# Analyzing the Capital Requirements for High-Yield Investments by Banks


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**Abstract**

In the aftermath of the GFC (Global Financial Crisis), banks' investments in high yield funds are under close scrutiny by governments and the general public alike. An interesting new Basel Committee (2013) paper presents the framework for calculating the capital requirement for banks' equity investments in funds. In search for an economic rationale for the proposed framework, we compare the proposed equation with the Merton framework that returns the probability that an equity investment turns out to be worthless. We find an interesting resemblance between, on the one hand, the framework proposed by the Basel Committee to calculate the capital requirements for banks' equity investments in funds and, on the other hand, the Merton framework. We conclude that, although the proposed framework by the Basel Committee may appear odd at a first glance, there appears to be an economic rationale for its form.

## Introduction

In the aftermath of the GFC, do banks still invest in high-yield funds? And if so, how is the capital requirement for banks that invest in these high-yield funds determined?

The GFC of 2007-2008 led to the bailout of banks by governments and the collapse of large financial institutions around the world. As a result, the credit risk of banks increased leading to a desire by policy makers for banks to maintain more prudent equity levels.[1] The TED Spread (a measure of credit risk for lending between banks) increased significantly by the end of 2008. The aforementioned illustrates that banks considered each other risky counterparts at the peak of the financial crisis and anticipated a relatively high probability of non-recovery of credit. One would expect that banks now maintain more prudent equity levels (Admati et al., 2010) and pursue less risky investment strategies. Nevertheless, banks' equity investments in high yield funds do not appear to be dwindling. High-yield bonds are rated below investment grade by rating agencies and are also labeled as 'junk bonds'.

An interesting new Basel Committee (2013) paper presents the framework for calculating the capital requirement for banks' equity investments in funds. The framework intends to achieve a more risk-sensitive capital treatment for banks' equity stakes in funds. This risk-sensitivity is implemented by making the capital requirement dependent on the risk of the fund's assets and its leverage.

The framework consists of three approaches, the "look-through approach", the "mandate-based approach" and the "fall-back approach". The first approach is the most granular and risk-sensitive and we will focus on that approach in this paper. The *look-through approach* requires a bank to risk weight the fund's assets as if the exposures were held directly by the bank. Hence, it can only be used if the bank has sufficient information on the underlying exposures of the fund. However, the capital requirement is also dependent on the

[1] For an interesting paper on banks' equity levels, we refer to Admati et al. (2010).

leverage of the fund. For the application of the *look-through approach* leverage is calculated as the fund's ratio of total assets to total equity. The leverage adjustment is applied to the capital requirement as follows. First, banks need to calculate the total risk-weighted assets of the fund. Second and using the total risk-weighted assets calculated in the first step, banks can calculate the average risk weight of the fund (*Avg RWfund*) by dividing the total risk-weighted assets by the total assets of the fund. Third, using the *Avg RWfund* calculated previously and taking into account the leverage of the fund (*Lvg*), the risk-weighted assets for a bank's equity investment in a fund (*RWA investment*) can be represented as follows:

$$RWA\ investment = Avg\ RWfund \cdot Lvg \cdot Equity\ investment \tag{1}$$

The idea is that the default risk of a fund is larger if that fund is highly leveraged and thus less able to absorb (both exogenous as endogenous) shocks. The factor $Avg\ RWfund \cdot Lvg$ in equation (1) is capped at 1250%. This directly implies that, taking 8% of the *RWA investment* as the capital charge, the absolute value of the capital charge is capped at 100% ($= 0.08 \cdot 12.5 \cdot 100\%$) and that our equation (1) expands to:

$$Capital\ charge = 0.08 \cdot \min(Avg\ RWfund \cdot Lvg, 12.5) \cdot Equity\ investment \tag{2}$$

Example: Suppose we have collected the following information pertaining to the equity investment of a bank in a particular fund:

- The average risk weight of the fund equals 50%.
- The leverage equals 20. Because $everage = \frac{Total\ Assets}{Equity}$, this implies that equity comprises 5% of the fund's total assets.
- The bank's equity investment in the fund equals 20.000€.

