

Kamakura
Corporation

KAMAKURA

RISK INFORMATION SERVICES

Kamakura Non-Public Firm Models

Version 2

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I. Introduction

The Kamakura Risk Information Services Non-Public Firm Model, first launched in August 2011, brings the same state of the art credit risk technology to the evaluation of non-public firms that the KRIS Public Firm Model and KRIS Sovereign Default Models have delivered since 2002 and 2008 respectively. Like the KRIS Public Firm and Sovereign Default Models, the KRIS Non-Public Firm Model provides bankers, investors, investment managers, dealers, traders, other lenders and auditors a powerful but simple and objective means of assessing the credit quality of non-public firms. Credit quality is measured with an explicit default probability and term to maturity, so there is no confusion about the debate about whether a credit risk measure is “point and time” and “through the cycle.” The KRIS default probabilities are all “point in time” measures of credit risk on the user-selected date, and the best “through the cycle” default probability is the longest maturity offered by the KRIS service for that class of counterparty.

Kamakura’s Non-Public Firm Models offer many benefits to organizations that require a testable and reliable means for analyzing the credit quality of non-public firms:

- Complete, seamless integration with the KRIS Public Firm Model and the KRIS Sovereign Default Model
- Total integration with Kamakura’s industry-leading enterprise-wide risk management software package Kamakura Risk Manager, just as with the KRIS Public Firm Model, the KRIS Sovereign Default Model, and other models provided by Kamakura
- Methodological benefits include objective quantification of firm default risk, updated daily, and maximum utilization of available data.
- Operational benefits include low cost credit analysis across a large number of non-public firms and default model accuracy that exceeds the accuracy of many default models for public firms.

The term structure of default probabilities for Individual non-public firms is derived from inputs that include nine inputs from the industry-leading KRIS Public Firm Models, company financial information, macroeconomic factors, industry specific attributes and other inputs. These inputs are updated monthly for non-public firms and daily for public firms. Inputs will be updated daily for non-public firms when the KRIS Users Group recommends daily frequency to Kamakura. The term structure of default probabilities for non-public firms includes 1 year, 2 year, 3 year and 4 year maturities. The KRIS Non-Public Firm Models are part of Kamakura Risk Information Services (KRIS), a web-based information service available by annual subscription.




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KRIS

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The world's
best performing
quantitative
credit modeling technology

Kamakura Risk Information Services (KRIS) provides credit professionals with the data, tools and insights necessary to manage risks inherent in credit portfolios and to optimize credit investment decisions. KRIS is utilized by major financial institutions and regulators around the world as a means of accurately pricing credit risk.

DEFAULT PROBABILITIES
KRIS provides a full term structure of default for both corporate and sovereign credit names based upon a multiple models approach. Kamakura default probabilities are updated daily and cover more than 29,000 companies in 36 countries.

IMPLIED SPREADS, IMPLIED RATINGS AND DEFAULT CORRELATIONS
In addition to default probabilities, KRIS provides additional quantitative measures of credit worthiness such as implied spreads and implied ratings for 29,000+ global companies. KRIS default correlations are available across the entire KRIS universe of corporate names for all models and default terms.

TROUBLED COMPANY INDEX
The Kamakura Troubled Company Index provides a daily measure of global credit quality based on the aggregate level of default probabilities in the KRIS coverage universe.

CREDIT PORTFOLIO MANAGEMENT
KRIS provides users with the ability to create and track credit name portfolios and to view these portfolios in a variety of online analytical reports or downloaded for further analysis.

CREDIT PORTFOLIO ANALYSIS AND SIMULATION
KRIS Portfolio Analysis provides users with an integrated, easy to use and powerful Monte Carlo based credit portfolio simulation and reporting engine. KRIS Portfolio Analysis allows sophisticated investors and credit managers to more accurately model complex credit portfolios and to gain greater understanding of the valuation and loss distributions inherent in credit portfolios.

The KRIS Non-Public Firm Models provide unique advantages and superior results to credit market participants. Each firm is evaluated in the context of its country, industry sector, and industry sub-sector. The KRIS Non-Public Firm Model, currently in version 2.0, is updated regularly and incorporates the kind of innovations that have resulted in Credit Magazine Innovation Awards in 2008, 2009, and 2010 (two awards). Each upgrade is given an explicit version number and comes with an extensive KRIS Non-Public Firm Technical Guide that presents full descriptions of model inputs, all formulas and coefficients, and a complete suite of Basel-related model accuracy tests. The Technical Guide is made available to KRIS Non-Public Firm Model clients and their regulatory agencies.

