Kamakura Corporation

KAMAKURA RISK MANAGER

VERSION 8.0

INTRODUCTION TO KRM

ALM
Credit Risk
Market Risk
Liquidity Risk
Capital Allocation
Performance Measurement
Basel II and III and Solvency II
FAS 157 and 133 and IFRS
Integrated Risk System

—JUNE 2013—

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I. Introduction

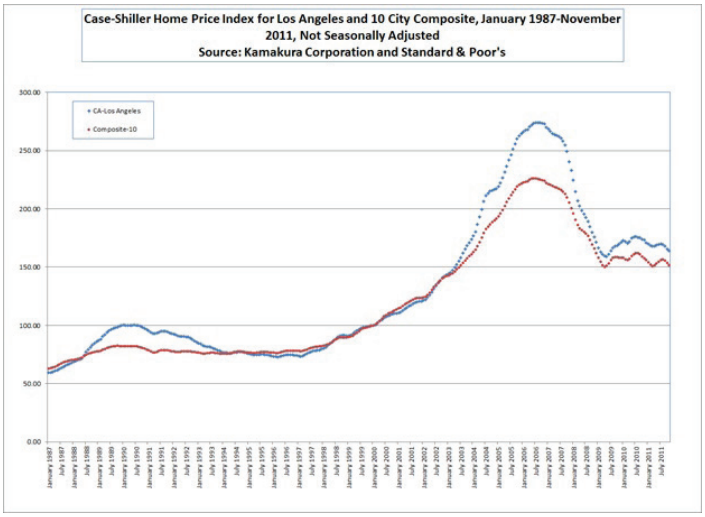
During the credit crisis of 2007–2009, the chief executive officers of Citigroup, Merrill Lynch, Bear Stearns, Wachovia, Washington Mutual, and UBS were fired because of risk management failures at their organizations. Countrywide Financial was sold to Bank of America in a distress sale for the same reason. Without exception, these institutions relied on legacy interest rate risk, market risk, and credit risk systems that were simply unable to answer one basic question: what happens to our institution if home prices drop by 40%? Kamakura Risk Manager (KRM) is designed to answer this and many closely related questions in order to give management, the Boards of Directors, shareholders, and regulators an accurate view of the total risk of the organization, including traditional narrowly defined risk "silos." Such stress testing is now mandatory in Europe and the United States for major bank holding companies under the Supervisory Capital Assessment Program introduced in 2009 and under the Comprehensive Capital Analysis and Review 2012. Kamakura Risk Manager is the first risk system in the world to incorporate these capabilities, capturing the impact of any user-defined risk factor on defaults, prepayments, credit spreads, valuation, cash flow, and net income.

KRM is a total risk system used for:

- performance measurement,
- integrated investment portfolio and actuarial risk measurement,
- asset and liability management,
- interest rate risk,
- transfer pricing,
- liquidity risk,
- credit risk,
- Solvency II capital ratios,
- Basel II capital ratios,
- Basel III capital and liquidity ratios,
- capital allocation,
- risk-adjusted return on capital, and
- market-oriented accounting calculations like FAS 133/IAS 39 and FAS 157.

II. Macro Factors Matter in Enterprise Risk Management

After peaking in mid-2006, home prices in the United States began to drop at a rate unprecedented in modern U.S. financial history. The graph below shows the Case-Shiller home price indices for Los Angeles and the 10-City Composite Index. Home prices in Los Angeles dropped 41.9% from their peak in September 2006 to May 2009. The 10-City Composite Index peaked in June, 2006 and dropped 33.5% by April 2009. The fact that home prices were a critical risk factor for major financial institutions was not a surprise. On December 10, 2003, Kamakura Managing Director for Research Professor Robert Jarrow and four co-authors published the Loss Distribution Model mandated by the U.S. Congress for the Federal Deposit Insurance Corporation. That study explicitly identified home prices as one of three macro-factors driving correlated default of U.S. banks.



Some of the financial institutions with the largest losses from the 2007–2009 credit crisis have explicitly admitted that the losses stemmed from a lack of understanding of the exposure that the companies had to home prices. For example, Ann Reese, chairwoman of Merrill Lynch's audit committee, said the board held "numerous discussions" with management about its investments in the months before the credit crisis. "The board initially didn't realize that prices of CDOs were linked to the U.S. housing market," she said. "The CDO position did not come to the board's attention until late in the process," said Reese, a former chief financial officer of ITT Corp. and who now is co-executive director of the non-profit Center for Adoption Policy. "For reasons that we have subsequently explored, there was not a sense that these triple-A securities should be included in the overall exposure to residential real estate."[1] Another example comes from the Shareholders' Report on UBS's Write-Downs (April 18, 2008) on the reasons for UBS's massive losses in real-estate-related CDO tranches: "Whilst there were a number of credit spread RFL [risk factor limits] limits in place, there was no RFL that specifically addressed certain factors relevant to Subprime exposure, such as delinquency rates or residential real estate price developments."

