On the choice of liquidity horizon for incremental risk charges: are the incentives of banks and regulators aligned?

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The recent incremental risk charge to the Basel market risk framework requires banks to estimate, separately, the default and migration risk of their trading portfolios that are exposed to credit risk. The new regulation requires the total regulatory charges for trading books to be computed as the sum of the market risk capital and the IRC for credit risk. In contrast to Basel II models for the banking book, no model is prescribed and banks can use internal models to calculate the IRC. In the calculation of IRCs, a key component is the choice of the liquidity horizon for traded credits. In this paper we explore the effect of the liquidity horizon on the IRC and, in particular, confirm that the framework for assigning liquidity horizons proposed by regulation is consistent with banks’ motivation to conserve the regulatory capital requirement. We consider a stylized portfolio of twenty-eight bonds with different ratings and liquidity horizons to evaluate the impact of the choice of the liquidity horizon for a certain rating class of credits. We find that, in choosing the liquidity horizon for a particular credit, there are two important effects that must be considered. The first effect is that the bonds with short liquidity horizons can avoid further downgrading by frequently trading into a bond of the same initial quality. The second effect is the possibility of multiple defaults. Of these two effects, the multiple default effect will generally be more pronounced for non-investment-grade credits as the probability of default is severe, even for short liquidity periods. For medium investment-grade credits, these two effects will in general offset one another and the IRC will be approximately the same across liquidity horizons. For high-quality investment-grade credits, the effect of the multiple defaults is low for short liquidity horizons as the frequent trading effectively prevents severe downgrades. Our findings are

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also supported by empirical results from the credit-spread term structure. Therefore, the liquidity horizon specification in the IRC requirement from the Basel Committee “is consistent with the market reality and banks’ incentives in capital requirement conservation”. Consequently, it alleviates the concerns in IRCs model validation.

1 INTRODUCTION

Trading books in banks consist of positions held with intent to trade or to hedge other positions, while the banking books are usually made of held-to-maturity items. Therefore, market risk and migration risk are more critical to the trading books. Banks have been calculating internal-model market-based risk capital charges for many years. The Basel Committee on Banking Supervision updated its market risk capital requirement in the comprehensive Basel II accord in 2006 (Basel Committee on Banking Supervision (2006)). It is also included in the most recent accord, Basel III (Basel Committee on Banking Supervision (2011)). In addition to the general market risk, a more specific credit-spread risk of exposures to the idiosyncratic risk of debt securities or equities was added to the requirement as well. The credit risks, including the default and rating-migration risk contained in banks’ trading books, were not subject to internal-model approval until 2009, when the Basel Committee published a consultation paper introducing the incremental risk charges (IRCs) to banks subject to internal models for market risk capital (Basel Committee on Banking Supervision (2009a)). The IRC requirement was put in place due to the amount of credit exposure in banks’ trading operations and recognition of the fact that credit exposures may give rise to substantial losses. The IRC must be assessed on a weekly basis at a 99.9% value-at-risk (VaR) confidence level using a risk horizon of one year. The IRC capital is supposed to complement the current market VaR framework, which measures risk on a ten-day holding period at the 99% confidence level. No specific model, approach or method is prescribed for banks in terms of IRC estimation.

While the IRC requirement for capturing credit-default and credit-migration risk on a one-year horizon may be consistent with many banks’ current internal models for assessing credit risk capital, the IRC also requires banks to assign credits to liquidity or trading horizons. The liquidity horizon should reflect the time required to sell or hedge the credit under stressed conditions. In this paper we apply a portfolio credit risk model that can be used to capture the credit-migration risk and the default risk that is consistent with the IRC requirement. Under this model framework, we evaluate the IRC for corporate bonds with different ratings and liquidity horizons using a multifactor portfolio credit risk model. The purpose of this paper is to study the sensitivity of the IRC to bond rating and, in particular, to the bond liquidity horizon.
One of our main motivations for this study is to investigate whether banks have incentives to choose a liquidity horizon for credits that is contrary to the regulatory and market view. Indeed, if interests are not aligned for regulators and banks on the choice of the liquidity horizon, then the regulatory burden on validation of banks’ choices of liquidity horizons in their IRC model will be high. However, our findings confirm that banks have incentives to choose a liquidity horizon for a security that is consistent with both the regulatory view and the market liquidity. This means that regulators can focus their validation of a bank’s IRC model on other aspects of the model, such as the ability of the model to capture concentration risk.

This paper is organized as follows. In Section 2 we give an overview of the IRC addition to the Basel amendment for market risk in the trading book. Section 3 introduces the common multifactor model for portfolio credit risk by first giving an overview of the foundation univariate and multivariate Merton (1974) model. We then proceed to discuss the multifactor model version used to model portfolio risk. The multifactor model was first used in CreditMetrics (1999) and, since then, has become one of the most popular models for portfolio credit risk. In Section 4 we calculate IRCs and, in particular, analyze the effect of the liquidity horizon for a stylized portfolio of twenty-eight bonds distributed across seven different rating classes, with different liquidity horizons within each class. Finally, in Section 5 we summarize our findings.

2 INCREMENTAL RISK CHARGE

The IRC addition (Basel Committee on Banking Supervision (2009a)) to the market risk amendment (Basel Committee on Banking Supervision (1996)) seeks to estimate the migration and default risks of traded credit products using a risk horizon of one year and a confidence level of 99.9%. The 99.9% confidence level and the one-year horizon are consistent with the confidence level used in Basel II advanced approaches for traditional banking-book credit estimates of capital charges. However, in contrast to Basel II models for the banking book, where the risk-weight calculation is set to a one-factor model that every bank uses, the IRC model is an internal model, allowing banks the flexibility to decide which model to use for calculating portfolio credit risk.

The IRC includes positions that are subject to risk charges for a specific interest rate risk, such as corporate bonds. However, the IRC captures the migration and default risks of an exposure holding fixed any market variations such as interest rate risk and spread risk within a rating class. The IRC is not allowed to capture any diversification effects between market and credit risk. This means that the IRC is added to the total market risk charge to yield a total market and credit risk charge for items in the trading book.
A key feature of the IRC is that banks are allowed to capture the fact that traded credits, in contrast to the banking-book positions, may be actively traded during the one-year risk horizon. The trading horizon is specified by the bank, although restrictions on the specification are given. Specifically, the trading horizon or liquidity horizon is subject to a floor of three months. Moreover, investment-grade credits are expected to be more liquid than non-investment-grade and, hence, they have a shorter liquidity horizon. In this setting the liquidity horizon represents the time that is required to sell the position or to hedge all material risks covered by the IRC model in a stressed market. The liquidity horizon must be measured under conservative assumptions and should be of a sufficient length such that the act of selling or hedging, in itself, does not materially affect market prices. Moreover, the liquidity horizon is expected to be greater for positions that are concentrated, reflecting the longer period needed to liquidate such positions. This longer liquidity horizon for concentrated positions is necessary to provide adequate capital against two types of concentration, namely, issuer concentration and market concentration.

