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**Citibank London Correlation Book
October-November 2005**

Scope

We participated in the FRB's two-week review of Citibank London's Structured Credit business, focusing on the Correlation book activities. My efforts focused on participating in meetings with business management, correlation traders, market risk managers, and finance functions. OCC personal in New York reviewed global model controls and FRB personnel focused on operations, technology, and infrastructure adequacy related to the correlation book.

Key Conclusions

- Price and transaction risk are high. While outright correlation risks have been reduced, potential downside risk associated with changes in market liquidity, pricing paradigms, and model risks could considerably impair results. The transaction processing environment is highly manual and with various systems and process weaknesses. Operational losses associated with trade capture and event monitoring have been numerous and significant in aggregate.
- The product grew ahead of infrastructure capabilities. Audit warnings were not heeded. Eventually, operational errors eventually led management to stop taking on new business in 3Q05. A key regulatory priority should be ensuring that current business and control approval processes provide for comprehensive, transparent, and timely risk assessment both at product inception & on an ongoing basis.
- The limitations in the current technology systems environment constrain analytic capabilities and thereby weaken risk and product control processes. The upcoming systems and analytical improvements should provide for more sophisticated ways to measure risk and reserve for risk.
- Transactional risk is high and has been escalated by a historically manual processing environment, weaknesses in change control, and infrastructure inadequacies that have made exception identification difficult. In addition to focusing on the technology environment, management should assess resource, supervision, and procedures in evaluating operational errors/losses.

- While historic correlation activity was booked in CGML, synthetic CDOs have been booked in Citibank NA since April/May 2005. Presently, risk management and product control functions do not manage risk at the legal entity level.

Recommended Follow Up

- A targeted follow up should be conducted which focuses on Structured Credit once business returns to Business as Usual. In addition to reviewing any formal commitments made in response to examination, scope should include:
 - Updated assessment of risk profile and new product strategy.
 - RAD support in the review of model risks, controls, and roadmap/strategy. Scope should focus on correlation products, including CDO² and ABS CDOs.
 - Assessment of new products/CMAC processes.
 - Assessing adequacy of process for assessing infrastructure adequacy and resiliency on ongoing basis.
 - Review of progress on implementing improvement to Risk Management and Finance functions (limits, reserves, and price testing)
 - More detailed review of legal entity bookings, financial performance, and risk profile.

DETAILED FINDINGS

Risk Profile

Price and transaction risk are high. While outright correlation risks have been reduced, potential downside risk associated with changes in market liquidity, pricing paradigms, and model risks/parameter uncertainties could considerably impair results. The transaction processing environment is highly manual and with various systems and process weaknesses. Operational losses on trade input and event monitoring have been numerous and significant in aggregate.

- The core business activity is structuring and risk managing customized, single tranche CDOs for investors. The structures will reflect the client's preference for risk, related to capital structure and portfolio composition and diversification. Client demand has been strongest for mezzanine tranche exposure. The desk will also make markets various index CDO products.
- The bespoke portfolios are managed as a portfolio and are generally hedged by index CDOs.
- The business can run risk to general credit spreads and default probabilities, issuer specific spreads and defaults, and recovery rates. These, however, are not the primary risks the business runs. Rather, the desk is exposed to various residual risks, which are largely related to correlation arising to one way business flows.
- Most significantly, sensitivity to correlation will differ across the capital structure, where the bank tends to be short mezzanine risk and long equity and super senior. In addition, bespoke portfolios and their index hedges may also have different sensitivities to correlation. The desk also highlights index vs. single name credit spread, CDO² inner correlation, and Credit/FX quanto risks. Lastly, it is understood that the new base correlation framework does not capture high/low spread portfolios and super senior tranches well.