Kamakura Risk Manager provides risk managers, senior management, Boards of Directors, shareholders, and regulators the capability to analyze explicitly the total risk impact of macro-economic and other pervasive risk factors such as home prices, interest rates, foreign exchange rates, longevity risk, other insurance risks, risk of natural and other disasters, stock prices, oil prices, commercial real estate prices, and commodity prices.

KRM for Interest Rate Risk and Asset and Liability Management

Kamakura's senior management team has more than 300 years experience as ALM and interest rate risk managers. Kamakura Risk Manager's powerful ALM capabilities include user-defined multi-factor interest rate models, multiple approaches to prepayment analysis including state of the art logistic probabilities of prepayment, dynamic movements in new business, state of the art options models consistent with the work of Professor Robert Jarrow, and modern valuation techniques for valuing complex assets and liabilities such as life insurance policies, bank owned life insurance, non-maturity deposits, servicing rights, and so on. KRM allows up to 99,999 user-defined time periods of any varying length.

- **KRM Data:** Either transaction level data (best practice) or summarized data.
- **KRM Term Structure Models:** N-factor term structure models (up to 999,999 factors) can be defined by the user.
- **KRM Fixed Income Options:** Closed form solutions, lattice solutions, and Monte Carlo solutions are available.
- **KRM Prepayment Models:** Logistic prepayment, multinomial logit for integrated prepayment and default generation, traditional prepayment functions, prepayment tables, and a wide range of prepayment speed models.
- **KRM Options Exercise:** Fixed income options can be exercised rationally or "irrationally" subject to transaction costs to mimic actual consumer behavior.
- **KRM Non-Maturity Deposit Modeling:** Modeling can be done either using the no-arbitrage approach of Jarrow-van Deventer (1996, 1998) or by using specific user defined formulas for rate and balance evolution as a function of interest rates and the credit risk of the institution, in order to capture accurately the kind of deposit run-off experienced by firms like Washington Mutual ($26 billion out-flow), Northern Rock PLC (which lost 63% of "customer accounts"), and Wachovia.
- **KRM Default Modeling:** KRM ALM analysis can use a wide range of default models as outlined below in the KRM for credit risk section.
- **KRM Yield Curve Smoothing:** KRM provides the user with the choice of six yield curve smoothing methods and six credit spread methods for fitting current market yield curves. Among the choices are the maximum smoothness forward rate method of Adams and van Deventer (1993).
- **KRM Yield Data Format:** KRM accommodates a wide array of interest rate data formats from raw bond prices to common libor and swap market conventions.
- **KRM Roll-over and New Business Modeling:** KRM allows dynamic balance sheet evolution using a rich array of user choices regarding the investment of scheduled and unscheduled cash flows, the amount and nature of new business, and the dynamic evolution of deposit balances.
- **KRM Matched Maturity Margin Simulation:** As noted in the next section, KRM can simulate net income on both a gross basis and a matched maturity basis, recognizing the transfer pricing strategy followed by the institution.

III. KRM for Transfer Pricing and Performance Measurement

As Kamakura's van Deventer, Imai, and Mesler noted in their 2004 book Advanced Financial Risk Management, performance measurement and transfer pricing have changed enormously since Wm. Mack Terry and his team at Bank of America invented the transfer pricing concept in 1973. Kamakura Risk Manager uses the exact date of cash flow, adjusted for holidays, weekends, business day conventions and so on, to assign a cost of funds to each asset and a credit for funds for each liability. Users define which yield curve is the basis for transfer pricing, so appropriate adjustments can be made for the underlying liquidity and credit risks of the instrument being transferred. Kamakura Risk Manager boasts a wide array of yield curve and credit spread smoothing techniques and methodologies for transfer pricing assets and liabilities with embedded options.

- **KRM Transfer Pricing Techniques:** KRM allows the user to select from multiple transfer pricing techniques. The best practice technique is an exact day count matched maturity funds transfer pricing cost based on current yield curves using one of the yield curve smoothing techniques outlined in the KRM for Interest Rate Risk Management Section. Other techniques include transfer pricing based on constant duration or weighted average interest rate approaches.
- **KRM Transfer Pricing for Historical Data:** Transfer prices can be "recreated" on historical yield curve data and assets originated in the past by applying the technique selected by the user to data which existed at the historical point in time.
- **KRM Simulation of Transfer Pricing Margins:** KRM can simulate net income forward on both a traditional basis and on a transfer pricing basis, allowing the user to see clearly how much of the variation in net interest income is due to funding mismatches and how much is due to a matched maturity funding strategy.

