ProMS®

IPRE Portfolios: Meeting the FSA Requirements for IRB PD Models

Radley & Associates Ltd

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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1.0 Introduction

This document describes how the correct use of ProMS can satisfy the requirements of the FSA for IRB compliant ratings models. The FSA requirements are listed in the consultation document issued by the Credit Risk Standing Group on September 23rd 2010, entitled; *Internal Ratings Based PD Models for Income Producing Real Estate Portfolios*. Each section in the document refers to the corresponding requirement in the appendix containing the summary requirements.

ProMS is a cashflow simulation model that simulated the investment property cash flow in 10,000 macroeconomic scenarios and calculates the number of scenarios in which default events occur to estimate default probability, expected loss and loss distribution in any future time period.

2.0 Risk Drivers

2.1 Cash flows.

2.1.1 For a compliant rating system we expect that the firm should be able to demonstrate that the difference in deal ratings when tenant ratings are altered is intuitive;

To demonstrate that the difference in deal ratings with respect to tenant default rates is intuitive, we carried out a sensitivity analysis on a single unit template loan, changing the input tenant PD across a range of tenant PDs. The template loan is a single tenant, floating rate loan (see details in Appendix under: Sensitivity test 1). There are no lease events in the next 12 months, so the loan has interest rate risk and tenant default risk. The results are show in Exhibit 1 below.

Exhibit 1: Single Tenant PD and Loan PD (Floating Rate)

Tenant PD	12month PD
0.05%	1.45%
0.10%	1.47%
0.25%	1.60%
0.50%	1.80%
1.00%	2.20%
2.50%	3.45%
5.00%	5.55%
10.00%	9.44%
25.00%	21.08%

As tenant PD rises, so the 12month PD rises. At the lowest tenant PD, the 12 month PD is dominated by interest rate risk, in this case, approximately 1.4%.

2.1.2 The transformation of ratings into non-rent payment probability is intuitive. Even where tenants are rated by the firm, the PD should not usually represent a direct read across to probability of non-payment

Repeating the exercise, replacing the floating rate with a fixed rate, the effect of the interest rate risk is eliminated and we are left with tenant risk only.

Exhibit 2: Single Tenant PD and Loan PD (Fixed Rate)

Tenant PD	12month PD
0.05%	0.05%
0.10%	0.07%
0.25%	0.20%
0.50%	0.40%
1.00%	0.80%
2.50%	2.05%
5.00%	4.15%
10.00%	8.04%
25.00%	19.68%

At the lowest tenant PD, all 5 tenant defaulting scenarios (out of 10,000) result in a default. As the number of tenant defaulting scenarios grow, the probability of finding a tenant before the loan defaults increases. So in the 100 tenant defaulting scenarios associated with the tenant PD of 1%, a new tenant is found in 20 cases, reducing the loan default to 80bps. This ratio is fairly consistent as the tenant PD increases; in about 20% of cases, a new tenant is found in time, in 80% of cases a new tenant is not found and the loan defaults. This ratio is dependent on the shape of the void distribution for the sector (see voids in the cashflow methodology documentation), the rent free period following the void, and the default criteria settings chosen by the lender to calibrate the system. Note that the input tenant PD is a PIT measure in this example.

Conclusion; the translation from tenant default to 12month PD is intuitive, though not a one to one translation.

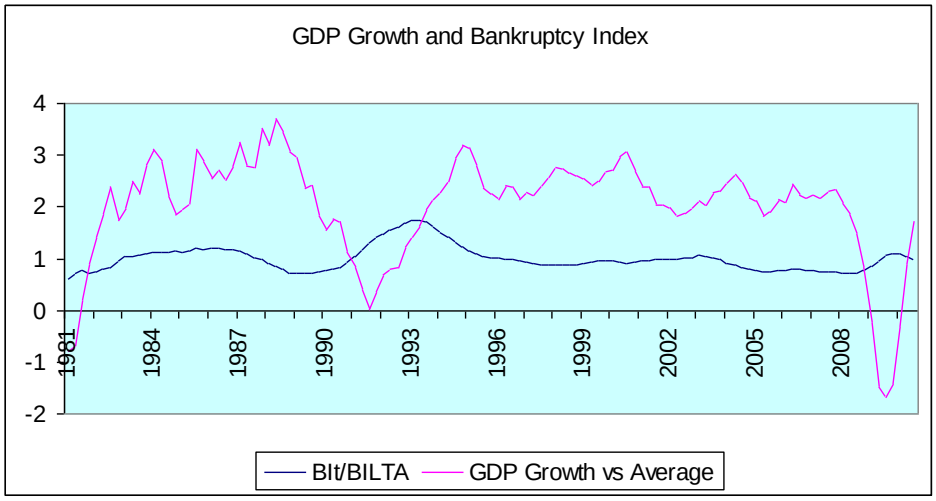
2.1.3 Even where tenants are rated by the firm the PD should not usually represent a direct read across to probability of non-payment due to, for example, model philosophy issues. Addressing this is likely to be a key area since we have seen many firms struggle with what divergence is expected between observed default rate and PD in different economic conditions in the mid corporate space;

In the above examples, the input tenant PD, PDo, is a PIT measure, so no translation is required from TTC tenant grades. In the event that lenders use TTC grades for tenants, an IRB compliant translation from PIT to TTC is required. In the absence of a lender's own PIT to TTC translation, ProMS uses the following translation;

(1) $PDo\ (PIT) = PDo(TTC).(BIo/\ BI_{LTA})$

Where BIo is the current level of the bankruptcy index and BI_{LTA} is the long term average of the bankruptcy index. The bankruptcy index is derived by dividing the total number of insolvencies in the UK (a series from the ONS) by the total number of VAT registered traders in the UK (from HMRC) in the same period.