When trading credits at their liquidity horizon, the requirement is that the credit is replaced by a credit with the same risk profile such that the initial risk level of the portfolio is maintained. In practice, this means that the newly traded credit should have the same initial rating as the original credit, but also that the new credit should not change the portfolio features, such as concentration, or the maturities of the investments. Therefore, in order to preserve the initial risk level from both an exposure and a portfolio perspective, the newly traded credit should have the same stand-alone characteristics as well as correlation with the rest of the portfolio. Concentration and diversification risk is not changed by trading credits.

A bank that applies an IRC to its trading book positions must seek to validate the model empirically, as far as possible, using backtesting. However, because of the limited availability of the historical loss data, other means of testing the model may be used, such as stress testing and scenario testing. The specification of the exposure correlation, driving the concentration risk, is one of the key parameters that needs to be validated.

Many banks currently employ a corporate-wide portfolio credit risk model to evaluate the potential losses in the banking and trading book due to the deterioration of credits. This means that banks have already specified a portfolio credit risk model that defines the concentration and diversification of the portfolio. It is reasonable to expect that the same model will be used in the regular evaluation of banks’ IRCs. However, in banks’ standard portfolio credit risk model, the concepts of liquidity horizon and the trading of credits are usually not considered. The assumption of a one-year buy-and-hold portfolio is frequently used, even for traded credits. Therefore, in banks’ application of the portfolio credit risk model to the IRC, one of the most crucial parameters is the choice of the liquidity horizons. Hence, there is a need to
understand the effect the choice of the liquidity horizon has on the required IRC. In this context, an important question is whether the regulatory prescribed approach for assigning short liquidity horizons for high-quality credits and long liquidity horizons for low-quality credits, being consistent with market observed liquidity, is also consistent with banks’ preferred assignment of liquidity horizons in order to minimize the IRC. That is, whether we can prove that there is a consistency between regulators and banks in the assignment of liquidity horizons based on their view of the market liquidity. We employ a multifactor portfolio credit risk model to a stylized portfolio of bonds with the purpose of evaluating the effect that choice of the liquidity horizon has on the required capital for default and migration risk.

3 THE PORTFOLIO CREDIT RISK MODEL

In our analysis of IRCs for default and migration risk, we use a multifactor version of the Merton (1974) model. The multifactor version of a multivariate Merton model was first used in CreditMetrics (1999). The model is used by many banks to estimate portfolio credit risk. Key aspects of the model are its calibration of sensitivity parameters to the systematic factors driving default and migration risk, and its assessment of the level of the unexplained idiosyncratic portion. Another important feature of the model is that it provides a structural explanation not only for default migration but also for credit migration. All these features together make this class of model especially suitable for meeting the IRC requirement.

Below, we first introduce the univariate and multivariate Merton model and then proceed to discuss the multifactor version.

3.1 The classical Merton model

In the Merton structural bond pricing model (Merton (1974)) the objective is to provide the price of a zero-coupon bond granted to a defaultable firm for a given period of time, ie, to develop a theory of the structure of credit risky discount rates. In the original version of the model there is no market risk involved and the obtained differentials in discount rates are therefore solely due to credit risk. In the setup of the model, it is supposed that the firm has only two classes of claims:

(1) a single homogeneous class of debt;

(2) the residual claim, equity.

In this simple setup, \(V(t)\), the value of the assets of the firm, follows a geometric Brownian motion:

\[
dV(t) = \mu V(t) \, dt + \sigma V(t) \, dW(t)
\]
and on the liability side of the balance sheet of the firm, the total value is financed by equity, \( S(t) \), and one representative zero-coupon (noncallable) debt contract, maturing at time \( T \), with face value \( K \). This gives the identity:

\[
V(t) = P(t, T; R) + S(t)
\]

where \( P(t, T; R) \) is the credit risky bond value. We now note the following. If \( V(T) \leq K \), then the zero-coupon bond is worth \( V(T) \), whereas if \( V(T) > K \), then the zero-coupon bond is worth \( K \). Hence, the value of the risky debt at time \( T \) is:

\[
P(T; T; R) = \min(V(T), K)
\]

or:

\[
P(T; T; R) = K - \max[K - V(T), 0]
\]

where we recognize the last term as the terminal value of a standard Black–Scholes (Black and Scholes (1973)) European put option on the firm’s assets with strike price \( K \) and maturity \( T \). By the no-arbitrage principle we have, for \( t < T \), that a risk-free debt position \( Ke^{-R(T-t)} \) is equivalent to a risky debt position \( P(t, T; R) \), with paying interest rate \( R \), the same as the non-credit risky debt, and a long position in a put on the value of the firm, \( p \). We can therefore write:

\[
Ke^{-R(T-t)} = P(t, T; R) + p
\]

and:

\[
P(t, T; R) = Ke^{-R(T-t)} - p
\]

The holders of the risky debt have therefore, with paying rate \( R \), issued a put option on the firms assets with strike \( K \). The price of the put option can therefore be interpreted as the cost of eliminating the credit risk, or the required premium on \( R \) for taking on credit risk.