IV. KRM for Market Risk

As noted above, Kamakura Risk Manager includes both traditional approaches to value at risk and credit adjusted value at risk and a much more modern approach: a dynamic multi-period credit-adjusted value at risk including component VAR. This flexibility allows market risk managers to replicate legacy systems while moving forward to a more modern approach that allows multiple VAR horizons and an analysis period as far beyond the traditional 10-day VAR calculation as the user thinks is appropriate. Many KRM users, for example, look at VAR analysis where the time horizon is many years.

- **KRM Multi-period Dynamic VAR:** KRM employs the asset and liability market practice of dynamic balance sheet modeling and fully multi-threaded Monte Carlo simulation to generate a dynamic multi-period value at risk that recognizes both portfolio evolution and the potential default of counterparties. Many Kamakura clients regard this as the best practice VAR calculation.
- **KRM Historical VAR:** KRM also calculates traditional historical value at risk based on historical movements in the yields on securities currently held by the institution. This common calculation, of course, will only be correct if the future has the same risk characteristics of the historical period used for modeling. Historical VAR can be calculated either using relative changes in asset prices (percentage changes) or absolute changes in asset prices (i.e. the dollar, yen, or Euro change in price).
- **KRM "Matrix" or Variance-Covariance VAR:** KRM also includes the selection of the traditional variance-covariance approach to VAR, which assumes that returns on assets held by the institution are normally distributed. This common calculation understates risk because of its implicit assumption that default will not occur. Using historical stock return volatility for Lehman Brothers, for example, implies that the probability of a 100% decline in the stock price (which occurred in September 2008) is 0.000000%.
- **KRM "Component" VAR:** KRM supplements traditional VAR with Component VAR. Component VAR is a variation on the standard value at risk formulation with three important properties. First, the sum of the component VARs for each transaction equals the component VAR of the portfolio as a whole, unlike the traditional VAR calculation. Second, if a transaction is deleted from the portfolio, the component VAR of the revised portfolio will equal the component VAR of the original portfolio minus the component VAR of the deleted transaction. It can be shown that the change in component VAR is a close approximation to the change in traditional VAR that will result. Third, the component VAR will be negative for transactions which act as a hedge for the remainder of the portfolio.
- **KRM Single Period Monte Carlo Simulation VAR:** KRM can be used for a single period Monte Carlo-driven value at risk in addition to the multi-period approach outlined above.
- **KRM Marginal VAR:** KRM Version 8.0 includes the output of the marginal contribution to VAR from taking an additional dollar of exposure to a particular asset or liability.

V. KRM for Credit Risk and Credit Portfolio Management

Kamakura Risk Manager provides credit risk managers with a steady way forward from traditional reliance on internal and external ratings to a full multi-period macro-factor driven simulation where default probabilities for all counterparties (from retail to small business to listed companies to sovereigns) rise and fall with the economy. It is the latter approach that provides true "see through" risk assessments of exposure to macro factors like home prices, avoiding the losses that Merrill Lynch, Citigroup, and UBS incurred because of the lack of transparency in macro-factor risk. Kamakura Risk Manager users can derive "delta hedges" on total portfolios and full balance sheets for each macro factor. Kamakura Risk Manager allows the use of internal ratings, internal default models, third party ratings, and default models, and the Kamakura Risk Information Services public firm, non-public firm, and sovereign default models, which can be seamlessly loaded into Kamakura Risk Manager.

- **KRM Logistic Default Models:** KRM can use user-defined or third party default models based on logistic regression or multinomial logit and user-defined variables to simulate default/no default on a multi-period basis for retail, small business, corporate, municipal and sovereign counterparties. Because this approach allows the explicit incorporation of macro-factors like home prices, oil prices, interest rates, mortality rates and so on, many KRM users regard this approach as the only methodology which would have allowed the losses of the 2007-2009 credit crisis to be avoided.
- **KRM and Logistic Regression:** KRM has the logistic regression calculation built in, so that users with particularly large modeling data bases can employ the powerful relational data base management capability in KRM for maximum modeling accuracy. Common statistical packages rely heavily on text files for inputs and have a relatively small tolerance for large data sets, so the KRM logistic regression calculation is an attractive alternative. If logistic regression models are derived outside of KRM, their coefficients are simply loaded into KRM for simulation of forward default probabilities.
- **KRM and KRIS Default Models:** KRM can seamlessly load and use the corporate, non-public firm, and sovereign default probabilities that Kamakura provides as part of its Kamakura Risk Information Services default probability service. The KRIS service also includes the correlation between default probabilities for any pair of companies of the 31,000 global companies in the 37 countries covered by the KRIS service.
- **KRM and Merton/Copula Default Models:** KRM can also use the traditional Merton approach to risky debt and the related copula approach to simulate default/no default as an alternative to the logistic regression approach. Although many analysts have cited the copula approach as a contributor to valuation errors in the 2007–2009 crisis, it remains a popular modeling benchmark among market participants.
- **KRM and Internal Ratings:** KRM allows internal ratings and the default probabilities associated with the ratings to be simulated forward. From the evolution of the ratings "transition matrix," default probabilities and credit spreads of all classes of borrowers can be simulated forward. This is also a popular choice among market participants.

