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Supervisory requirements and expectations for portfolio level counterparty credit risk measurement and management

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Abstract

Purpose – This study aims to survey supervisory requirements and expectations for counterparty credit risk (CCR).

Design/methodology/approach – In this paper, a survey of CCR including the following elements has been performed. First, various concepts in CCR measurement and management, including prevalent practices, definitions and conceptual issues have been introduced. Then, various supervisory requirements and expectations with respect to CCR have been summarized. This study has multiple areas of relevance and may be extended in various ways. Risk managers, traders and regulators may find this to be a valuable reference. Directions for future research could include empirical analysis, development of a theoretical framework and a comparative analysis of systems for analyzing and regulating CCR.

Findings – Some of the thoughts regarding the concept of risk will be considered and surveyed, and then how these apply to CCR will be considered. A classical dichotomy exists in the literature, the earliest exposition upon which is credited to Knight (1921), who defines uncertainty is when it is not possible to measure a probability distribution or it is unknown. This is contrasted with the situation where either the probability distribution is known, or knowable through repeated experimentation. Arguably, in economic and finance (and more broadly in the social or natural as opposed to the physical or mathematical sciences), the former is a more realistic scenario that is being contended with (e.g. a fair vs loaded die, or die with unknown number of sides.) The authors are forced to rely upon empirical data to estimate loss distributions, but this is complicated because of changing economic conditions, which invalidate forecasts that our econometric models generate.

Originality/value – This is one of few studies of the CCR regulations that is so far-reaching.

Keywords Credit risk, Counterparty credit risk, Basel, Market risk

Paper type Conceptual paper

1. Introduction and motivation

A bank's CCR exposure quantifies how much money the counterparty might owe the bank in the event of default. The CCR quantity is broken down into *current exposure* ("CE"), which measures the exposure if the counterparty were to default today, and *potential exposure* ("PE"), which measures the potential increase in exposure that could occur between today and some time horizon in the future. The time of default time is typically modeled as a stochastic stopping time. As opposed to that known as the CE to a counterparty, the PE must be estimated, usually by simulation.

First, the *expected positive exposure* ("EPE") is computed by simulating a large number (on the order of 10^2 - 10^3) different paths for the various underlying future prices



in the possible market environments, using a so-called “regularized” variance–covariance matrix (“VCM”). The system then performs the following operations:

- prices each of the derivative transactions on each path for each sample date[1];
- computes collateral call amounts based upon mark-to-market (“MTM”) calculations;
- where relevant, applies the portfolio effects of netting and collateral; and
- aggregates exposure results to compute the average exposure along a term structure.

While an EPE may be a good indicator of the cost to replace a contract, should the counterparty default, it is not helpful in the trade inception approval process, as it is volatile and one needs a high confidence interval picture. Therefore, many banks will also report a very high (e.g. 97.7th or 97.5th) percentile of the exposure distribution over a large number of paths.

Note that these peaks in exposure profiles are not simply added over different products for a given counterparty, as these peaks may happen at different points in time. Rather, the time profiles of exposures are summed over products traded with a single CP, and the peak of that time profile is the summary PE measure. This methodology is conservative, as PEs are simply added over counterparties, while the bank may enter trades that mitigate each other in terms of PE with different counterparties.

We can readily see that CCR measurement necessarily combines the tools from standard market risk measurement with the tools from standard credit risk determination. This frequently requires a *probability-of-default* (“PD”), *loss-given-default* (“LGD”), *exposure-at-default* (“EAD”) and a credit rating of the counterparty[2], which presents unique challenges related to both that we shall discuss herein.

The *credit valuation adjustment* (“CVA”) is defined as the product of the EPE times the LGD times the *cumulative mortality rate* (“CMR”), where the CMR is simply a multi-period PD rate. This is structurally equivalent to pricing EPE as the contingent leg of a *credit default swap* (“CDS”), by applying the counterparty spread to it. Such a spread is either a market quote if the name has a bespoke traded CDS or a pseudo-CDS spread computed along a grid arrayed by region, industry, rating and tenor; and in the worst case, bond or loan spreads are used, giving rise the basis risk. It can be recognized that it is this part of the process that joins the market and the credit risk aspects of the algorithm. Market risk measurement practices are used in mapping derivatives exposures to a set of market risk factors (e.g. spreads, volatilities or correlations), simulating those factors out to a forward-looking time horizon and determining the distribution of the level of exposures over various realizations of these risk factors in the simulation. Separately, standard credit risk processes provide assessments of the credit quality of the counterparty, such as PD and LGD estimation.

Direct or originating businesses (i.e. trading desks) are viewed as credit portfolios: as their positions get in the money, this gives rise to CCR, as the counterparty may default while owing money to the bank. The CVA represents a daily MTM transfer price of default risk charged to the originating business for insuring default risk, which is the price of a pseudo-CDS hedge with the EPE as underlying notional. The group (e.g. the market risk management department) that sells insurance to the business at inception of

the trade will cover any loss due to counterparty default. As the exposure rises, due to either an increase in the position or a decrease in the credit quality of the counterparty, the CVA increases as it MTM. On the other hand, a profit is reported if the CVA decreases, due either to the bank's position becoming less in-the-money, an improvement in the counterparty's credit rating or just the passage of time without any credit event. However, no further credit-related charges or costs are incurred by the business. In the limit, the CVA disappears as the maturity of the derivative contract is reached and payment – if any is due – is made to the bank.

Products that are new or too complex to be properly simulated within the main CCR engine are dealt with “offline”. This usually means assigning them “risk factors” or, more generally, “add-ons”, that are conservative and do not allow for netting; for this reason, such offline trades may account for up to 50 per cent of the total exposure, although only 5-10 per cent of trades are made. The problem is that the CCE is not sensitive to actual risk any longer: the sum of these add-ons may lead to the same measure of CCE for a set of offsetting trades as it does for a set of trades that have no offsets. Hence, these add-ons are really suited only for CCE with counterparties having single trades. Moreover, the large exposures they generate are not taken seriously by management, and these products do not undergo the complementary/downstream risk management processes such as *stress testing* (ST), which results in risk measures that do not provide a comprehensive view of the risks that banks face. Worse still, management may increase limits for these products, aware that their CCR is overstated, thus defeating the purpose of these add-ons.