Disregarding the fact that, in practice, a firm’s assets are in general not tradable, we apply standard Black–Scholes reasoning to obtain the value of (3.1). We arrive at:

\[
P(t, T; R) = Ke^{-R(T-t)} \left[ N(d_2) + \frac{V(t)}{Ke^{-R(T-t)}} N(-d_1) \right]
\]

where \( N \) is the cumulative distribution function of the stochastic variable \( Z \sim N(0, 1) \) and:

\[
d_1 = \frac{\ln(V(t)/K) + (R + \sigma^2/2)(T - t)}{\sigma \sqrt{T - t}}, \quad d_2 = d_1 - \sigma \sqrt{T - t}
\]

Clearly \( P(t, T; R) \leq Ke^{-R(T-t)} \). The above analytical expression of the value of credit risky debt expressed in prices is, however, simpler to interpret when expressed
as an interest rate spread on $R$, denoting the resulting credit risky interest rate by $\tilde{R}$. Consider, therefore, the credit risky equivalent bond value:

$$P(t, T; \tilde{R}) = Ke^{-\tilde{R}(T-t)} \tag{3.3}$$

enabling us to solve for the required $\tilde{R}$ in (3.3), yielding:

$$\tilde{R} = R - \frac{1}{T-t} \left( \ln \left[ \frac{V(t)}{Ke^{-R(T-t)}} \right] + \ln \left( \frac{N(d_2)}{N(-d_1)} \right) \right) \tag{3.4}$$

The required credit spread, in excess of $R$, is then a function of:

- the leverage ratio:
  $$\frac{V(t)}{Ke^{-R(T-t)}}$$
  or, inversely, of the quasi-debt ratio:
  $$\frac{Ke^{-R(T-t)}}{V(t)}$$

- the volatility of the firm’s assets $\sigma$ (ie, the firm’s business risk);

- the maturity of the debt issue (ie, $(T-t)$).

By declaring a firm to be in default at time $T$ if $V(T) - K < 0$, and using the corresponding risk-neutral asset process:

$$dV(t) = RV(t) \; dt + \sigma V(t) \; dW_t$$

we find, since $Z \sim N(0, 1)$, that:

$$P(V(T) < K) = P \left( Z < \frac{\ln(K/V(t)) - (R - (\sigma^2/2))(T-t)}{\sigma \sqrt{T-t}} \right) = N(-d_2)$$

is the risk-neutral probability of default (PD). By rearranging (3.2) as follows:

$$P(t, T) = Ke^{-R(T-t)} - e^{-R(T-t)} \; PD(1 - r)$$

where $PD = N(-d_2)$, $K$ is the exposure at default (face value of debt) and:

$$1 - r = \left[ 1 - \frac{V(t)}{Ke^{-R(T-t)}} \frac{N(-d_1)}{N(-d_2)} \right]$$

where $r$ is the recovery rate. Hence, we can now interpret the value of risky debt as the value of secure debt minus the risk-neutral expected loss due to default.
By approximating the spread equation (3.4) as follows:

\[
\tilde{R} \approx R + \frac{1}{T-t} \text{PD}(1-r) = R + \frac{1}{T-t} \text{PD} \times \text{LGD}
\]
\[
\approx e^{-(R+\pi)(T-t)} K
\]

we can now simply price risky debt. Here, \(\pi = \text{PD} \times \text{LGD}\) is the part added due to credit risk.

### 3.2 The multivariate Merton model

In the previous section we derived the Merton bond pricing model, which provided us with structural estimates of the bond issuer PD as well as the ultimate losses should default occur. The PD of a single issuer was obtained as:

\[
\text{PD} = N(-d_2)
\]

where:

\[
d_2 = \frac{\ln(V_t/K) + (R + \sigma^2/2)(T-t)}{\sigma \sqrt{T-t}} - \sigma \sqrt{T-t}
\]

with \(K\) being the nominal debt value, \(V_t/K\) being the leverage ratio where \(V_t\) is the value of assets. Furthermore, \(R\) and \(\sigma\) are, respectively, the short-rate of interest and the volatility of the asset process.

For a portfolio of \(N\) bond issuers we are now concerned with the probability that the sum of \(N\) Bernoulli loss indicators \(\{L_i\}_{i=1}^N\) attain the value of \(n \leq N\), ie:

\[
P \left( \sum_{i=1}^N L_i = n \right)
\]

(3.5)

As an extension of the univariate case, consider, therefore, an \(N\)-dimensional geometric Brownian motion process for the asset values \(\{V_t\}_{t=1}^N\):

\[
dV_t = D[V_t] \mu dt + D[V_t] \sigma dW_t
\]

(3.6)

where \(\mu = (\mu_1, \ldots, \mu_N)\)'s, \(\sigma\) is an \(N \times N\) square-root matrix (ie, \(\sigma \sigma' = \Sigma\), the covariance matrix) given by:

\[
\sigma = \begin{bmatrix}
\sigma_{11} & \cdots & \sigma_{1N} \\
\vdots & \ddots & \vdots \\
\sigma_{N1} & \cdots & \sigma_{NN}
\end{bmatrix}
\]

with \((i, j)\)th element \(\sigma_{ij}\). Here:

\[
\left( \sum_{j=1}^N \sigma_{ij}^2 \right)^{1/2} = 1 \quad \text{for all } i
\]
Furthermore, $D[x]$ is an $N \times N$ diagonal matrix with the vector $x$ on the diagonal and $W_t = (W_{1t}, \ldots, W_{Nt})'$ are independent standard Wiener processes. However, $\tilde{W}_t = \sigma W_t$ are $N$-correlated Wiener processes. In particular, the instantaneous correlation between $\tilde{W}_{it}$ and $\tilde{W}_{jt}$ is given by:

$$
\rho_{ij} \ dt = E(d\tilde{W}_{it} \ d\tilde{W}_{jt}) - E(d\tilde{W}_{it}) E(d\tilde{W}_{jt}) = \sigma'_i \sigma_j
$$

In full analogy with the PD in the univariate case, here we find, for an issuer $i$:

$$
P(V_{iT} < K_i) = P \left( V_{it} \exp \left( \left( \mu_i - \frac{1}{2} \sum_{j=1}^{N} \sigma_{ij}^2 \right) (T-t) + \sum_{j=1}^{N} \sigma_{ij} Z_j \sqrt{(T-t)} \right) < K_i \right)
$$

with $Z_j \sim N(0,1)$, yielding:

$$
P \left( \tilde{Z}_i < \frac{\ln(K_i/V_{it}) - (\mu_i - ((\sigma_j^2)/2)(T-t))}{(\sum_{j=1}^{N} \sigma_{ij}^2)^{1/2} \sqrt{T-t}} \right) = N(-d_2^i)
$$

where:

$$
\tilde{Z}_i = \frac{\sum_{j=1}^{N} a_{ij} Z_j}{(\sum_{j=1}^{N} \sigma_{ij}^2)^{1/2}} \sim N(0,1) \quad \text{and} \quad a_{ij} = \frac{\sigma_{ij}}{(\sum_{j=1}^{N} \sigma_{ij}^2)^{1/2}}
$$

Estimating the probability defined in (3.5) requires the calibration of the asset process parameters $\mu$ and $\Sigma$. However, as in the univariate model, in practice we face the problem that asset values are nontraded and, hence, unobserved. In practical implementation of the multivariate Merton model we must therefore use equity data as a proxy for asset values, ie, assuming that the correlations and volatilities of asset returns and equity returns are comparable.