- **KRM and Rating Agency Ratings:** KRM also allows third party rating agency ratings and transition matrices to be used to simulate default and credit spreads on a forward-looking basis.
- **KRM and Third Party Default Probabilities:** KRM allows the user to supply KRM with default probabilities from any source, whether they be from internal models or from third party vendors.
- **KRM and Loss Given Default Derived from Collateral Values:** KRM provides the user with many choices for modeling loss given default. The best practice technique, in the view of many KRM users, is to allow the user to specify how the factor driving the value of the collateral underlying the loan (say the home price or automobile price) evolves in response to changes in other macro factors. In a default scenario, KRM takes the collateral value for that loan at that point of time in the given scenario and then assumes the collateral is liquidated subject to transactions costs with a user-specified time lag from the event of default. This approach can be used even for unsecured debt instruments by modeling the "value of company assets" in the Merton style as effective collateral.
- **KRM and Random Loss Given Default:** Loss given default or the recovery rate can also be modeled in KRM as a random risk factor without modeling collateral explicitly.
- **KRM and Exposure at Default:** Basel II and Basel III require a detailed analysis of the potential exposure at default of many classes of credits. The exposure at default will be random if the transaction allows for prepayment (a "call" by the issuer of the debt) or additional drawdown (a "put" of the debt instrument to the lender by the borrower). KRM includes embedded rational and "irrational" exercise of these options by all classes of borrowers so that the exposure at default is calculated in a very realistic way.
- **KRM and Credit Default Swaps:** KRM includes valuation, cash flow generation, and financial accrual calculations for credit default swaps and a very wide array of other credit risky instruments.
- **KRM and Collateralized Debt Obligations:** KRM includes the capability to model both "cash flow" and "synthetic" collateralized debt obligations down to the individual collateral level. KRM also has links to the Intex and other CDO libraries for automated access to the waterfalls on individual CDO deals. For CDO transactions that are new or are not included in the Intex libraries, users can overlay their own waterfalls on the transaction level cash flow generated by KRM to get realistic cash flows and valuations for a particular tranche and waterfall structure.
- **KRM and Guarantees:** KRM allows the user to analyze the guarantee or "wrap" of a given credit instrument as a separate and distinct transaction, recognizing that the guarantor itself may default in a way that is correlated with the default of the underlying borrower whose credit has been guaranteed. After the failure of monoline insurer Ambac as a result of the credit crisis, this level of realism is considered mandatory by most of KRM users.

VI. KRM for Solvency II, Basel II and Basel III Capital Calculations

Many financial institutions have learned that Basel II requires more than a "risk weight multiplier" and this opinion is even stronger as the Basel III regulations emerge from national supervisors around the world. Solvency II for the insurance industry presents the same challenges. The existing Basel II Capital Accords from the Basel Committee on Banking Supervision incorporate a complex set of rules as to what risk weight should be assigned to a particular asset. Kamakura Risk Manager includes the full set of rules to make these calculations in a very efficient and accurate manner. Kamakura and its distributors have installed KRM for Basel II purposes from Warsaw to Hong Kong, with the appropriate modifications through the KRM-rp web based reports portal for unique national Basel II implementations. Solvency II and Basel III reporting also take advantage of the KRM-rp reporting system. Besides the Basel II and III calculations within Kamakura Risk Manager, Kamakura's risk experts provide advisory services to clients around the world on credit modeling, Basel II-compliant model audits and other key Basel II-related topics. Version 8.0 of KRM includes several updates to enable expeditious implementation of the Basel Standardized approach, as outlined in the Capital Requirements Directive (CRD) and the Prudential Sourcebook for banks, building societies and investment firms (BIPRU). KRM-rp's Basel II reports adhere to the Common Reporting Standards (COREP) specified for Basel II.

- **KRM for Simulating Basel II, Basel III, and Solvency II Capital Ratios and Liquidity Ratios Forward:** KRM is much more than a simple report on Basel II, Basel III, and Solvency II capital ratios (and in the case of Basel III, liquidity ratios) at the current point of time. The full power of KRM interest rate and credit simulation capabilities can be used to simulate capital ratios and liquidity ratios forward in time on a realistic basis so that management gets maximum early warning of potential regulatory capital shortfalls.
- **KRM for Standard Basel II Capital Ratios:** KRM calculates the standard Basel II capital ratios as part of the normal "mark to market" calculation in KRM.
- **KRM for the Advanced Internal Ratings Based Basel II Calculations:** KRM's powerful credit risk modeling capabilities make KRM the ideal vehicle for institutions pursuing the "Advanced IRB" approach to Basel II. From model building to exposure at default simulation, KRM has the richness to produce Basel II and Basel III Capital Ratios with maximum accuracy.
- **KRM and Kamakura Consulting for Basel II, Basel III, and Solvency II:** From Warsaw to Hong Kong, Kamakura has consulted with the modeling and risk management teams of some of the world's most sophisticated financial institutions on a number of Basel II, Basel III, and Solvency II techniques: default model construction, model audits and measures of model accuracy, linking internal ratings to default probabilities, linking third party ratings to default probabilities, linking credit scores to default probabilities, and insuring that the business cycle and macro-economic factors are properly linked to default probabilities in order to create realistic evolution of default probabilities at every point in the business cycle.
- **KRM and Local Basel II, Basel III, and Solvency II Rules and Reporting:** Using the web-based reports of KRM-rp, Kamakura has worked with clients all over the world to