Exhibit 3: UK Bankruptcy Index relative to Long Term Average and UK GDP Growth



The data illustrates how the bankruptcy index rises following the 1990s recession and (less so) following the 2008/9 recession. Note that the severity of the index change is less in 2009/9 owing to lower prevailing interest rates.

2.1.4 Selection of parameter values and/or distributions, and their impact on deal ratings, is well supported and intuitive;

ProMS uses a range of parameter values to condition the cashflow analysis. The parameters are chosen using industry wide data or lender data where lenders believe that their overall book of loans is significantly different to the market.

The parameters used are chiefly at a use sector level, employing the main IPD use sectors, allowing the model to align with IPD published sectorial data.

Exhibit 4: Example Sectorial Assumptions for UK Standard Shops

Assumptions for UK Standeard Shops	***Suggested Source***	***Example Settings***
Lease events		
Percentage Leases Continued At Break	Strutt and parker Lease Event report (annual)	85%
Percentage Leases Renewed at Lease End	Strutt and parker Lease Event report (annual)	42%
Probability Of New Tenant At Break	Strutt and parker Lease Event report (annual)	6%
Probability Of New Tenant At Lease End	Strutt and parker Lease Event report (annual)	24%
Sales Costs		
Valuation error/ideosyncratic error standard deviation	RICS/IPD Report on Valuation error	13.40%
Collateral Sale Discount From Market Price	Lender experience	10%
Sale Costs	Lender experience	5%
Vacant Value Discount From Market Price	Lender experience	20%
Void Costs		
Length Of Rent Arrears At Tenant Default	Lender experience	3 months
Average Void Period (Lognormal)	Strutt & Parker	3 months
Volatility of Void Period (Lognormal)	Strutt & Parker	2.92
Estimated Average Void Period (Real)	Calculation see note	*11.53*
Recoverable Service Costs	Only used as override in the event that these costs are not known by lender	0.30%
Irrecoverable Operating Costs	Only used as override in the event that these costs are not known by lender	0.20%
Depreciation		
Depreciation Cycle	IPF, Reading university and Others	35 years
Newly Refurbished ERV	IPF, Reading university and Others	95%
Second Hand ERV	IPF, Reading university and Others	75%
Refurbished Capital Value	IPF, Reading university and Others	95%
Second Hand Capital Value	IPF, Reading university and Others	75%
Future tenants		
Standard Length of Lease	BPF Annual Lease Review	10 years
Standard Review Cycle	BPF Annual Lease Review	5 years
Standard Rent Review Type	BPF Annual Lease Review	Up only
Standard Break Year	BPF Annual Lease Review	5 years
Average Rent Free Period	BPF Annual Lease Review	5 months
Average Tenant PD	Strutt & Parker	1.50%

The sensitivity of loan grades to changes in these parameters were tested using a series of template loans designed to reflect the impact of the parameters.

Template loans for sensitivity testing

Sensitivity test 1 is a single tenant loan with no lease events within the next 12 months. It is used for sensitivity testing primarily of tenant default risk.

Sensitivity test 2 is a single tenant loan with a break date within the next 12 months. The loan is used primarily for sensitivity testing of break probabilities and void periods.

Sensitivity test 3 is a single tenant loan with a lease end date within the next 12 months. The loan is used for sensitivity testing of lease event probabilities and rent free periods following lease renewals.