### 3.3 Multifactor model for returns and rating migration

A popular version of the multivariate Merton model (see CreditMetrics (1999)) employs a factor model as an approximation to the issuer’s vector asset process. That is, the standardized returns for issuer $i$, $\tilde{Z}_i$, is driven by a multifactor model. The factors are observed indices such as country indices, sector indices and other global economic factors. The returns of an issuer $i$ are described by the following linear multifactor model:

$$
\tilde{Z}_i = \sum_{j=1}^{N^*} \beta_{ij} Z_j + \lambda_i \varepsilon_i
$$
where the $Z_j$ are now interpreted as credit factors, i.e., $Z_j \sim N(\mu_j, \sigma_j)$, with $\beta_{ij}$ the sensitivity of issuer $i$ to the $j$th index factor. The $\varepsilon_i$ are assumed to be independent and identically distributed standard normal variables that are independent of the $Z_j$. Since the $Z_j$ are not necessarily standardized we can obtain the standardized $\hat{Z}_i$ as:

$$
\hat{Z}_i = \phi_i \left( \sum_{j=1}^{N^*} \beta_{ij} Z_j \right) + \sqrt{1 - \lambda_i} \varepsilon_i
$$

where $\Sigma$ is the covariance matrix of $(Z_1, \ldots, Z_N)$ and $\beta = (\beta_1, \ldots, \beta_N)$.\(^1\) In this model the default threshold, as given by the debt level $B_i$ in the Merton model, is obtained empirically using the observed default frequency. That is, for a given observed default probability $p$, the threshold is obtained as $N^{-1}(p)$, where $N^{-1}$ is the inverse normal distribution function. For different classes of rating categories we have $K$ distinct transition probabilities to the $K$ classes, i.e., for an issuer belonging to class $k$, we have $p_{k1}, p_{k2}, \ldots, p_{kk}$. In this case the $K$ thresholds are obtained from the $K$ transition probabilities and the realized rating is determined by the realized return, $\hat{Z}_j$, and the thresholds.

By analogy with the Merton model, the value of a zero-coupon credit with face value $K$ is calculated as:

$$
P(t, T, k) = e^{-\pi(k)(T-t)} K
$$

where the interest rate for credits in class $k$, $\pi(k)$, is determined exogenously from observed interest rates in the market for similar rated credits.

4 CALCULATION OF INCREMENTAL RISK CHARGES

The calculation of IRCs for a portfolio of credits involves a portfolio credit risk model for the calculation of losses, as well as the capability of trading credits at their corresponding liquidity horizon. For the portfolio credit risk model we use a multifactor model for each of the issuers to describe the concentration and idiosyncratic risks of the portfolio. At the liquidity horizon of a bond, the bond is traded for another bond, with the same risk characteristics, i.e., with the same initial rating and multifactor model. The multifactor model remains the same between traded bonds to ensure that

\(^1\) Note here that the horizon of the covariance matrix, $\Sigma$, must be consistent with the simulation horizon of the standardized factor, $\hat{Z}_i$. For example, if $\Sigma$ is calculated on monthly data and the simulation horizon is yearly, then $\Sigma$ must be scaled by $\sqrt{12}$ for consistency.
portfolio level risk characteristics remain constant, i.e., concentration risk. At a particular horizon the valuation of the bonds uses a credit discount rate that is contingent on the particular realized rating class and the loss is measured against the corresponding credit, holding the initial rating fixed at the same horizon. This way of measuring loss means that the realized loss is only due to downgrades and defaults and not due to discounting effects. This is consistent with the fact that the IRC should not measure market risk effects.

In our analysis of IRCs we simulate losses at horizons of three, six, nine and twelve months and the bonds with a liquidity horizon of less than twelve months are traded for a bond with the same risk characteristics that the original bond had initially. This means that if the bond had a rating of $k$ at the start of the analysis, the bond is replaced by a bond with rating $k$ at each of the liquidity horizons.

4.1 Bond data and model

The stylized portfolio consists of twenty-eight zero-coupon bonds that are distributed across seven nondefault categorical rating classes corresponding to Moody’s categories of ratings: Aaa, Aa, A, Baa, Ba, B and Caa. A particular bond in a rating class is assigned the different liquidity horizons of three, six, nine and twelve months. A bond with a liquidity horizon of three months is traded at all the possible horizons, i.e., three, six and nine months, while a bond with six-month liquidity horizon is traded at the six-month horizon. Similarly, a bond with a nine-month liquidity horizon is traded at a nine-month horizon and a bond with twelve-month liquidity horizon is a buy-and-hold bond under the risk horizon of one year. In our stylized portfolio, all bonds have a face value of 100 units of currency and the maturity term is set to four years. In the valuation of the bonds we use a discounting rate that is contingent on the rating of the bond. In particular, the seven nondefault rating classes have associated a credit-adjusted interest rate that is used for discounting. Since all the bonds have a maturity term of four years and the analysis horizon is confined to one year, it suffices to specify the interest rates used for discounting between three and four years. Table 1 on page 49 displays the discounting interest rates used at the three- and four-year maturity horizons. Discounting rates between three and four years are obtained using linear interpolation. In case of default we assume a recovery of 25% of the exposure amount.\(^2\) The exposure amount is measured here as the value holding fixed for the initial rating at that particular horizon. The analysis of the IRCs for the twenty-eight bonds uses a transition matrix to describe the probabilities of migrating from one class to another. Our base transition matrix is the Moody’s average one-year

