HONG KONG MONETARY AUTHORITY

Research Memorandum 08/2006
June 2006

# *AN APPROACH TO MEASURING PROVISIONS FOR COLLATERALISED LENDING**

***Key Points:***

- *Under the framework of Basel II, banks which adopt the internal ratings-based approach will be required to compare their actual provisions with expected losses. Any shortfall (i.e., the expected loss exceeds the provision) should be deducted from capital of the bank. It is therefore important to ensure banks make adequate provisions against expected losses. In addition, both sound policy and the Banking Ordinance require banks to take a forward-looking view of provisions.*

- *These requirements raise the issue of how to determine an adequate level of provisions in response to changing market conditions, in particular requiring adequate provisions from an expected-loss perspective.*

- *The purpose of this paper is to employ a simple model for measuring provisions for collateralised loans. The collateral value and the probabilities of default (PD) of borrowers are the two correlated input variables in the model. The model incorporates forward-looking elements including volatility of the collateral value and correlation between the collateral value and the PD into the measured provisions. The model can be readily extended to measuring provisions for loans without collateral provided that the expected values and volatility of the loans' recovery rates can be estimated.*

- *Some calculations of provisions with different loan-to-value ratios and one-year PD are presented for illustrative purposes. For example, using the classified-loan ratio of 1.49% as at September 2005 as a proxy of the PD and the loan-to-value ratio of 180% (which corresponds to the loss-given-default of about 45%), the provision for loans is about 0.66% of the outstanding loan value.*

- *Promotion of forward-looking provisions in assessments of risk can obviate the need for large increases in provisions when the economy is in recession. This means that procyclicality of lending would be reduced to some extent.*

*Prepared by*: Cho-hoi Hui and Tom Fong
Market Research Division
Research Department
Hong Kong Monetary Authority

** The conclusions herein do not represent the views of the Hong Kong Monetary Authority.*

## I. INTRODUCTION

Under the framework of Basel II, banks which adopt the internal ratings-based approach will be required to compare their actual provisions with expected losses (see Basel, 2004). Any shortfall (i.e., the expected loss exceeds the provision) should be deducted from Tier 1 and Tier 2 capital of the bank and any excess (i.e., the provision exceeds the expected loss) will be eligible for inclusion in Tier 2 capital subject to a cap set by individual bank supervisors. It is therefore important to ensure adequate provisions are made by banks against expected losses. In addition, both sound policy and the Banking Ordinance require banks to take a forward-looking view of provisions. These requirements raise the issue of how to determine an adequate level of provisions in response to changing market conditions, in particular requiring adequate provisions from an expected-loss perspective.[1]

The purpose of this paper is to employ a simple model developed by Hui *et al*. (2006) for measuring forward-looking provisions for collateralised loans. The model is applied to a pool of collateralised loans with broadly the same loan-to-value ratio due to default, where the collateral coverage is treated as a put option with the strike price equal to the outstanding loan amount of the pool. The collateral value and the probabilities of default (PD) of borrowers are the two correlated input variables in the model. The model incorporates forward-looking elements including volatility of the collateral value and correlation between the collateral value and the PD into the measured provisions.

Basel II defines expected loss as 12.5 times PD times loss-given-default times exposure-at-default (see Basel, 2004).[2] This makes the assumption that the PD and loss-given-default are uncorrelated variables. It is however noted that defaults are likely to be clustered during times of economic distress and loss-given-default may be correlated with default rates. For example, an increase in defaults in residential mortgage loans (RMLs) leads to an increase in the supply of properties associated with those defaulted loans, and correspondingly to a reduction in their prices and to larger losses for banks.

---

[1] It is noted that the new Hong Kong Accounting Standard 39 has created a conceptual gap between "accounting provisions" and "regulatory provisions" (see the HKMA's guidance note entitled "Impact of the New Hong Kong Accounting Standards on AIs' Capital Base and Regulatory Reporting" circulated to the banking industry in April 2005). The new accounting standards adopt a primarily "incurred loss" approach to provisioning. This approach is backward-looking in the sense that provisions for impairment must be based on loss experience and only recognised after the event on which the loss experience is based has occurred. As banks are expected to adopt more sophisticated approaches to setting provisions, such conceptual gap would gradually be less significant.

