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Safe,
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Markets

ISDA Standard Initial Margin Model (SIMM^{TM}) for Non-Cleared Derivatives

December 2013

Appendix: Risk Factors and Idiosyncratic Risk

March 2014

Executive Summary

In order to facilitate the introduction of final BCBS-IOSCO guidelines for "Margin requirements for non-centrally cleared derivatives", published September 2, 2013 (BCBS 261, "the Guidelines"), ISDA is proposing a standard initial margin model (SIMM) which could be used by market participants. A common methodology would have several key benefits to the market, such as permitting timely and transparent dispute resolution and allowing consistent regulatory governance and oversight. In order to realize these benefits, agreement between market participants and global regulators on several key assumptions will be required. These assumptions, which are detailed in this document, are:

1. General structure of margin calculations
2. Requirement for margin to meet a 99% confidence level of cover over a 10-day standard margin period of risk
3. Model validation, supervisory coordination and governance
4. Use of portfolio risk sensitivities ("Greeks") rather than full revaluations
5. Explicit inclusion of collateral haircut calculations within the portfolio SIMM calculation

Background

The Guidelines require pairs of covered entities to exchange initial margin (IM) using either a schedule-based or an approved model-based calculation,[1] with rigorous and robust dispute resolution procedures in place.[2]

The second BCBS-IOSCO consultation, released in February 2013, presented the results of a quantitative impact study (QIS) that reported an impact of 0.7 trillion EUR with 50mm EUR threshold, using an assumption of model-based derivation of initial margins. Impacts for use of schedule-based margins were not presented, but ISDA estimated over 8 trillion EUR in the case of 50mm EUR thresholds. In particular, over 4 trillion EUR would be demanded of the major dealers (Category A firms[3]) by their clients, an amount that the major dealers would not possibly make available. The industry has concluded that model-based margins are feasible, but that the general use of schedule-based margins is not, and that it is essential to the success of this framework that dealers' clients have access to an approved margin model.

Dispute resolution for IM based on models poses an industry challenge. If each covered entity were to apply its own margin model, it would have to build the margin model its counterpart was using in order to ensure that its counterpart's margin call was right. Duplicating all of one's counterparts' margin models is infeasible and for most dealers' clients totally impossible. It is not just the matter of the computer code (many run on proprietary platforms), but also of maintaining the same data sets. Consequently, the industry has sought an understanding from the BCBS-IOSCO Working Group on Margin Requirements (WGMR) that the industry will develop a standard initial margin model that industry participants may use to call each other for initial margin, as a satisfactory minimum. ISDA has initiated an effort to develop such a model for margining non-cleared derivatives, by convening the ISDA SIMM Committee composed of both sell-side and buy-side

[1] BCBS para 3.1
[2] BCBS para 3.12
[3] Category A firm as understood within the context of the Sep'12 QIS

ISDA members. This paper represents some of the Committee's initial thoughts regarding constraints for a SIMM, what the general mathematical structure must be, how a margin coverage standard must be interpreted, and how a model for margin and a model for collateral could be combined.

The Committee has identified 9 criteria that a SIMM should satisfy

The ISDA SIMM Committee has identified the following key criteria that a candidate model for SIMM should satisfy:

Criteria	Description
Non-procyclical	Margins are not subject to continuous change due to changes in market volatility
Ease of replication	Easy to replicate calculations performed by a counterparty, given the same inputs and trade populations
Transparency	Calculation can provide contribution of different components to enable effective dispute resolution
Quick to calculate	Low analytical overhead to enable quick calculations and re-runs of calculations as needed by participants
Extensible	Methodology is conducive to addition of new risk factors and/or products as required by the industry and regulators
Predictability	IM demands need to be predictable to preserve consistency in pricing and to allow participants to allocate capital against trades
Costs	Reasonable operational costs and burden on industry, participants, and regulators
Governance	Recognizes appropriate roles and responsibilities between regulators and industry
Margin appropriateness	Use with large portfolios does not result in vast overstatements of risk. Recognition of risk factor offsets within the same asset class.

Non-procyclicality: ISDA has commented in the past that because the amounts involved are so great, linking initial margin to market volatility could violently exacerbate contractual defaults in a time of stress. While including a period of stress in the margin scenarios or in the calibration can reduce the frequency of future episodes which are more volatile than those provided for in margin, prudence dictates there will always be some, and, if margin is *explicitly linked* to ensure adequacy through all future episodes, the size of the amounts involved will further exacerbate the stress borne at those times. Consequently, SIMM should not be explicitly linked to market levels or volatility, nor should scenarios automatically update with time. Instead it is proposed that scenarios or model calibration be updated periodically, for example annually, and then solely at the discretion of the global regulatory body, who may at a time of stress believe it more prudent to phase in, in discrete steps, a calibration increase.