Using equation (2), it follows that:

$$Capital\ charge = 0.08 \cdot \min(0.5 \cdot 20, 12.5) \cdot 20.000€ = 16.000€$$

As illustrated by the example, the formula appears relatively easy to apply. Nevertheless, it is less obvious why the risk would increase proportionally with the leverage ratio. In order to analyze this formula we compare it to the Merton model in which the equity is seen as a call option on the bank's asset value (see Appendix 1). The option is only 'in the money' if the assets earn sufficient return after paying off the debt holders.

**Theoretical background**

The Basel Committee on Banking Supervision recently proposed equation 1 as a method to calculate the risk-weighted assets for a bank's equity investment in a fund. At a first glance, the proposed equation by The Basel Committee appears to be somewhat peculiar for two reasons. First, it incorporates a leverage ratio that satisfies $\lim_{Equity \to 0} \frac{Total\ Assets}{Equity} = \infty$. This implies that (disregarding the $\min(Avg\ RWfund \cdot Lvg, 12.5)$ factor in equation 2), the $RWA\ investment$ in equation 1 will go to infinity when *Equity* approaches 0. Second, a coherent theoretical argument to support equation 1 is lacking. Stated differently, there appears to be no economic rationale to justify the form of equation 1. In this paper, we investigate whether there is an economic justification for equation 1. More in particular, we hypothesize that equation 1 can be theoretically justified using the Merton approach that returns the probability that an equity stake turns out to be worthless, i.e., we propose a economic rationale for equation 1 as proposed by The Basel Committee on Banking Supervision. On the relevant domain, the probability of default derived from the Merton framework appears to quite closely match the regulatory capital formula proposed by the Basel Committee.

## Methods and results

Below we will compare the equity risk that is determined by the capital charge using the *look through approach* to the probability that the call option is not exercised, i.e., the probability that the equity stake turns out to be worthless according to the Merton framework. We will calculate the capital charge for an equity stake in a high-yield fund. The analyses are based on the following parameters:

- The capital charge is calculated for average risk weights between 50% (A+ to A- bonds) and 150% (below BB- bonds).
- The fund's percentage equity to total assets ranges between 1% (high leverage) and 90% (low leverage).
- The Merton framework uses a total assets volume that is standardized to 1. The current stock price *S* of the call option equals the current asset value, so it is set equal to 1.
- The strike price is equal to 1 minus the fund's percentage equity to total assets, so it ranges between 10% (low leverage) and 99% (high leverage). The strike price is equal to the percentage debt to total assets. This because $Strikeprice = 1 - \frac{Equity}{Total\ Assets} = \frac{Total\ Assets - Equity}{Total\ Assets} = \frac{Debt}{Total\ Assets}$.

  If the stock price is above the strike price, i.e. if the assets are worth more than the fund's debt, the call option is 'in the money' and the equity has a positive value. However, if the asset value is below the percentage debt to total assets, the fund defaults and the equity, and hence the call option, is worthless.
- A risk-free rate of 4% is assumed.

- A volatility of 20% is assumed, in accordance with the high-yield profile of the fund (risk weight 50% and higher).

**Table 1: Notation summary and used parameters**[2]

| Parameter | Notation | Value(s) |
|---|---|---|
| Average Risk Weights | Avg RWfund | $\{Avg\ RWfund \in 0.50 + \mathbb{N} * 0.2 \cap Avg\ RWfund \leq 1.50\}$ |
| Equity/Total Assets | E/Total Assets | $\{\frac{E}{TotalAssets} \in 0.01 + \mathbb{N} * 0.01 \cap \frac{E}{TotalAssets} \leq 0.90\}$ |
| Stock price | S | 1 |
| Strike price | Q | $\{Q \in 0.10 + \mathbb{N} * 0.01 \cap Q \leq 0.99\}$ |
| Risk-free rate | r | 4% |
| Volatility | ∂ | 20% |

Below we show the call option price against the percentage equity to total assets. Note that the option price is above the percentage equity to total assets (expressed with the help of the red line). The difference between the option price and the percentage equity to total assets converges to zero as the fund progresses to a 100% equity funding situation. This is an important outcome. It shows that equity holders do not have an incentive to reduce the leverage of the bank, since the value of their call option on the bank's assets increases slightly less than the percentage equity to total assets.

**Figure 1: Call option price versus percentage equity to total assets**

[2] Later in this paper we will relax the dependency of our results on our choice of parameters by varying the volatility level.

