



# Stress Testing Commercial Real Estate Portfolios

Approaches to assessing risk in property lending

Radley & Associates is an independent firm dedicated to the development of advanced simulation based analytics for the Commercial Real Estate industry. Our clients include leading banks, fund managers and REITS. We have deep expertise in property, simulation modelling, econometric analysis and risk.

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## Why we need to be sure banks correctly understand the risk in their property loan portfolios

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One of the biggest questions facing politicians, central bankers, rating agencies and regulators throughout the world is the stability of commercial banks. Potential weaknesses in these institutions pose a systemic threat to national and regional economies. Following the disruptions to the world's financial system in 2007 questions have been asked of the banks to understand the level of future losses that may or may not be caused by multiple factors including falling asset prices, falling income, rising interest rates and general uncertainty over economic growth.

Given the scale of Commercial Real Estate lending in most economies losses in this asset class have the unique ability to absorb what capital remains in the banking system. Various estimates have placed the potential levels of bad Commercial Property debt inside UK banks at around £50 billion<sup>1</sup>. The situation across other economies in the Euro Zone, Middle East and US is perhaps worse. It is therefore essential that banks truly understand if they can survive the next few years without another massive injection of state aid to keep them afloat.

It is important for regulators to reassure not only the markets but also the public that they have fully analysed and understood the risks still lurking within the banking system and are confident that the measures used for this assessment are robust and realistic.

### Stress Testing Commercial Real Estate Portfolios

In this article we review existing approaches to stress testing for real estate loan portfolios and identify weaknesses in current approaches which are so fundamental as to produce results that should not be relied upon by policy makers.

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<sup>1</sup> Financial Times 20 May 2010: "A record £50bn of bank loans made against commercial property in the UK are in trouble following the sharp slump in real estate values from the peak of the market, according to the annual bellwether report into property lending published on Friday. The amount of debt either in default or breach of terms has rocketed to a fifth of the total outstanding property debt, which has increased marginally to a record high of about £228.3bn." Figures from the 2010 De Montfort University Annual Report on Commercial Real Estate lending

## Introduction

Stress testing is one of the fastest growing risk management techniques amongst lenders. Both the processes of stress testing, involving senior management in developing a better understanding of their bank's main risks, and the techniques required to measure the impact of stress tests, are evolving rapidly. Around the world, regulators are getting wise to the value of stress tests to their new found desire for macro-prudential regulation. After the very public round of stress tests in the US banking sector, the UK and other regulators have followed suit. Conversely, the reluctance of the European regulators to carry out similar public stress tests on banks in the Euro-zone is causing raised eyebrows amongst the commentariat and investors alike. Stress tests are designed to calculate the expected impact of a hypothetical set of changes in the economy – or shocks - on a bank's asset quality, losses and capital. They ask the fundamental question: if we suffered this sort of shock, would we survive?

The source and design of each stress scenario might be internal or provided by the regulator: in either case there are organisational and technical challenges in implementing stress tests. This article focuses on the technical aspects of stressing a particularly difficult but significant section of banking assets, namely, Income Producing, Commercial Real Estate portfolios.

## The scope of CRE loan stress testing

Stress tests are designed to examine a combined set of risks which are often calculated separately, namely credit, market, liquidity and operational risk. Of particular interest is the way that these risks are correlated or additive in nature.

Fig 1

<b><i>Risk type</i></b>	<b><i>Market</i></b>	<b><i>Credit</i></b>	<b><i>Liquidity</i></b>	<b><i>Operational</i></b>
<b><i>Significance</i></b>	High	High	Assume illiquid	Normally low
<b><i>Correlation of risks</i></b>	Very high with credit risk	Very high with market risk	NA	Not correlated
<b><i>Factors to model</i></b>	Changes in interest rates, market rents, capital values, bankruptcy rates, vacancy rates.	Lease structures, rental agreements, loan structures.	NA	NA

**Liquidity**

Though CRE loans may not be completely illiquid in theory, the safest and easiest assumption to make is that CRE loans are completely illiquid: if there is a market shock, we can assume that CRE loans can only be sold at a large discount to face value. From a modelling point of view, we can afford to ignore liquidity risk by assuming complete illiquidity.

