APPENDIX 17A. The large homogeneous pool (LHP) approximation.

The large homogeneous pool (LHP) approximation of Vasicek (1997) is based on the assumption of a very large (technically infinitely large) portfolio. The loss distribution is defined via:

$$\Pr(L < \theta) = \Phi\left(\frac{\sqrt{1-\rho}\,\Phi^{-1}(\theta) - \Phi^{-1}(p)}{\sqrt{\rho}} \right),$$

where $\Phi(.)$ represents a cumulative normal distribution function, p is the (constant) default probability and ρ the correlation parameter. The granularity adjustment formula of Gordy (2004) gives the Basel II approximation given in Equation (17.1).

APPENDIX 17B. Asset correlation and maturity adjustment factor formulas in Basel II.

a) Asset correlation

In the Basel II advanced IRB approach the correlation parameter is linked to the default probability (PD) according to the following equation:

$$\rho = 0.12 \times \frac{1 - \exp(-50 \times \text{PD})}{1 - \exp(-50)} + 0.24 \times \left(1 - \frac{1 - \exp(-50 \times \text{PD})}{1 - \exp(-50)}\right)$$

Error! Reference source not found. shows the dependence of both asset correlation and the default-only capital charge on PD.

b) Maturity factor

The factor $\text{MA}(\text{PD}, M)$ is the maturity adjustment that is calculated from PD and M according to:

$$\text{MA}(\text{PD}, M) = \frac{1 + (M - 2.5) \times b(\text{PD})}{1 - 1.5 \times b(\text{PD})}$$

where $b(\text{PD})$ is a function of PD defined as:

$$b(\text{PD}) = \left[0.11852 - 0.05478 \times \ln(\text{PD})\right]^2.$$

Note that maturity adjustment is capped at 5 and floored at 1.

APPENDIX 17C. Treatment of netting and collateral in the current exposure method (CEM).

a) Netting

Netting benefits of add-ons are handled in a simple but ad hoc fashion using a factor NGR, which is the ratio of the current net exposure to the current gross exposure for all transactions within the netting set. For *n* trades within a netting set, then NGR is given by:

$$\text{NGR} = \frac{\max\left(\sum_{i=1}^{n} \text{MtM}_i, 0\right)}{\sum_{i=1}^{n} \max(\text{MtM}_i, 0)},$$

where MtM_i is the MtM value of the ith trade in the netting set. NGR can be seen to define the current impact of netting in percentage terms (an NGR of zero implies perfect netting and an NGR of 100% implies no netting benefit).

Where legally enforceable netting agreements are in place, the total add-on is calculated according to the following formula:

$$\text{Add-on} = \left(0.4 + 0.6 \cdot \text{NGR}\right) \cdot \sum_i \text{Add-on}_i$$

where Add-on_i is the add-on for transaction *i*. Only 60% benefit of current netting is therefore accounting for in any future exposure.

b) Collateral

The impact of current collateral held against a netting set is incorporated into EAD as follows (see http://www.bis.org/publ/bcbs128.pdf):

$$\text{EAD} = \max(0, \text{RC} + \text{add on} - C)$$

where RC is the replacement cost of the portfolio, C is the volatility-adjusted collateral amount (i.e. the value of collateral minus a haircut) and "add on" is the total add-on on the portfolio of transactions under the netting set.

APPENDIX 17D. The standardised method.

The standardised method (SM) in Basel II was designed for those banks that do not qualify to model counterparty exposure internally but would like to adopt a more risk-sensitive approach than the CEM - for example, to account for netting. Under the SM, one computes the EAD for derivative transactions within a netting set as follows:

$$EAD = \beta \times \max\left[MtM - C, \sum_i |RPE_i - RPC_i| \times CCF_i \right]$$

where $MtM = \sum_i MtM_i$ and $C = \sum_j C_j$ represent, respectively, the current market value of trades in the netting set and current market value of all collateral positions assigned against the netting set. The terms $|RPE_i - RPC_i|$ represent a net risk position within a "hedging set" i which forms an exposure add-one then multiplied by a conversion factor CCF_i determined by the regulators according to the type of risk position. Finally, β is the supervisory scaling parameter, set at 1.4, which can be considered similar to the alpha factor discussed in Chapter 17.

A hedging set is defined as the portfolio risk positions of the same category (depending on the same risk factor) that arise from transactions within the same netting set. Each currency and issuer will define its own hedging set, within which netting effects are captured. However, netting between hedging sets is not accounted for. Instruments with interest rate and foreign exchange risk will generate risk positions in these hedging sets as well as their own (such as equities or commodities for example). Within each hedging set, offsets are fully recognized; that is, only the net amount of all risk positions within a hedging set is relevant for the exposure amount or EAD. The long positions arising from transactions with linear risk profiles carry a positive sign, while short positions carry a negative sign. The positions with non-linear risk profiles are represented by their delta-equivalent notional values. The exposure amount for a counterparty is then the sum of the exposure amounts or EADs calculated across the netting sets with the counterparty. The use of delta-equivalent notional values for options creates a notable difference compared with the CEM. The CEM adopts a transaction-by-transaction approach instead of considering the netting set as a portfolio. The SM in contrast allows for the netting of positions and positions such as short options (that would not contribute under the CEM) will offset some of the exposure risk.