\(^2\) We intentionally set the recovery rate low in order to ensure that the default state is the maximum loss state for all bonds. The choice of a low recovery rates will simplify the interpretation of the results.
transition matrix between 1920 and 1996 (Moody’s (1997)), displayed in Table 2 on the facing page. The transition matrix has empirical transition probabilities for the Moody’s rating classes Aaa, Aa, A, Baa, Ba, B and Caa, as well as the default state, D. The matrix has been estimated conditional on no withdrawal of rating and, hence, contains no category attributed to nonrated exposures as is usually the case. We refer the reader to Moody’s (1997) for details on the construction of the empirical transition probabilities. In our analysis, though, we need the three-month transition matrix to evaluate the transition probabilities for all the three-month liquidity horizons, i.e., zero to three months, three to six months, six to nine months and nine to twelve months. We therefore construct a generator matrix from the Moody’s transition matrix (see Israel et al (2001)). The generator matrix, \( Q \), is obtained from the transition probability matrix, \( A \), such that:

\[
Q = \sum_{k=0}^{n} (-1)^k \frac{D^{k+1}}{k+1}
\]

where \( D = A - I \), with \( I \) the identity matrix. The required power \( r \) of the initial transition matrix \( A \) is then calculated as \( B = e^{rQ} \) using the Taylor expansion:

\[
B = I + \sum_{k=1}^{n} \frac{(rQ)^k}{k!}
\]

In this way we obtain transition probabilities for the three-month horizon as well as longer liquidity horizons, such as six months and nine months, from the generator matrix \( Q \). Table 3 on page 50 displays the generator matrix, \( Q \), obtained from the Moody’s one-year average transition probability matrix for the Moody’s rating classes Aaa, Aa, A, Baa, Ba, B and Caa, as well as the default state, D.

In the simulation of the standardized return of an issuer, for each of the bonds 1 to 28 we use the same multifactor model. The model is a four-factor model with factors \( Z_1 \), \( Z_2 \), \( Z_3 \) and \( Z_4 \). The four systematic variables are jointly normally distributed with the monthly covariance matrix given in Table 4 on page 51. The systematic factor parameters, or so-called loadings, are given by 0.6231, 0.33, 0.0268 and 0.0201 for the factors \( Z_1 \), \( Z_2 \), \( Z_3 \) and \( Z_4 \), respectively. The idiosyncratic normal random variable has parameter 0.9. This gives a multifactor model \( R^2 \) of 1 − 0.92 = 0.19.\(^3\) In the application of the model we simulate 100,000 samples of the factor model for each of the issuers. This is done for all the liquidity horizons of three, six, nine and twelve months using an arithmetic Brownian motion model for the systematic factors \( Z_1 \), \( Z_2 \), \( Z_3 \) and \( Z_4 \).

\(^3\)In this paper we do not study the portfolio effects of IRC calculations. We have therefore chosen a stylized model of correlation such that all issues share the same multifactor model for the systematic factors. At the same time, the multifactor model for the issuers have been chosen such that it is empirically realistic on the issue level, ensuring that the issue level results are realistic.
TABLE 1  Credit-adjusted interest rates for the seven nondefault Moody’s rating classes, Aaa, Aa, A, Baa, Ba, B and Caa, for maturity terms of three and four years.

<table>
<thead>
<tr>
<th>Rating category</th>
<th>Interest rate (three years)</th>
<th>Interest rate (four years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa</td>
<td>0.02651775</td>
<td>0.02934361</td>
</tr>
<tr>
<td>Aa</td>
<td>0.02687823</td>
<td>0.02990976</td>
</tr>
<tr>
<td>A</td>
<td>0.02784931</td>
<td>0.03124889</td>
</tr>
<tr>
<td>Baa</td>
<td>0.02933442</td>
<td>0.03306486</td>
</tr>
<tr>
<td>Ba</td>
<td>0.03176641</td>
<td>0.03581472</td>
</tr>
<tr>
<td>B</td>
<td>0.05451719</td>
<td>0.05929989</td>
</tr>
<tr>
<td>Caa</td>
<td>0.12388839</td>
<td>0.12019516</td>
</tr>
</tbody>
</table>

TABLE 2  Moody’s 1920–96 average one-year transition matrix for the nondefault rating grades Aaa, Aa, A, Baa, Ba, B and Caa, and the default state, D.

<table>
<thead>
<tr>
<th></th>
<th>Aaa</th>
<th>Aa</th>
<th>A</th>
<th>Baa</th>
<th>Ba</th>
<th>B</th>
<th>Caa</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa</td>
<td>0.9218</td>
<td>0.0651</td>
<td>0.0104</td>
<td>0.0025</td>
<td>0.0002</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aa</td>
<td>0.0129</td>
<td>0.9162</td>
<td>0.0611</td>
<td>0.007</td>
<td>0.0018</td>
<td>0.0003</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A</td>
<td>0.0008</td>
<td>0.025</td>
<td>0.9135</td>
<td>0.0511</td>
<td>0.0069</td>
<td>0.0011</td>
<td>0.0002</td>
<td>0.0007</td>
</tr>
<tr>
<td>Baa</td>
<td>0.0004</td>
<td>0.0027</td>
<td>0.0422</td>
<td>0.8916</td>
<td>0.0525</td>
<td>0.0068</td>
<td>0.0007</td>
<td>0.0003</td>
</tr>
<tr>
<td>Ba</td>
<td>0.0002</td>
<td>0.0007</td>
<td>0.0044</td>
<td>0.0511</td>
<td>0.8708</td>
<td>0.0557</td>
<td>0.0046</td>
<td>0.0125</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0</td>
<td>0.0001</td>
<td>0.0069</td>
<td>0.0652</td>
<td>0.852</td>
<td>0.0354</td>
<td>0.0387</td>
</tr>
<tr>
<td>Caa</td>
<td>0</td>
<td>0.0003</td>
<td>0.0004</td>
<td>0.0037</td>
<td>0.0145</td>
<td>0.06</td>
<td>0.783</td>
<td>0.1381</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

$Z_2$, $Z_3$ and $Z_4$, and a normal idiosyncratic variable that is specific to each issuer. The realized loss of the twenty-eight bonds is aggregated across the liquidity horizons such that, for a bond with a three-month liquidity horizon, the loss is aggregated at horizons of three, six, nine and twelve months, whereas, for a bond with a liquidity horizon of twelve months, the loss is measured as the loss at the twelve-month horizon.

4.2 Analysis results

For our twenty-eight stylized bonds we calculate the IRC at the 99.9% VaR level by aggregating the loss across the liquidity horizons. The IRC results are presented in Table 5 on page 55. Table 5 on page 55 displays the obtained IRC, the maximum potential loss and the realized loss ratio for each liquidity horizon, for the bonds in rating classes Aaa to Caa. While the absolute IRC level in Table 5 on page 55 is of immediate interest, it is also interesting to focus on the realized loss percentage of the IRC loss to maximum loss. The ratios show the true risk percentage that is
TABLE 3  The transition generator matrix obtained from Moody's 1920–96 average one-year transition matrix for the nondefault rating grades Aaa, Aa, A, Baa, Ba, B and Caa, and the default state, D.