ensure that differences in individual country Basel II calculations and reporting formats are correctly produced in KRM-rp, including local language reporting and automated PDF file generation for electronic file submission.

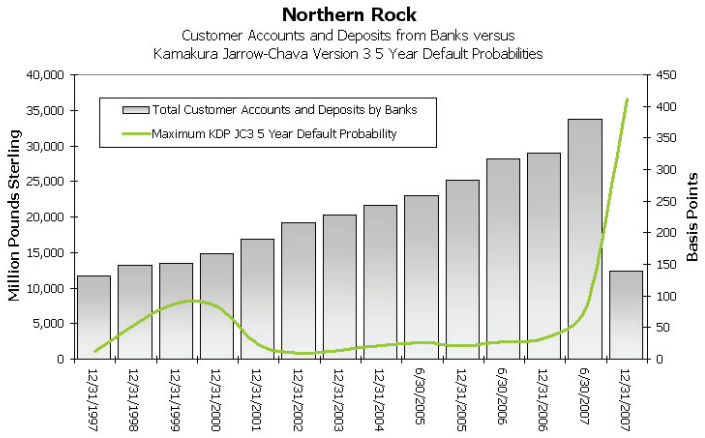
VII. KRM for Capital Allocation

Kamakura Risk Manager's dynamic balance sheet simulation capabilities make it very clear that capital requirements have a term structure. Financial institutions' capital needs grow as the time horizon lengthens and when the business cycle turns down. Kamakura's multi-period simulations show the period-by-period picture of that capital needed to achieve a target institutional rating, default probability, and likelihood of survival. Stress testing of economic capital in Kamakura Risk Manager demonstrates clearly how macro-economic factors like interest rates, home prices, oil prices, stock market prices, foreign exchange rates, mortality risk, and commercial real estate prices affect capital requirements.

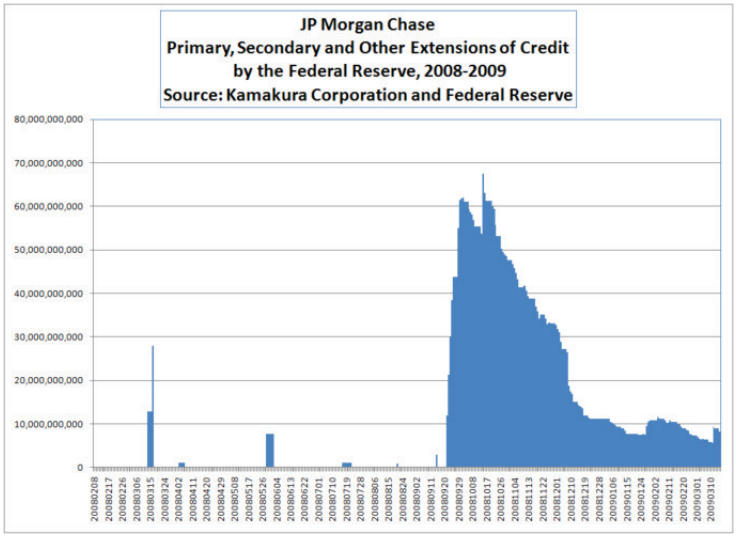
- **KRM Dynamic Multi-Period Credit-Adjusted Capital Simulation:** As noted in the asset and liability management and credit risk sections above, KRM allows users to simulate capital needs for an institution in a framework that recognizes cyclical default probabilities, cash flow reinvestment and the sensitivity of liability suppliers to the credit risk of the institution. (See the section below for more in that regard.) The result of these powerful capabilities is a realistic term structure of capital needs of unsurpassed accuracy. Many KRM users regard this approach as the most practice and realistic calculation for capital requirements.
- **KRM Single Period Credit-Adjusted VAR for Capital Allocation:** Many institutions have a capital allocation policy that is based on a single period credit adjusted value at risk calculation. KRM provides this special case in addition to the more general and more accurate multi-period approach outlined above.
- **KRM Capital Allocation at the Transaction Level:** KRM can calculate transaction-level capital requirements in two ways. The first way is via the sophisticated Monte Carlo simulation techniques above, where the nth percentile transaction value determines the capital required in accordance with the policy of the institution doing the analysis. The second way is more general. In many institutions, the capital required often includes considerations above and beyond the Monte Carlo outputs. For institutions with this kind of capital allocation policy, KRM takes the user-supplied capital allocation formula and applies this formula to each individual transaction to get required capital. Kamakura Risk Manager can handle up to 999,999,999 Monte Carlo scenarios on a fully multi-threaded basis.
- **KRM Calculation of the Institution's Own "Inside Out" Default Probability:** As a by-product of the capital allocation calculation over N user defined periods, KRM can also produce the probability that the institution will default in each period. The institution's default probability can be defined in various ways. A common choice is to measure the percentage of scenarios in period J in which the institution has mark to market capital that is negative. An alternative definition is the percentage of scenarios in period J in which the firm has both exhausted its marginal borrowing capabilities and its cash reserves,