Ease of replication: A common model achieves this if the inputs are the same. However, market participants do not generally share or use the same pricing models, so inputs can easily differ. Even if a common mathematical formula is used, inputs and dependencies between inputs vary across firms. Ease of replication is necessary to effective dispute resolution. Clients with lower capacity in infrastructure and operations must have access to the model, too, to facilitate their access to the non-cleared markets.

Transparency: A common model must allow participants access to the drivers of the calculation at all levels of aggregation in order to speedily detect "outs" and errors**.** Transparency is necessary to effective dispute resolution.

Quick to calculate: The initial margin calculation will have to be performed at every price quotation so that the price provided will properly reflect the credit and collateral valuation adjustments. Practically, this means the calculation must be done within a few seconds, certainly within less than a minute, no matter how large or complex the existing portfolio of trades with the counterparty may be.

Extensible: The SIMM specification first derived will likely need refining over time, reflecting further risk factors perhaps, as well as additional offset recognition. The model will need to be easily extensible and stable to the addition of new risk factors.

Predictability: Market participants need to be able to predict initial margins in order to a) price trades correctly and manage their portfolios responsibly; and b) prudently allocate investment capital to trading risk. Without margin predictability, many market participants will be unable to trade, as they won't be able to predict on a forward basis what margins will be.

Costs: While large swap dealers may be able to invest in complex models, it is imperative that all covered entities be able to build or buy the model, to facilitate access to the non-cleared markets.

Governance: While the industry will create a consensus around a viable, appropriate and efficient SIMM calculation that meets these criteria, regulators should approve the risk factors involved in the calculation and the calibration of the model to an appropriate level that includes a period of stress. It is expected that regulators will also, on an annual basis, re-evaluate the set of risk factors and the period over which to calibrate the model, as necessary.

Margin appropriateness: Many types of margin calculation perform poorly with portfolios that reflect a large number of risk factors. For example, while SPAN models (Standardized Portfolio Analysis of Risk), commonly used by CCPs, meet many of the criteria here, with a large number of risk factors they fail to faithfully recognize all the potential risk factor offsets, and the margin, relative to that generated by more efficient internal models, increases out of proportion to the risk. Within an asset class, positions with offsetting risk factors should earn a lower margin than were the positions margined separately and summed, correctly reflecting those correlation benefits or offsets where appropriate.

General structure of margin calculations

Margin calculations can be thought of as proceeding in two steps:

In the first, market scenario shocks for each risk factor are applied to the portfolio, and changes in portfolio valuations are recorded. Scenario shocks may be specific to each risk factor, such as in a "factor model," or each scenario shock may represent a shock to each risk factor, as seen in historical or Monte Carlo value-at-risk (VaR) scenarios, where a scenario is a 10-day change in risk factor values starting on a given day, or a specific Monte Carlo path, respectively.

In the second step, an aggregation function ("aggregator") of those recorded valuation changes is applied: for example, taking into account risk factor offsets, sorting the valuations and selecting the 99^{th} worst, etc. In each case, the aggregation function takes the set of valuation changes derived from shocks to risk factors and produces a single number as a summary risk measure, or margin. In factor models, it is typical to add the losses from each scenario, or just the top three or four; in VaR models, the aggregation works by sorting the gains and losses in order from greatest gain to worst loss, and selecting the result corresponding to the confidence level sought, e.g., the 99th percentile observation. Another choice is to take the square root of the sum of squared losses, the root mean square,[4] and multiplying it by a normal standard deviate corresponding to 99%, thus deriving a normal or Gaussian covariance VaR approach.

Mathematically, we can write these two steps as follows:

Each scenario **S** in { S(j) | j=1..J } is defined as a set of shocks { s(j,k) | k=1..K } where k runs over the set of K risk factors.

1. Calculate the change in present value of portfolio P, D(j)(S(j),P) = PV(S(j),(P)) – PV(P) under each scenario S(j) in **S**, where PV(S(j),P) is the present value of the portfolio under scenario S(j), and PV(P) is just the current present value of the portfolio.

