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# Marking-to-model credit and operational risks of loan commitments: A Basel-2 advanced internal ratings-based approach☆

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ABSTRACT

Within a marking-to-model framework, this research computes the bank's capital charge for credit and operational risks of loan commitments at Basel-2 fixed audit date. This is done in three steps. The first one prices commitment credit risk as a Gram–Charlier put value and determines the commitment forward-funding proportion. In the second one, put value and funding proportion are combined to compute Basel-2 'fair' capital charge for credit and operational risks. By producing a moderate total capital charge, marking-to-model offers substantial capital relief with respect to the corresponding charge computed with Basel-2 simplified approach. Both charges are however larger than the corresponding nil charge arrived at in Basel-1. In the third step, marking-to-model reveals its flexibility by showing how banks can determine the cost of their exposure to borrowers' credit-rating downgrades and how they can also hedge any exposure to commitment default risk.



## 1. Introduction

That Basel-2 (Basel Committee on Banking Supervision, 2006) offers banks capital relief when they compute their capital charge for commitment risk with their own procedure instead of the simplified standardized approach may seem counter-intuitive in a period of credit crisis. This paper intends to show that this may not be the case for short-term irrevocable commitments.[1] While Basel-2 internal procedure does offer capital relief with respect to the simplified approach, both Basel-2 procedures do indeed produce increased capital charges compared to the one arrived at in Basel-1 — a more acceptable situation in a credit-crisis environment. We focus here on loan commitments for two reasons. They are the banks' most important off-balance-sheet credit instrument and Basel-2 proposes to change the way the risk-weighted balance of short-term irrevocable credit commitments is computed.

We first highlight the commitment relative importance with the aggregate figures from Canada's six largest chartered (commercial) banks.[2] In 2008, their contractual amount of commitments ($433.2 billion — all amounts in Canadian $) represents 73.7% of all of their off-balance-sheet credit instruments. And the amount of undrawn commitments represents 59.94% of that of on-balance-sheet drawn commercial loans (namely, the banks' $722.7 billion of exposure at default — their EAD). Due to changes in Basel-2 commitment risk weights, we focus here on the $215.3 billion of short-term irrevocable commitments, which represent 49.7% of all irrevocable commitment contracts. In short, loan commitments are essential to commercial banking.

Next, Basel-2 proposes to change the way the risk-weighted balance of short-term irrevocable credit commitments is computed.[3] More specifically, the simplified standardized approach introduces a new 20% credit-conversion factor (CCF) and a new 100% principal-risk factor (PRF) for those commitments — both weights being previously nil in Basel-1. Beyond the simplified approach, Basel-2 also offers

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[1] Basel-2 maintains Basel-1 (Basel, 1988) distinction between short-term commitments, namely those with an initial term to maturity less than one year, and longer-term ones, namely those with an initial term to maturity longer than one year. Irrevocable commitments are unused portions of firm authorizations to extend credit and revocable commitments are offers but no obligations to extend credit.

[2] Figures are from the 2008 annual reports of (an oligopoly of) six banks, namely the Bank of Montreal, the Bank of Nova Scotia, the Canadian Imperial Bank of Commerce, the National Bank, the Royal Bank and TD Canada Trust. Basel-2 simplified standardized approach is representative of such an industry-wide situation.

[3] Basel-2 simplified approach leaves most of Basel-1 commitment credit-risk coefficients unchanged. Namely, both credit-conversion factor (CCF) and principal-risk factor (PRF) remain 0% for all revocable commitments irrespective of their term-to-maturity, and the 50% CCF and 100% PRF also remain in force for longer-term irrevocable commitments.

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foundation and advanced internal ratings-based (IRB) approaches; for clarity, only the advanced one is considered here. The latter allows certain banks to device their own way to compute their capital charge, to the extent that the procedure is vetted by the regulators in accordance with the supervisory review process of Basel-2 second pillar. While banks can so reduce their capital charge regarding the credit risk of short irrevocable commitments, this relief is offset to a certain extent by the introduction in Basel-2 of operational risk.[4] In addition, capital relief is also capped by a transient capital floor: 90% and 80% relative to Basel-1 for the first and second year of the implementation of any Basel-2 advanced IRB procedure.

That Basel-2 simplified approach directly relates credit risk of short irrevocable commitments to their capital charge is a welcome step forward. But the connection will be stronger if Basel-2 accounting-based conversion and risk factors are replaced by model-based concepts, which also have the advantage to be consistent with the disclosure approach extolled in Basel-2 third pillar. So, we propose a marking-to-model procedure[5] in which the commitment capital charge is based on a measure of the commitment true credit risk and the expected credit-line takedown (namely the average amount of the credit line draw down when the line is exercised). Marking to model commitment credit risk is thus viewed as an advanced IRB approach that (i) combines the (put) valuation of commitment credit risk with an exercise-cum-takedown empirical proportion, (ii) substitutes put value and funding proportion for the principal-risk and credit-conversion factors prescribed in Basel-2 simplified approach, and (iii) adds a new capital charge for commitment operational risk. Marking-to-model does rise however a couple of questions. 1) Does a Basel-2-generated European put option correctly reflect the commitment 'true' credit risk? 2) Does this implicit put value reflect any asymmetry and/or excess kurtosis in the density function of the underlying credit line? 3) To what extent is credit-line funding dependent on the varying remaining term to commitment expiry? And 4) Does the 'fair' capital charge corresponding to the commitment 'true' credit and operational risks offer the bank any capital relief?