[2] See Basel (2004) about the definitions of expected loss and default in Basel II.

Since the information associated with these factors is in general available in banks' portfolios or public data, the model can be readily used for assessing provisions against expected loss in a forward-looking view. The next section is a brief description of the model for measuring provisions. Some illustrative calculations of provisions for RMLs and other collateralised loans are presented in Section 3. Concluding remarks are in the last section.

## II. MODEL FOR MEASURING PROVISIONS

The PD denoted by $D$ is defined as an average PD of a currently performing loan (or a pool of RMLs) over a time horizon of $t$. For RMLs, the pool is composed of loans with broadly the same loan-to-value ratio. Let $V$ denote the collateral value securing the loan (or the pool of RMLs) and $L$ denote the outstanding loan value. Both $V$ and $D$ are assumed to follow a lognormal process.[3] According to equation (6) in Hui *et al*. (2006) for measuring provisions against expected loss, the formula for measuring provisions is:

$$P(D,V,t) = D\exp(-rt)\times\left[LN\left(-\frac{z_0}{\sqrt{2c_1}}\right) - V\exp\left[\rho\sigma_D\sigma_V t-(s-r)t\right]N\left(-\frac{z_0+2c_1}{\sqrt{2c_1}}\right)\right] \quad (1)$$

where

$$z_0(V,t) = \ln(V/L)+(r-s)t - c_1 + \rho\sigma_D\sigma_V t\,, \quad (2)$$

$$c_1(t) = \frac{\sigma_V^2 t}{2}\,, \quad (3)$$

and $N$ is the cumulative normal distribution function.[4] $\sigma_D$ and $\sigma_V$ are the volatility of $D$ and $V$ respectively. $\rho$ is the correlation between $V$ and $D$. $r$ is the risk-free interest rate and $s$ is a general rental yield in the property market or a dividend of an equity.

---

[3] PD could be mean reverting to capture the characteristics of a business cycle (Hui *et at.*, 2006). As provisions are measured over a one-year time horizon in this paper, the mean-reverting process can be simply ignored.

[4] N($x$) denotes the cumulative distribution function for a standard normal random variable (i.e. the probability that a normal random variable with mean zero and variance of one is less than or equal to $x$). The normal cumulative distribution function is, for example, available in Excel as the function NORMSDIST.

## III. CALCULATIONS OF PROVISIONS

Using the proposed model, provisions for RMLs are presented in this section for illustrative purposes. The calculation of provisions is based on a baseline scenario under which the monthly index of private domestic premises in Hong Kong and the monthly problem-loan ratio of RMLs in banks reported by the HKMA are used to estimate input parameters.[5] The problem-loan ratio is defined as the sum of the delinquency ratio (i.e. more than three months overdue) and the rescheduled-loan ratio. The problem-loan ratio can be viewed as a proxy of the default rate of the loans.[6] The sample covers the periods from June 1998 to December 2005 for the problem-loan ratio and from January 1993 to December 2005 for the price index.[7] The data series and their descriptive statistics are presented in Figure 1 and Table 1 respectively. The data are used to form the baseline scenario where the annualised volatility of the property price index is $\sigma_V = 10.9\%$; the annualised volatility of the problem-loan ratio is $\sigma_D = 21.17\%$; and the correlation between the price index and the problem-loan ratio is $\rho = -0.39$.

Table A1 in the Annex illustrates the provisions with different loan-to-value ratios and one-year PD based on the baseline scenario where the other input parameters are $r = 4.5\%$, and $s = 5\%$. The provision is expressed as a percentage of the loan value. The one-year time horizon is chosen because banks are expected to review their provisioning levels for loans at least on an annual basis or when necessary. Table A1 shows that provisions are required for RMLs with loan-to-value ratios of 100% and 90% even though their current loss-given-default is considered to be zero.[8] As the forward-looking elements, including volatility of the property price and correlation between the property price and the PD, are incorporated into the calculations of provisions, provisions are also necessary for RMLs in positive equity. For example, given the PD and the loan-to-value ratio of 1% and 100% respectively, the provision of the RMLs is about 0.05% of the outstanding loan value.