2. Apply the aggregation function, A to **D**(P) = {D(j)(P) | j=1..J }: margin of the portfolio, M(P) = A(**D**(**S**,P))

As each of the risk factors, **R** = { R(k) | k=1..K }, fall into one of the four identified asset classes—currency/rates, equity, credit and commodities—it is natural to separate the risk factors into four groups corresponding to these asset classes, and to run a margin assessment separately for each of them, and add those results. That is, take all the risk factors corresponding, say, to equities, apply equity scenarios shocks to the portfolio and apply an equity specific aggregator to those changes in portfolio present values; do the same for each of the other asset classes, and then add up the four aggregation results. In that manner, only risk factor offsets within each asset class are provided.[5] Mathematically:

1. Given the four sets of risk factors, **R**(i) = { R(i,k)|k=1..K(i) }, define the set of scenarios across the risk factors in that class, **S**(i) = **S**(i,j) = { s(i,j,k) | j=1..J(k) }, and apply them to the portfolio to derive the corresponding changes in present values, **D**(i)(P)

2. Apply the aggregation function designed for each asset class to its corresponding set of portfolio value changes to get the margin for each asset class, M(i)(P) = A(i)(**D**(i)(**S**(i),P)), and sum them over i:
   Portfolio margin M(P) = Sum{ M(i)(P) | i= 1..4 }

The policy framework suggests a different way to avoid providing risk offsets between the asset classes which we believe does not meet the stated objectives, would be considerably slower to calculate, and would create substantial confusion in the marketplace over the asset class in which each trade would be placed. If the rules require the industry to identify which asset class each trade uniquely belongs to, and then run a single margin calculation for each asset class grouping of trades, the following issues result:

1. Most trades contain interest rate risk, a good portion of non-credit class trades also contain credit risk, and all trades denominated in a currency other than the domestic currency contain currency risk; therefore, separating trades into the groups by identifying the main source of risk will not in itself avoid providing risk offsets across asset classes.

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[4] The simple root mean square (RMS) is applied when the risk factors have already been orthogonalised, i.e., designed to have zero correlation with each other.

[5] Thereby satisfying the informing spirit in BCBS261 para 3.4, page 12.

2. The full set of scenarios across all risk factors would have to be run across each of the trade groups, thereby increasing running times by a factor of 4, equivalent in running time terms to *doubling* the number of risk factors under the framework outlined above.

3. Most problematically, identifying the asset class to which a trade belongs cannot be derived by principle for a substantial portion of uncleared derivatives. For example, option structures embedded in convertible bonds contain interest rate risk, credit risk and equity risk each in material amounts with the dominant one dependent on market conditions. Another example would be hybrid derivatives, where, for example, the payout depends on the best performing asset class over the life of the derivative. Not having a principled way to establish the asset class to which a trade belongs can easily create persistent dispute resolution issues.

4. Further and perversely, derivatives used to modify the counterparty portfolio exposure, i.e., hedges, or risk-reducing trades, would lead to higher, not lower, margin requirements. For example, in a portfolio of CDS trades on US and EU names with a given counterpart, both parties may choose to reduce the interest rate and foreign exchange risk with each other using interest rate and FX derivatives (the type which does not have a clearing obligation). If these hedging trades have to be separated into separate classes from the CDS, the resulting margins will increase. On the other hand, if just the risk factors are separated into their respective asset classes, margin will be risk sensitive and reflect the lower portfolio and counterparty risk.

The framework's objectives would only be met by a requirement to group trades into asset classes if the risk of each trade clearly fell into one and only one asset class, and that is not the case. Consequently, ISDA advises instead that final rules require any margin model to provide only risk offsets between risk factors, since risk factors are clearly identifiable as belonging to a single asset class, and risk management incentives are maintained.[6]

Requirement for margin to meet a 99% confidence level of cover over a 10-day Margin Period of Risk ("MPOR") standard

While the requirement to meet this standard seems straightforward, it merits a full discussion.

The standard approach is to ensure the shocks applied to each risk factor provide 10-day cover 99% of the time over a period of history, and then with a sensible aggregation function, portfolio margins will also meet that standard. Typically, back-testing is applied to simple portfolios containing a single risk factor to assert the input shocks are sufficient, and then to balanced pairs of risk factors to assert offsets are not overly generous. What is not done is to check the margin scheme against all possible portfolios which, first, would take forever, and second, may appear unnecessary. However, there are strict conditions under which it would be unnecessary; or equivalently, only under strict conditions can one assert a margin scheme will achieve a cover standard for all portfolios given it does so for single risk factor portfolios and for balanced pairs of risk factors. We shall call this the "margin cover assertion" or MCA.

The first condition is a technical one. Mathematically, if the cover standard is a value-at-risk (VaR) standard—which 99% of 10-day cover is—then it just cannot be done. A necessary condition for

[6] It has been observed, however, that in bank capital models, simulation paths are only considered on a per asset class basis, and maintaining all asset class scenario paths for each simulation might be a considerable rebuild. This problem requires more analysis and ISDA is in the process of consulting with its members.

