Viewing Market Risk as Contingent Liquidity Risk

- The thesis of this talk is that the principal tool for market risk management should be a disciplined use of stop-loss limits, but this also requires tools for managing the liquidation risk of positions that need to be closed-out because of stop-loss limits
- Note that this liquidation risk is a contingent risk – it only arises under stop-loss conditions
- To see how this works more clearly, let’s start with a thought experiment in which this liquidation risk does not exist

The Thought Experiment

- Suppose a firm had traders who were independent contractors, each of whom only traded on futures exchanges. The firm announces that it will supply capital to the traders, but will not provide any credit guarantees for their trading.
- Brokers would still be willing to deal with these traders, since they could use margining and forced position liquidation to limit their credit exposure
- Total firm's current risk can be estimated by the amount of capital actually employed by its traders
- Total firm's potential risk can be estimated by the amount of capital allocated to its traders

The Thought Experiment

- Trading management decisions would just amount to how much capital to allocate to each trader and whether to add capital to allow a position to be carried once the capital is exhausted
- The system is only as good as management discipline in taking stop-loss limits seriously – extending new capital only when the trader can make a good case for a strategy yielding results if given more time
- Trading management could withdraw unused capital in response to a change in market conditions (e.g, more volatile markets) or a change in frimwide strategy, but this could sabotage trader strategies
- Trading management will want to assure that traders are using diverse strategies, so limits must be relative to strategy
- This is a good prototype for a stop-loss limit system

What changes when firms provide credit guarantees of their traders' positions?

- Management now has to worry about how much can be lost after the stop-loss limit is hit, since the firm must absorb liquidation losses, not the brokers
- Similar to how the brokers limits liquidation losses through a required margin, the firm can estimate potential liquidation losses
- Risk management consists of the stop-loss limits plus management of the contingent risk of liquidation losses when stop-loss limits are hit or when the firm wishes to withdraw capital

Does this paradigm apply to the market-making function?

- **Yes:** for that part of market-making that involves discretionary position taking (either proprietary or long-term illiquid positions accommodating customers)
- **No:** for that part of market-making that requires temporary holding of liquid inventory to accommodate customers. The proper risk model for this aspect of the business does not involve looking at current exposures; instead, you need to estimate the long-term average cost of being forced to hold unwanted positions on a regular basis.

Calculation of the Liquidation Margin

- This calculation is very different for liquid and non-liquid positions
- For liquid positions:
  - Statistical calculation of “normal day” extreme moves, the value-at-risk
  - Experienced judgment in creating stress-test scenarios for unusual periods of market illiquidity
  - Making sure that current position is properly marked-to-market at least daily is critical – you don’t want to be dealing with a trader who knows he’s through his stop-loss limit when you don’t

Calculation of the Liquidation Margin for Liquid Positions

- Implications for model validation
  - Models may be used for interpolation between liquid price quotes
  - Models will be used for calculation of the impact of market changes on positions in the VaR and stress test calculations
  - These model uses are robust and easy to test, since they can constantly be checked against actual liquid market quotes
  - Only need to be concerned with current Greeks (you can always ask that positions be reduced in future in reaction to changing Greeks)

Calculation of the Liquidation Margin for Illiquid Positions

- Three distinct types of illiquidity with very different risk management implications:
  - Product with sporadic liquidity – there is a liquid two-way market, but quotes are not continuously available
  - Product with full liquidity but you are holding a position size that can not readily be liquidated
  - Product with one-way market – products for which almost all customer interest is on one side of the market and ability to lay off risk is limited by all dealers having similar positions

Calculation of the Liquidation Margin for Product with Sporadic Liquidity

- Need to build a model that relates pricing on this product to products with full liquidity
- Must change MTM continuously based on changes to these related products, using the model
- Estimate the degree of added liquidation risk caused by the uncertainty of the modeled relationship
- The key rule is that the illiquid product must show an added degree of liquidation risk above that of the more liquid proxy product
- The model is relatively easy to check, since it can be recalibrated every time a new sporadic quote becomes available

Calculation of the Liquidation Margin for Position of Illiquid Size

- Can estimate liquidation risk by VaR-like price moves over a time period in which orderly liquidation can take place
- Alternatively, can model the market impact of large volume
- In either case, this is an adjustment for added cost of liquidation beyond the normal liquidation costs of a smaller position
- Need to be concerned with the impact of changing Greeks throughout the liquidation period