---

[5] Private domestic premises refer to residential properties which are developed and managed by private developers.

[6] It is however noted that a one-year default rate is expected to be higher than the problem-loans ratio as the default rate is a cumulative figure while the number of problem loans will be reduced after writing off the loans.

[7] The data can be obtained at http://www.info.gov.hk/hkma/eng/statistics/msb/attach/T0307.xls of the HKMA and http://www.info.gov.hk/rvd/property/content.htm of the Valuation Department of the Hong Kong SAR Government.

[8] It is noted that the estimation of loss-given-default is required to be forward looking under Basel II. Some banks may use past internal data to estimate loss-given-default.

As the annualised volatility of the property price index is 10.9%, the potential change of the property price over a one-year period is about 10.9% at a confidence level of 68.3%. Therefore, the values of the provisions for RMLs with loan-to-value ratios of 110% or above (i.e. RMLs in negative equity) are more or less the same as the values of expected loss defined in Basel II. For example RMLs with the PD and the loan-to-value ratio of 2% and 120% respectively, the provision is about 0.34% of the outstanding loan value.[9] The value is close to the expected loss defined in Basel II. Comparing the values in Tables A1 and A3 where the loan-to-value ratios increase from 90% to 110%, the increases in the values of expected loss defined in Basel II are sharper than the increases in the provisions.

The baseline scenario of the calculations of provisions above can be applied to measuring provisions for other loans with collateral. As the collateral for other loans could include items with higher volatility (for example, equities, commercial real estate and other physical collateral), the annualised volatility of the collateral value is set to be $\sigma_V = 30\%$ in the baseline scenario.[10] The classified-loan ratio is used as a proxy of the default rate of the loans. The sample data covers the period from March 1997 to September 2005 (see Table 1 for their descriptive statistics). The annualised volatility of the classified-loan ratio is 30.47%, and the correlation between the collateral value and the classified-loan ratio is assumed to be -0.29%.[11]

Table A2 in the Annex shows the provisions with different loan-to-value ratios and one-year PD based on the baseline scenario. Regarding loans with loan-to-value ratios of 100% or below, provisions required for them are higher than that required for RMLs due to the higher collateral value volatility associated with other loans. For example, the provision for a loan with the PD and the loan-to-value ratio of 1.5% and 100% respectively is 0.19% of the outstanding loan value, while the corresponding provision for RMLs is only 0.07%. Given the annualised collateral value volatility of 30% in the calculations, the values of provisions for loans with loan-to-value ratios of 130% or above are more or less the same as the values of expected loss defined in Basel II (see Table A3).

---

[9] It is noted the provision is a value discounted by the risk-free interest rate under the model while there is no such discounting under the calculations of expected loss defined in Basel II.

[10] Frye (2000) estimates that the volatility of collateral value is 32%, suggesting that collateral values are very volatile. Also see Allen and Saunders (2003). The standard supervisory haircut (i.e. 15%) under Basel II for main index equities also assumes their annualised volatility to be 32%. Regarding other equities listed on a recognised exchange, their annualised volatility is assumed to be 54% for haircut (i.e. 25%) purposes.

[11] The property price index is used as a proxy for the estimation of the correlation.

Using the classified-loan ratio of 1.49% as at September 2005 as a proxy for the PD and a loan-to-value ratio of 180% (which corresponds to the loss-given-default of about 45%), the provisions of those loans are about 0.66% of the outstanding loan value.[12] Comparing the values in Tables A2 and A3 where the loan-to-value ratios increase from 80% to 140%, the increases in the values of expected loss defined in Basel II are sharper than the increases in the provisions.

## IV. CONCLUDING REMARKS

The proposed model can be readily extended to measuring provisions for loans without collateral provided that the expected values and volatility of the loans' recovery rates can be estimated. The recovery rate of the loan value can be treated as a proxy for the collateral value.