<table>
<thead>
<tr>
<th></th>
<th>Aaa</th>
<th>Aa</th>
<th>A</th>
<th>Baa</th>
<th>Ba</th>
<th>B</th>
<th>Caa</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa</td>
<td>0.0000</td>
<td>0.0817</td>
<td>-0.0817</td>
<td>0.0013</td>
<td>3.0173E-07</td>
<td>2.63646E-05</td>
<td>1.53069E-06</td>
<td>4.59901E-06</td>
</tr>
<tr>
<td>Aa</td>
<td>0.0115</td>
<td>0.0888</td>
<td>-0.0888</td>
<td>0.0020</td>
<td>0.0022</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A</td>
<td>0.0009</td>
<td>0.0263</td>
<td>-0.0263</td>
<td>0.0553</td>
<td>0.0053</td>
<td>0.0020</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Baa</td>
<td>0</td>
<td>0.0017</td>
<td>-0.0017</td>
<td>0.1245</td>
<td>0.0580</td>
<td>0.0069</td>
<td>0.0010</td>
<td>0.0009</td>
</tr>
<tr>
<td>Ba</td>
<td>1.3043E-06</td>
<td>0.0010</td>
<td>-0.0010</td>
<td>0.0531</td>
<td>0.0648</td>
<td>-0.1873</td>
<td>0.0264</td>
<td>0.0895</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0.0010</td>
<td>-0.0010</td>
<td>0.0043</td>
<td>0.0648</td>
<td>-0.1873</td>
<td>0.0264</td>
<td>0.0895</td>
</tr>
<tr>
<td>Caa</td>
<td>0</td>
<td>0.0049</td>
<td>-0.0049</td>
<td>0.0093</td>
<td>0.0272</td>
<td>-0.3607</td>
<td>0.2435</td>
<td>0.0000</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
TABLE 4  Covariance matrix for the systematic factors in the multifactor model for the bonds.

<table>
<thead>
<tr>
<th></th>
<th>$Z_1$</th>
<th>$Z_2$</th>
<th>$Z_3$</th>
<th>$Z_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z_1$</td>
<td>0.007191</td>
<td>0.004117</td>
<td>0.003889</td>
<td>0.002926</td>
</tr>
<tr>
<td>$Z_2$</td>
<td>0.004117</td>
<td>0.004845</td>
<td>0.003942</td>
<td>0.003037</td>
</tr>
<tr>
<td>$Z_3$</td>
<td>0.003889</td>
<td>0.003942</td>
<td>0.006162</td>
<td>0.002911</td>
</tr>
<tr>
<td>$Z_4$</td>
<td>0.002926</td>
<td>0.003037</td>
<td>0.002911</td>
<td>0.002469</td>
</tr>
</tbody>
</table>

realized, at the 99.9% VaR level, in the IRC model for the specific bond of the rating grade with assigned liquidity horizon. Because of our choice of a low recovery rate of 25% in case of default, the maximum loss is interpreted as the loss obtained when the maximum number of defaults that can occur is realized. This means that a bond with a liquidity horizon of three months can default up to four times, whereas a bond with a liquidity horizon of six or nine months can default up to twice, and, finally, a buy-and-hold bond, having liquidity horizon twelve months, can only default once during the risk horizon of one year.\(^4\)

For the investment-grade credits in Table 5 on page 55, ie, bonds 1–12 belonging to rating class Aaa, Aa or A, we observe that the IRC is smallest for the shortest liquidity horizon of three months. For the bonds in rating grade Aaa, the IRC is seen to increase substantially when going from a three-month liquidity horizon to a six-month liquidity horizon. However, for the nine- and twelve-month horizons the IRC decreases significantly compared with the six-month liquidity horizon, although they are not as low as for the three-month liquidity horizon case. For bonds rated in class Aa, the IRC increases when moving from a liquidity horizon of three months to one of six or nine months. However, in contrast to the bonds in rating class Aaa, the maximum IRC is achieved for the bonds in rating class Aa when the bond is a buy-and-hold bond. The bonds rated in rating category A have the smallest IRC level with the shortest liquidity horizon of three months. The IRC level becomes higher with little variation in longer liquidity horizons, ie, six, nine and twelve months. We also observe, for the investment-grade bonds, that the realized loss ratio increases with decreasing bond rating quality and, in general, with increasing liquidity horizon.

\(^4\) In general, the loss ratio increases with the liquidity horizon because the longer a bond is held, the more likely it is to default and, hence, to realize the maximum loss. The worse the rating grade of the bond, the closer the loss ratio is to 100% as the probability of realizing the maximum loss is high.
To understand the obtained results for the investment-grade bonds, it is useful to consider the two effects that are involved in the determination of the IRC for a particular bond. Firstly, for a bond that trades frequently, we expect a multiple default risk effect since the newly traded bond is exposed to default and migration risk. However, for the high investment-grade credits that have a relatively small probability of default, we should expect this effect to be rather small, even for high loss quantiles such as at the 99.9% IRC level. The second effect, working in the opposite direction to the multiple defaults effect, is the positive effect of frequent trading to prevent further downgrades. Trading frequently in general mitigates the losses for investment-grade credits.

Returning to the analysis of the premium-rated bonds, ie, the bonds in rating class Aaa, we observe that the IRC increases as we move from a liquidity horizon of three months to one of six months, and then decreases as we move from a liquidity horizon of six months to one of nine and twelve months. This result can be interpreted in the context of the two offsetting effects of short liquidity horizons yielding a positive probability of multiple defaults (or severe migrations) and, at the same time, potentially mitigating default by frequent trading. The bond with a three-month liquidity horizon benefits from the mitigating effect of frequent trading as the short-term three-month default probability is effectively null. However, at the six-month horizon, as the IRC and the realized loss ratio increase, it seems that there is indeed a multiple defaults effect. This is because the six-month liquidity horizon involves two three-month periods and, hence, the six-month liquidity horizon can effectively give rise to multiple defaults by first migrating in the first three months and then defaulting at the second three-month period that is within the six-month horizon. The bond with a nine-month liquidity horizon benefits from the second trading period being relatively short at three months. Hence a default in both the nine-month and three-month horizon bonds is not possible since the three-month default probability is effectively null. For the bond with a liquidity horizon of twelve months, ie, the buy-and-hold bond, the IRC is the same as for the bond with a nine-month liquidity horizon. However, the realized loss ratio has increased from the nine-month bond. On an absolute level, though, since the nine-month liquidity horizon bond has the same IRC as the corresponding twelve-month buy-and-hold bond, the second liquidity period of the nine-month liquidity horizon bond of three months contributes very little to the IRC.