A relatively new but expanding practice is to model *debt valuation adjustment* (“DVA”) in the CCR framework, reflecting an institution's own option to default. Counterparties implicitly charge counterparties for their option to default, as when a derivative position is out-of-the-money with respect to the institution in question, it is, in effect, borrowing from the counterparty and implicitly paying for its outstanding liability through its credit spread. One way for a bank to fund its CVA would be to generate income from the sale of CDS's on itself, which cannot be done, hence the remaining portion of credit risk as reflected by CVA. However, note that such “gut” appeal DVA stems from the realization that if a bank enters a par swap agreement with a counterparty that has the same credit spread, then theoretically, credit risk considerations should not enter the pricing decision (i.e. the CVA and DVA should cancel for both parties in the transaction).

Analogously to the CVA, scenarios for underlying market factors are generated and averaged over the resultant negative portfolio MTM values (liabilities), taking into account legal netting and collateral agreements. The resulting *expected negative exposure* (“ENE”), floored at zero if a bank gets in-the-money in any given scenario, is what risk managers expect to owe its counterparties on its derivative portfolio at the time of its default. It is priced as the contingent leg of a credit default swap using the bank's bank spreads, assuming that all deals are netted where possible, reflecting the fact that within the bank's jurisdiction, it is likely that its counterparties would legally seek to net all positions upon its default.

For collateral considerations, often two types of defaults are considered. First, consider the case in which a bank defaults idiosyncratically, and a “springing” unilateral collateral agreement is assumed. This reflects the likely behavior of counterparties, which, upon a worsening of a bank's credit worthiness, will either

demand to enter into unilateral collateral agreements where there are none or to renegotiate existing collateral agreements to terms favorable to them. Second, there is the case of a systemic default, where a bank's default is part of a broad economic downturn. In this case, it is much less clear that counterparties will be able to impose or change collateral agreements in their favor, and thus springing collateral is not considered. The final ENE is a weighted average of the two cases, such that the relative weight is the relative likelihood of an idiosyncratic, as opposed to a systematic, default. These weights could be determined by the relative intensities of default implied by a bank's par spread curve and its risk premium spread curve backed using a capital asset pricing model ("CAPM") methodology.

2. Conceptual issues in CCR: risk vs uncertainty

In this section, we will consider and survey some of the thoughts regarding the concept of risk, and then consider how these apply to CCR. A classical dichotomy exists in the literature, the earliest exposition upon which is credited to Knight (1921), who defines uncertainty is when it is not possible to measure a probability distribution or it is unknown. This is contrasted with the situation where either the probability distribution is known, or knowable through repeated experimentation. Arguably, in economic and finance sciences (and more broadly in the social or natural as opposed to the physical or mathematical sciences), the former is a more realistic scenario that we are contending with (e.g. a fair vs loaded die, or die with unknown number of sides). We are forced to rely upon empirical data to estimate loss distributions, but this is complicated because of changing economic conditions, which invalidate forecasts that our econometric models generate.

Popper (1945) postulated that situations of uncertainty are closely associated with, and inherent with respect to, changes in knowledge and behavior. This is also known as the rebuttal of the historicism concept, that our actions and their outcomes have a pre-determined path. He emphasized that the growth of knowledge and freedom implies that we cannot perfectly predict the course of history. For example, a statement that the US currency is inevitably going to depreciate, if the US does not control its debt, is not refutable and therefore not a valid scientific statement according to Popper (Figure 1).

Shackle (1990) argued that predictions are reliable only for immediate future. He argues that such predictions impact the decisions of economic agents, and this has an effect on the outcomes under question, changing the validity of the prediction (a feedback effect). This recognition of the role of human behavior in economic theory was a key impetus behind rational expectations and behavioral finance. The implication is that risk managers must be aware of the model limitations that a ST regime itself changes behavior (for example, banks "gaming" the regulators CCAR process.) The conclusion is that while it is valuable to estimate loss distributions that help make explicit sources of uncertainty, we should be aware of the inherent limitations of this practice, which is a key factor in supporting the use of ST to supplement other risk measures. Finally, some desirable features of a risk measure were postulated, collectively known as *coherence*. They argue that value at risk (VaR) measures often fail to satisfy such properties.

In light of these consideration, we may see that a meta-problem in estimating CCR exposure over long horizons (e.g. 10, 20, 30 years) is that it may simply inestimable. When one tries to forecast prices one or ten days ahead for trading VaR purposes, or