- Explicit price risk peaked in April, when a pipeline of pending deals closed. At this time, the market moved against the desk and some hedges they had lined up fell away. The losses they took were largely due to their positions across the capital structure (skew). Since the, risk along the capital structure has been significantly reduced.
- Total revenue for the entire Structured Credit business in FY 2004 was 120MM that was 14MM behind plan. Total revenue as of September 30, 2005 was 8MM that was 125MM behind plan. The key drivers of the negative variance were losses taken on the correlation book due to trading losses during the May market dislocation and September events. The correlation desk has made losses of approximately 45M on the year.
 - Portfolio trading lost 35MM in May due to a 28MM loss from correction of a model error in CDO² pricing and a 15MM loss due to market moves credit tranche pricing.
 - In May, much of the loss was identified following concerns over extreme market movements the Desk performed a recalibration of the skew in the model used to mark their books. The correlation skew is derived from limited observable data from index and index tranches. The pricing model is reliant upon correct market spreads and interpolation assumptions of the correlation skew across the capital structure. In March, the desk identified problems in interpolating the skew that made the model unstable. The model produced spurious results which when corrected accounted for an additional loss of 28MM.
 - September losses were due to 17MM on the bespoke correlation trading was due to a 14MM loss on correction of a mapping error in PT between trade details and model analytics, 3MM loss on market movements, and 2.5MM in loss due to recalibration of the skew.
- The in business risk manager is much more involved in this business, and now estimates downside risk/stress to be 63MM vs. 143MM in 2Q05. He noted that the desk has significantly reduced its exposure to a parallel shift in correlation risk. In terms of skew risk, the desk is viewed as exposed to skew steepening as it is short equity, long mezzanine and senior, and short super senior. While reduced, this remains the dominant risk. Bucketing of CDO² along with CDO is difficult. Exposures to credit spread and recovery rates are secondary and have been reduced as well.
- The market risk manager estimates that the risk associated with parameter uncertainties and model risk to be 50MM presently. He estimated the downside 50MM to be last April when outright exposures were much higher. The stable downside assessment is based on the view that market and model uncertainty are larger than previously assessed. This 50MM covers portfolio trades (CDOs, CDO², and Index CDOs). The lump sum is decided with Risk management and reflects “little net risk but individually toxic trades”. This products potential impact is by far the largest of any of the unverified products in Europe.
- The total structured credit inventory totals around 10MM, with approximately 2.5MM being externally verified, 2MM is model/input verified, 3.5MM verified using alternative procedures and 2.5MM being unverified. The level of unverified trades has remained stable during the first nine months of the year and is largely related to correlation trades. Please note, the level of unverified trades is not an indicator of market risk exposure to unverified risk positions.
- One senior risk manager noted that he viewed the business to be at capacity for CDO² trades and he would be reluctant to approve more of this business.

Primary Observations

The product grew ahead of infrastructure capabilities. Audit warnings were not heeded. Eventually, operational errors eventually led management to stop taking on new business in 3Q05. A key regulatory priority should be ensuring that current business and control approval processes provide for comprehensive, transparent, and timely risk assessment both at product inception & on an ongoing basis.

- There was no CMAC product approval for CDOs/correlation trading. It is not clear from discussion with London CMAC when or if this would occur under the current process. The synthetic CDOs were initially approved on a transactional basis by CMAC or through Alternative Handling. However, this was suspended once portfolio market risk limits were implemented. We found no evidence of a CMAC level product approval that considered the business strategy or infrastructure adequacy. Nor is there a clear description of which types of transactions require still require approval at the individual level (e.g. bespoke trades which may not be well diversified).
- Last fall, Internal Audit warned that infrastructure was not adequate to handle growth, but business grew nonetheless. After the May losses, Audit conducted a further business monitoring review and issued a report with a number of observations and recommendations. They recommended that the business and support groups consider restricting new products until a commensurate improvement in infrastructure is made to support further increases in business.
- The RCSA process did not seem to drive any clear stop to the business.
- In response to the serious operational issues, the desk and business management have now developed a detailed action plan addressing infrastructure and control. This includes governance committees, technology improvements, model improvements, booking reviews, and a halt in new business.