Kamakura calls this "inside out" default probability analysis because the institution is using its "inside" knowledge of the full balance sheet to estimate the default probability, which it can then compare to the "outside" world's estimate of the default probability using only publicly available information.

VIII. KRM for Non-Maturity Deposits



On September 14, 2007, the Bank of England was forced to intervene to protect Northern Rock against the first bank run in the United Kingdom in more than a century. The chart at the left shows that Northern Rock, based in Newcastle, lost 63% of its customer accounts and deposits from banks as the bank's default probability rose approaching December 31, 2007. Many bankers overlook the fact that demand and savings deposit volumes are highly sensitive to the credit risk of the bank itself. Kamakura Risk Manager allows users to model "non-maturity" deposit volumes and their link to macro-economic factors and bank risk with maximum accuracy. The same phenomenon is captured by the Kamakura Risk Information Services Liquidity Risk data base which tracks borrowings by 1,305 financial institutions from the U.S. Federal Reserve between February 8, 2008 and March 16, 2009. The graph below shows that the liquidity risk funding shortfall for JPMorgan Chase reached $67.5 billion dollars at the point of greatest distress during the crisis:



Kamakura executives Professor Robert Jarrow and Dr. Donald R. van Deventer have published extensively (1996, 1998, 1999, 2004) on how modern derivatives technology can be used to measure the profitability and risk profile of ordinary deposits.

IX. KRM for Liquidity Risk Management

In January 2008 it was announced that Bank of America would buy mortgage lender Countrywide Financial Corporation. Like the case of Northern Rock, home price declines were devastating for Countrywide's mortgage business. As investors perceived higher default risk for Countrywide, the annual premium for five-year credit default swaps on Countrywide broke out of a narrow range between 50 and 100 basis points and climbed to almost 300 basis points by September 30, 2007. The result was a 94% decline in Countrywide's ability to issue commercial paper. By December 31, 2007, credit default swap quotes exceeded 800 basis points and Countrywide was completely shut out of the commercial paper market. By June, 2008, Countrywide was forced to borrow $6.3 billion from the Federal Reserve in order to survive until the close of its merger with Bank of America. Kamakura Risk Manager allows users to measure carefully how movements in macro-economic factors like home prices and interest rates can affect liquidity risk and the institution's ability to fund itself with both retail and wholesale deposits.

X. KRM for Insurance

Kamakura Risk Manager allows users to simulate a rich array of insurance events. Using modern probability techniques, users can simulate the probability of occurrence of events like default/no default, prepay/don't prepay, pay on a life insurance policy or don't pay, and so on. Using Kamakura Risk Manager, leading edge actuaries can explicitly incorporate the impact of the economy on mortality rates, as recent economic developments in Russia and Japan make so clear. Similarly, the advance of medical technology and the impact on mortality from new diseases can be simulated in a rich and realistic way, consistent with the most recent developments in medical statistics.

- **KRM and the Mathematics of Mortality Rate Modeling:** In 1971, D.R. Cox published a famous paper on the use of continuous time mortality rates for the pricing of life insurance policies. These probabilities, known as "Cox processes," are the basis for modern credit risk modeling known as the reduced form approach. Robert Jarrow, Stuart Turnbull, David Lando, and many others have employed this approach in credit risk research. Because of their common basis on the same mathematics, the links between insurance and credit risk modeling are very strong. KRM fully exploits these links.
- **KRM and Mortality Tables:** Traditional mortality tables show the mortality rate for a relatively small number of attributes of the underlying insured, such as age, male/female, smoker/non-smoker, and so on. Mortality tables have the identical structure to the user-defined prepayment tables discussed in the asset and liability management section of this report. Kamakura is actively working with insurers to allow them to incorporate proprietary mortality tables in KRM.