MCA is that the cover standard be "consistent"[7] which, for example, expected shortfall (ES) is but VaR is not. That said, while there are interesting edge case examples showing how VaR completely fails to be consistent, these examples are based on joint probability functions one seldom meets in practice. With more common risk factor joint probabilities, while VaR is still not consistent, it is typically nearly consistent,[8] and the cover achieved by adding two portfolios that meet a 99% cover standard will be nearly 99% in practice.

The second, more important, condition is that the risk factors modeled cover, or span, all the randomness or risk of all portfolios under consideration. With listed futures, a risk factor can be supplied for each future, or as the SPAN model does, a risk factor for each commodity, albeit with an "inter-month charge" for every future. This is feasible as the number of listed expirations is not too great. For interest rate swaps, though, any date can be expiration,[9] and one needs to be content with a much smaller number of risk factors that span nearly all of the risk. That is, given two risk factors with adjacent expirations, e.g., the risk factors for 2yr and 3yr swaps, the 2.5yr swap rate is not a deterministic function of the 2yr and 3yr rates, though in practice its rate is not far from their average.

One approach is to define the major traded tenors—2yr, 5y, 10yr and 30yr—as risk factors. Another is to use principal components analysis (PCA). Typically, for an interest rate curve, three factors—parallel shift, curve rotation or twist, and curve bend—span 96 to 98% of the risk, and that very high explanatory power, in excess of 99.5%, can be achieved with six factors. (It is important to note that the Swedish CCP, NASDAQ OMX, has been authorized to clear interest rate swaps using the three factors described above.)

When one considers not only linear instruments but also options, the spanning problem becomes even more challenging. In principle, each expiration and strike pair define a separate risk factor. Indeed, the markets trade butterfly positions expressly to get exposure to particular risk characteristics of a given strike and expiration. Since it is impractical to use risk factors for every strike and expiration, models have been used to capture a very high proportion of the risk. Without implying that a direct, simplistic comparison between listed and bilateral trades is appropriate, the following are some examples:

- For listed futures and options, SPAN uses a single volatility shift risk factor, per expiration, which typically captures well the risk almost all portfolios present.

- In the interest rate option markets, market makers typically describe their risk in terms of three factors for each major expiration: i.e., shift, twist and bend in the volatility curve, the 'volatility smile', at each of the 2yr, 5yr, 10yr, and 30yr expirations. The 12 risk factors thus defined clearly do not span the entire risk of the interest rate options markets, but may cover, for typical portfolios, a high proportion of the risk.

- In equity markets, for a given company or index, the volatility smile at each expiration is relatively stable, as is the relationship across the time dimension, and one can measure much of the risk in terms of one volatility parameter, at least out to one year. For longer expirations another volatility factor should be used.

[7] A risk standard is consistent if given two portfolios that meet the standard, the standard is achieved by the portfolio containing the positions of both portfolios.
[8] If the risk factor joint probability functions are Gaussian (i.e., joint normally distributed), then VaR will be consistent, as the linear combination of normal random variates is also normal.
[9] Of which there are in excess of 7,500 for each currency that has 30 year swaps.

- While CDS swaps have standard terms—and thus risk factors can be prescribed, e.g., for listed futures, one for each expiration—CDS tranche markets are less amenable, as each attachment and detachment point pair define a separate potential independent price point. Modeling approaches for tranches are still not universally accepted in the industry, although stochastic correlation and recovery models are viable and relatively parsimonious.

The following points should be emphasized from this discussion:

- In non-cleared markets, the number of actual risk points is typically orders of magnitude greater than those of the clearable markets. Indeed, options at arbitrary strikes create risk spaces of infinite dimension. Given the need for parsimonious[10] models, it must be expected that a greater proportion of potential risks goes uncaptured. The emphasis must be on capturing the risk of typical portfolios, rather than on every possible portfolio.

- It is always possible to construct portfolios that are orthogonal to the risk factors selected, and thus the risk of which is not captured by those risk factors. Given the enormity of the number of possible portfolios, and the finite number of risk factors, it is always possible to construct portfolios that have next to no risk when measured against the selected risk factors. For example, for the listed futures and options market, using SPAN as the risk capture model, a delta hedged risk reversal—a long cap and short put, each with the same delta—at a given expiration, will have no delta or vega risk, and only earns the short charge specified. Where the shape of the volatility smile can dramatically change, such as in all the commodity and currency markets, this options strategy will be seriously under-margined. In the interest rate swap markets, pairs of bar-bells can be constructed that have no exposure to curve shift, twist or bend. Indeed, using any three risk factors a portfolio with four positions can be constructed that shows no risk to them—it is a matter of simple linear algebra.[11] And if one buckets the exposures by maturity, then within each bucket will be unmeasured risk exposure.[12]

- Given the above, it is appropriate to focus the risk factor selection on the risk of the portfolio types typically seen, and to ignore specific edge case and unusual portfolios, even though the risk of these may be under-measured. The BCBS –IOSCO framework for margin requirements for non-centrally cleared derivatives is intended to reduce systemic risk, not necessarily the risk presented at the single entity level. The objective here is to design a minimum margin requirement, across all one’s counterparts, and where counterparts are presenting such unusual portfolios—and one has concern for the counterparts’ performance—one may always require a higher margin.