Exhibit 5: Sensitivity Test Results

Test	*Assumption*	*Base parameter value*	*Units*	*Test loan*	*Test Parameter value*	*Base12 month PD*	*Test 12 month PD*
1	Percentage Leases Continued At Break	85	%	Sensitivity test 2	75%	11.99%	19.71%
	Percentage Leases Renewed at Lease End	42	%				
2	Probability Of New Tenant At Break	6	%	Sensitivity test 2	3%	11.99%	12.79%
3	Probability Of New Tenant At Lease End	24	%	Sensitivity test 3	30%	39.96%	38.42%
4	Average Rent Free Period	5	months	Sensitivity test 3	8	39.96%	46.23%
	Sales Costs						
6	Valuation error standard deviation	0	%	Sensitivity test 1	13%	2.23%	2.23%
7	Collateral Sale Discount From Market Price	10	%	Sensitivity test 1	15%	2.23%	2.23%
8	Sale Costs	5	% of market price	Sensitivity test 1	10%	2.23%	2.23%
9	Vacant Value Discount From Market Price	20	%	Sensitivity test 1	na		
	Void Costs						
10	Length Of Rent Arrears At Tenant Default	3	months	Sensitivity test 1	6	2.23%	2.37%
11	Average Void Period (Lognormal)	3	months	Sensitivity test 2	2	12.23%	12.20%
11	Volatility of Void Period (Lognormal)	2.92	months	Sensitivity test 2	1.92	combined test with lin	
	Estimated Average Void Period (Real)	*11.53*	11.53 months				
12	Recoverable Service Costs	0.3	% of ERV	Sensitivity test 2	2.00%	12.23%	12.24%
13	Irrecoverable Operating Costs	0	% of value	Sensitivity test 2	2%	12.23%	39.25%
	Depreciation						
15	Depreciation Cycle	35	years	Sensitivity test 2	25	12.23%	12.25%
16	Newly Refurbished ERV	95	% of new build ERV	Sensitivity test 2	see below		
16	Second Hand ERV	75	% of new build ERV	Sensitivity test 2	55	12.23%	12.34%
	Refurbished Capital Value	95	% of new build value	Sensitivity test 2	na		
	Second Hand Capital Value	75	% of new build value	Sensitivity test 2	na		

Test 1
In test one the probability of a break being exercised was increased by 10% and the PD increased from 11.99 % to 19.71%, or by 7.7%. In most cases an exercised break resulted in default but in some cases, a tenant was found before default occurred, so the increase in PD was not one for one. Good intuitive result.

Test 2
In test 2, the probability of having a new tenant ready, after a break is exercised was reduced from 6% to 3%. The 12month PD increased from 11.99% to 12.79% or by 1.80%. Again this is less than a one to one relationship, as there are some scenarios where a replacement tenant is found before a default occurs. Good intuitive result.

Test 3
In test 3, the probability of tenant staying at lease end is set at 24% resulting in a loan default of 39.96%. This PD falls to 38.42% if the parameter is reset to 30%. Note that in about half the scenarios, a new tenant is found following a tenant leaving at the lease end in both cases. (i.e. 39.96%/(1-24%) and 38.42%/(1-30%). Good intuitive result.

Test 4
In test 4, the rent free period is increased from 5 months to 8 months. This should result in more cases where a lease end is exercised resulting in a default as the rental income is delayed even further after the void period. In the test, the 12month PD increased from 39.96% to 46.23%. Good intuitive result.

Test 5
Changing the average tenant PD is successfully tested in section 2.2 above.

Test 6
Valuation error, is the observed standard deviation of the difference between the index value of a property from its valuation date and the actual (non-distressed) sale value as measured by RICS/IPD (see valuation error or idiosyncratic risk). This value should increase the volatility of realised collateral values and, because of the cut-off point, the LGD of a loan. It should not affect the PD of a loan as it only affects the collateral value and not the rental income. The PD of the test loan is not affected, staying at 2.23%.

Test 7 and 8
These tests measure the effect of changes in the sales costs and distressed sale discount or haircut to the recoverable collateral value. Like the changes in test 6, there should be no effect on PD. In both these tests, the 12month PD remains unchanged at 2.23%.

Test 9
The vacant value discount is only used in the case where a vacant value for the collateral property(s) is not available. Again, it has an effect only on those cases where there is no vacant valuation and will only affect the LGD not the PD. Not tested.

Test 10

In this test, the length of rental arrears at tenant default is increased from the standard assumption of 3 months to 6 months. This should increase the number of defaults as the reduction of income in the defaulting scenarios will cause more scenarios to default. (Note that there are also scenarios defaulting because of interest rate risk and these will be unaffected). In the test, the 12month PD increased from 2.23% to 2.37%. In other words, of the 100 tenant defaulting scenarios, 237 – 223 or 14 will now result in default because of the extra rental arrears that previously would not have defaulted. Good intuitive result.

Test 11

In this test the parameters that describe the distribution of void periods are tested. The model uses assumptions for the mean and standard deviation of a log-normal void distribution based on data collected by IPD/Strut and Parker. The average value is also conditioned by the position of the economic cycle, but this is tested elsewhere. In the test, the mean was reduced from natural log of mean 3 months to 2 months and the standard deviation from natural log of 2.92 months to 1.92 months. The reduced void period and volatility should reduce the defaulting scenarios where replacement tenants are not found quickly enough. The 12month PD was reduced from 12.23% to 12.20% as a result of this change. The direction of change is intuitively correct. The small scale of the change is accounted for by the fact that most of the defaults in this test are caused by interest rate risk rather than rental income risk.

Test 12

Recoverable service costs, expressed as a % of ERV are only carried by the borrower in the event of a tenant default and are otherwise charged to the tenant. This cost will only have an effect during void periods, tending to very slightly reduce the chance that a loan will recover in time with a new tenant, effectively increasing the lost income from the actual rent to the actual rent plus 2% of the rent. The 12month PD in the test increased from 12.23% to 12.24% reflecting this subtle increase in risk.