Structural models are used extensively to value directly commitment credit risk. For instance, Thakor, Hong, and Greenbaum (1981), and Ho and Saunders (1983) derive option-like values for fixed-rate commitments. Thakor (1982) and Chateau (1990, 2007) obtain European and American put formulas for floating-rate commitments, and Chateau and Wu (2007) price extendible credit lines. Finally, revolving lines are priced in Hawkins (1982) and commercial paper backup credit lines are modeled in Loukoinova et al. (2007). Recently however, Jarrow and Turnbull (2000), Hugston and Turnbull (2001) and Chava and Jarrow (2007) have introduced a reduced-form approach[6] to loan commitments, in which their pricing is related to that of risky and defaultable corporate bonds (Jarrow & Turnbull, 1995). This approach complements the structural studies in that it considers credit lines over time, namely both phases of off-balance-sheet commitment and on-balance-sheet outstanding loan. The approach stresses valuing all aspects of credit lines simultaneously, but does not separate commitment risk pricing from the other risks specific to outstanding loans, as mandated in Basel-2. Moreover, in computing the capital charge in Basel-2 simplified approach, the risk weights applied to commitments are different from those applied to corporate bonds. The approach is also problematic for the commitment main users, the small and medium firms, which may not have access to bond debt. Commitments are a primary market without secondary market; yet it is from the bond secondary market that the reduced form approach gathers bond prices and firm-specific information. And finally, indirect pricing is also very much dependent on the calibration of the parameters of the bond model (Vasicek, Cox–Ingersoll–Ross, Hull–White, and so on). Here we propose to extend the structural approach by: (i) pricing the futures put option embedded in the commitment (ii) adjusting its value for any nonnormal skewness and excess kurtosis in the risk-neutral density of the underlying indebtedness futures value[7], and (iii) making sure that its arbitrage-free value satisfies the Jondeau–Rockinger positivity constraint as well as the true Martingale restriction.[8] The resultant expression values the futures put option embedded in short-term irrevocable commitments.

To the extent this put value correctly reflects the credit risk of short irrevocable commitments, it seems sensible to determine its impact on the bank's risk-weighted capital charge mandated by Basel-2. The aggregate value of undrawn short-term commitments is reported as an off-balance-sheet entry to the bank annual consolidated balance sheet. For many of the one-year commitments at that date, the remaining term to commitment maturity is less than the initial term. The annual reporting date also often coincides with Basel-2 capital-adequacy audit date. While it is the fixed markup of the floating-rate commitment[9] that gives rise to the put option, it is Basel-2 fixed audit date that makes the option European. In brief, the European put value corresponds to the bank's notional liability for carrying the commitment unused portions at the capital-adequacy fixed audit date.

Marking to model commitment risk within Basel-2 time frame is performed in three steps. In a first step, we value the Basel-2-generated Gram–Charlier put option embedded in short irrevocable commitments. A takedown proportion is defined next: it combines an exercise-indicator function that captures the line exercise decision to a partial takedown proportion that increases with the time left to commitment expiry. As commitment puts are but the notional values of embedded credit-risk derivatives, simulations are required to quantify the cost of the bank's exposure to commitment credit risk. In a second step, put value and takedown proportion are combined to compute the 'fair'[10] capital charge for the credit risk of short irrevocable commitments. To which is added a fair charge for commitment operational risk. Marking to model both risks produces moderate total capital charges, imposes some quasi-market discipline and aligns regulatory and economic capital requirements of short irrevocable commitments. The model-based procedure is chosen next as benchmark from which to assess the capital charge computed with Basel-2 simplified procedure. While the comparison highlights the capital relief offered by the advanced procedure, it also shows that both Basel-2 charges are larger than the Basel-1 corresponding charge. In the third and final step, marking to

[4] Operational risk is defined in Basel-2 as the "risk of loss resulting from inadequate or failed internal processes, people and systems or from external events."

[5] In the absence of a secondary market for credit commitments, they are marked-to-model instead of marked-to-market. While marking to model also applies to longer-term commitments, we consider short ones here since Basel-2 simplified approach focuses on their weight changes.

[6] For a detailed exposition of structural versus reduced-form approaches, consult Bielecki and Rutkowski (2002) or Güdüz and Uhrig-Homburg (2008).

[7] There have been significant advances in research on contingent claims with nonnormal skewness and excess kurtosis. Corrado and Su (1996) use the Gram–Charlier Type-A series expansion of a normal density function to derive the value of a European call option adjusted for skewness and kurtosis. And the latter skewness coefficient is corrected by Brown and Robinson (2002). A lengthy literature also exists that addresses the question of the non-zero skewness and greater-than-three kurtosis of various returns: beyond the afore-mentioned references, consult Andersen, Benzoni, and Lund (2002), Backus et al. (2004), Jondeau and Rockinger (2001), Knight and Satchell (1997), Lekkos (1999), Li (2000), and Wilkens and Röder (2006), among others.

[8] The true Martingale restriction corresponds to a first-moment restriction on a truncated (here four-moment) expansion of the normal density function; the latter actually becomes a Gram–Charlier density when the Jondeau–Rockinger positivity constraint is satisfied. This approach is developed in Backus et al. (2004), Corrado (2007), Jurczenko et al. (2002a,b, 2004), Ki et al. (2005), or Kochard (1999). This restriction takes into account the third and fourth moments of the risk-neutral density function of the indebtedness-value changes; it is thus more general than Longstaff's (1995) Martingale restriction based on the first two moments of the log-normal density.

[9] A floating-rate is defined as "fixed markup over a stochastic cost of funds". According to the Federal Reserve survey of year 2001 (Board of Governors of the Federal Reserve System, 2001), 82% of U.S. commercial and industrial lending is done via loan commitments, with the vast majority being of the floating-rate type.

[10] The term "fair" implies here that the arbitrage-free valuation also aligns regulatory and economic values.