The illustrative calculations of provisions show that the increase in the provisions with the increase in the loan-to-value ratio (i.e. the decline in the collateral value) is relatively mild when the loan goes into negative equity. Promotion of calculating provisions from a forward-looking perspective by using the proposed model can therefore obviate the need for sharp increases in provisions when the economy is in recession. This means that procyclicality of lending would be reduced to some extent.[13]

[12] The classified-loan ratio for loans excluding RMLs should be higher than 1.49% because of the low problem-loan ratio of RMLs, which was 0.54% as at December 2005.

[13] See section 5 in Borio *et al*. (2001) about the relationship between procyclicality and provisioning policy.

**References**

L. Allen and A. Saunders (2003) "A survey of cyclical effects in credit risk measurement models". *BIS Working Paper*, no. 126.

Basel Committee on Banking Supervision (2004) *International convergence of capital measurement and capital standards: a revised framework*, BIS, Basel.

C. Borio, C. Furfine and P. Lowe (2001) "Procyclicality of the financial system and financial stability: issues and policy options". *BIS Papers*, no. 1 (part 1).

J. Frye (2000) "Depressing recoveries". *Risk*, 91-4, November.

C.H. Hui, C.F. Lo, P.K. Man and T.C. Wong (2006) "Measuring provisions for collateralised retail lending". *HKMA Research Memorandums*, http://www.info.gov.hk/hkma/eng/research/RM1-2006.pdf, forthcoming in *Journal of Economics and Business*.

**Figure 1. Price index of private domestic premises (*V*) and problem-loan ratio (*D*) of residential mortgage loans**

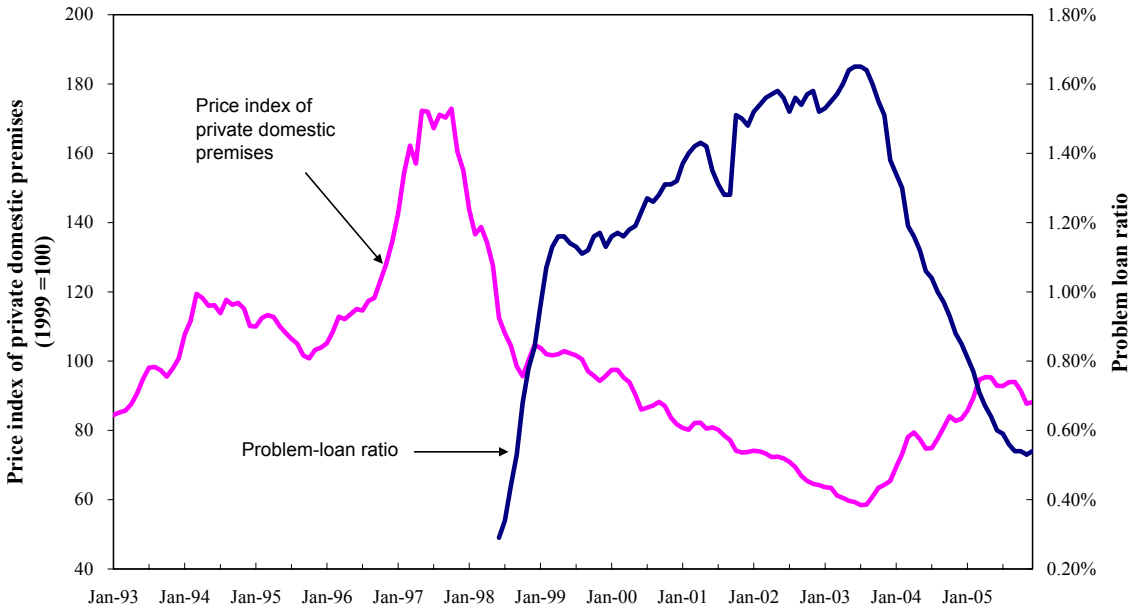


**Table 1. Statistics of the data series of *V* and *D***

| Variables | Number of samples | Data coverage | Sample mean | Standard derivation | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Price index of private domestic premises (1999 = 100) | 156 | Jan-1993 to Dec-2005 | 98.6 | 26.3 | 58.4 | 172.9 |
| Implied monthly price appreciation by the index# | 155 | Feb-1993 to Dec-2005 | 0.0003 | 0.0315 | -0.1259 | 0.0093 |
| Problem loans ratio | 91 | Jun-1998 to Dec-2005 | 0.0117 | 0.0036 | 0.0029 | 0.0165 |
| Classified loans ratio | 35 | Mar-1997 to Sep-2005 | 5.3769 | 2.8370 | 1.4903 | 10.6141 |