Test 13

Irrecoverable costs, (expressed as a percent of the value of the property) are costs carried by the landlord and reclaimable from tenants – in most cases this is small. In the test, the irrecoverable costs were increased from 0 to 2% of the value of the property, significantly impacting the ability of the landlord to meet the debt service. The 12month PD increased strongly from 12.23% to 38.25%.

Test 15

By altering the depreciation cycle assumption, the rate at which buildings depreciate (obsolescence not dilapidations) is very slightly increased. As a result, there may be some scenarios in which the ERV for new tenants falls faster and reduces the rental income for replacement tenants. The effect should be slight as we are only interested in scenarios with voids followed by lower rent levels where these lower rent levels are enough to default the loan. In the test, the 12month PD increased from 12.23% to 12.25%. Again, noting that most defaults are associated with interest rate risk, this small PD increase is in line with expectations.

Test 16
The newly refurbished ERV and second hand ERV levels also determine the rate at which a property's ERV falls, *relative to the index*, over time. In this test, the slope of relative ERV decline was increased from 95% - 75% to 95% - 55%, i.e. a higher depreciation rate. The effect should be to increase the number of defaulting scenarios and, for the same reasons as above, the effect should be small. In the test it was measured as increasing 12month PD from 12.23% to 12.34%

Other variables, such as the capital value depreciation, affect the capital values of collateral but not the default probability and are not tested here.

2.1.5 Impact on the deal rating is intuitive for such features as: type of building, geographical location and building quality.

2.1.5.1 Type of building.
The type of building or the use sector of collateral property chiefly affects the probabilities associated with lease events, such as the break exercise probability. The sector also affects average void lengths and the rate of depreciation of the asset relative to the capital value and open market indices.

A test was run, using a standard loan (Sensitivity test 2), changing the sector of the property to investigate the impact on PD. The sector assumptions for the test were as follows;

Exhibit 6: Use Sector Assumptions

Summary Sector Asscumptions	***Standard shops***	***Standard offices***	***Standard industrials***
Lease events			
Percentage Leases Continued At Break	85	75	80
Percentage Leases Renewed at Lease End	42	41	36
Probability Of New Tenant At Break	6	9	8
Probability Of New Tenant At Lease End	24	18	24
Average Rent Free Period	5	9	5
Average Tenant PD	1.5	0.6	1.9
Implied void at break	*9*	*16*	*12*
Void Costs			
Length Of Rent Arrears At Tenant Default	3	6	6
Average Void Period (Lognormal)	3	10.83	19
Volatility of Void Period (Lognormal)	2.92	2.87	2.62
Estimated Average Void Period (Real)	*11.53*	*19.07*	*25.86*
Recoverable Service Costs	0.3	0.3	0.3
Irrecoverable Operating Costs	0	0.2	0.2
Depreciation			
Depreciation Cycle	35	35	35
Newly Refurbished ERV	95	95	95
Second Hand ERV	75	52	52
Refurbished Capital Value	95	95	95
Second Hand Capital Value	41	41	41
implied depreciation rate	*0.82%*	*1.85%*	*1.85%*

Following a break, it can be seen that standard offices are most likely to experience a void, followed by standard industrial properties and shops are least likely to experience a void. (NB all data sourced from Strutt & Parker/IPD Lease Event Review).

Retail units on average, tend to depreciate against the index less than industrial and office units (tenants tend to modernise retail units more than offices or industrials) so capital values (absent refurbishments) will fall less.

Note industrials have the longest expected void periods and this should increase their PDs relative to other sectors.

The test loan 'Sensitivity Test 2' – with a break in 6 months – was tested, each time changing only the use sector of the collateral property.

Exhibit 7: Use Sector Effects on PD

Sector	*12month PD*
Standard shop	12.30%
Standard office	22.65%
Standard industrial	21.55%

In the test, the lower void probability for shops comes through in the 12month PD results. The highest void probability is for standard offices, which is replicated in the 12month PD results. Note that the second order effect of the average length of voids hits industrial property the hardest and this is reflected in the narrowing of the 12month PD gap relative to the void probabilities of the office and industrial sectors.

2.1.5.2 Geographical location

Properties of the same use sector but located in different regions of the UK exhibit different levels of rent and collateral value volatility. In ProMS, this volatility is modelled by associating the post code of each collateral property with the regional coverage of an IPD regional index. Market rent volatility affects the probability of default indirectly since replacement tenants following a void may be paying a market rent that is incapable of servicing the loan. This effect should be very limited.

Exhibit 8: Geographic Effects on PD

Standard Retail	*CV volatility*	*ERV volatility*	*12 month PD*
South East	11.50%	11.03%	17.98%
Rest of UK	10.11%	4.84%	17.90%

The test illustrates the small effect that geography has on 12 month PD but the direction of the effect is intuitive. In the south east, higher ERV volatility results in 8 more defaulting scenarios, where ERVs fall far enough that the new tenant's rent level is insufficient to avoid a three month debt service arrears that tips the loan into default. Note that the test loan initial ICR is over 140%, so the fall in ERV must be fairly significant to affect the loan. The difference in regional volatility for other use sectors is even less marked than in retail units, so the effect is even more subdued. Note that significant differences in collateral value levels, between geographies, is already taken into account in the model through the valuation of the collateral property, so only the relative volatility affects loans made in two regions of comparable amounts and LTVs.