Model validation, supervisory coordination and governance

Given the limited capability of any model to capture all the risk, it is imperative that regulators approve in advance what risk factors are to be used, or alternatively, specify for what portfolios (the “reference portfolios”) the model must demonstrably assess adequate margin. In addition, regulators must agree on a reference period (that includes a period of stress) for each asset class. ISDA proposes to work with regulators on deriving suitable choices for the reference periods and for the

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[10] Speed of calculation and transparency are the key concerns. With too many risk factors, calculation will slow—since running times generally will increase with the square of the number of risk factors, given the need for offset recognition—and the ability to see into what is the source of a margin dispute (transparency) will be seriously impaired.
[11] See http://en.wikipedia.org/wiki/Linear_algebra where the notion of spanning is described
[12] See the NIMM proposal, BCBS 254.

risk factors or reference portfolios. Without a common choice among regulators, a common model is not possible.

Because a choice will anchor the model and define its effectiveness and limitations, it is essential that the model be extensible, and that it can be easily extended to incorporate new risk factors, meet the requirements for additional reference portfolios, and be re-calibrated for an update to the reference periods. It is proposed here that initial choices be agreed for a preliminary first year, and that regulators monitor the effectiveness of the model during that year. It is further proposed that regulators annually re-evaluate the set of risk factors, the reference portfolios and the reference period; and that the industry will produce the extended model specification that will meet the 99% 10-day cover requirement on those enriched risk factors for those additional reference portfolios over that updated reference period.

ISDA proposes from the outset to keep the model relatively parsimonious to ensure the model calculation does not impede trading and risk management and preserves transparency in dispute resolution, while meeting the objectives of the policy framework. As several of the requirements of the framework are globally deployed (such as application of thresholds across all trading at a counterparty group level), it is imperative that global regulators have a consistent approach towards application of the 99% 10-day standard. This proposal would facilitate such an approval process and regular updates to the requirements in a transparent procedural fashion.

Use of portfolio Greeks rather than full revaluations

For all but the simplest vanilla derivatives, valuation tends to involve solving complex equations, and can take a significant amount of time. Some calculations on commonly traded interest rate derivatives can take minutes, with longer times seen in other asset classes such as credit. As initial margin calculations may involve the application of hundreds of shocks to the instrument, with full price re-evaluation, initial margin calculation could take hours or all day. Given that creating a customer price will involve an adjustment for initial margin based on their current portfolio of trades, it is imperative that a SIMM model approximates the response to shocks with a fast calculation if we are to avoid derivative price-making coming to a standstill.

The ISDA SIMM Committee believes that the most efficient way to approximate a derivative contract's response to shocks is to pre-compute a sensitivity or "delta" of the derivative contract for each risk factor, and approximate the response by multiplying each sensitivity by the respective risk factor shock size. For example, if the risk factor is a parallel shift in USD interest rates, then the sensitivity is generally known as the "DV01" or "dollar value of an 01", that is, the change in dollar valuation for a 1 basis point parallel shift in USD interest rates.[13] For a simple swap, a large component of the margin would be the DV01 times the shock size for the parallel shift.

For convenience, and with respect to common parlance, we shall refer to the set of portfolio's sensitivities to each of the risk factors as the portfolio's Greeks. Using a portfolio's Greeks, instead of full re-evaluation, application of the scenario shocks to a derivatives portfolio now becomes a simple matter of multiplication and addition, and can thus be done very fast and is easily checked for errors.

Indeed, using portfolio Greeks, the SIMM calculation separates out into the following three steps:

[13] Actually, it is important to know the terms of the interest curve being shifted: is it on par swap rates, zero coupon rates, or forward rates? Is the shift up or down in rates, what is the size of the shift, etc.? Precise definition of the sensitivities with respect to each risk factor will be imperative for the model to be well defined, and thus open to robust dispute resolution.

1. Calculate the portfolio Greeks to each of the risk factors. Each firm can do this using their proprietary models, a vendor-supplied model, or their counterpart could provide the Greeks if necessary. This step will take a considerable amount of time and computational resources, and is best done overnight.