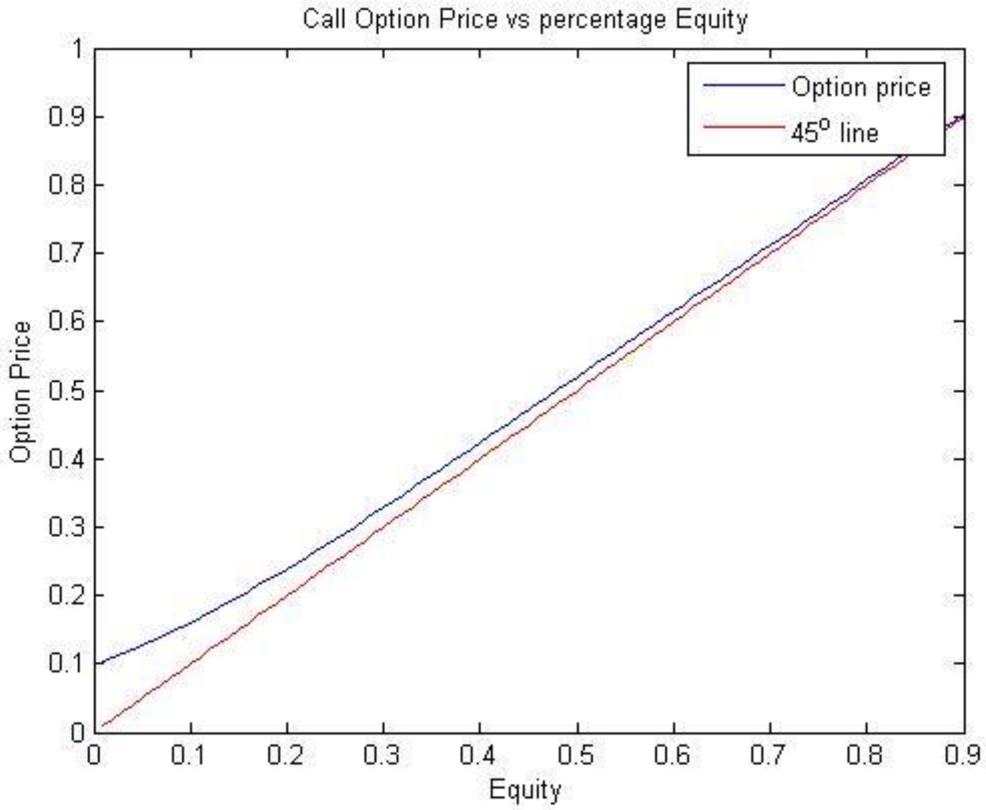
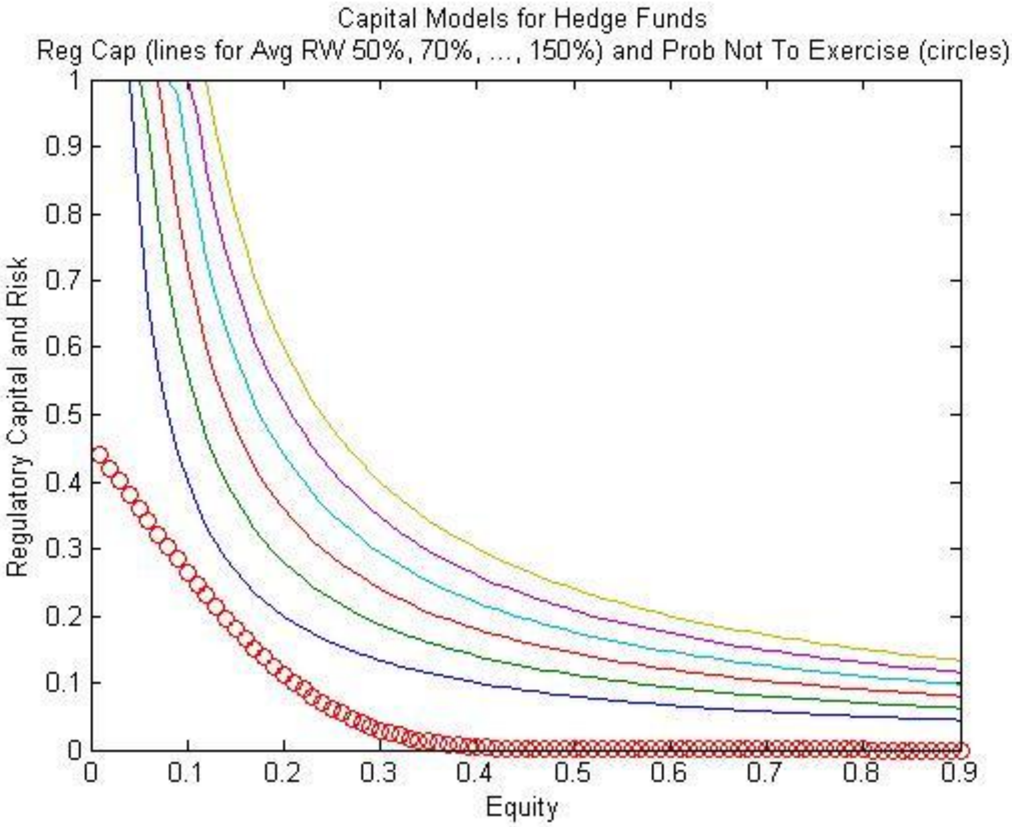