2.1.5.3 Building quality.

The model philosophy adopted in ProMS assumes that the valuation is the best guide to building quality and that the quality of a building is reflected in its valuation. The quality of a building may also reflected in its yield, which is also explicitly modelled in ProMS. One aspect of quality that has a major bearing on loan risk is the age the property and whether it has been refurbished recently. A sensitivity test was run, using 'Sensitivity Test 2' as a template loan. New buildings depreciate faster than old buildings and the depreciation rates are set in the sector assumptions (see

Exhibit 4 above). As a result of faster depreciation in new buildings, rents and capital values depreciate more rapidly, relative to the ERV and Capital Value indices, thus increasing the LGD relative to older buildings but also reducing the potential rental income, so that, in a small number of cases, at the margin, the rent for a new building might fall faster and thus default a loan, where an older building would not see such a default.

Exhibit 9: Test results

Building condition	*12 month PD*	*12 month LGD*	*Cumulative LGD*
Brand new	16.00%	3.08%	4.40%
Second Hand	15.96%	2.59%	3.42%
Newly Refurbished	15.96%	2.99%	4.22%

The 12 month PD fell by 4 basis points, reflecting the slower rate of depreciation on older buildings which is a good intuitive result. Note that the LGD in the shorter and longer term is higher for new, and therefore more rapidly depreciating, buildings, than it is for older buildings. Newly refurbished buildings also depreciate less quickly than new buildings, though their long term capital value deprecation – see 12month and cumulative LGDs – is somewhere between brand new and second hand property.

2.1.5.4 Prime and secondary property

Some risk managers suggest that prime property is lower risk than secondary property because primary property value is less volatile than secondary property. Though definitions of 'prime' and 'secondary' vary between and within institutions, a good proxy measure is yield. Within each sector, low yield properties are usually considered to be more 'prime' than higher yielding 'secondary' properties. IPD have published sectoral level quarterly data on the change in capital values for three classes of yield; low, medium and high. The data covers the period from 1999 – 2010, 38 quarters.

Exhibit 10: Capital Value Volatility of IPD Prime, Secondary and Tertiary Property.

Standard deviation of quarterly capital value changes 1999-2010	*Standard Retail*	*Shopping centres*	*Retail warehouses*	*Central and inner London Office*	*Rest of South East & Eastern Offices*	*Rest of UK Offices*	*All Industrials*
Low Yield (prime)	3.92%	4.17%	5.26%	4.93%	3.88%	4.04%	4.02%
Mid Yield (secondary)	3.82%	4.98%	5.43%	4.81%	3.77%	3.76%	3.77%
High Yield (tertiary)	3.89%	4.90%	5.12%	5.46%	3.81%	4.10%	3.82%

The analysis shows that only for shopping centres are prime properties less volatile in terms of capital value changes. For 6 of the 7 sectors for which there is data, the least volatile segments are either secondary or tertiary property.

At best, we can say the data is not sufficient to support the view that prime building collateral values are less volatile and therefore less risky. ProMS does not distinguish between the collateral value volatility of properties on the basis of perceived judgements of building quality beyond the normal recognition of the valuation and yield of the collateral property in the cash-flow model. Where the 'primeness' of

collateral is supported by strong tenants on long leases, these are recognised and explicitly modelled by ProMS; both tenant quality and lease event effects are discussed above.

2.1.6 *Where data is missing or unavailable the treatment is conservative.*

2.1.6.1 Missing data

Where risk driver data is missing, ProMS either makes a conservative assumption, but will allow a loan to be graded, or it will prevent grading altogether. Where missing data is allowed, the following conservative assumptions are made and the loan can be graded:

- Vacant value not known. Lenders set a conservative discount for vacant value which is automatically applied if the vacant value data is not entered.
- Tenant PD not known. If a tenant's PD is not known, a conservative average sectoral PD can be set as a default value.
- Date of refurbishment and/or build is not known. In the event that this data is not presented to the model, the collateral property is assumed to be brand new and the steepest rate of depreciation is applied to the building's value relative to the index.
- No tenant details: if there are no tenant details, the unit is assumed to be vacant.