2. For each scenario, for each risk factor, multiply the scenario's risk factor's shock by the portfolio's sensitivity to that risk factor, and sum the results across the risk factors for that scenario: simple multiplication and addition, leading to a result for each scenario.

3. Apply the aggregation function to the scenario results: generally not much more complicated than step 2.

The SIMM will consist of the detailed directions for deriving portfolio Greeks, together with specifying the size of the risk factor shocks under each scenario, and the algorithm for implementing the aggregation function.

Including initial margin collateral haircuts in the SIMM calculations

BCBS261 para 4.3 allows for collateral haircuts also to be calculated using risk-sensitive quantitative models. We know that the efficiency of model-based margins relative to schedule based margins are substantial, and we expect that similar efficiencies will be obtained for using a risk based model for collateral as well.

The ISDA SIMM committee proposes that SIMM should be considered for collateral haircuts. First, developing two separate models seems a waste, as does their implementation. Second, while no model is necessarily adequate for nonlinear derivatives, it can assure statistical adequacy for simple collateral. Preliminary thinking indicates that additional risk factors for funding risk in each type of collateral may be necessary though.

There are two ways to use a derivatives margin model for collateral. The first is simply to apply SIMM to the collateral so that the collateral value net of the SIMM collateral calculation equals or exceeds the margin be called.

The second is more efficient and accounts for common risk factors between the derivative portfolio and the collateral provided. Sensitivities to the SIMM risk factors are derived for the collateral provided, and added to the portfolio sensitivities, providing a total sensitivity over both the portfolio and the collateral for each risk factor. SIMM steps 2 and 3 are then applied to the total sensitivities. Sufficient collateral has been provided if the collateral value exceeds the SIMM calculation for the total sensitivities. As a trivial example, if the portfolio is simply a USD swap fixed rate payer, then providing US Treasuries will reduce the sensitivity of the package (portfolio plus collateral) to USD interest rates, resulting in lower risk and earning lower margin and haircut.

The ISDA SIMM committee believes further consideration is warranted but has not reached a firm conclusion at this time.

Conclusion

Risk calculation on portfolios of non-cleared derivatives is certainly not a new topic, as such calculations are currently being performed for purposes such as capital or under bilateral Initial Margin agreements. However, two key distinctions require this proposed framework.

First, methodologies used for capital calculations are not appropriate for initial margin for non-cleared derivatives. It is important to note that the first main objective outlined by the final guidelines, "Reduction of systemic risk," is a very different one than the general aim of capital calculations regularly employed on similar portfolios by prudentially regulated institutions. While the latter aims to accurately reflect all reasonable types of risk such a portfolio may have, the former need not. For example, it may make sense to include FX volatility skew scenarios into a capital simulation, but this is not a systemically relevant type of risk which would be important for the purposes of universal two-way initial margin aimed at reducing systemic risk. Thus, while both types of portfolios of non-cleared derivatives ultimately have the same potential underlying risk factors, only a subset of them which are systemically relevant, such as USD interest rates, commodities prices, or broad credit spread movements, would be required to protect against such systemic risks. Further, the timing of capital calculations can be slower and the amount of transparency lower (counterparties will not need to independently verify these calculations every day) than is a pre-requisite for the current purpose.

Second, bilaterally agreed methodologies are also not a realistically tenable solution. During a period of market stress, the effort required to independently verify calculations and resolve disputes (many of which would likely be due to changes in transparent, unilaterally-determined market parameters used by the calculating party, such as correlation or volatility) would promote neither of the objectives of the final guidelines, and rather likely increase systemic risk due to an accident.

Thus, ISDA proposes to develop a standardized model which market participants can use that is better suited to the current purpose. The key aims of such a model include:

- Efficiency, speed, transparency and reproducibility
- Non-procyclicality
- Being governable and extensible
- Not limiting entry to market

The successful development and deployment of such a model will require an agreement with regulators around issues discussed above such as calculations based on Greeks and a framework for approval via a number of reference portfolios and periods. The successful implementation of a standardized model also will require coordination among regulators in their model approval process.

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Appendix: Risk Factors and Idiosyncratic Risk

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Background

Any model for SIMM that meets the identified criteria (see "Standard Initial Margin Model for Non-cleared Derivatives" published by ISDA December 2013) must be built around a concise set of largely independent macro risk factors that capture the great majority of the risk that all manner of equity, credit and commodity portfolios present. While the risk present in foreign exchange and interest rate asset classes can be well assessed with such a concise set of macro risk factors, the macro risk factor approach alone doesn't work for the other asset classes—equities, credit and commodities—where risk can spring from positions that themselves reflect no macro risk.