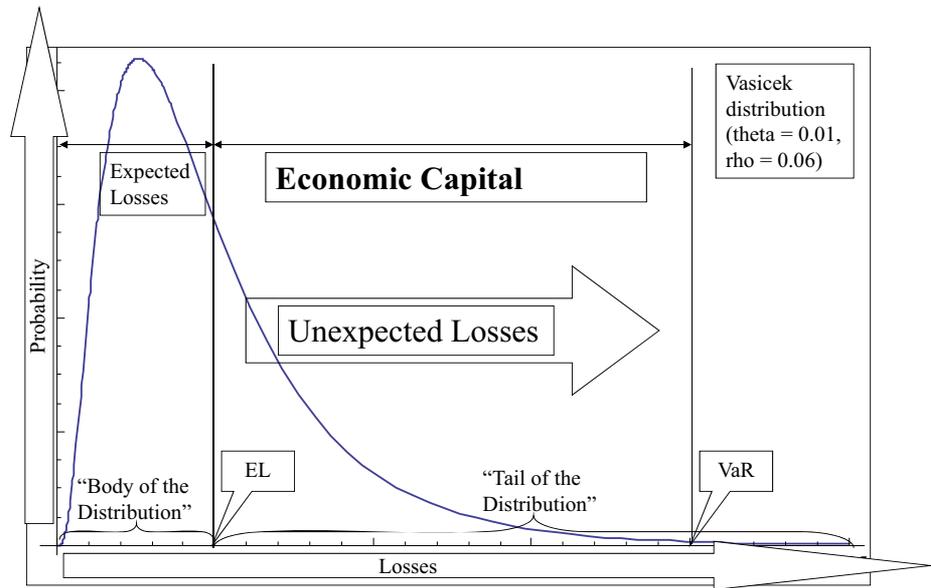


Figure 1.
Stylized representation of economic capital

even one year ahead for other regulatory capital purposes (e.g. credit capital for banking book exposures), one is dealing with quantifiable risk. But when trying to forecast an exchange rate or a commodity price 30 years ahead, one is dealing with unquantifiable Knightian uncertainty. We take past history as a single homogeneous sample and believe that we have considerably increased our knowledge of the future from the observation of the sample of the past. For example, the study of the US financial markets of the early twentieth century will certainly be of great help to an economic historian, but we should question any kind of inference that come out of this analysis with respect to current applicability, as the structure of the institutions and the markets has changed to such a degree.

To illustrate this issue, consider the evolution of the rates markets in the USA. In the last 30 years, short-term interest rates flirted in this jurisdiction, went from nearly 20 per cent at the peak of the 1980's Bull Market, to the very low single digits in the wake of Federal Reserve quantitative easing following the financial crisis. Therefore, we see how this non-stationarity can make past data quite irrelevant in such situations of dramatic regime change. However, this is not only a problem for long-dated FX or IR contracts, as trying to make multi-year forecasts the commodity or equity can be seen as pointless endeavor. There exist no qualitative adjustments, such as the conservative factors applied by many large banks to exposures they cannot really model within their main CCR engine, that can lend credence to this practice.

It has been said that what began with the best intentions from a collection of idealistic modeling enthusiasts has degenerated into pseudoscience at best, and fraud at worst. In this view, the game is to disguise charlatanism under the veneer of mathematical sophistication, and leading to propositions that cannot be validated or refuted, as we are not dealing in controlled experimentation, leading to the illusion that we understand markets. This self-attribution phenomenon usually gets worse with one's mathematical

knowledge: the more complex the equations, the more we believe in our models. However, financial engineering still measures risks using models built upon historical data as the core tool deployed to future events. We will just say at this point that the mere possibility of the distributions not being stationary makes the entire long-dated CCR estimation seem like a costly mind game. As we rely increasingly on models of increasing mathematical complexity, our confidence becomes greater that we have correctly modeled all price dynamics, and this may be a false sense of security. We see the phenomenon that new traders on the block dismiss past traders who blew up spectacularly as not sophisticated enough, and are persuaded that their models are more refined and better able to forecast future market movements, until they blow up quite dramatically themselves.

3. Supervisory requirements for CCR[3]

CCR is defined as the risk that the counterparty to a transaction could default or deteriorate in creditworthiness before the final settlement of a transaction's cash flows. Unlike a loan, where only a bank faces the risk of loss, CCR creates a bilateral risk of loss because the market value of a transaction can be positive or negative to either counterparty. The future market value of the exposure and the counterparty's credit quality are uncertain and may vary over time as underlying market factors change. The regulatory focus is on institutions with large derivatives portfolios, in setting their risk management practices, as well as by supervisors as they assess and examine CCR management.

CCR is multidimensional, affected by both the exposure to and credit quality of the counterparty, as well as their interactions, all of which are sensitive to market-induced changes. Constructing an effective CCR management framework requires a combination of risk management techniques from the credit, market, and operational risk disciplines. CCR management techniques have evolved rapidly and improved over the past decade, along with increased complexity of derivative instruments under management. While institutions substantially improved their risk management practices, in some cases, implementation of sound practices has been uneven across business lines and counterparty types. The financial crisis of 2007-2009 revealed weaknesses in CCR management: timeliness and accuracy of exposure aggregation capabilities and inadequate measurement of correlation risks. The crisis also highlighted deficiencies in monitoring and management of counterparty limits and concentrations, ranging from poor selection of CCR metrics to inadequate infrastructure.

BCBS (2004), the "revised framework", was intended to promote a more forward-looking approach to capital supervision that encourages banks to identify and manage the risks they face. Treatment of CCR arising from over-the-counter (OTC) derivatives and repos in either trading or banking books was first set forth in an amendment to the original 1988 Basel Accord (BCBS, 1988) treatments for the CCR of repo-style. BCBS (2004) represents joint work with the International Organization of Securities Commissions (IOSCO) on the treatment of CCR for OTC derivatives, repo-style and securities financing.

The regulations specify three methods for calculating EAD for transactions involving CCR: the internal model method (IMM), a standardized method (SM) and the (at the time existing) current exposure method (CEM).

3.1 Commonalities across approaches to CCR

Positions that give rise to CCR exposures share certain generic characteristics. First, generate a credit exposure: the cost of replacing the transaction if the counterparty defaults assuming there is no recovery of value. Second, exposures depend on one or more underlying market factors. Third, transactions involve an exchange of payments or financial instruments identified with an explicit counterparty having a unique PD.

CCR for a position at any point in time is equal to the maximum of zero or replacement cost (market value) for each counterparty over tenure. This may include the use of collateral to mitigate risk, legal netting or “rights of offset” contracts and the use of re-margining agreements. The fact that similar risk characteristics, products and related activities with CCR are managed by institutions using similar methods and processes imply they may merit similar capital requirements. However, there are differences in rule treatment between “OTC” exposures and *securities financing transactions* (SFTs). SFTs include securities lending and borrowing, securities margin lending and repurchase and reverse repurchase agreements.

The Basel II/Revised Framework (BCBS, 2004) already provides three methods for SFTs: a simple approach, a comprehensive approach with both supervisory and non-supervisory haircuts and a VaR model.