Where the following data is unavailable, the system will not provide a grade;

- Per property:
    - Valuation and date
    - Leasehold vs. freehold tenure
    - Post code (to describe geography)
    - No. of units
- Per unit:
    - Status of unit occupied/vacant
    - Identity of tenant
    - Tenant SIC code (optional)
    - Tenant PD (see above)
    - Lease end date (if occupied)
    - Break date (or 'none scheduled')
    - Rent (if occupied)
    - ERV (if occupied)
    - Rent review date (or 'none scheduled')
    - Rent review type (or 'none scheduled')
- Per facility or loan
    - Start date
    - Term
    - Initial loan amount and loan disbursement schedule
    - Loan/RCF
    - Principle repayment terms
    - Interest rate structure and level
    - Hedging present or not

2.1.6.2 Methodology and conservatism.

Conservatism is built in to the methodology in a number of ways, though never without good reason, usually based on empirical data. A complete description of the conservative assumptions can be found in 'ProMS Conservative Modeling Assumptions.xls' and by reading 'ProMS Cashflow Methodology.doc'. The chief conservative assumption is that borrowers will provide no cash support if the collateral property income is insufficient to cover the debt service requirement. If there *is* borrower equity in a deal, this assumption is very conservative since most borrowers will find other sources of funds rather than have their property taken by their lender. In calculating losses however, this is taken into account since defaulting deals with significant borrower equity are unlikely to cause loss. Hence ProMS is likely to record a default with no loss in cases where there might not have been either a default or a loss. As a result, simulation tends to generate slightly higher than expected PDs and compensatingly lower LGDs, the expected loss figure being unbiased in all cases.

2.2 Interest Rate Risk

2.2.1 Interest rate risk should be included as a relevant risk driver (unless portfolio is exclusively hedged).

Interest rate risk is recognized in the 10,000 interest rate scenarios presented to the cashflow simulation model for any loans that are not fully hedged for the entire length of the loan. The effect of changes in interest rates over the next 12months and over the life of the loan are both modeled. Interest rate risk is calculated for;

- floating rate loans (over LIBOR or Base rate)
- fixed then floating rate (for the floating rate portion)
- part fixed and part floating facilities
- floating then fixed loans

The mitigating effects of interest rate caps and floors can also be modeled.

2.2.2 The way in which interest rate risk is included in the deal rating should be intuitive with respect to model philosophy. For example a point in time rating should consider the current interest rate and likely change over a 1-year time horizon. Whereas, a through the cycle model needs to consider the interest rate risk averaged over an economic cycle.

ProMS' 12month PD estimates are point in time ratings. The 12month PD for floating rate loans is based on current interest rates and the possible changes in interest rates over the next 12 months. Note that to default within the next 12months, the interest rate increase must be high enough to cause a three month arrears (hard default) or a decision that the loan is unlikely to repay (soft default).

2.2.3 The firm should be able to demonstrate that the model rates hedged and unhedged deals differently and that the magnitude of the difference in these ratings is intuitive.

A template loan (Sensitivity test 1) was run, as a

- fixed rate loan, fixed at 5%
- floating rate loan of 3% above LIBOR
- fixed rate for two years followed by floating (same rates and margins)

Exhibit 11: Interest Rate Risk

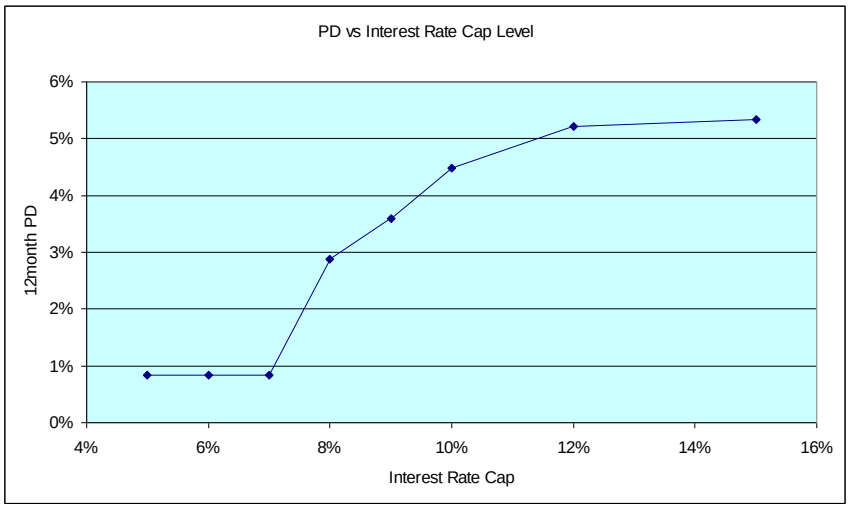
Interest Rate Structure	*12month PD*	*Annual Equivalent PD*
Fixed at 5%	0.90%	7.10%
Floating at 3% over LIBOR	5.33%	27.37%
Fixed then floating (rates as above)	0.90%	26.64%

The 12month PD of the fixed rate loan is significantly lower at 0.9% that the floating rate loan at 5.33%. In the scenario set used in 2010Q2, interest rates are at a historic low and many scenarios are upward pointing in the short and medium term. The test loan has about 90 basis points of tenant default risk (tenant PD is 1%) in the fixed rate version, which indicates that there is about 4.43% chance of interest rates rising sufficiently to default the loan.

The fixed then floating rate example has the same 12month PD as expected since the rates are fixed for longer than the next 12 months. ProMS also calculates the annual equivalent PD (1-P(non default over life of loan))^(1/term) - or the PD that, if applied every year of the loan, gives the same lifetime default result. These results are also intuitive, since the fixed rate loan has the lowest lifetime equivalent PD, the floating rate loan has the highest PD. The two year fix, does provide risk mitigation in the first two years thus reducing the average PD from 27.4% to 26.6%.