Figure 1 illustrates that the option value of the equity is most valuable at low solvency levels (see, also, Lubberink, 2013).

In figure 2 below we show the regulatory capital (8% of RWA) according to the *look through approach* for several average risk weights (50%, 70%, …, 150%). We compare the outcomes of the risk capital to the investment's default risk as measured by the Merton approach. Within the Merton approach, the probability of not exercising the option, i.e., the probability that the equity investment turns out to be worthless, equals Φ(-d2).

**Figure 2: Regulatory capital for bank's equity investments in funds compared to the probability that the investment turns out to be worthless**



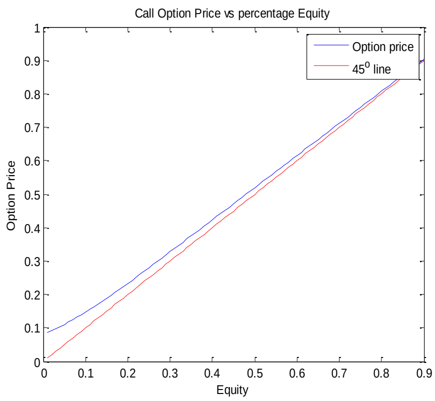
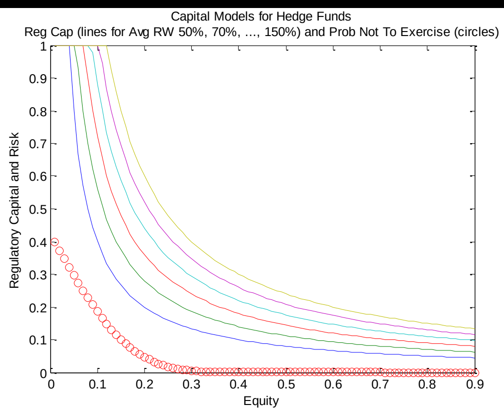

From the figure we can conclude that the regulatory capital formula follows more or less the shape of the probability to not exercise in the Merton approach. Also, the capital requirement is conservatively above this probability for risk weights below 150% (corresponding to below BB- bonds) and more than 50%. Figure 2 also suggests that the Regulatory Capital lines and the investment's default risk as measured by the Merton approach will intersect as we lower the Avg RWfund. In fact, supplemental analysis reveal that this intersection, with the current parameters, will occur when the risk weight is set to a value around 35% (Equity equals 0.13 in that case). Although a direct calculation of this intersection is not possible (one equation, two unknowns), the following equation must hold in the intersection point as proven in Appendix 2:

$$Avg\ RWfund = \frac{62.5E^2}{\sqrt{2\pi}(1-E)} e^{-\frac{1}{2}\left(-5\ln\left(\frac{1}{1-E}\right)-0.1\right)^2} \quad (3)$$

## Discussion and conclusions

Our conclusion is that, although the multiplication with the leverage ratio may seem odd, the resulting regulatory capital requirement for banks' high-risk equity investments in funds turns out to be reasonable if the fund's assets comprise externally rated high-yield corporate debt. One potential counterargument against the aforementioned conclusion is the suggestion that our conclusion is largely contingent on our choice of parameters. Especially the choice of our volatility level is subject to potential criticism as it is well known that changing volatility levels has a large influence on the probability of default according to the Merton approach. As such, we replicate figures 2 and 3 using volatility levels of $\partial$=0.15 and $\partial$=0.25 respectively. Table 2 shows the results of these additional robustness checks.