An “IMM” to CCR is available for both SFTs and OTC derivatives, but the non-model methods available for the latter are not applicable to the former. Institutions use several measures to manage their exposure to CCR, including *potential future exposure* (“PFE”), *expected exposure* (“EE”) and “EPE”. Banks typically compute these using a common stochastic model (Figure 2). PFE is the maximum exposure estimated to occur on a future date at a high level of statistical confidence, often used when measuring CCR exposure against credit limits. EE is the probability-weighted average exposure estimated to exist on a future date. EPE is the time-weighted average of individual expected exposures estimated for given forecasting horizons (e.g. one year). EPE is generally viewed as the appropriate EAD measure for CCR, since such are treated similarly to loans, and reduces incentives to arbitrage regulatory capital across product types, therefore internal model and standardized employ this for EAD.

Consistent with the Revised Framework for credit risk, the EAD for instruments with CCR must be determined conservatively and conditionally on an economic downturn (i.e. a “bad state”). To accomplish such conditioning in a practical, pragmatic and conservative manner, the internal model and standardized methods proposed scale EPE using “alpha” and “beta” multipliers. Alpha is set at 1.4 for both the internal model and the standardized methods, but supervisors have the flexibility to raise alpha in appropriate situations. Banks may internally estimate alpha and adjust it for both correlations of exposures across counterparties and potential lack of granularity across a firm’s counterparty exposures. The alpha multiplier is also viewed as a method to offset model or estimation errors. Industry and supervisors’ simulations suggest alphas may range from approximately 1.1 for large global dealers to >2.5 for new users of derivatives with concentrated or no exposures. Supervisors proposed to require institutions to use supervisory specified $\alpha = 1.4$ with the ability to estimate a firm portfolio-specific alpha subject to supervisory approval and a floor of 1.2. To estimate alpha, a bank would compute the ratio of *economic capital* (“EC”) for counterparty credit risk from a joint simulation of market and credit risk factors to EC when counterparty

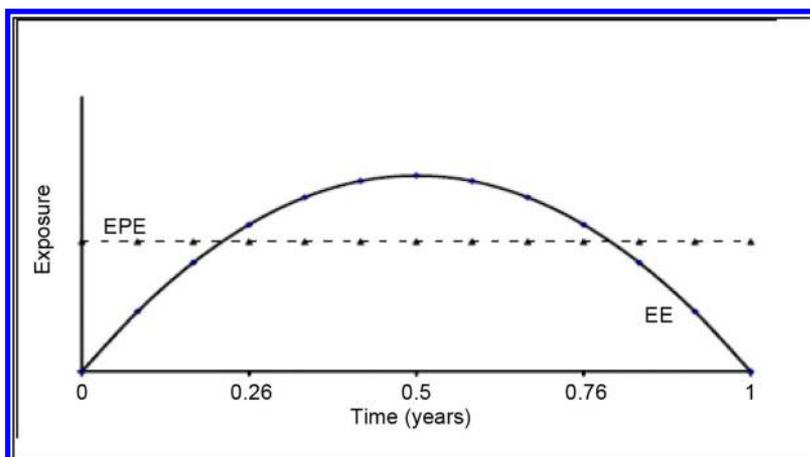


Figure 2.
EEP for CCR

exposures are a constant amount equal to EPE. Under the internal model method, the resulting risk weight may be adjusted to reflect the transaction's maturity (Figure 3).

Banks may estimate EAD based on one or more bilateral "netting sets", a group of transactions with a single counterparty subject to a legally enforceable bilateral netting arrangement. Bilateral netting is recognized for purposes of calculating capital requirements within certain product categories: OTC derivatives, repo transactions and on-balance-sheet loans/deposits. However, the Amended Accord and Revised Framework netting across product categories is not recognized for regulatory capital purposes. The intent is to allow supervisors discretion to permit banks to net margin loans secured by purchased securities and executed with a counterparty under a legally enforceable master agreement. This is not intended to permit banks to net across different types of SFTs or to net SFTs against OTC derivatives that might be included in a prime brokerage agreement. Cross-Product Netting Rules recognize such between OTC derivatives and SFTs subject to national supervisor determination that enumerated legal and operational criteria are widely met. Bank should have obtained a high degree of certainty on the legal enforceability of the arrangement under the laws of all relevant jurisdictions in the event of a counterparty's bankruptcy. It is also important

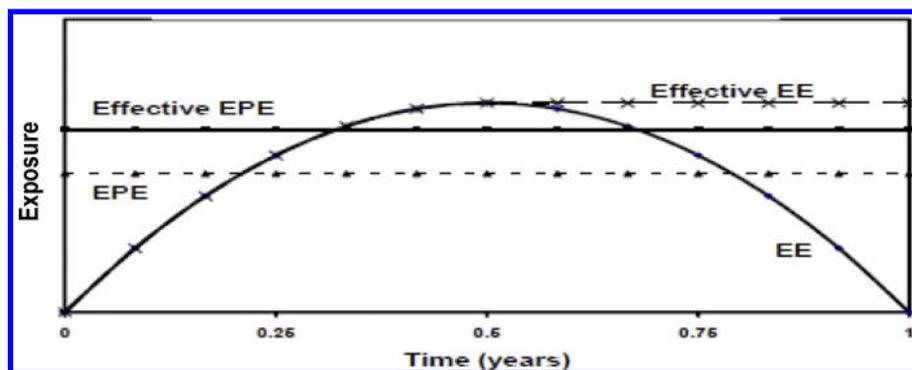


Figure 3.
Effective EE and Effective
EPE for CCR

that the bank demonstrate to the supervisory authority that it effectively integrates the risk-mitigating effects of cross-product netting into its risk management systems. Requirements are added to those that already exist for the recognition of any master agreements and any collateralized transactions included in a cross-product netting arrangement. Netting other than on a bilateral basis, such as netting across transactions entered by affiliates under a cross-affiliate master netting agreement, is not recognized for regulatory capital.