The effect of interest rate caps on interest rate risk was tested using the same test loan with a floating rate (LIBOR + 3%) but subject to interest rate caps at various levels.

Exhibit 12; The Effect of Caps on Interest Rate Risk.



At levels below 7%, the interest rate cap effectively removes interest rate risk as the rental income is sufficient to cover debt servicing in all cases at or below the cap. The PD is 90bp, the same as for a fixed rate loan. At 15% or above, the cap provides no protection since the PD is at 5.33%, the same as for a floating rate loan. Between 7% and 15%, the cap provides varying levels of interest rate risk protection. This curve varies with the structure of each loan, depending on its rental income level and volatility as well as the ICR.

2.3 Refinance Risk

2.3.1 Refinance risk should be included as a relevant risk driver (unless portfolio contains only amortising loans). This should conform to a BIPRU compliant definition of default which is based on whether a third party would provide finance on materially similar conditions

One of the major advantages of integrating loss modeling and default modeling into a single simulation approach is that the conditions of a loan at term can be described in detail (LGD, ICR, interest rates, occupancy, rent, lease events etc.) in each scenario. From this information the number of remaining scenarios in which a refinance default occurs can be calculated and thus the refinance PD established.

ProMS uses the BIPRU definition of refinance default, namely that if a third party lender would not be prepared to refinance the loan on substantially similar terms, then the loan is in default. The two main criteria modeled in ProMS to determine refinance risk are LTV ratios and Interest Cover Ratios.

A conservative default level of LTV is set by the users – for example in today's market this might be 60%. Loans that have LTVs below this level at term are assumed to be refinanced elsewhere and no default is recorded. Since simple LTV ratios are not the only criteria for refinance, ProMS also considers the strength of the rental income at term in each scenario. Where leases have more time to run until the next lease event and the rent is above the debt service requirements, a calculation is made as to the chance that the LTV could be reduced to below the hurdle with this 'known'

surplus income, referred to as the refinance capacity. The refinance capacity for each scenario, RCi, being defined as;

(2) $RCi_{t=T} = \Sigma_{s=1 to S} REi_{t=T} . (Tle – Tt) . (1\text{-}PD(tenant)) – INTi_{t=T} . (Tle – Tt)$

where $REi_{t=T}$ is the rent, Tle – Tt is the time remaining from term to the next lease event, $INTi_{t=T}$ being the prevailing interest rate at term – assumed fixed for the remained of the time to the next lease event.

A refinance default of this type, (D3A = 1) is recorded if

(3) $LTVi_{t=T} – RCi > LTV\ hurdle$

So, for example, if a refinance hurdle is set at 60% and at the term date the LTV is 64%. If the rental income is 6%, secure for 5 years, and the interest rate is 5%, then there is 5 years x (6%-5%) = 5% refinance capacity, reducing the adjusted LTV to 59%, thereby avoiding a refinance default.

At term, loans may only be refinanced 'under materially similar conditions' if the rental income at term is also sufficient to cover the interest required at term. This criterion is especially important for loans that have fixed rate to term. A loan that meets the LTV criterion may not, in some circumstances, be able to refinance, because the prevailing interest rates at term may be too high for the rental income.

A refinance default of this type (D3B = 1) is recorded if the loan's ICR at term is below a hurdle rate set by the master model user in line with current lending policy.

(4) $D3B = 1 \text{ if } [REi_{t=T} / INTi_{t=T}] < ICR\ hurdle$

A refinance default occurs if either of these criteria is met (i.e. if the LTV is too high OR the ICR is too low).

(5) D3 = 1 if [D3A OR D3B =1]

2.3.2 The firm should be able to demonstrate that the model rates interest only and amortising deals differently in the final year and that the magnitude of the difference in these ratings is intuitive

To illustrate the difference between interest only and amortising loans, the test loan 'Sensitivity test 4' was adapted to be either interest only or amortising and graded at each level of amortization.

Sensitivity test 4 is a 5 year loan of £700,000 with a fixed interest of 5%, collateralized with a property currently worth £1,000,000; a single tenant (PIT PD of 1%) paying £60,000 rent with no rent reviews or breaks before the lease break in 2018. Thus rental risk and lease event risk have been removed from the loan. The refinance hurdle is set at 60%.

The loan was run as interest only and then amortized to different levels requiting different levels of balloon repayment.

Exhibit 13: 12month PD and Refinance PD for Different Levels of Amortisation

Amortising to	Amortising to	12month PD	Refinance PD	Lifetime equivalent PD
100%	£700,000	0.85%	27.75%	7.26%
95%	£665,000	0.92%	19.52%	5.23%
90%	£630,000	0.98%	13.02%	3.74%
85%	£595,000	0.98%	8.21%	2.70%
80%	£560,000	80.49%	6.24%	84.15%

The first test is non-amortising or interest only and the 12 month PD is 0.85%, reflecting tenant default risk (less than the 1% tenant PD, as a new tenant may be found in time to prevent default). There is no refinance default risk in the 12month PD figure. The refinance default risk is 27.75%. In other words, the chance that the loan, having survived to term, will suffer a refinance default is 27.75%

In the second test, the loan amortises by £35,000 or 5% over the life of the loan. The increased debt service burden of principle repayment, makes the 12month PD slightly higher at 92 basis points, but the refinance default probability has fallen as expected - to 19.52%.