**Operational risk**

Though there certainly is a degree of operational risk in CRE lending, it is not commonly associated with other classes of risk. Although instances of fraud and other operational failures may be more noticeable in times of market stress (this is particularly common in the case of valuation fraud) the actual risk, in a modelling sense, is not correlated with the shock – possibly only the *measurement* of operational risk events. It is reasonable to assume, in the first instance, a continuing level of operational risk whatever the stress scenario. In an ideal world, the correlations of operational risk with market shocks could be observed and some way of incorporating these effects could be modelled. But given the relative infancy of quantitative risk modelling in CRE portfolios, the safest assumption to allow a qualitative override of stress tests to reflect any management assumptions about how operational risk and the other main classes are related to stress conditions.

**Market and Credit risks**

So we are left with the major challenge of modelling market and credit risk in CRE loans. A simple historical observation is that CRE loan losses have been concentrated in economic downturns. Loan losses, for example, in the UK between 1995 and 2007 were vanishingly small (and even the small amount of these losses were, arguably, the result of fraudulent valuations which strictly count as operational defaults). The story in other markets is similar: it is hard to lose money on income producing, property backed, lending in benign markets with rising collateral values – whatever the credit risk factors of a particular loan. But during a market downturn, many of the factors on which credit quality depends decline in unison: rents fall, tenant default rates rise, void periods lengthen and collateral values plummet. These correlations are critical to understanding and modelling CRE risk and thus performing CRE stress tests.

**Time Horizon**

The loss characteristics of CRE loans are highly time dependent, varying significantly over the years even without allowing for changes in the economy. In the absence of secondary markets, (a safe assumption for stress-testing), CRE loans continue to present a risk to term, thus the modelling time horizon recommended (by the FSA) is to loan maturity. Note that the maturity date for CRE loans is a particular risk point in that refinance risk is concentrated at this point. For the purposes of risk measurement, (whatever we might do in practice), we need to assume that a loan that cannot refinance is in default and will in almost all cases result in a loss of some sort (actual or accounting).

## Measures

The chief output measure for stress tests should be the level of losses or the expected loss (EL) in each future year in the stress scenario to maturity. Using existing CRE risk models may be inadequate, as many rating models focus on static, one-year, probability of default (PD) measures. But we know that a CRE loan may have a high probability of default but a low measure of loss given default. For example, a 20% LTV loan may suffer from temporary loss of income and thus a high PD, but the expected loss is still insignificant; either the borrower finds cash to cover the debt service from other sources or the collateral covers the loan amount. Either way, PD alone is insufficient for modelling loss. The difficulties of defining default are also significant. Many CRE lenders in recessionary economies are unsure how to categorise their problem loans: if the *'inability to refinance loans on commercial terms with other lenders'* is taken as a technical default, then default rates in some books exceed 50%. If *'non-performance'* is the criterion, then defaults are smaller by an order of magnitude. These PD measurement problems can more or less invalidate regression models based on default histories.

The second, related, and more deep-seated problem is that regression based PD models assume, by their nature, that past losses are reflective of future losses: the very fallacy that stress testing is designed to overcome.

## Top down modelling

Most stress testing is carried out using top down models, modelling the portfolio as a whole or breaking the portfolio into segments by product type or LTV band, geography etc. Top down modelling is often carried out using historic loss data for each segment. It has many appealing practical advantages; it is easy, cheap and quick to carry out. However, the results rest on a number of critical assumptions:

- Large numbers of small loans
- Homogenous loan structures
- Homogenous collateral assets/lease structures
- Small number of factors to stress
- Extensive historic loss data for sensitivity analysis

For CRE loans, none of these critical assumptions hold true. Typical portfolios are relatively small in number – though high in value; extremely varied both in terms of loan structure and in terms of lease structures - the loans often having multiple tranches, interest structures and principle repayment structures. There are many factors to stress and loss data, however extensive and well recorded (rare on our experience), is always insufficient to isolate each factor to measure its stress sensitivity. Put in more practical terms, how can a single, top down model explain the difference between, for example:

- loan A: a 12 year floating rate, amortising loan (with a junior portion) comprising a single unit with a government quality tenant on a 8 year inflation based lease with no breaks and current LTV of 93% and
- loan B: has 3 years to term, with 3 units, one of which is empty, on a fixed rate, interest only, 85% LTV loan

It is easy to see that top down models are likely to be crude at best: our experience is that they are also significantly misleading.