Note:

#: The implied monthly price appreciation is calculated by ln(PPI(t)) - ln(PPI(t-1)), where PPI is the price index of private domestic premises

**Annex**

**Table A1. Provisions for Residential Mortgage Loans – Baseline Scenario**

| Provision | Loan-to-value Ratio | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PD | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 1.00 | 1.10 | 1.20 | 1.30 | 1.40 | 1.50 | 1.60 | 1.70 | 1.80 | 1.90 | 2.00 |
| 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% |
| 0.05% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.01% | 0.01% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% |
| 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | 0.02% | 0.03% | 0.03% | 0.04% | 0.04% | 0.04% | 0.05% | 0.05% |
| 0.25% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.03% | 0.04% | 0.06% | 0.07% | 0.08% | 0.09% | 0.10% | 0.11% | 0.11% | 0.12% |
| 0.40% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.04% | 0.07% | 0.09% | 0.11% | 0.13% | 0.15% | 0.16% | 0.17% | 0.18% | 0.19% |
| 0.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | 0.05% | 0.09% | 0.12% | 0.14% | 0.16% | 0.18% | 0.20% | 0.22% | 0.23% | 0.24% |
| 0.75% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.04% | 0.08% | 0.13% | 0.17% | 0.21% | 0.25% | 0.28% | 0.30% | 0.32% | 0.34% | 0.36% |
| 1.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.05% | 0.11% | 0.17% | 0.23% | 0.28% | 0.33% | 0.37% | 0.40% | 0.43% | 0.46% | 0.48% |
| 1.30% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.06% | 0.14% | 0.22% | 0.30% | 0.37% | 0.43% | 0.48% | 0.52% | 0.56% | 0.60% | 0.63% |
| 1.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.07% | 0.16% | 0.26% | 0.35% | 0.42% | 0.49% | 0.55% | 0.60% | 0.65% | 0.69% | 0.73% |
| 2.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.10% | 0.21% | 0.34% | 0.46% | 0.57% | 0.66% | 0.73% | 0.80% | 0.86% | 0.92% | 0.97% |
| 2.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% | 0.12% | 0.27% | 0.43% | 0.58% | 0.71% | 0.82% | 0.92% | 1.00% | 1.08% | 1.15% | 1.21% |
| 3.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.04% | 0.14% | 0.32% | 0.52% | 0.69% | 0.85% | 0.98% | 1.10% | 1.20% | 1.30% | 1.38% | 1.45% |
| 4.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.19% | 0.43% | 0.69% | 0.92% | 1.13% | 1.31% | 1.47% | 1.61% | 1.73% | 1.84% | 1.94% |
| 5.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.06% | 0.24% | 0.54% | 0.86% | 1.16% | 1.41% | 1.64% | 1.83% | 2.01% | 2.16% | 2.30% | 2.42% |
| 6.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.07% | 0.29% | 0.64% | 1.03% | 1.39% | 1.70% | 1.97% | 2.20% | 2.41% | 2.59% | 2.76% | 2.91% |
| 10.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.12% | 0.48% | 1.07% | 1.72% | 2.31% | 2.83% | 3.28% | 3.67% | 4.02% | 4.32% | 4.60% | 4.85% |
| 15.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.18% | 0.72% | 1.61% | 2.58% | 3.47% | 4.24% | 4.92% | 5.50% | 6.02% | 6.49% | 6.90% | 7.27% |
| 20.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.24% | 0.97% | 2.15% | 3.44% | 4.62% | 5.66% | 6.55% | 7.34% | 8.03% | 8.65% | 9.20% | 9.70% |

Note : The time horizon is one year. The annualized $\sigma_V$ and $\sigma_D$ are 10.88% and 21.71% respectively. Other parameters are $r$ = 4.5% and $s$ = 5%. The correlation $\rho$ is -0.3919.