Suggested actions:

- We should ask management and control functions to perform lessons learned assessment on product roll out to determine how new product and business monitoring processes could perform more effectively and avoid business stoppage and unacceptable operational losses in the future.
- It may be useful to develop a business level policy implementing CMAC which is auditable, e.g. clearly articulates which type of trades require higher level of review due to processing, valuation, or risk management issues (e.g. a bespoke trade with concentrated portfolio)
- We should ask the business and control personnel to agree to measures of infrastructure risk that trigger escalation and management action. (E.g. measures of resource adequacy, systems resiliency, operational exceptions)
- Audit comments should include more specifics on what type of growth is acceptable or not.

The limitations in the current technology systems environment constrain analytic capabilities and thereby weaken risk and product control processes. The upcoming systems and analytical improvements should provide for more sophisticated ways to measure risk and reserve for risk.

- The desk originally was originally managing the books by dividing risk according to tranche breakeven spread. This ran into problems with CDO² trades. They also tried to match risk profile of the book using an optimized set of index tranche trades. This was used to determine bid offer and liquidity reserves. Recent events highlighted various needed improvements. New methods underway include 1) performing explicit correlation scenarios which correspond to widening of specific parts of the capital structure, 2) using a skew which spans time and debt structure and 3) computing index tranche notionals to flatten out detailed correlation delta risk
- The business and Technology are currently designing front office risk reports for the correlation book that will further improve reporting of correlation exposures and other less transparent risk
- On a daily basis, Finance performs a PNL validation to ensure that the correct PNL is calculated. This involves various PNL reasonable checks, including a profit attribution analysis against market movements. Results are discussed with the trader and uploaded into official reporting systems.
- The current profit attribution analysis (PAA) system has not been effective in explaining PNL nor has it provided a good control for identifying errors. Residual PNL is often inexplicably large. It lacked detail, accuracy, reliability, and information on the impact of edits/amendments. The frequency is also not ideal for Correlation trading, which is only being done weekly. The new release of PT is in its late stages of testing. The new attribution will provide a systems based daily profit attribution analysis. This will include detail at the name and tranche detail and will be generated daily. The desk has been testing the new process and found that it has done well in backtesting—even during the points of extreme market volatility. The target implementation of this is November 2005 and it should provide a robust platform for viewing PAA.
- Market risk limits are based on interest rate exposure, ratings concentration, single issuer credit exposure, recovery rate, overall correlation, and correlation by capital structure. Market Risk limits need to be revisited once analytic improvements are implemented and risk can be measured in better ways across capital structure and tenor. Skew is included in the limit structure. However, neither basis risk (bespoke vs. index) or FX risk is captured. Risk is not controlled/monitored at the legal entity level (presently)
- As pricing models do not capture numerous risks, various reserves are used. Reserve methods are blunt and rather simplistic and analysis of risk in unverified portfolios is only its initial stages.
 - Correlation is repriced using a base correlation framework and 4 curves. Current systems limitations prevent daily repricing, but this is to be addressed shortly. Skew across the capital structure was implemented this year.
 - All positions are repriced to an assigned curve; so bespoke portfolios are not repriced using a customized correlation curve. Desk management indicates that this presents little risk, as 90% of the bespoke deals are diversified. I didn't see analysis (desk, Risk, product control) that addressed this, however.
 - The desk acknowledges that the base correlation framework has problems with high/low spread portfolios and super senior positions. These are both areas of targeted research for next year. These observed weaknesses are consistent with

those noted by other firms, who have also noted them as high priority issues to be addressed.