- **KRM and the Use of Logistic Mortality Rates:** Logistic regression has long been used in medical science to predict mortality as a function of the current health condition of the underlying subject, the exposure to various diseases, and the exposure to various treatment regimes. KRM has the ability to model mortality both as a function of medical and health inputs and economic conditions (as Japan and Russia have proven is relevant) in a realistic way.
- **KRM and Internal Mortality Models:** KRM can load internal mortality models directly for modeling forward, in a manner exactly parallel to the default modeling capabilities outlined in the credit risk section of this overview.

XI. KRM for FAS 157 "Level 3" Valuations

Financial Accounting Standard 157 requires institutions to model thinly traded "hard to value" assets accurately. During the 2007-2009 credit crisis, this valuation capability became essential to many firms as the trading in mortgage-backed securities and tranches of collateralized debt obligations came to a near stand-still. Kamakura Risk Manager provides a state of the art framework that generates completely transparent valuations and an understanding of how bid-offered spreads in thinly traded markets reflect sampling error and other uncertainties in the valuation process. Kamakura consultants are actively engaged in valuation services using KRM for sophisticated financial institutions around the world.

XII. KRM-lm for Limits Management

KRM Limits Manager is a web-based add-on to KRM that allows users to specify complex rules and limits for credit and trading risk exposure. Like all of Kamakura's web based applications, KRM-lm is designed on a multi-lingual basis and can display the logo of the KRM-lm user's institution.

KRM-lp for Loan Pricing

The KRM Loan Pricing module is also a web-based add-on to Kamakura Risk Manager which allows KRM's sophisticated capital allocation simulations to be used to price individual loans according to the financial institution's pricing policies. It is currently used by hundreds of lending officers world-wide. Like all of Kamakura's web based applications, KRM-lp is designed on a multi-lingual basis and can display and logo of the KRM-lp user's institution.

KRM-dm for Data Mapping

The KRM Data Mapping module is another web-based tool which is used to automate the mapping of market data and client portfolio data to standard KRM table formats. The efficiency of the KRM-dm tool is one of the many reasons why Kamakura has a flawless installation record for KRM and an excellent reputation for fast and efficient installations.

XIII. Other KRM Features

Kamakura Risk Manager includes the KRM-sa Security Administrator module. KRM-sa controls the rights of various uses to access selected input data bases, output data bases, and assumption sets. KRM Version 8.0 includes an extremely secure encryption of client-specific information in KRM-sa related tables and in the KRM license file.

KRM Processing Volumes

Because of the flexibility of the Kamakura Risk Manager architecture, KRM is used by clients to process portfolios that range in size from a few hundred transactions to more than 700 million, a volume record currently held by one of the largest banks in China. It is very common for KRM to be used on portfolios with millions of transactions because of the high speed processing that KRM is able to achieve.

KRM Processing Speed

KRM Version 8.0 is a fully multi-threaded application that is designed to work either on a desktop or on an array of servers for maximum speed. Because of the multi-threading capability, "worker threads" can be designated for either analysis or data base tasks in a way that takes full advantage of state of the art multi-CPU computers.

KRM Securities Coverage

Kamakura Risk Manager has an extraordinarily comprehensive ability to value and produce cash flows and financial accruals for a very wide range of transaction types. KRM has steadily grown in its ability to handle complex securities as the market place has evolved. KRM can process equities, all standard fixed income instruments, insurance liabilities, odd-amortization "one of a kind" securities, collateralized debt obligations, foreign currency derivatives, interest rate derivatives, mortgage-backed securities, and much more.

XIV. KRM Modeling Choices

Kamakura is firmly committed to a multiple models approach to risk analysis. The user's ability to change modeling assumptions with a mouse click is essential for understanding potential model risk. It also is critical in allowing users to replicate existing "common practice" risk calculations while they evolve from "best practice" to "emerging best practice." KRM includes a full range of alternative techniques for interest rate simulation, options valuation, yield curve smoothing, default modeling, prepayment modeling, insurance event modeling, foreign exchange rate simulation, and so on.

- **Default modeling:** Merton default models, reduced form default models, ratings based default models, and transition matrices
- **Simulation of random default probabilities:** KRM supports historical sampling, correlated default probability simulation, macro-factor, and other factor driven default probability simulation and time-based drifts in default probabilities.
- **Simulation of credit spreads:** Linear credit spread functions, logistic credit spread functions (see RISK Magazine, Jarrow, Li, Mesler and Van Deventer, September 2007), and random simulation of credit spreads on a correlated basis.
- **Fixed income options valuation:** Closed form solutions, lattice solutions, and Monte Carlo solutions. Options can be exercised rationally or irrationally. Models employed include both term structure model-based options formulas and Black options formulas. All standard options types are included, such as European, American, and Bermudan options.
- **Equity and foreign exchange options valuation:** The full range of Black-Scholes variations is included in KRM.
- **Futures contract valuation:** Futures valuations are fully consistent with the term structure of interest rates and modern no arbitrage financial theory.
- **Prepayment modeling:** KRM supports prepayment functions, prepayment tables, logistic probabilistic prepayment, and third party models like Andrew Davidson & Co.
- **Yield curve smoothing:** Linear smoothing, four variations of cubic spline smoothing, and the Adams and van Deventer (1994) maximum smoothness forward rate smoothing.
- **Credit spread smoothing:** The same six choices listed above for yield curve smoothing also apply to credit spread smoothing, where yields are calculated by smoothing relative to a user-specified risk free curve.