For example, market neutral long-short positions in equity derivatives still contain risk, and basis risk between delivery locations in a commodity class—say WTI crude oil against Brent crude oil—have lower risk than outright long or short positions, but they are certainly not risk free.

How can we provide a means to assess for residual risk in such hedged positions without introducing an impractically immense number of risk factors, and all the problems that would then ensue?

Problem formulation

Taking equity derivatives, a simple example[1] of a parsimonious macro risk factor approach is one that provides for

a) a global systematic market factor,
b) a regional factor for each market center,
c) and a factor for each major market sector.

We may consider these factors independent of (or orthogonal to) each other: certainly we may construct them iteratively (or hierarchically) so that there is no systematic risk in the regional risk factors, and neither systematic nor regional risk in the sector factors.

In such a risk factor model, the risk of each individual equity would be presented in terms of its global systematic risk component, its regional risk component, and the risk deriving from its sector. Each risk component can be measured historically using the equities' historical correlation to each component and the historical volatility of the each component. The risk of any individual equity however exceeds the risk from its risk factor components, with the residual risk identified with the specific risk of the individual equity, often called its idiosyncratic risk. Idiosyncratic risk is by construction independent and

[1] Another simple approach to determine a set of macro risk factors that describe the majority of the asset class risk is to use a Principal Components Analysis (PCA) which yields by construction factors that are independent and orthogonal to each other. Indeed, a set of macro risk factors describing the main drivers of risk in the asset class can be arrived at through many means. The one presented here has an intuitive appeal and is easy to describe.

orthogonal to the collection of risk factors of which it is the residual, and it is also considered orthogonal to and independent of any other specific equity risk.

Mathematically we may write, since the risk factors are independent and orthogonal by construction, and the idiosyncratic risk is also orthogonal (by definition):

$$\mathrm{Var}(\ \mathrm{Equity}_k) = \sigma_k^2 = \Sigma_i(\ \beta_{ik}\ \sigma_i)2 + \mathrm{Idio}_k^2 = \Sigma_i(\ \rho_{ik}\ \sigma_k)^2 + \mathrm{Idio}_k^2$$

where

σ_k is the volatility of the equity 'k'
ρik is the correlation between the equity 'k' and risk factor 'i'
Idiok is the residual idiosyncratic risk for equity 'k'
Var($\cdot$) measures the variance of the risk, or *risk variance*[2]

and using the identity that $\beta_{ik}\ \sigma_i = \rho_{ik}\ \sigma_k$ for all i, k, from the definition of β_{ik}, the stock's "beta" to the respective macro or market risk factor.

Turning this around gives us a simple formula for idiosyncratic risk:

$$\mathrm{Idio}_k^2 = \sigma_k^2 - \Sigma_i(\ \rho_{ik}\ \sigma_k)2 = (1 - \Sigma_{i\rho ik}^{\ 2})\sigma_k^2$$

where proper measurement and calibration of the correlations ensures $\Sigma_i\rho_{ik}^2$ never exceeds 1.

A portfolio of equity risks would then have risk variance calculated via:

$$\mathrm{Var}(\ \mathrm{Equity\ portfolio}) = \Sigma_i(\Sigma_k w_k\rho_{ik}\ \sigma_k)^2 + \Sigma_k w_k^2(1 - \Sigma_i\rho_{ik}^2)\sigma_k^2$$

where w_k is the portfolio weight (positive or negative) in equity 'k'. (For portfolios of general equity derivatives, we would propose that w_k be the notional equivalent equity risk, as measured through sensitivity calculations.)

To illustrate, consider a risk balanced long-short position in two equities in, say, the automotive sector, in the same region: Ford and GM is the classic choice. Assessing the risk of the position solely in terms of the specified risk factors delivers a risk-free position. But once we account for the idiosyncratic risk components, we get:

$$\mathrm{Var}(\ \mathrm{Ford\text{-}GM}\ ) = w_{Ford}^2(1 - \Sigma_i\rho_{iFord}^2)\sigma_{Ford}^2 + w_{GM}^2(1 - \Sigma_i\rho_{iGM}^2)\sigma_{GM}^2$$

where $w_{Ford}\sigma_{Ford} = -\ w_{GM}\sigma_{GM}$ so that the portfolio is properly risk balanced and market/sector neutral.

A similar approach for credit derivatives is straightforward.

[2] In this paper it is assumed that margin is a function (generally a simple multiple) of risk variance, and the mathematics of risk variance will also apply to margins, suitably scaled.

For commodities, identifying the parsimonious set of risk factors will take some work. BCBS 254[3] has suggested they be Electricity, Oil and Gas, Metals, Agriculture and Other, with no global systematic risk factor. Assuming this set, a long-short position in two crudes would result in zero risk unless the risk of different delivery grades and locations is provided for as idiosyncratic risk. Consequently we believe a similar approach will also work for commodities, albeit with more factor granularity than NIMM has so far provided.