### Market and Credit Risk correlation

The main risk classes that affect CRE loan losses are multi-dimensional and highly correlated. Not only do changes in a range of market variables affect the debt service and collateral recovery characteristics of a CRE loan, they change over the life of a loan as the rental income and debt servicing costs are affected by breaks, lease ends and rent review dates as well as changes in interest rate structures such as fixed to floating dates. Some of the main effects are summarised in Fig 2 below:

Fig 2: effects of stress factors on debt service and collateral recovery characteristics

		<i>Market changes or stress scenarios</i>					
		<i>Interest rate changes</i>	<i>Changes in Capital Values</i>	<i>Changes in market rents</i>	<i>Inflation</i>	<i>Bankruptcy rates</i>	
<i>Debt service and collateral recovery characteristics</i>	<i>Rent</i>			YES	YES for RPI type leases	YES – creates voids	
	<i>Operating cost</i>			YES rent free periods	YES	YES vacant units incur additional costs	
	<i>Interest due</i>	YES for floating rate					
	<i>Principle repayment</i>	YES for amortising loans	YES in case of covenants	YES for surplus principle repayment types			
	<i>Collateral value</i>		YES				

To compound this already complex picture, the changes in market factors themselves are highly correlated. It may not be sufficient to model a fall in capital values in isolation since the correlation of capital values with market rents is very high. If a unit is expecting a market rent correction (for example in a forthcoming lease event) this may reduce debt servicing capability at the precise point that collateral values are falling. The correlations affect each loan structure differently and not always in the same direction. For example, a

fall in capital values can be associated with a deflationary recession with low interest rates that protect and favour floating rate loans over fixed rate loans (e.g. UK 08/09). But in some recessions, interest rates rise significantly, *penalising* rather than rewarding floating rate loans. Some of these correlations are illustrated in Fig 3. Again, they may change over time.

Fig 3: correlations between stress factors and their second order impacts on loss characteristics.

		<b>Market changes = stress scenarios</b>				
		<b>Interest rate changes</b>	<b>Changes in Capital Values (CV)</b>	<b>Changes in market rents (ERV)</b>	<b>Inflation</b>	<b>Bankruptcy rates</b>
<b>Debt service and collateral recovery characteristics</b>	<b>Rent</b>	Indirectly via correlation of rent and interest rates (yield)	Indirectly via correlation of rent and capital values (yield)		Indirectly via correlation of ERV with inflation	Indirectly via ERV correlation with bankruptcy
	<b>Operating cost</b>	Indirectly via correlation of LIBOR with inflation	Indirectly via correlation of CV with inflation	Indirectly via correlation of ERV with inflation		
	<b>Interest due</b>		Indirectly via correlation of CV with LIBOR		Indirectly via correlation of RPI with LIBOR	Indirectly via interest rate correlation with bankruptcy
	<b>Principle repayment</b>		Indirectly via correlation of CV with LIBOR			
	<b>Collateral value</b>	Indirectly via correlation of CV with LIBOR		Indirectly via correlation of CV with ERV	Indirectly via correlation of CV with Inflation	

### The ideal stress test model

If highly heterogeneous loans, with small amounts of loss data, compounded by default measurement problems and with multiple, highly correlated risk factors are not suited for top-down stress models, what approach *should* we consider?

From the analysis above, we can see that a good stress test model must:

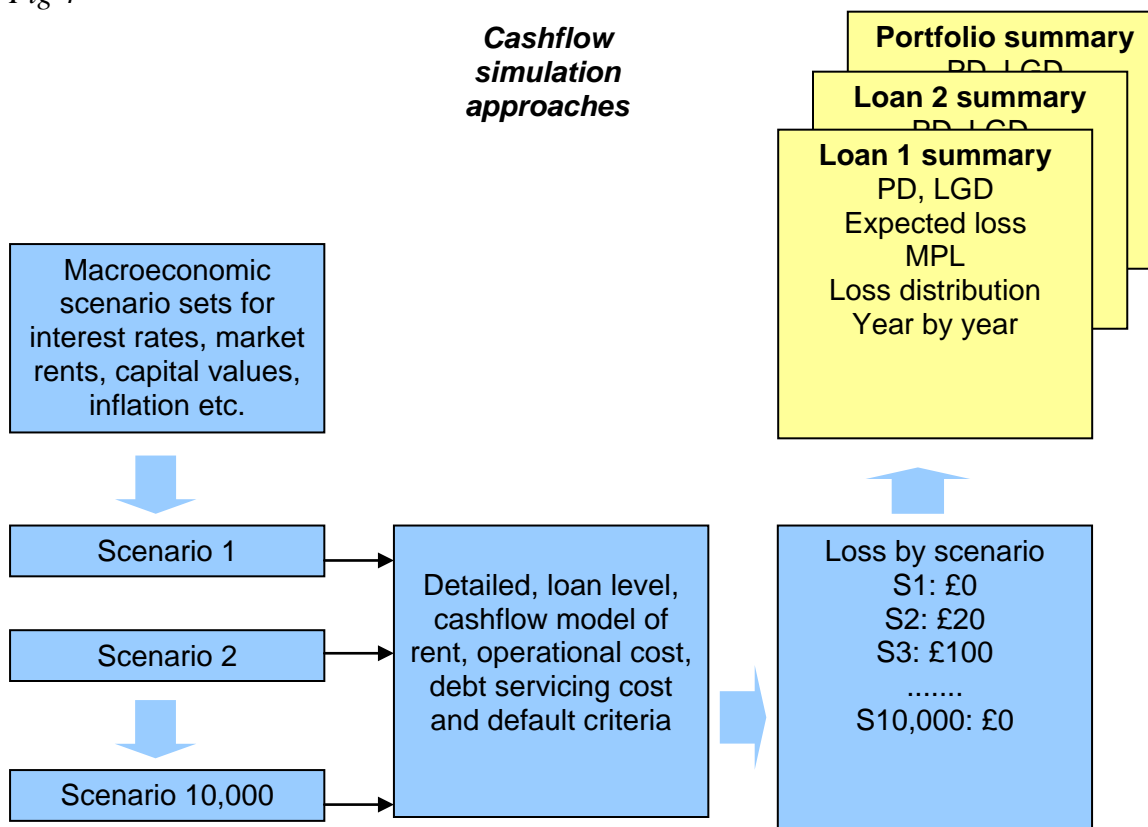
- Model Market risk and Credit risk together
- Avoids the need for loss history
- Does not depend on problematic issues of PD measurement
- Recognises correlations between market risk factors
- Multi-year models recognising EL changes over time
- Calculates refinance risk
- Focus on EL rather than uncorrelated PD and LGD measurement

### Macroeconomic cashflow simulation models.

The advent of cashflow simulation risk models has enabled some banks to make stress testing fast, flexible and more accurate. Though they pose some significant implementation challenges, the users of these models are in no doubt as to their ability to generate detailed, granular, bottom up stress tests at the loan and portfolio level.

Simulation modelling approaches use a cashflow model of each borrower, modelling their ability to service their loans from the modelled rental income. In the event that the loan cannot be serviced, the model calculates the loss (if any) resulting from a recovery process. In each year and in each scenario the model calculates a loss. These losses are averaged over a large number of scenarios to calculate an expected loss. Schematically this process is illustrated in Fig 4.

Fig 4



This approach has a number of significant advantages in stress testing portfolios over other methodologies. To calculate the risk statistics using a cashflow approach, each loan must be described in terms of its net rental income:

- number and type of units
- actual rents per unit
- rent review dates
- rent review types (e.g. inflation indexed, open market, agreed etc.)
- break dates
- lease end dates
- tenant quality (normally a tenant PD estimate)
- operating costs

Then, to calculate the debt servicing costs, users need to describe:

- the number and seniority of loan tranches (if more than one)
- the loan amount
- the interest rate structure (fixed/floating)
- interest rate (over what measure, e.g. LIBOR)
- currency
- swap rate (if hedged)
- date of change if interest rate regime is to change (e.g. fixed to floating)
- rate cap or floor

To calculate recoveries, users need to describe

- the age of the building (to apply different depreciation rates)
- the value of the building and its valuation date (to track changes since valuation)
- the vacant value of the building (the loss will be affected by the type of default – did the tenant vacate or was the interest rate too high?)

Once we have a full description of each loan (see challenges, below), it becomes practical to model how it would perform in one scenario. And from this point, it becomes possible to model large numbers of possible scenarios, and over many years.

Some events are independent of market factors (will a tenant leave or stay at the lease end?). These can only be modelled statistically, but the attraction of the simulation approach is that by laws of large numbers, a set of scenarios can describe independent probabilistic events such as the departure (or otherwise) of tenants. In simulation, like in the real world, a tenant's decision is always binary: they stay or they go; we do not have to calculate 'expected rents' by applying averages.

Once the loan descriptors have been presented to the simulation model, we can ask, what scenarios should we use to model the cashflows?