Calculation of the Liquidation Margin for Product with One-Way Market

- Model becomes critical and hard to validate
- Must employ as much liquid market data in the model as possible to avoid unnecessary staleness of MTM
- Must clearly identify illiquid inputs and estimate liquidation risk through conservative assumptions (relative to **net** exposure to illiquid inputs)
- Model Greeks are only useful in representing sensitivities to liquid market data; they cannot be used in identifying the potential cost of being wrong about the illiquid inputs (since your risk on the illiquid inputs is not to small hedgable changes)
- Important that these assumptions be made independently of the traders

Calculation of the Liquidation Margin for Product with One-Way Market

- Use liquid product proxies to represent these trades in computations designed for the firm's liquid positions, such as VaR and stress tests
- Model difference between actual product and liquid proxy to create conservative liquidation assumptions
  - To avoid dependence on unverifiable models, need to focus on liquidation in conditions such as maturity or becoming liquid through the passage of time
  - Modeling as simulation over time generally very difficult to do and relies on inside trader knowledge
  - Modeling as infrequent rehedge can make use of more public information
- The liquid proxy is just a form of representation; it is not intended to dictate hedging action to the trading desk

Calculation of the Liquidation Margin for Product with One-Way Market

- **Example: Illiquid maturity interest rate swap**
  - Suppose there is a liquid two-way market in a certain currency's swaps out to 7 years, but only a one-way market to pay 10 year fixed
  - The firm could use a 7-year swap as the liquid proxy for the 10-year swap and conservatively estimate the illiquid piece as the cost of a one-time trade, 3 years from now, to reverse a 4-year swap and put on a 7-year swap
  - Every day for which public liquid quotes of 4 and 7 year swap rates are available contributes an independent data point for estimating this cost
  - This approach generalizes to illiquid maturity options and cliquets, though a range of strikes needs to be used to offset the impact of price changes prior to the one-time trade date and the full vol-surface (skew as well as time) needs to be considered

Calculation of the Liquidation Margin for Product with One-Way Market

- **Example: Sale of a digital option**
  - Use a call spread (selling a call at a strike lower than the digital's strike and buying a call at a strike above the digital's strike) as a proxy for selling a digital option
  - Estimate the illiquid piece as the difference between the potential payout on the digital and payout of the call spread
  - Hypothetical size of the call spread depends on how wide the strikes are set – the narrower the difference in strikes, the larger is the required size
  - Selection of the strikes for the call spread needs to be wide enough to make for liquid trade size and manageable deltas and gammas as the trade evolves

Calculation of the Liquidation Margin for Product with One-Way Market

- **Example: Barrier option**
  - Suppose there is a one-way market for selling a barrier call option
  - A liquid proxy would be selling a European call option with the same strike and expiry date as the barrier option along with the purchase of European put options struck below the barrier
  - If the barrier is never struck, the put expires worthless
  - Estimate the illiquid piece by the cost of reversing the European call and put positions at the time the barrier is hit, relative to a set of scenarios
  - The size of the put options in the proxy can be set to minimize this cost
  - This is similar to Peter Carr's approach (and gives the same results when vol skew and drift are zero) but utilizes more expiry dates for the puts and uses optimization relative to scenarios
  - Every day for which public liquid quotes for the volatility surface of the European options is available contributes an independent data point for estimating this cost
  - This approach can easily be extended to double barriers, partial barriers, lookback options, and compound options

Calculation of the Liquidation Margin for Product with One-Way Market

- **Challenge: Using liquid European options (and liquid American options, where available) as proxies for illiquid American options**
  - Most significant case is American swaptions
  - The most reasonable proxy is a series of European options at different tenors, but scenarios must now include price paths (to calculate the payoff of each European option), not just final prices
  - How do you keep the number of scenarios manageable?

Calculation of the Liquidation Margin for Product with One-Way Market

- **Challenge: Using liquid single-name credit swaps and liquid CDO tranches as proxies for illiquid CDO tranches**
  - To avoid dependence on CDO tranche pricing models, must rely on final default loss outcomes
  - Any static hedge relying on final default loss outcomes will show large variances between the position and the proxy in a significant percentage of scenarios, even if expected loss and correlations are assumed known
  - If you're going to use dynamic hedges, what are the rules?

Calculation of the Liquidation Margin for Product with One-Way Market

- **Challenge: Using liquid single-name and index options and forwards as proxies for illiquid options on equity baskets**
  - Any static hedge will result in large variances between the position and the proxy in a significant percentage of scenarios
  - Dynamic hedging with forwards can make for a much more reasonable fit
  - Dynamic hedging results are easy to compute by simulation for simple basket options (you can use the Black-Scholes deltas), but what about complex rainbow structures?