Non-internal model method

BCBS 254 has presented a non-internal model method, NIMM, that provides for each asset class a notional based set of systematic risk factors—for the equity, credit and commodity asset classes, just a single one per hedging set—and as suggested above, leaves the rest as idiosyncratic risk, independent of and orthogonal to the systematic risk factor, and to the idiosyncratic risk of other specific equities, credits or commodities within the same hedging set.

Indeed, leaving aside the interest rate and foreign exchange asset classes, and considering only NIMM's approach for the equity, credit and commodity asset classes, NIMM provides the factor model given above with just one systemic risk factor for each such asset class. Indeed, for these asset classes, NIMM provides the residual idiosyncratic risk as:

$$\mathrm{Idio}_k^2 = (1 - \rho_k^2)\sigma_k^2$$

where ρ_k is the correlation of the respective risk 'k' to the given sole systematic risk factor.

The following questions must thus be addressed:

- Is one systematic risk factor enough?
- When does one have too many risk factors?
- What's the problem with having no systematic risk factor and only idiosyncratic risk?

NB: When addressing these questions, it is assumed that the model is properly calibrated, and thus that the idiosyncratic risk is always calculated as the residual: $\mathrm{Idio}_k^2 = (1 - \Sigma_i\rho_{ik}^2)\sigma_k^2$

Addressing the last question first, if there's no systematic risk factor, $\mathrm{Idio}_k = \sigma_k$ for every risk element, and since idiosyncratic risks are assumed independent of and orthogonal to each other, a long only portfolio would have risk that tended to zero with increasing equal risk weight diversification. For example, if one invests a fixed value V, divided into equal amounts in N stocks each with risk σ, say, then the risk variance of the portfolio would be

$\mathrm{Var}(\Sigma_n \mathrm{Idio}_n) = \Sigma_n \mathrm{Var}(\mathrm{Idio}_n)$ since idiosyncratic risks are independent and orthogonal

$= \Sigma_n (\sigma/N)^2$ since the fixed value V is invested risk equally in each of N stocks

[3] Non-internal model method for capitalizing counterparty credit exposures, Jun'13, BCBS

$= \sigma^2/N$ which tends to zero as N tends to infinity

However, since that is not how we observe long-only portfolios of individual equities or credits behave, positing at least one common risk factor is required.

Turning to the other two questions, is one systematic risk factor enough, and when do we know we do have enough risk factors?

The key for determining when there are enough risk factors is when the resultant residual idiosyncratic risk is actually independent from and orthogonal to the idiosyncratic risks deriving from other risks being considered together. (By construction, the idiosyncratic risk will always be orthogonal to (and have zero correlation with) the risk factors from which it derives.) Having independent residual idiosyncratic components will never exactly be the case, that is, correlations between pairs of residual idiosyncratic components will never be exactly zero, so one needs first prescribe a criterion by which it can be claimed it is close enough, that the residuals are orthogonal enough.4

NIMM and SIMM compared

Where SIMM has parallels with NIMM, it proposes to increase the accuracy relative to NIMM in two directions. In the first, SIMM will not consider notional amounts as a basis for the risk, but instead will use risk-equivalent notional amounts[5]. Thus for a stock option, SIMM proposes to use the option's actual risk sensitivity to the underlying stock, its delta.

In the second, SIMM proposes to use more than a single common risk factor, to endeavor to capture more of the common variance that can be explained by simple risk factors (but nevertheless treat the remaining risk as idiosyncratic residuals). Doing so will improve the performance of the model, relative to NIMM, for portfolios containing risk with common direction, while better accounting for risk offsets in portfolios where there are truly offsetting risks. Naturally there is a trade-off between a greater number of factors and complexity, and thereby the introduction of superfluous risk factors, and the SIMM committee will propose criteria for deciding when there are enough common risk factors, and the residual risk idiosyncratic.

General structure of margin calculations

The SIMM white paper does not explicitly reference or consider idiosyncratic risk elements, only macro risk factors in its description of the general structure of margin calculations. Instead it describes the systematic or macro risk part of the calculation alone. The idiosyncratic part may be separately assessed and combined with the macro risk component in line with the equations above:

$$\text{Total margin} = \sqrt{(\text{ Macro component}^2 + \text{Idiosyncratic component}^2)}$$

[4] Given the vastness of this project, for the first phase we might consider that if correlations of residual are generally below 15%, we have enough risk factors, and residuals can be considered idiosyncratic.
[5] And value sensitivities to rate and spread moves.