For the bonds in rating class Aa we note that the IRC increases as the liquidity horizon increases and, hence, the dominating effect is the positive effect of mitigating losses by trading frequently. We also observe that the realized loss ratio increases as the liquidity horizon increases, such that the bonds in rating category Aa in general benefit from frequent trading, the mitigating effect of frequent trading being stronger than the multiple defaults effect. For the bonds in rating category A, we also see an
increasing realized loss ratio as the liquidity horizon increases, though the actual IRC level remains the same across liquidity horizons of six, nine and twelve months. The three-month liquidity horizon bond has the lowest level of IRC for A-rated bonds.

For the medium investment-grade bonds in rating class Baa we note that the IRC level is constant over the three-, six-, nine- and twelve-month liquidity horizons. However, the realized loss ratio increases as we increase the liquidity horizon. In particular, the bond with a three-month liquidity horizon has a realized loss ratio of 25%, whereas the bonds with six- and nine-month liquidity horizons have a realized loss ratio of 50%, and the buy-and-hold bond with twelve-month liquidity horizon has a realized loss ratio of 100%. For the bonds in rating class Baa, the constant level of IRC across liquidity horizons can be attributed to the two effects of multiple defaults and the effect of the trade truncating the possibility of further downgrades approximately offsetting each other. The bonds rated in rating category Ba show an increase in the realized loss ratios compared with the Baa-rated bond. We also note that the category of bonds rated Ba is the first rating category that has the minimum IRC level at the twelve-month liquidity horizon, ie, for the buy-and-hold bond. This is consistent with the fact that, on an absolute IRC level, the effect of multiple defaults is stronger than the mitigating effect of frequent trading for this rating category.

For the speculative-grade rating classes, ie, bonds in rating classes B and Caa, Table 5 on page 55 shows that it is always beneficial to assume a long liquidity horizon if one wants to minimize the level of the IRC. This is due to the fact that, for these bonds, the probability of default is severe and hence there is a high probability of multiple defaults and losses if the credit is allowed to trade, especially at the high 99.9% level VaR at which the IRC is measured. The realized loss ratio is 100% or close to 100% for all the bonds in rating categories B and Caa. The preference for a long liquidity horizon for speculative-grade credits, to minimize the IRC level, is also consistent with the guidance set forth by regulators that they do expect that lower-rated bonds should have a longer liquidity horizon than investment-grade bonds. Banks’ preferred assignment of longer liquidity horizons for non-investment-grade bonds is therefore consistent with the regulators’ view.

To summarize our findings from the above analysis, we note that, in the calculation of IRCs, there are two important effects that must be considered. Firstly, for bonds with short liquidity horizons there is a mitigation effect of preventing the bond from further downgrades by trading it frequently. Secondly, there is the effect of the possibility of multiple defaults. Of these two effects, the multiple default effect will generally be more pronounced for non-investment-grade credits as the probability of default is severe even for short liquidity periods and, hence, IRCs will generally increase the shorter the liquidity horizon. For medium investment-grade credits these two effects will, in general, offset one another and the IRC will be approximately the same across
liquidity horizons. For investment-grade credits the effect of the multiple defaults is low for short liquidity horizons as the frequent trading effectively prevents severe downgrades. Not surprisingly, this result regarding preferred liquidity horizons for investment-grade and non-investment-grade credits, in the context of IRC, coincides with results in the credit-spread term structure modeling literature (see, for example, Merton (1974), Sarig and Warga (1989), Fons (1994), Longstaff and Schwartz (1995) and, in particular, Jarrow et al (1997)). That is, the investment-grade credits have increasing credit spreads and the non-investment-grades or speculative grades have downward-sloping spreads reflecting the survival-contingent effects.

5 SUMMARY AND CONCLUSIONS

The IRC calculations required by regulators represent a substantial challenge for banks in adapting their current portfolio credit risk models for traded credits to incorporate assumptions about liquidity horizons. The assigned liquidity horizon for any particular credit represents the bank’s view on the time required to fully hedge or sell the credit without any significant negative liquidity effects on the price. Moreover, the assigned liquidity horizon should, according to regulators, be valid even under stressed conditions. Using the experience of the recent crisis, this requirement has the practical implication that, in effect, only investment-grade credits can be considered to have relatively short liquidity horizons, whereas medium-grade credits should have fairly long liquidity horizons and, finally, non-investment or speculative-grade credits effectively need to be considered as buy-and-hold securities. In the calculation of IRCs there are two important effects at play that determine the IRC for a particular credit rating and liquidity horizon: namely, the mitigation effect of preventing the bond from further downgrades by trading it frequently; and the multiple default effect obtained from frequent trading. In the case of medium rating grade credits these effects roughly offset each other so that the IRC level remains approximately constant across the choice of liquidity horizon. However, for non-investment-grade credits the multiple default effect is stronger, such that, in general, one should expect a lower IRC for conservative assumptions about the liquidity horizon, i.e., by assuming that the credit is buy and hold. For investment-grade credits, the mitigation effect from frequent trading is generally stronger than the multiple defaults effect due to low default probabilities. Hence, a short liquidity horizon is preferred for high-quality credits as this assumption gives a lower IRC in general. This result shows that the market and regulatory rationale for assigning stressed liquidity horizons to credits is aligned with banks’ preferred choice of liquidity horizons to minimize the IRC add-on to the total capital charge for the trading book. While it is noticeable that regulators’ interest in keeping liquidity horizons short only for investment-grade credits is aligned with banks’ incentives in terms of how to allocate the liquidity horizons across different
TABLE 5  Maximum loss, incremental risk charge and realized loss ratio for the sample bonds 1–28 rated in Moody’s categories Aaa, Aa, A, Baa, Ba, B and Caa with different liquidity horizons of three, six, nine and twelve months.