3.2 Summary of regulatory methods for CCR

The BCBS has articulated the principle that banks should be allowed to use the output of their “own estimates” developed through internal models in an advanced EAD approach. To achieve this, the regulators permit qualifying institutions to use internal EPE estimates of defined netting sets of CCR exposures in computing the EAD for capital purposes. In general, internal models commonly used for CCR estimate a time profile of EE over each point in the future, which equals the average exposure, over possible future values of relevant market risk factors (e.g. interest rates, FX rates, etc.). The motivation for this was the need for more consistent treatments which is particularly critical if banks may use their own estimates to calculate EAD through an internal model.

Relatively short-dated SFTs pose problems in measuring EPE, as when estimating a time profile of EE in an internal model, this only considers current transactions. For some SFT portfolios, the expected exposure might spike up rapidly in the first few days before dropping off sharply at maturity. However, a counterparty may enter new, or roll over an existing, SFTs, generating new exposure not reflected in current EE time profile. An additional problem arises when short-term transactions are combined with long-term transactions, so that EE is “U-shaped”, which implies if short-term rolled over, the decline in EE might understate the CCR amount. These issues can also apply to short-term OTC derivatives.

Effective EPE always lie somewhere between EPE and peak EE. In the case of upward vs downward sloping EE profiles, Effective EPE will equal EPE or peak EE, respectively. In general, the earlier (later) that EE peaks, the closer Effective EPE will be to peak EE (EPE). Under the IMM, a peak exposure measure is more conservative than Effective EPE for every counterparty, and can be used with prior supervisory approval. While banks generally do not use Effective EPE for internal risk management purposes or in economic capital models, it can easily be derived from a counterparty’s EE profile.

The consensus is that this is a pragmatic way of addressing roll-over of short-dated transactions and differentiating counterparties with more volatile EE time profiles. EEs can be calculated based from risk-neutral or physical risk factor distributions, the choice of which will affect the value of EE, but will not necessarily lead to a higher or lower EE. The distinction often made is that the risk-neutral distribution must be used for pricing trades, while the actual distribution must be used for risk measurement and economic capital.

The calculation of an Effective EPE has elements of both pricing (i.e. in the calculation of M, for instance) and simulation. Ideally, the calculation would use distribution appropriate to whether simulation or pricing is being done, but it is difficult to justify the added complexity of using two different distributions. Because industry

practice does not indicate that one single approach has gained favor, supervisors are not requiring any particular distribution to be used.

Exposure on netting sets with maturity greater than one year is susceptible to changes in economic value from deterioration in the counterparty's creditworthiness short of default. Supervisors believe that an effective maturity parameter (M) can capture the effect of this on capital and the existing maturity adjustment in the Revised Framework is appropriate for CCR. However, the M formula for netting sets with maturity greater than one year must be different than that used in the Revised Framework to reflect dynamics of counterparty credit exposures. The approach for CCR provides such a formula based on a weighted average of expected exposures over the life of the transactions relative to their one-year exposures. As in the Revised Framework, M is capped at five years, and where all transactions have an original maturity less than one year that meet certain requirements, there is CCR-specific treatment.

If the netting set is subject to a margin agreement and the internal model captures the effect of this in estimating EE, the model's EE measure may be used directly to calculate EAD as above. If the internal model does not fully capture the effects of margining, a method is proposed that will provide some benefit, in the form of a smaller EAD, for margined counterparties. Although this "shortcut" method will be permitted, supervisors would expect banks that make extensive use of margining to develop the modeling capacity to measure the impact on EE. To the extent that a bank recognizes collateral in EAD via current exposure, a bank would not be permitted to recognize the benefits in its estimates of LGD.

3.3 Supervisory requirements and approval for CCR

Qualifying institutions may use internal models to estimate the EAD of their CCR exposures subject to supervisory approval, which requires certain model validation and operational standards. This applies to banks that do not qualify to estimate the EPE associated with OTC derivatives but would like to adopt a more risk-sensitive method than the CEM. The SM is designed both to capture some certain key features of the internal model method for CCR and to provide a simple and workable supervisory algorithm, with simplifying assumptions. Risk positions in the SM are derived with reference to short-term changes in valuation parameters (e.g. durations and deltas) and assumed open positions remain over the forecasting horizon. This implies that the risk-reducing effect of margining is not recognized and there is no recognition of diversification effects.

In the SM the exposure amount is defined as the product of the larger of the net current market value or a "supervisory EPE" times, and a scaling factor termed "beta". The first factor captures two key features of the IMM not mirrored in CEM with respect to netting sets that are deep in the money: the EPE is almost entirely determined by the current market value at the money, current market value is not relevant, and CCR is driven only by potential changes in values of transactions. By summing the current and add-on exposure, CEM assumes that, simultaneously, the netting set is at and deep-in the money. The CEM derives replacement cost implicitly at transaction and not portfolio level as the sum of the replacement cost of all transactions in the netting set with a positive value. The SM derives current market value for CCR as the larger of the sum of market values (positive or negative) of all transactions in the netting set or zero. The first factor captures two key features of the IMM not mirrored in CEM with respect to netting

sets that are deep in the money: the EPE is almost entirely determined by the current market value at the money, current market value is not relevant and CCR is driven only by potential changes in values of transactions.

Through summing the current and add-on exposure, CEM assumes that, simultaneously, the netting set is at and deep-in the money. This is the second factor and serves two purposes. First, the same purpose as the alpha in the IMM conditioning on a downturn addresses stochastic dependency of market values of exposures across counterparties as well as estimation and modeling errors. It also seeks to compensate for the fact that the first factor may, at times, be lower than the Effective EPE under the IMM. This second concern is relevant for netting sets that are narrowly focused on certain risk areas (e.g. interest swaps that are mostly denominated in the same currency). Unless the netting set is very deep in the money, the Effective EPE will exceed both the NCMV and the “supervisory EPE”, as the latter is calibrated to transactions that are at the money. “Supervisory EPE” does not allow for basis risk and price risk is reflected only by deltas, so beta is set considerably higher than alpha. However, some allowance made for non-recognition of diversification which tends to make the first factor larger than Effective EPE.