We need scenarios at a minimum for the following macroeconomic variables:

- Interest rates (LIBOR)
- Inflation (RPI)
- Bankruptcy rates
- Property capital values – by sector (CV)
- Market rents – by sector (ERV)

For grading loans a large set of scenarios should be used that realistically reflect the probability of different outcomes in the economy. From this, risk statistics can be generated *that reflect the operation of market changes on individual loan factors*. Thus we might say, such and such a loan is will default in 100/10,000 scenarios in the next year with an average loss of 10% but will default in 500/9,900 remaining scenarios with an average loss of 12% the year after. The scenarios themselves must be designed to replicate the historical trend, volatility and correlations of the macroeconomic variables. So, for example, if rents and capital values are highly correlated historically (which they are) we should make sure that the scenarios exhibit similar levels of correlation. This element of the model makes sure that the correlation of risks is properly recognised. There may be little loss data for CRE loans, but there *is* good data about the correlation of commercial property prices with other economic factors.

So far we have seen how a simulation model can calculate PD in a wide range of possible scenarios in normal conditions. To convert this model to a stress test model, we need only present a single scenario, the stress scenario, to the cashflow model and run it 10,000 times. The resulting EL is an accurate estimate of the expected loss in the stress scenario. (The scenario still needs to be run 10,000 times because there are independent events such as tenants leaving at lease ends that are still unknown, even if we ‘know’ the future of the economic parameters.)

Criteria for an ideal model fig 5:

<b>Criterion</b>	<b>Simulation modelling</b>
Model Market risk and Credit risk together	Yes. In the interplay of market scenarios and loan specific description
Avoids the need for loss history	Yes. Loss history data is replaced, by analogy, with economic data
Does not depend on problematic issues of PD measurement	PD definition is flexible – primary measure is expected loss
Recognises correlations between market risk factors	Yes in the scenarios – historic cross-correlations can be replicated in the scenarios
Multi-year models recognising EL changes over time	Yes. Multi-year cashflow model generates multi-year risk statistics
Calculates refinance risk	Yes. The probability that a loan cannot be refinanced can be calculated using the scenarios.
Focus on EL rather than uncorrelated PD and LGD measurement	Yes, loss is calculated directly in each scenario

### **Challenges for implementing simulation based stress-testing models**

As ever, there are both organisational and technical challenges in making this somewhat complex approach work. They can be summarised under the two headings of *Data Quality* and *Calculation Quality*.

In the first place, the actual, current information describing the loan must be available for the model. Lenders are typically good at recording the conditions of the loan (structure, interest rates, balance etc.) but less good at maintaining information on their borrowers. Descriptions of the borrower's lease structures, rents, tenants are often good at the point of loan approval but the quality of this type of data often deteriorates over time. If a key tenant is no longer paying the rent, five years into a loan, we need to know this fact for stress testing purposes.

The key to maintaining risk data is to have a system that proactively warns users when certain data fields require updating (e.g. upcoming rent review dates) – these are the 'carrots'. The process that generates exception reports for stale or out of date can be described as the 'stick'. Such systems significantly improve operational control but careful IT implementation and consistent management are required to deliver cleansed, validated and up-to-date risk data of the required quality.

The large volume of calculations present there own challenges. To stress a portfolio through large numbers of scenarios, year-by-year, unit-by-unit, building-by-building, facility-by-facility within a few hours is now possible using state of the art techniques.

But it does require modelling abilities well beyond the use of spreadsheets or simplistic Monte Carlo systems. Stress modelling at the portfolio level also requires highly cleansed and validated loan data for a wide range of loan types to be presented to the simulation engine in a rigorous and controlled manner. Exercises using Excel or simple Monte Carlo tend to be difficult to recreate (for audit purposes) and incorporate high levels of model risk. Assumption management (for there are always assumptions to manage in any model) can become a problem unless they are managed in a specialist database.

### **Conclusions**

Stress-testing is a valuable tool in the armoury of senior management and is increasingly being demanded by regulators. For CRE portfolios (and other asset backed lending such as shipping finance, aircraft leasing, and project finance portfolios) existing, top down stress-test models and regression type grading models are not usually adequate and may even be significantly misleading. This is because CRE loans are highly heterogeneous and combine high levels of interrelated market and loan specific risk as well as being highly sensitive to economic shocks. Possibly the only fast and accurate approach to stress-testing is to use macroeconomic cashflow simulation models. Although they present some technical and implementation challenges, these can be overcome and the approach lends itself to all aspects of stress testing, the results of which can be of significant strategic value to senior management.