**Table 2: Replication of figures 1 and 2 using different volatility levels**

<table>
<tr><th>Volatility level</th><th>Figure 1 revisited</th><th>Figure 2 revisited</th></tr>
<tr><td>∂=0.15</td><td>
</td><td>
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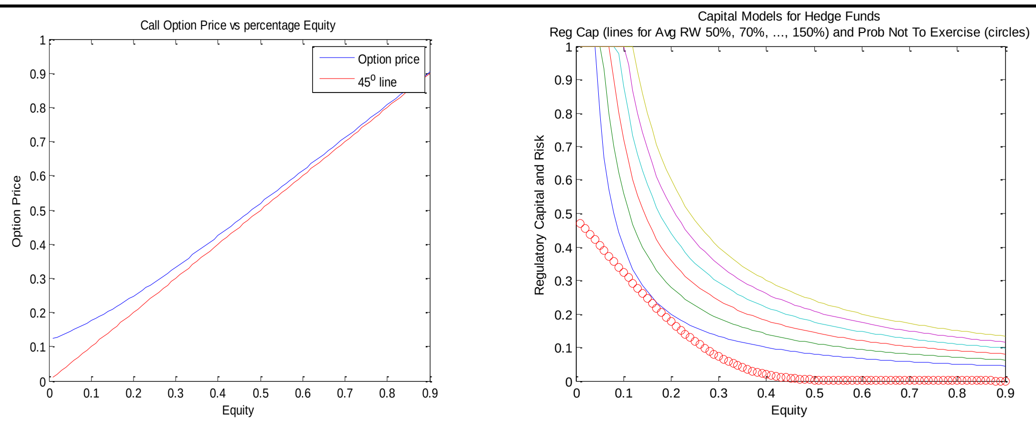
∂=0.25




These additional analyses reveal that changing volatility levels have little impact on our results. Needless to say, varying the volatility levels will impact equation 3 via f(*Equity*), see Appendix 2.

However, some red flags remain. If (for whatever reason) the risk weight of the fund's assets is underestimated, the *look through approach* may turn out to be too optimistic. It relies heavily on an adequate rating. Also, it does not take other relevant risk factors into account such as the quality of the fund's management or the concentration of the fund's assets. To illustrate the latter, consider two funds X and Y shown in Table 3.

**Table 3: Two funds**

| Assets | Risk Weights (%) | Asset concentration fund X (€) | Asset concentration fund Y (€) | Assets adjusted for risk X (€) | Assets adjusted for risk Y (€) |
|---|---|---|---|---|---|
| A | 100 | 50 | | 50 | |
| B | 100 | | 10 | | 10 |
| C | 100 | | 10 | | 10 |
| D | 100 | | 10 | | 10 |
| E | 100 | | 10 | | 10 |
| F | 100 | | 10 | | 10 |
| G | 0 | 50 | | 0 | |
| H | 0 | | 50 | | 0 |
| Total | NA | 100 | 100 | 50 | 50 |

Funds X and Y both possess 100€ in total assets and both carry 50€ of risk weighted assets. Except for the extreme case where $\rho_{BC} = \rho_{CD} = \rho_{DE} = \rho_{EF} = 1$ (i.e., the two funds are mathematically equivalent), the exposure to risk of the two funds will differ. This different exposure to risk is not captured by the currently described method. Despite these red flags, we are confident in concluding that there appears to be an economic rationale for the form of the RWA investment formula proposed by the Basel Committee.

## Implications

We offer two direct implications from our analysis. First, there appears to be an economic rationale for the capital requirement formula proposed by the Basel Committee. As such, one can be assured that the capital requirement formula is not a completely new, haphazard method of determining required capital for banks, but instead follows from sound economic arguments. Second, we focus in this paper on the 'look-through' approach, and not on the 'mandate-based' or 'fall-back' approach, because the 'look-through' approach is most granular and risk-sensitive. Indeed, the 'look-through' approach can only be used if the bank has sufficient information on the underlying exposures and leverage of a fund. However, calculating the risk weight of a high-yield fund is an inherently subjective exercise, and other risk factors such as concentration of a fund's assets are ignored when determining the banks' capital requirement. As such, our analysis also implies that calculating the capital requirement, using the Basel formula, for banks that invest in high-yield funds is prone to error because other relevant risk factors are not taken into account.