The recognition of hedging within netting sets is another key conceptual difference between the SM and IMM in comparison to the CEM. In CEM, the size of the netting effect does not depend upon hedging, but what portion of the transactions is in the money: none out of the money implies no netting is recognized. For example, consider two ATM and exactly identical but offsetting transactions with same party subject to netting. Under the CEM, there is positive exposure, whereas under either the AM or the IMM, there is zero exposure. In general, the recognition of netting increases with the extent to which out-of-the-money transactions are present within a netting set.

Under the SM, supervisory EPE is determined by mapping to risk positions that represent certain key drivers of potential change in value, following a technique commonly used in market risk modeling (e.g. delta/gamma hedging). Risk positions of the same category (e.g. the same currency), that arise from transactions within the same netting set, form a so-called hedging set within which hedging is fully recognized. Hedging sets are designed to capture general market risk. With respect to interest rate risk, there is no differentiation of the categories by the issuer of any underlying debt instrument. However, there is a differentiation with regard to the type of reference rate used, for example sovereign vs corporate issued instruments.

In the case of floating rate instruments, the sensitivity to interest rate changes with the remaining maturity is synonymous to the time to next adjustment. On the other hand, for equities price changes across issuers too different to permit netting at a national index level, netting is only permitted at the individual level. Non-linear instruments require the capability of being represented in delta equivalent form which is compliant under the SM or the IMM. Unlike the CEM, that considers only purchased options, in the SM, sold options enter with negative signs and give rise to CCR. Modified duration/delta and an imperfect model of basis risk imply limited recognition of offsets by narrowed time bands of hedging sets.

Regulators expect that the board should clearly articulate the bank’s risk tolerance for CCR through policies and a framework for establishing limits. Further, they expect that management should establish a comprehensive risk measurement and a management framework consistent with this. At a minimum, supervisors require that

policies should clearly address risk measurement, reporting, tools, processes, legal and operational issues with respect to CCR. Furthermore, the view is that policies should be detailed and contain an escalation process for the review and approval of policy exceptions. Banks are expected to report counterparty exposures at a frequency commensurate with the materiality and complexity of exposures. Reporting should include concentration analysis and CCR ST for an understanding of exposures and potential losses. Finally, reports should include an explanation of issues influencing accuracy and reliability of CCR measures.

3.4 Supervisory guidance regarding CCR

Given the complexity of CCR exposures, banks should use a range of risk metrics for a comprehensive understanding of this risk. These metrics should be commensurate with the size, complexity, liquidity and risk profile of the bank's CCR portfolio. Banks typically rely on certain primary metrics for monitoring, secondary metrics for a more robust view, of CCR exposures. Banks should apply these metrics to single exposures, groups of exposures and the entire CCR portfolio, and should be applying special assessing of their largest exposures.

3.4.1 CCR supervisory guidance: general guidelines. Sophisticated bank and large dealers should measure and assess:

- current and potential exposure (both gross and net of collateral);
- stressed exposure (broken out by market risk factors);
- aggregate exposures and stressed exposure, as well as CVA, segmented by market factors;
- additional relevant metrics, such as for-credit derivatives jump-to-default risk on the reference obligor, and economic capital usage;
- correlation risks, such as wrong-way risk; and
- the credit quality of collateral.

Banks's CCR systems:

- should have sufficient capacity to aggregate at varying levels of aggregation (industries, regions, products, business line, legal entity) or other groupings to identify concentrations;
- should be sufficiently flexible to allow for timely aggregation of all CCR exposures and other forms of credit risk;
- should calculate counterparty CE and PE on a daily basis on previous day's position exchange of collateral; and
- include all trades at each level of aggregation.

Banks should consider the full range of credit risks in conjunction with CCR: on- and off-balance-sheet activities; contractual and non-contractual and contingent and non-contingent risks; and underwriting and pipeline risks.

While a common metric across all risks is not required, banks should be able to view exposures to a given counterparty in one report. Such reports should exhibit consistency in an exchange rate and account for legal enforceability of any netting agreements they

may have to a counterparty. Management should have an understanding of the specific approaches used and the internal capital adequacy models should incorporate CCR.

3.4.2 CCR supervisory guidance: concentrations. Concentration pose a significant concern as it can add to sudden increase in CCR, causing potentially large unexpected losses. Banks should have processes to identify, measure, monitor and control concentrations both a legal entity and firm-wide basis. Concentration risk should be identified both quantitatively and qualitatively, as beaches of risk tolerance limits could result in material loss or damage to a bank's reputation. All credit exposures should be considered part of concentration management (i.e. loans, OTC derivatives, CDO tranches, etc.) Total credit exposures should include the size of settlement and clearing lines, or other committed lines. CCR concentration management should identify, quantify and monitor counterparty exposures with certain characteristics.

It is expected that large exposures are driven by a market factor or transaction type. Second, it is expected that systems can support supplement statistical measures of potential exposure with other measures providing an alternative view, e.g. stress tests. Third, it is expected that systems can support supplement individual or across affiliated legal entities at the parent level or in an aggregate. Fourth, it is expected that systems can support supplement industries or other obligor groupings. Fifth, it is expected that systems can support supplement geographic/country groupings sensitive to similar macro shocks. Sixth, it is expected that exposure is driven by the same risk factors: "crowded trades". Seventh, it is expected that systems can support collateral concentrations including single or portfolios of counterparties. Eight, it is expected that systems can support non-cash collateral for all product lines covered by agreements. Finally, it is expected that systems can support SPEs, important because these represent payment capacity

Banks with significant CCR should have a comprehensive, organizationally integrated ST framework. This framework should inform day-to-day exposure/concentration management through identifying extreme conditions that could strain the bank's resources. No less than quarterly, management should evaluate test results for evidence of excessive risk, and formulate the appropriate reduction strategy.