KRM Links to Kamakura Risk Information Services Default Probabilities

Kamakura Risk Manager links seamlessly to the Kamakura Risk Information Services default models. This link allows clients with KRM and KRIS licenses to load KRIS default probabilities, default formulas, and default correlations into KRM for analysis with the click of a mouse. No other enterprise wide risk systems vendor offers these capabilities. Kamakura Risk Information Services was launched in 2002. KRIS now includes default probabilities on more than 31,000 public firms in 37 countries. KRIS also includes default probabilities, for non-public firms, for 183 sovereign nations, default rates for 4 classes of mortgage loans, and a number of other default models that have not yet been publicly announced.

XV. About Kamakura Risk Manager, Version 8.0

Kamakura Risk Manager, first offered commercially in 1993, has been under continuous expansion and improvement since the first lines of code were written in 1990. The KRM system is written in modern C++ class libraries that are constantly being improved from a speed and accuracy point of view. KRM version 8.0, for example, contains much more functionality but 31% fewer lines of code than KRM version 6.3. KRM comes with a rich data base architecture that is Open Data Base Connectivity compliant with proper security. KRM runs on both Windows and UNIX, and relational data bases like MS SQL Server, Oracle, and Sybase can all be used with KRM. KRM currently supports the following data bases for use on 64-bit servers: MS SQL 2005 and 2008 and Oracle 10G R2. The KRM application server runs on Windows operating systems, but the data base servers can be run on both UNIX and Windows platforms. Kamakura Risk Manager is designed as a multiple-models risk management system, featuring a rich array of interest rate simulation techniques, default modeling approaches, prepayment simulation alternatives, and embedded options valuation methodologies. Kamakura Risk Manager is delivered with an optional set of Java-based web tools including the KRM-Risk Portal (rp) for wide dissemination of risk reports around the organization, KRM-Data Manager (dm) for easy data loading to KRM tables, KRM-Limits Manager (lm) for state of the art risk limits monitoring, and KRM-Loan Pricing (lp) for modern risk-adjusted return on capital loan pricing. KRM produces cash flows, financial accruals and valuations at all user-defined forward time periods for the full range of financial instruments, from collateralized debt obligation tranches to mortgage backed securities to simpler instruments like bonds, deposits, loans, credit default swaps, options, interest rate swaps, life insurance policies, non-maturity deposits, foreign exchange transactions, and so on.

XVI. About Kamakura Corporation

Founded in 1990, Honolulu-based Kamakura Corporation is a leading provider of risk management information, processing and software. Kamakura was named to the World Finance 100 by the Editor and readers of World Finance magazine in 2012. In 2010, Kamakura was the only vendor to win 2 Credit Magazine innovation awards, including one with distribution partner Thomson Reuters. Kamakura Risk Manager, first sold commercially in 1993 and now in version 8.0, is the first enterprise risk management system with users focused on credit risk, asset and liability management, market risk, stress testing, liquidity risk, counterparty credit risk, and capital allocation from a single software solution. The KRIS public firm default service was launched in 2002. The KRIS sovereign default service, the world's first, was launched in 2008, and the KRIS non-public firm default service was offered beginning in 2011. KRIS default probabilities are displayed for 4,000 corporates and sovereigns via the Reuters 3000 Xtra service and the Thomson Reuters Eikon service. Kamakura has served more than 220 clients ranging in size from $1.5 billion in assets to $1.6 trillion in assets. Kamakura's risk management products are currently used in more than 30 countries, including the United States, Canada, Germany, the Netherlands, France, Austria, Switzerland, the United Kingdom, Russia, the Ukraine, Eastern Europe, the Middle East, Africa, South America, Australia, Japan, China, Korea, India and many other countries in Asia.

Kamakura has world-wide distribution alliances with Fiserv (www.fiserv.com), SCSK Corporation (http://www.scsk.jp/index_en.html), Unisys (www.unisys.com), and Zylog Systems (www.zylog.co.in) making Kamakura products available in almost every major city around the globe. To follow the troubled company index and other risk commentary by Kamakura on a daily basis, please follow Kamakura CEO Dr. Donald van Deventer (www.twitter.com/dvandeventer), Kamakura Chief Administrative Officer Martin Zorn (www.twitter.com/riskmgrhi), and Kamakura's official twitter account (www.twitter.com/KamakuraCo).

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