As with the CEM, collateral is only accounted for with respect to the current MtM component and future collateral is not specifically considered. The calibration of credit conversion factors (CCFs) is assumed for a 1-year horizon on at-the-money forwards and swaps because the impact of volatility on market risk drivers are more significant for at-the-money trades. Thus, this calibration of CCFs should result in a conservative estimate of PFE. Supervisory CCFs are shown below.

Credit conversion factors (CCFs) for financial instrument hedging sets. These are given in paragraphs 86-88 of Annex 4 in BCBS (2006).

Instrument type	*CCF*
Foreign exchange	2.5%
Gold	5.0%
Equity	7.0%
Precious metals (except gold)	8.5%
Electric power	4.0%
Other commodities (except precious metals)	10.0%

APPENDIX 17E. Effective maturity calculation and double default formula.

a) Effective maturity calculation

Under Basel II, the effective remaining maturity in the case of simple instruments such as loans with fixed unidirectional cashflows is defined as the weighed average maturity of the relevant transactions given by a simple duration formula without interest rate effects:

$$\text{Effective Maturity(M)} = \frac{\sum_i \text{CF}_i t_i}{\sum_i \text{CF}_i},$$

where CF_i is the magnitude of the cashflow at time t_i (defining today as zero).

The cash flows of OTC derivatives are highly uncertain, and a more complex formula is required to calculate the effective maturity. The effective maturity is defined at the netting set level from the full EE profile that extends to the expiration of the longest contract in the netting set. If the original maturity of the longest dated contract contained in the set is greater than 1 year, the effective maturity is calculated according to:

$$M = 1 + \frac{\sum_{t_k > 1\text{yr}} \text{EE}(t_k)\, \Delta t_k\, B(0, t_k)}{\sum_{t_k \leq 1\text{yr}} \text{Effective EE}(t_k)\, \Delta t_k\, B(0, t_k)},$$

where $B(0, t_k)$ is the risk-free discount factor from the simulation date t_k to today, Δt_k is the difference between time points, $EE(t_k)$ is the EE at time t_k and Effective EE is basically a non-decreasing EE (defined in Appendix 11.D). Similar to the general treatment under corporate exposures, *M* has a cap of 5 years (a 1-year floor is implicitly present in the formula). Note that if the denominator in the above equation becomes rather small then the effective maturity can be large. This means that netting sets with rather small exposure up to 1 year (for example, due to the underlying market value being significantly negative) will have capital determined by a small exposure with a high maturity.

The above equation is conceptually consistent with the effective remaining maturity for more simple instruments. For more detail, see Picoult (2005).

For netting sets in which all contracts have an original maturity of less than 1 year, the effective maturity is set to 1 year. However, the 1-year floor does not apply to certain collateralised short-term exposures. The instruments included in this category are OTC derivatives and SFTs that have the original maturity of less than 1 year, are fully or nearly-fully collateralised and subject to daily re-margining. For such transactions, the effective maturity for a given netting set is calculated as the weighted average of the contractual remaining maturities, with notional amounts used as weights:

$$M = \frac{\sum_i A_i M_i}{\sum_i A_i},$$

where A_i is the notional and M_i is the contractual remaining maturity for contract i. This effective maturity is subject to a floor equal to the largest minimum holding period of the transactions in the netting set.

We show some examples of calculations for *M* for different exposure profiles in the Figure below. Netting set 1 has a bullet exposure and its effective maturity is therefore slightly smaller than its maturity due to interest rates effects. Due to having a small EE in the first year,[1] netting set 2 has a high effective maturity of 6.51 years, which is capped at 5 years (according to the formula defined in Appendix 11.A). Finally, netting set 3 has an effective maturity of 3.21 years, which is relatively small since the EE is concentrated within shorter maturities.