The severity of factor shocks should be consistent with the purpose of the ST. If the object is to test solvency, then banks should model historical extreme, but plausible, stressed market conditions and evaluate impact on capital resources and earnings. On the other hand, if the purpose is day-to-day portfolio monitoring, hedging and management of concentrations, then the scenarios should be of a lesser severity and of higher probability of occurrence. Furthermore, in STs, risk managers should challenge the strength of assumptions made about the legal enforceability of netting and the ability to collect and liquidate collateral.

Finally, a sound ST framework should include the following elements:

- measurement of largest counterparty impacts across portfolios and material concentrations within segments of a portfolio;
- complete trade capture and exposure aggregation across all forms of trading at the counterparty level, including outside of the main credit system at frequency consistent with that of tests;
- stress of principal market risk factors individually for all material counterparties on a consolidated basis, and on at least a quarterly frequency;

- tracking of concentrations in volatile currencies, particularly for repos and SFTs, where liquidation large collateral may be difficult;
- assessment of non-directional risks from multi-factor ST scenarios, at a minimum addressing separate scenarios for severe economic or market events on the one hand, and a significant decrease in broad market liquidity on the other;
- consideration of stressed joint exposures and counterparty creditworthiness at specific and group levels in aggregate for banks;
- if CVA methodology is used, banks should ensure that the stress test sufficiently captures additional losses from potential default and basic ST of CVA to assess performance under adverse scenarios, incorporating any hedging mismatches;
- concurrent ST of exposure and non-cash collateral for assessing wrong-way risk;
- identification and assessment of exposure levels for certain counterparties (for example, sovereigns and municipalities), where the bank may be concerned about willingness to pay; and
- integration of CCR stress tests into firm-wide stress tests.

3.4.3 CCR supervisory guidance: CVA. CVA can be defined as fair value adjustment to transaction valuation, reflecting a counterparty's credit quality. The market value of CCR and a market-based framework to understand and value CCR is embedded in all derivatives contracts when counterparties are subject to credit risk, where the latter includes default, downgrade and credit spread risks. CVA may be unilateral, only to reflect the counterparty's credit quality, or bilateral, reflecting the bank's own credit quality as well.

Bilateral CVA is one-sided CVA ("1SCVA") plus a DVA. In the case of credit risk due to counterparties' subject to default risk, 1SCVA is typically used, but for pricing derivatives with a counterparty (or the market risk of derivatives transactions), a two-sided CVA ("2SCVA") should be used. CVA is not new, but the importance has grown due to changes in accounting rules that requires banks to recognize this in earnings. CVA has become a more critical component of modeling CCR, to mitigate banks' exposure to the MTM impact of CCR.

CVA management should be consistent with sound practices for other material MTM risks and should include:

- Business units engaged in trades related to CVA management should have independent risk management functions.
- Systems for CVA risk metrics should be subject to controls as other MTM risks (e.g. independent validation and benchmarking through alternative modeling frameworks).
- CVA cost and risk should be allocated to the business unit of origination and be incorporated into the RAROC of a given business.
- CVA measurement and management frameworks should provide incentives for prudent risk-taking decisions and risk mitigation.
- CVA engines should measure sensitivities to changes in credit and market risk factors to determine material drivers of MTM changes (e.g. a regular test that CVA MTM sufficiently explained by these, including a backtesting of CVA VaR).

If a bank is hedging CVA MTM, the framework or model should gauge the effectiveness of this activity through the measurement of basis risk and similar sensitivities, which is important to capture non-linearities (e.g. correlation between market and credit risk). Banking organizations with material CVA should measure the risk on an ongoing basis, including VaR models with CVA measurement capabilities. While currently in the early stages of development, such models may prove to be effective tools for risk management purposes. A key advantage of CVA VaR, as opposed to more traditional metrics, include the capture of CCR exposure variability, counterparty's spread and correlation. This is significantly more complicated than VaR for market risks, as it should match the percentile, horizon and include all risks for the CVA change. All material counterparties covered by CVA valuation should be included in the VaR model. A CVA VaR calculation that keeps the exposure or counterparty PD static is not adequate, as this will omit dependence between the two variables, and risk from the uncertainty of a fixed variable. The framework should assess the ability of the VaR measure to accurately capture the types of hedging used by the banking. Banking organizations with material CVA should measure the risk on an ongoing basis, including VaR models with CVA.

3.4.4 CCR supervisory guidance: wrong way risk. Wrong way risk (WWR) occurs when the exposure to a counterparty is positively correlated with the PD of the counterparty. *Specific WWR* is because of the nature of the transaction, while *General WWR* is attributed to counterparties PD positively correlated to general factors.

WWR is an important aspect of CCR, as it has caused major bank losses, and so should generally be avoided due the increased risk. Banks need a process to systematically identify, quantify and control both WWRs across OTC derivatives and SFT portfolios. Banks should maintain policies for both WWRs with respect to tolerance limits, ongoing identification processes and escalation to senior management as well as identifying, approving and otherwise managing situations when there is a legal connection between the counterparty and underlying exposure.

Banks should regularly perform WWR analysis for OTC derivatives, at least at industry/regional levels and for SFTs on broad asset classes of securities.

3.4.5 CCR supervisory guidance: limits. Limits are an integral part of a CCR management framework, and these limits should be formalized in CCR policies and procedures. For limits to be effective, a bank should incorporate these into an exposure monitoring system independent of business lines. It should perform ongoing monitoring of exposures against and have risk controls that require action to mitigate exceptions. A review of exceptions should include escalation to a managerial level that commensurate with the size or nature of mitigation.