The next two tests show steeper amortisation rates to 90% and 85%. The 12month PD approaches the tenant PD since there is a higher and higher debt service burden, reducing the chance of recovery in the event of a tenant default. The refinance default probability continues to fall, reflecting lower levels of loan outstanding at term.

In the final test, the amortisation is now too steep and the rental income is unable to service the debt from the start, resulting in defaults in almost all scenarios. The refinance default is now only 6% - but there are very few remaining scenarios at this point.

Note the lifetime equivalent PD improves with better amortisation up to the point that the debt service burden is too great.

Exhibit 14; Rate of Change in Refinance Risk with respect to Amortisation Level

Amortising to	Refinance PD	Change in refinance PD
100%	27.75%	0
95%	19.52%	-8.23%
90%	13.02%	-6.50%
85%	8.21%	-4.81%
80%	6.24%	-1.97%

Note that the reduction in refinance PD bears diminishing returns as the amortisation level increases as there are relatively smaller numbers of scenarios where capital values fall to these more extreme levels.

The choice of refinance hurdle effects refinance risk levels. A test was conducted in which a test loan (Sensitivity Test 4) with no amortisation, was run setting the refinance hurdle at different levels and the refinance risk recorded.

Exhibit 15: Refinance Risk at Different Levels of LTV Refinance Hurdle

Refinance hurdle	*12month PD*	*Refinance PD*
55%	0.85%	39.36%
60%	0.85%	27.75%
65%	0.85%	18.17%
70%	0.85%	11.85%
75%	0.85%	7.84%
80%	0.85%	4.94%

Note that the 12month PD is unaffected by the refinance hurdle as expected. The level of refinance PD (in year 5) increases as the refinance hurdle is made more demanding.

2.3.3 Given the time horizon associated with IRB estimates (i.e. 12 months) the refinance risk could have a zero weight until the deal enters its final year for point in time models. In these cases the risk should be captured in stress testing and Pillar 2

ProMS reports default probabilities for each year of a loan, and includes refinance risk in the final year. Thus the refinance risk has a zero weigh until its final year. Lenders may view the 12month PD, the refinance PD, the PD in each year, the cumulative PD from all events in all years or an Annual Equivalent PD, (a PD that reflects the cumulative PD as though it were a constant annual default rate). An example (Sensitivity Test 4) output is illustrated below.

Exhibit 16: illustrative 12 Month, Refinance and Annualised PD Measures

Figures Expressed as % of Today's Today's Exposure

	Next 12 Months	Cumulative	Annualised
Loan Class	Investment - SPV		
Probability of Default	0.85%	31.39%	7.26%
Probability of Soft Default (D1)	0.11%	0.48%	0.10%
Probability of Hard Default (D2)	0.74%	4.58%	0.93%
Probability of Refinance Default (D3)	0.00%	27.75%	6.29%
Loss Given Default	3.07%	8.87%	8.87%
Loss Given Default (Downturn)	7.41%	13.72%	13.72%

2.3.4 The firm should be able to report by number, EAD and RWA cases that have been refinanced outside of the firm's usual lending criteria and show that the ratings for these cases are intuitive (we would expect these cases to be higher risk than most deals).

Loans which are refinanced outside a lender's policy will automatically attract higher risk measures as either the LTV will be higher or the ICR will be lower than loans originated within policy. ProMS records all loan terms at the point of origination or refinance, so standard reporting from ProMS will illustrate this increase.

3.0 Summary Conclusion

The use of a well-constructed cashflow simulation model such as ProMS can meet all the requirements of the Credit Risk Standing Group as laid out in their consultation document of September 2010. Its particular strength is in modeling the complex interactions of changes in the economy and the property market with individual loan structures and the lease structures of the underlying collateral investment properties. This article focuses on IPRE loans but similar models can be used for development finance and other asset backed lending where the outcomes depend as much on market changes as they do individual loan characteristics.

The accuracy of the model depends to some degree on the quality of the macroeconomic scenarios used to stress the loans through the simulation. The scenarios need to preserve historic trends, volatilities and cross-series correlations (such as inflation and interest rates) as well as long term relationships such as market rents and changes in collateral values. ProMS' scenario sets use 40 years' of quarterly back data and have been extensively back tested to ensure the plausibility and relevance of the scenario sets. The scenario sets are updated quarterly to ensure they are up to date with current market conditions. (See *ProMS Macro Model Back Test Results*). A fuller description of the methodology used in ProMS is available in *ProMS Risk Simulation for CRE Lenders*.

3.1 Further Information

Supporting documentation and source data used in the analysis are available from:

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