**Table A2. Provisions for Other Loans – Baseline Scenario**

| Provision | Loan-to-value Ratio | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PD | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 1.00 | 1.10 | 1.20 | 1.30 | 1.40 | 1.50 | 1.60 | 1.70 | 1.80 | 1.90 | 2.00 |
| 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% |
| 0.05% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.01% | 0.01% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% |
| 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.02% | 0.02% | 0.03% | 0.03% | 0.03% | 0.04% | 0.04% | 0.04% | 0.05% | 0.05% |
| 0.25% | 0.00% | 0.00% | 0.01% | 0.01% | 0.02% | 0.03% | 0.04% | 0.05% | 0.07% | 0.08% | 0.09% | 0.10% | 0.10% | 0.11% | 0.12% | 0.12% |
| 0.40% | 0.00% | 0.00% | 0.01% | 0.02% | 0.03% | 0.05% | 0.07% | 0.09% | 0.11% | 0.12% | 0.14% | 0.15% | 0.17% | 0.18% | 0.19% | 0.20% |
| 0.50% | 0.00% | 0.00% | 0.01% | 0.02% | 0.04% | 0.06% | 0.09% | 0.11% | 0.13% | 0.15% | 0.17% | 0.19% | 0.21% | 0.22% | 0.23% | 0.25% |
| 0.75% | 0.00% | 0.01% | 0.02% | 0.04% | 0.06% | 0.10% | 0.13% | 0.16% | 0.20% | 0.23% | 0.26% | 0.29% | 0.31% | 0.33% | 0.35% | 0.37% |
| 1.00% | 0.00% | 0.01% | 0.02% | 0.05% | 0.09% | 0.13% | 0.17% | 0.22% | 0.26% | 0.31% | 0.35% | 0.38% | 0.41% | 0.44% | 0.47% | 0.49% |
| 1.30% | 0.00% | 0.01% | 0.03% | 0.06% | 0.11% | 0.17% | 0.23% | 0.29% | 0.34% | 0.40% | 0.45% | 0.50% | 0.54% | 0.58% | 0.61% | 0.64% |
| 1.50% | 0.00% | 0.01% | 0.04% | 0.07% | 0.13% | 0.19% | 0.26% | 0.33% | 0.40% | 0.46% | 0.52% | 0.57% | 0.62% | 0.66% | 0.70% | 0.74% |
| 2.00% | 0.00% | 0.02% | 0.05% | 0.10% | 0.17% | 0.26% | 0.35% | 0.44% | 0.53% | 0.61% | 0.69% | 0.76% | 0.83% | 0.89% | 0.94% | 0.99% |
| 2.50% | 0.00% | 0.02% | 0.06% | 0.12% | 0.21% | 0.32% | 0.43% | 0.55% | 0.66% | 0.77% | 0.86% | 0.95% | 1.03% | 1.11% | 1.17% | 1.23% |
| 3.00% | 0.01% | 0.03% | 0.07% | 0.15% | 0.26% | 0.38% | 0.52% | 0.66% | 0.79% | 0.92% | 1.04% | 1.14% | 1.24% | 1.33% | 1.41% | 1.48% |
| 4.00% | 0.01% | 0.03% | 0.10% | 0.20% | 0.34% | 0.51% | 0.69% | 0.88% | 1.06% | 1.23% | 1.38% | 1.53% | 1.65% | 1.77% | 1.88% | 1.97% |
| 5.00% | 0.01% | 0.04% | 0.12% | 0.25% | 0.43% | 0.64% | 0.87% | 1.10% | 1.32% | 1.54% | 1.73% | 1.91% | 2.07% | 2.21% | 2.35% | 2.47% |
| 6.00% | 0.01% | 0.05% | 0.14% | 0.30% | 0.51% | 0.77% | 1.04% | 1.32% | 1.59% | 1.84% | 2.08% | 2.29% | 2.48% | 2.66% | 2.82% | 2.96% |
| 10.00% | 0.02% | 0.08% | 0.24% | 0.50% | 0.85% | 1.28% | 1.74% | 2.20% | 2.65% | 3.07% | 3.46% | 3.81% | 4.14% | 4.43% | 4.69% | 4.93% |
| 15.00% | 0.03% | 0.13% | 0.36% | 0.75% | 1.28% | 1.92% | 2.60% | 3.30% | 3.97% | 4.61% | 5.19% | 5.72% | 6.21% | 6.64% | 7.04% | 7.40% |
| 20.00% | 0.04% | 0.17% | 0.48% | 0.99% | 1.71% | 2.56% | 3.47% | 4.40% | 5.30% | 6.14% | 6.92% | 7.63% | 8.27% | 8.86% | 9.39% | 9.87% |