Supervisors expect that a sound limit system should include several elements:

- regular review of limits by a designated committee and process to escalate approvals to higher levels depending on the size of counterparty exposures, credit quality and tenor;
- establishment of potential future exposure limits, as well as limits based on other metrics, and limit the market risk arising through CVA (but does not eliminate the need to limit CCR);
- individual CCR limits should be based on peak exposures rather than expected exposures;

- peak exposures are appropriate for individual limit monitoring purposes, as they represent the risk tolerance for exposure to a single counterparty;
- expected exposure is an appropriate measure for aggregating exposures across counterparties in a portfolio credit model, or for use within CVA;
- consideration of risk factors like counterparty credit quality, tenor of the transactions and liquidity of the positions or hedges;
- sufficiently automated monitoring processes to provide updated exposure measures, at least daily;
- monitoring intra-day trading activity for conformance with exposure limits and exception policies; and
- include limit monitoring, trade procedures and trade's impact on limit utilization prior to execution, limit warning triggers at specific utilization levels and restrictions by credit risk management on allocation of limits.

3.4.6 CCR supervisory guidance: collateral. Banks are expected to control the re-hypothecation or other reinvestment of collateral received from counterparties, including the potential liquidity shortfalls resulting from the re-use of such collateral. In regard to the CCR associated with segregated margins, banks should perform a legal analysis concerning the risks of agreeing to allow cash to be commingled with a counterparty's own cash and re-hypothecation. Policies and processes to monitoring margin agreements with third-party custodians, as with bilateral counterparties, should identify the location of the account to which collateral is posted, or from which it is received. Such policies should also obtain periodic account statements or other assurances that confirm the custodian is holding the collateral in conformance with the agreement. Furthermore it is important that banks understand the characteristics of the account where the collateral is held (for example, whether it is in a segregated account), as well as the legal rights of the counterparty or any third-party custodian regarding this collateral.

3.4.7 CCR supervisory guidance: model validation. A bank should validate its CCR models initially and on an ongoing basis, and this process should include the following standard elements (Jacobs, 2010b):

- evaluation of the conceptual soundness and developmental evidence;
- ongoing monitoring including processes verification and benchmarking; and
- an outcomes-analysis process that includes backtesting.

The validation process should identify key assumptions and potential limitations assessing their possible impact on risk metrics across all components of the model subject to validation individually and in combination. The evaluation of conceptual soundness should assess the quality of design and construction of CCR models/systems, including documentation and empirical evidence supporting the theory, data and methods. Ongoing monitoring confirms that systems perform as intended and includes both process verification and the assessment of model data integrity and systems operation.

Benchmarking to intended assessment of the quality of a given model. Benchmarking is a valuable diagnostic tool in identifying potential weaknesses with

respect to a CCR model. This involves a comparison of the bank's CCR model output with those using alternative data, methods or techniques. Benchmarking can also be applied to particular CCR model components, such as parameter estimation methods or pricing models. Management should investigate the source of any differences in output and determine whether gaps indicate model weakness.

Outcomes analysis compares model outputs to actual results during a sample period not used in model development. This is generally accomplished using backtesting and should be applied to components of models, risk measures and projected exposure. While there are limitations to backtesting, especially for testing the longer-time horizon predictions of a given CCR model, it is an essential component of model validation. Banks should have a process for the resolution of observed model deficiencies detected including further investigation to determine the problem and appropriate course of action. If the validation is not performed by staff that is independent from the developers, then an independent review should be conducted by technically competent and independent personnel.

The scope of the independent review should include:

- validation procedures for all components, the role of relevant parties; and
- documentation of the model and validation processes.

This review should document its results, what action was taken to resolve findings and its relative timeliness. Senior management should be notified of validation results and take appropriate/timely corrective actions. The board should be apprised of summary results and internal audit should review and test models and systems validation and overall systems infrastructure as part of their regular audit cycle.

3.4.7 CCR supervisory guidance: close-out. Banks should have the ability to effectively manage counterparties in distress, including execution of a close-out, with policies and procedures outlining sound practices (Jacobs *et al.*, 2012.) Requirements for hypothetical close-out simulations should be done at least once every two years for the bank's complex counterparties. Standards for the speed and accuracy with which the bank can compile comprehensive counterparty exposure data and net cash outflows should be established, including the capacity to aggregate exposures within a few hours, and the sequence of critical tasks and decision-making responsibilities needed to execute a close-out

Requirements for the periodic review of documentation related to counterparty terminations and confirmation should include that the appropriate and current agreement should specify the definition of events of default and the termination methodology that will be used are in place, current, active and enforceable. Management should document their decision to trade with counterparties that are either unwilling or unable to maintain appropriate and current documentation. Established close-out methodologies should be practical to implement, particularly with large and potentially illiquid portfolios. Dealers should consider using the "close-out amount" approach for early termination upon default in inter-dealer relationships.

There should be requirement that the bank transmits immediate instructions to its appropriate transfer agent(s) to deactivate collateral transfers, contractual payments or other automated transfers contained in "standard settlement instructions" for counterparties or prime brokers that have defaulted on the contract or for counterparties or prime brokers that have declared bankruptcy.

4. Conclusions

In this paper, we have performed a survey of CCR including the following elements. First, we have introduced various concepts in CCR measurement and management, including prevalent practices, definitions and conceptual issues. Then we have summarized various supervisory requirements and expectations with respect to CCR. This study has multiple areas of relevance and may be extended in various ways. Risk managers, traders and regulators may find this to be a valuable reference. Directions for future research could include empirical analysis, development of a theoretical framework and a comparative analysis of systems for analyzing and regulating CCR.

Notes

- 1 Typically and for example: daily for the first two weeks, once a week out to a quarter, once a month out to a year, once a quarter out to 10 years and then once a year up to 50 years.
- 2 See Araten *et al.* (2004a, 2004b), Carey *et al.* (2001, 2007), Jacobs and Kiefer (2010), Frye and Jacobs (2012), Jacobs (2010), Jacobs *et al.*, 2012.
- 3 US Office of the Comptroller of the Currency, Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation and Office of Thrift Supervision 2011, Supervisory Guidance on Counterparty Credit Risk Management, June 29, 2011.

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