoints cannot be parameterised, so some tinkering with the portfolio is often done by hand," adds Andrew Feachem, director in the structured credit marketing team at ABN Amro in London.

In fact, investors usually have credit names that they like or dislike, and this often results in an iterative process with the client until they are satisfied with the composition of the portfolio. "The time it takes to construct the portfolio therefore generally depends on what resources a client has available to determine whether they are happy with the portfolio, and how much emphasis they place on the value of idiosyncratic credit risk against the general credit environment," says Feachem.

Merrill Lynch also uses proprietary tools for optimising CDO portfolios. The development of these systems means a process that may have taken days to complete 12–18 months ago now takes just hours, says Ronnie Roy, head of synthetic and exotic trading and structures at Merrill Lynch in New York. One technique used by the bank is to have a ready-prepared set of sample portfolios that can quickly be customised to a particular client's requirements. The process of portfolio construction and customisation is as automated as possible and is constantly fine-tuned. "Yesterday's product is no longer profitable, so we have to constantly develop new variations of products," says Roy.

But optimising the structure is just one of the challenges facing products providers. Failure to accurately and unambiguously specify term sheets can also lead to disputes over payouts, disagreements over whether a credit event has occurred, or quarrels over the timing of terminations. These disputes can damage client relations and the reputation of the structuring bank, while the lack of clear and precise documentation can put clients off buying structured products, says Jean-Marc Eber, chief executive of LexiFi, a Paris-based provider of software for designing and managing the life cycle of structured and other complex financial products. "We see many contracts in banks and their representations or descriptions are quite often inadequate, inaccurate or wrong," he says.

Trying to express contracts accurately in multiple languages is time-consuming. Even where it is accomplished, the process does not lend itself to automation. Eber, who was formerly global head of quantitative research in the capital markets division at Société Générale, struggled to find a precise way to express financial contracts until, like Mabbitt, he hit on the idea of adapting a computing approach to address the problem – in this case, he mimicked the way computer programming languages specify simplified but very precise sets of components and operators in order-instruct machines, which cannot deal with ambiguity, to carry out specific tasks.

Using the programming language approach, LexiFi created a relatively small set of contract components and simple operators with which it is possible to specify a wide range of financial contracts with the rigour required to avoid potential misinterpretation and to facilitate the automation of processing, from initial pricing to maturity.

One client of the product – called Modeling Language for Finance – is Société Générale Asset Management Alternative Investments (SGAM AI), which uses the system for specifying equity and fixed-income structured product contracts. One of the advantages of using the language is that it is possible to automatically generate the code that will be used in the pricing of products, and to check that the choice of pricing model is compatible with the product. But SGAM AI faces another challenge – because it takes an active approach to managing its products, it must specify the conditions under which it will make changes to the underlying portfolio.

"The difficulty is not to describe the pay-off if it is a normal pay-off, such as an Asian option linked to an active selection of stocks," says Thierry Mirabel, head of the structuring team at SGAM AI. "The difficulty is to write the rules of the selection of the stock and the process of changing one stock for another. So, it is a description of an investment process that we have to write in the term sheet."

This kind of clarity in the term sheet, whatever the language, is important in gaining regulatory approval for structured products, adds Mirabel: "The regulators want to see that the rules governing how the active management will be carried out are clearly expressed in the term sheet and in the prospectus before they will give approval for the product."

There will always be challenges in a market where competition is fierce and innovation and speed to market are paramount. Structurers, and those that have to manage the products through their sometimes extensive life cycles, will always be on the lookout for ideas and tools that will improve their profitability while minimising their risks. In this environment, a new generation of analytical tools is bound to emerge. ■