Note : The time horizon is one year. The annualized $\sigma_V$ and $\sigma_D$ are 30% and 30.47% respectively. Other parameters are $r$ = 4.5% and $s$ = 5%. The correlation $\rho$ is -0.2923.

**Table A3. Expected Loss for Collateralised Loans Based on the Basel II Definition**

| EL | Loan-to-value Ratio | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PD | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 1.00 | 1.10 | 1.20 | 1.30 | 1.40 | 1.50 | 1.60 | 1.70 | 1.80 | 1.90 | 2.00 |
| 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.02% |
| 0.05% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 0.01% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.03% |
| 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | 0.02% | 0.03% | 0.03% | 0.04% | 0.04% | 0.04% | 0.05% | 0.05% |
| 0.25% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.04% | 0.06% | 0.07% | 0.08% | 0.09% | 0.10% | 0.11% | 0.12% | 0.13% |
| 0.40% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.04% | 0.07% | 0.09% | 0.11% | 0.13% | 0.15% | 0.16% | 0.18% | 0.19% | 0.20% |
| 0.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.08% | 0.12% | 0.14% | 0.17% | 0.19% | 0.21% | 0.22% | 0.24% | 0.25% |
| 0.75% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.07% | 0.13% | 0.17% | 0.21% | 0.25% | 0.28% | 0.31% | 0.33% | 0.36% | 0.38% |
| 1.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.17% | 0.23% | 0.29% | 0.33% | 0.38% | 0.41% | 0.44% | 0.47% | 0.50% |
| 1.30% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.12% | 0.22% | 0.30% | 0.37% | 0.43% | 0.49% | 0.54% | 0.58% | 0.62% | 0.65% |
| 1.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.14% | 0.25% | 0.35% | 0.43% | 0.50% | 0.56% | 0.62% | 0.67% | 0.71% | 0.75% |
| 2.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.18% | 0.33% | 0.46% | 0.57% | 0.67% | 0.75% | 0.82% | 0.89% | 0.95% | 1.00% |
| 2.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.23% | 0.42% | 0.58% | 0.71% | 0.83% | 0.94% | 1.03% | 1.11% | 1.18% | 1.25% |
| 3.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.27% | 0.50% | 0.69% | 0.86% | 1.00% | 1.13% | 1.24% | 1.33% | 1.42% | 1.50% |
| 4.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.36% | 0.67% | 0.92% | 1.14% | 1.33% | 1.50% | 1.65% | 1.78% | 1.89% | 2.00% |
| 5.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.45% | 0.83% | 1.15% | 1.43% | 1.67% | 1.88% | 2.06% | 2.22% | 2.37% | 2.50% |
| 6.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.55% | 1.00% | 1.38% | 1.71% | 2.00% | 2.25% | 2.47% | 2.67% | 2.84% | 3.00% |
| 10.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.91% | 1.67% | 2.31% | 2.86% | 3.33% | 3.75% | 4.12% | 4.44% | 4.74% | 5.00% |
| 15.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 1.36% | 2.50% | 3.46% | 4.29% | 5.00% | 5.63% | 6.18% | 6.67% | 7.11% | 7.50% |
| 20.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 1.82% | 3.33% | 4.62% | 5.71% | 6.67% | 7.50% | 8.24% | 8.89% | 9.47% | 10.00% |

Note : The time horizon is one year. The loss-given-default is assumed to be the difference between the outstanding loan value and the current collateral value. EL = PD x (LTV – 1) / LTV, where EL is the expected loss, LTV is the loan-to-value ratio and the loss-give-default is (LTV – 1) / LTV.