Illustration of effective maturity for different 5 year EE profiles. Interest rates are assumed to be 5% for all maturities. EE1, EE2 and EE3 have effective maturities of 4.81, 5.00 and 3.21 years respectively.
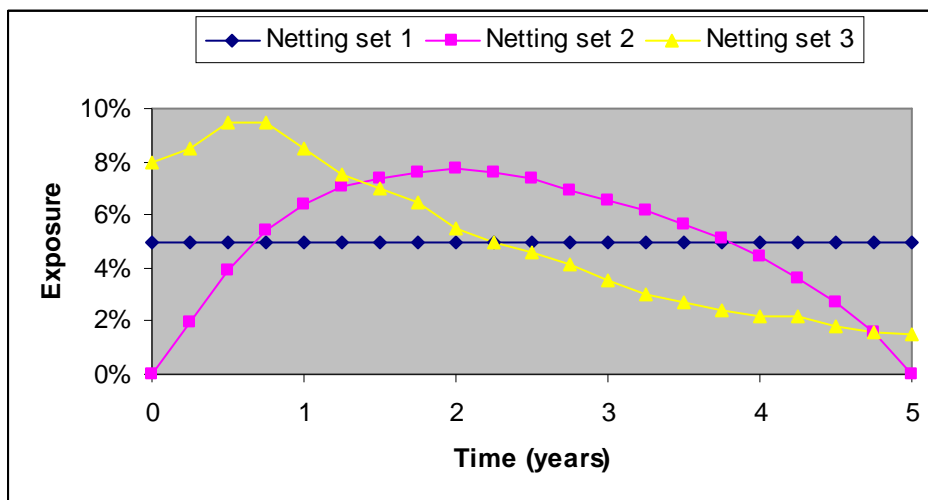
As discussed above, the minimum value of the effective maturity is 1 year. Basel II does not recognise a more risk-sensitive treatment but allows a notional weighting scheme. Transactions exempt from the 1-year floor must be classified as "non-relationship" transactions, i.e. there should be no relationship concerns that might hinder the termination or decision *not* to roll over the relevant transaction(s). OTC derivatives subject to this treatment must also be collateralised with daily margining and no room for undercollateralisation (such as thresholds).

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[1] This means that the denominator of the formula in Appendix 11.A becomes quite small resulting in the effective maturity being greater than the maximum maturity of the netting set (without the cap of 5 years).

b) Double default formula

The conditional default probability in the Basel II IRB capital formula is:

$$\Phi\left(\frac{\Phi^{-1}(PD_o)+\sqrt{\rho_o}\,\Phi^{-1}(0.999)}{\sqrt{1-\rho_o}}\right),$$

where we denote specifically PD_o and ρ_o as the default probability and asset correlation parameter of the obligor (original counterparty). To compute capital for a hedged exposure in the advanced IRB framework (BCBS, 2005), it is necessary to calculate the conditional default probability that both the obligor and guarantor will default. It is also critically important to consider the correlation between obligor and guarantor as high correlations will make the double-default more likely. By assuming an additional asset correlation parameter of ρ_g for the guarantor and an asset correlation between obligor and guarantor of ρ_{og}, the following conditional joint probability formula can be derived as a simple bivariate normal distribution function $\Phi_2(.)$:

$$\Phi_2\left(\frac{\Phi^{-1}(PD_o)+\sqrt{\rho_o}\,\Phi^{-1}(0.999)}{\sqrt{1-\rho_o}}, \frac{\Phi^{-1}(PD_g)+\sqrt{\rho_g}\,\Phi^{-1}(0.999)}{\sqrt{1-\rho_g}}; \frac{\rho_{og}-\sqrt{\rho_o\rho_g}}{\sqrt{(1-\rho_o)(1-\rho_g)}}\right).$$

The Basel committee considers a value of $\rho_{og} = 50\%$ in order to account for a wrong-way risk due to a correlation between the default probability of obligor and guarantor. Nevertheless, an operational requirement for recognition of double-default is that there is no "excessive correlation" between the credit quality of obligor and guarantor and double-default is not recognised for an exposure to a financial institution. A value of $\rho_g = 70\%$ is used which essentially assumes (conservatively) that the systemic risk of the guarantor is high. This correlation parameter is substantially higher than that for the obligor, ρ_g, which will follow the standard calculation (Appendix 11.B) and will therefore be between 12% and 24%. A limiting case of the above formula (for example, as PD_g increases to unity) is:

$$\Phi\left(\frac{\Phi^{-1}\left(\min(PD_o,PD_g)\right)+\sqrt{\rho_o}\,\Phi^{-1}(0.999)}{\sqrt{1-\rho_o}}\right).$$

This corresponds to the substitution approach.

The double-default capital formula also includes a loss given default function LGD_{og}, which corresponds to the worst case loss when pursuing recoveries from both an obligor and guarantor. Furthermore, the maturity adjustment component will also differ in the event of mismatch between the maturity of the original exposure and that

of the protection or guarantee. Any charge for maturity mismatch would be based on the *M* calculated within the IMM approach (Accord Annex 4, paragraph 38).

The Basel Committee proposed a simplified approach to the double-default formula where the capital is reduced by the following factor compared to the unhedged exposure case:

$$(0.15 + 160 \times PD_g).$$

The unhedged exposure is calculated using the usual formula, but using LGD_g instead of LGD_o. The aforementioned parameters of $\rho_g = 70\%$ and $\rho_{og} = 50\%$ were assumed when deriving this formula. The formula works well for small values of PD_g but can be seen to be more conservative than the unhedged case when $PD_g > 0.531\%$ (this corresponds to the above factor being greater than unity).

Double-default formula compared to Basel II adjustment factor for guarantor default probabilities of 0.1% (top) and 0.5% (bottom).