## Appendix I: Some elements of option theory

The Merton model treats a company's equity as a call option on its assets. As also discussed by Wang (2009), the balance sheet relationship gives that Equity + Debt = Assets. Now consider the future realization of these values as $\text{Equity}_\text{T}$, $\text{Debt}_\text{T}$ and $\text{Assets}_\text{T}$. In scenario 1, $\text{Debt}_\text{T} \geq \text{Assets}_\text{T}$, and the shareholders are left with nothing. In scenario 2, $\text{Debt}_\text{T} < \text{Assets}_\text{T}$, and the company has enough assets to pay off its debt and the shareholders equity value equals $\text{Assets}_\text{T} - \text{Debt}_\text{T}$. This is exactly the payoff function of a European call option with strike price $\text{Debt}_\text{T}$. The value of a call option c is $S(0) \cdot \Phi(d1) - K \cdot e^{-rT} \cdot \Phi(d2)$.

In the formula for the value of a call option, $\Phi(d2)$ is the probability to exercise the option. The probability to not exercise the option is $\Phi(-d2)$. In the Merton approach, $\Phi(-d2)$ is the probability that the equity turns out to the worthless, i.e., $\text{Debt}_\text{T} \geq \text{Assets}_\text{T}$. Hence, $\Phi(-d2)$ is an estimate of the firm's PD. Sometimes the Black-Scholes formula is enhanced to reflect the asset return drift instead of the risk-free rate.

**Appendix 2: Proof intersection equation Φ(-d2) and Regulatory Capital line**

$$normcdf = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{x} e^{-\frac{t^2}{2}}dt$$

$$pdf = \frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}x^2}$$

$$\frac{d}{dE}\big(\Phi(-d2)\big) = \frac{d}{dE}(0.08 \cdot Avg\ RWfund \cdot Equity^{-1})$$

$$f(E) = -d2$$

$$\frac{d\Phi(f(E))}{dE} = \frac{d\Phi(f(E))}{df(E)} \cdot \frac{df(E)}{dE}$$

$$\frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}f(E)^2} \cdot \left(\frac{d}{dE}\left(-\left(\frac{\ln\left(\frac{S}{1-E}\right) + r(T-t) + \frac{1}{2}\partial^2(T-t)}{\partial\sqrt{T-t}} - \partial\sqrt{T-t}\right)\right)\right)$$

$$= -0.08 \cdot Avg\ RWfund \cdot E^{-2}$$

$$\frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}f(E)^2} \cdot \left(\frac{d}{dE}\left(-\left(\frac{\ln\left(\frac{1}{1-E}\right) + 0.06}{0.20} - 0.20\right)\right)\right) = -0.08 \cdot Avg\ RWfund \cdot E^{-2}$$

$$\frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}f(E)^2} \cdot \left(\frac{d}{dE}\left(-5ln\left(\frac{1}{1-E}\right) - 0.1\right)\right) = -0.08 \cdot Avg\ RWfund \cdot E^{-2}$$

$$\frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}f(E)^2} \cdot \left(\frac{-5}{1-E}\right) = -0.08 \cdot Avg\ RWfund \cdot E^{-2}$$

$$Avg\ RWfund = \frac{62.5E^2}{\sqrt{2\pi}(1-E)}e^{-\frac{1}{2}\left(-5\ln\left(\frac{1}{1-E}\right)-0.1\right)^2}$$

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**References**

Admati, A.R., DeMarzo, P.M., Hellwig, M.F., Pfleiderer, P. (2010) Fallacies, irrelevant facts, and myths in the discussion of capital regulation: why bank equity is not expensive. Working paper.

Basel Committee. (2013) Capital requirements for banks' equity investments in funds – final standard. 13 December, http://www.bis.org/publ/bcbs266.htm, accessed 4 January 2014.

Lubberink, M.J.P. (2014) A primer on regulatory capital adjustments. 26th Australasian Finance and Banking Conference 2013. 1-39.

Wang, Y. (2009). Structural credit risk modeling: Merton and beyond. Risk Management, 16. 30-33.