<table>
<thead>
<tr>
<th>Bond</th>
<th>Rating class</th>
<th>Liquidity horizon (months)</th>
<th>99.9% maximum loss</th>
<th>IRC loss</th>
<th>Loss ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aaa</td>
<td>3</td>
<td>266.74</td>
<td>1.52</td>
<td>0.57</td>
</tr>
<tr>
<td>2</td>
<td>Aaa</td>
<td>6</td>
<td>133.37</td>
<td>10.05</td>
<td>7.53</td>
</tr>
<tr>
<td>3</td>
<td>Aaa</td>
<td>9</td>
<td>133.37</td>
<td>2.27</td>
<td>1.70</td>
</tr>
<tr>
<td>4</td>
<td>Aaa</td>
<td>12</td>
<td>66.68</td>
<td>2.27</td>
<td>3.40</td>
</tr>
<tr>
<td>5</td>
<td>Aa</td>
<td>3</td>
<td>266.14</td>
<td>9.85</td>
<td>3.70</td>
</tr>
<tr>
<td>6</td>
<td>Aa</td>
<td>6</td>
<td>133.07</td>
<td>9.85</td>
<td>7.40</td>
</tr>
<tr>
<td>7</td>
<td>Aa</td>
<td>9</td>
<td>133.07</td>
<td>10.96</td>
<td>8.24</td>
</tr>
<tr>
<td>8</td>
<td>Aa</td>
<td>12</td>
<td>66.53</td>
<td>26.9</td>
<td>40.4</td>
</tr>
<tr>
<td>9</td>
<td>A</td>
<td>3</td>
<td>262.8</td>
<td>25.79</td>
<td>9.81</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
<td>6</td>
<td>131.4</td>
<td>65.70</td>
<td>50</td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td>9</td>
<td>131.4</td>
<td>65.70</td>
<td>50</td>
</tr>
<tr>
<td>12</td>
<td>A</td>
<td>12</td>
<td>65.70</td>
<td>65.70</td>
<td>100</td>
</tr>
<tr>
<td>13</td>
<td>Baa</td>
<td>3</td>
<td>259.9</td>
<td>64.98</td>
<td>25</td>
</tr>
<tr>
<td>14</td>
<td>Baa</td>
<td>6</td>
<td>129.96</td>
<td>64.98</td>
<td>50</td>
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<tr>
<td>15</td>
<td>Baa</td>
<td>9</td>
<td>129.96</td>
<td>64.98</td>
<td>50</td>
</tr>
<tr>
<td>16</td>
<td>Baa</td>
<td>12</td>
<td>64.98</td>
<td>64.98</td>
<td>100</td>
</tr>
<tr>
<td>17</td>
<td>Ba</td>
<td>3</td>
<td>236.6</td>
<td>76.21</td>
<td>32.2</td>
</tr>
<tr>
<td>18</td>
<td>Ba</td>
<td>6</td>
<td>118.30</td>
<td>118.30</td>
<td>100</td>
</tr>
<tr>
<td>19</td>
<td>Ba</td>
<td>9</td>
<td>118.30</td>
<td>76.21</td>
<td>64.4</td>
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<tr>
<td>20</td>
<td>Ba</td>
<td>12</td>
<td>59.15</td>
<td>59.15</td>
<td>100</td>
</tr>
<tr>
<td>21</td>
<td>B</td>
<td>3</td>
<td>185.43</td>
<td>165.70</td>
<td>89</td>
</tr>
<tr>
<td>22</td>
<td>B</td>
<td>6</td>
<td>92.72</td>
<td>92.72</td>
<td>100</td>
</tr>
<tr>
<td>23</td>
<td>B</td>
<td>9</td>
<td>92.72</td>
<td>92.72</td>
<td>100</td>
</tr>
<tr>
<td>24</td>
<td>B</td>
<td>12</td>
<td>46.36</td>
<td>46.36</td>
<td>100</td>
</tr>
<tr>
<td>25</td>
<td>Caa</td>
<td>3</td>
<td>105.56</td>
<td>105.56</td>
<td>100</td>
</tr>
<tr>
<td>26</td>
<td>Caa</td>
<td>6</td>
<td>52.79</td>
<td>52.79</td>
<td>100</td>
</tr>
<tr>
<td>27</td>
<td>Caa</td>
<td>9</td>
<td>52.79</td>
<td>52.79</td>
<td>100</td>
</tr>
<tr>
<td>28</td>
<td>Caa</td>
<td>12</td>
<td>26.39</td>
<td>26.39</td>
<td>100</td>
</tr>
</tbody>
</table>

Credit grades, it is not surprising. Indeed, this finding, in the context of IRCs, that the best allocation of the liquidity horizon across credit qualities, with high-quality credits having short liquidity periods and low-quality credits having long liquidity horizons, coincides with the empirical credit-spread term structure. The investment-grade credits have increasing credit spreads and the speculative grades have downward-sloping spreads, reflecting the survival-contingent effects. Therefore, the liquidity horizon
specification in the IRC requirement from the Basel Committee is consistent with the empirical study of credit risk and banks’ incentives in capital requirement conservatism, and consequently alleviates concerns with regard to IRC model validation.

Finally, while this paper has not focused on examining correlated portfolios in the context of IRCs, instead focusing on stylized bonds to isolate the effect of the choice of the liquidity horizon from correlation effects, it is of interest to compare our results with the Basel quantitative impact study on the portfolio effects of IRCs (Basel Committee on Banking Supervision (2009b)). The finding of the Basel quantitative impact study is, not surprisingly, that the new IRC capital will, on average, increase the market risk capital charge. For example, for a uniform choice of a liquidity horizon of three months, the average increase in market risk capital from IRC, for the sample of twenty-five banks, is 103%. However, more closely related to our study are the Basel quantitative impact results obtained from the twenty-five sample banks when different uniform choices of liquidity horizons are made for the bank portfolios. The Basel results show an increase in the IRC capital when liquidity horizons increase. Specifically, increasing the liquidity horizon from one month to six months increases the capital charge by, on average, 20%. In addition, for sample banks that provided estimates for both one-month and three-month uniform liquidity horizons, the average increase in the capital charge is 3%. While, admittedly, correlation effects may blur our findings, in the context of the choice of liquidity horizons for bonds, it is interesting to note that the fact that the IRC capital increases, on average, for the Basel sample banks is consistent with our findings should those banks have, on average, investment-quality bond portfolios.

REFERENCES
Basel Committee on Banking Supervision (1996). Amendment to the capital accord to include market risks. URL: www.bis.org/publ/bcbs24.pdf.