- Price testing and analysis of the unverified portfolio is minimal, newly implemented, and not yet very conclusionary in nature. On a 3-4 month basis, Market Risk estimates a downside exposure, but this does not explicitly tie back to the valuation process. Recently, Finance has undertaken additional analysis of unverified portfolio, but it does not yet provide much more than an analysis prices vs. index/broker quotes. It is not clear when pricing adjustments would be taken (they haven't been to date). The analysis needs to provide more information on longer-term trends in sensitivities, risk, and potential PNL impact and ideally should tie more clearly back to the reserving/price adjustment process.
- Reserving analysis needs to reflect and respond to various uncertainties in a more specific and dynamic manner. Presently, model risks are captured in liquidity reserve, correlation pricing provision reserves, and withheld EITF reserves. The liquidity reserves are set using very wide bid asked spreads. The pricing provision reserves are set at 2.5% of the CRO1 by tranche (other than super senior). This provision is to "reflect the immaturity of the market for traded tranches and provides against any unforeseen degradation in their performance as hedges for the portfolio book and reflects the immaturity of the market for traded tranches." Some CDO EITF reserves could have been released, but Finance choose not to at this point and reallocated that reserve to liquidity. All day one PNL is fully deferred for CDO² and ABS CDOs.
- Generally reserves are fairly bluntly defined and do not tie back to all sources of uncertainty. Broadly, they are to address paradigm shift and weaknesses in the model and systems. But, they don't tie back to changes in specific sources of risk with much nuance. The new analytics should provide for ability to measure risk more dynamically. Finance agrees this detail is appropriate and has already identified some desired improvements.
- Price testing results and reserves are not analyzed or assessed on a legal entity basis. Presently, reserves are allocated 50/50 between CGML and Citibank NA.

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- While I was not involved in the operations meetings, my sense is that historic trade capture and editing have been highly manual. Risk has also been heightened by some significant systems conversions which may not have been subject to robust change control.
- Audit has broadly highlighted areas of specific concern as being: infrastructure to support correlation trading desk, completeness/accuracy of trade capture, stale marks, and transaction reporting.
- The business identified a trade which was incorrectly mapped (during a systems conversion) and which resulted in a 13MM loss in September.

- Background on this trade revealed a couple of breakdowns. In 2002, five correlation trades were booked on a spreadsheet. The PT system was not available at that point in time. These trades were customer back-to-back trades. The desk owned credit protection, but the credit protection life was much shorter than trade maturity, which was not correctly reflected in initial booking, thus creating an open position that the traders were not aware of due to the error in the excel sheet.
- In December 2004, the trades were re-booked correctly into PT. But, they were not correctly input in model analytics within PT. The credit end date was properly put into PT, but not into analytics. This rebook resulted in an overvaluation of \$4.2MM instead of a loss of 4.8MM. This was a net overvaluation of 9.4MM.
- The error was discovered in September 2005, as a part of a review prior to a new PT release. The MTM overvaluation at the time of identification was 12.7MM.
- The analysis does not explicitly indicate why the initial booking error occurred and was not identified timely (resources, procedures, manual processes). The analysis also does not explain why the second error occurred and was not identified through the change management process.
- In response to this event, the desk has halted trading and is reviewing all trades to ensure proper booking. In addition, the new version of PT should provide improved risk management and PNL attribution functionality.
- Presently, the business is reconciling all CDO trades back to original documents. They are taking on no new trades during this period. The desk head felt this one trade issue was not identified because the system change happened at the same time the vol skew was implemented and the PNL impact was probably masked.
- The reconciliation process is particularly focused on CDO², managed trades and trades with substitution rights, principal protected trades and trades with non standard payouts, and trades with embedded fees.
- The reconciliation thus far effort has identified the following themes:
 - Minor, but frequent differences in cash flow definitions
 - Portfolio differences (largely due to substitutions and name changes)
 - Single name CDS trade entry errors
 - Inconsistency in booking of CLN purchases
 - Trades incorrectly input into both PT and OASYS
- A number of new cash break and other exception reports have been developed. New processes have been implemented at the desk level related to error reports and trade input.
- Management has been highly focused on systems adequacy. They also need to evaluate results of reconciliation effort to determine adequacy of people and processes. When Alla (FRB) and Don met with the bank about the reconciliation effort, they felt that some of the misbookings reflected some breakdowns in basic controls (e.g., maker/checker review, etc).
- Management should identify various operational triggers for escalation and decision-making by senior management.