II. Benefits of the KRIS Non-Public Firm Models

Objective Credit Quality Measurement	The KRIS Non-Public Firm Models are based on state of the art reduced form credit model technology that is implemented using a series of logistic regressions. The KRIS Non-Public Firm Models provide objective relationships between observed default behavior and firm attributes, risk of public firms in the same country, industry sector, and industry sub-sector, and the state of the macro-economy.
Modern Default Correlation Technology	For all of the KRIS Models, correlated default can be simulated in Kamakura Risk Manager and KRIS Credit Portfolio Manager as a function of the random changes in macro-economic factors driving default for all classes of counterparties.
Future Economic Expectations	The Non-Public Firm explicitly incorporate inputs from the KRIS Public Firm Default Models which use an array of equity price related and macro factor inputs, thereby incorporating future economic expectations above and beyond backward looking company financial statements.
Maximum Utilization Of Historical Data	The multi-period statistical estimation approach incorporated in the Jarrow Chava reduced form modeling approach maximizes utilization of historical default, public firm default probabilities, financial and economic data often excluded in other models. This allows correct modeling of risk throughout the credit cycle.
High Performance Default Prediction	Default probability estimates provided by the KRIS Non-Public Firm Models are extremely accurate, superior to Merton model accuracy for public firms and even some reduced form models for public firms.
Future Credit Quality Prediction	The KRIS Non-Public Firm Models provide annual default probabilities that look forward at the next four years of default risk.
Business Cycle Related Default Correlation	Default probability correlations among non-public firms, public firms, sovereigns, and retail borrows is derived from the data, revealing their common dependencies on a list of key macro-economic drivers of default risk.
Low Cost Credit Analysis	The KRIS Non-Public Firm Models offer an objective assessment of credit quality without requiring high cost credit analysts or credit modelers and extensive commitment of internal resources.
Large Scale Credit Assessment	The low cost of analyzing individual firms and the use of a quantitative model allows users to apply the KRIS Non-Public Firm Models to a large number of non-public firms at a reasonable cost.
Portfolio Analysis System Compatibility	Default probabilities obtained from the KRIS Non-Public Firm Models can be consistently and directly incorporated in portfolio valuation, cash flow and net income analyses in the Kamakura Risk Manager software and in KRIS Credit Portfolio Manager.

III. Applications

Applications of the KRIS Non-Public Firm Models range from relatively simple analyses of firm creditworthiness to credit-adjusted valuation, cash flow and net income analyses of a firm's obligations to credit-adjusted portfolio risk measurement using Kamakura Risk Manager or KRIS Credit Portfolio Manager. A partial list of potential applications is shown in the accompanying diagram.

Investment management firms can use the Non-Public Firm Models to identify potential trading opportunities. Default probabilities produced by each of the Models can be used to rank firms by riskiness with reliance on legacy credit ratings.

Default probabilities produced by the KRIS Non-Public Firm Models can also be used to estimate fair values for potential investments on a credit-adjusted basis, and these estimates can be compared with actual investment pricing to determine the value of the investments.

Banking firms can use the KRIS Non-Public Firm Models to satisfy their requirements for a Probability of Default (PD) model for their non-public firm clients under the Basel II and Basel III guidelines for both the Foundation and Advanced versions of the Internal Ratings Based approaches. Since the KRIS Non-Public Firm Models describe relationships between non-public firm defaults, public firm default probabilities, non-public firms' characteristics and economic conditions, they can be objectively tested for statistical significance and predictive power. The results of these

Applications of the Kamakura Public Firm Models

Comparing And Ranking Firm Creditworthiness

Compare non-public firm default probabilities to determine relative creditworthiness versus other counterparties

Modeling Correlated Default in Credit Portfolios

Use non-public firm default probabilities to more accurately measure the "tail risk" in credit portfolios

Assisting Credit Approval Decisions

Reduce credit losses by incorporating default probabilities into credit approval processes for non-public firms

Monitoring Changes In Firm Creditworthiness

Observe changes in non-public firm credit quality to identify credit deterioration prior to its reflection in debt market prices

Simulating Non-Public Firm Defaults

Use default models to simulate the timing of potential defaults of non-public firms on a realistically correlated basis

Estimating Non-Public Firm Credit Spreads

Use non-public firm default models and obligation recovery models to estimate the credit yield spread required by investors

Valuing Non-Public Firm Obligations

Use non-public firm credit spread models and instrument valuation models to estimate instrument values for non-public firms

Comparing Non-Public Firm Trading Opportunities

Compare pricing of non-public firm debt priced using estimated default probabilities vs. observed market prices

Simulating Credit-Adjusted Cash Flows and Income

Use non-public firm credit models and instrument cash flow and income models to estimate future credit-adjusted cash flow/income

Hedging Portfolio Value and Cash Flows

Use non-public firm credit, correlation and instrument models to improve estimated hedges of credit-adjusted portfolio value and cash flows

Measuring Portfolio Value At Risk

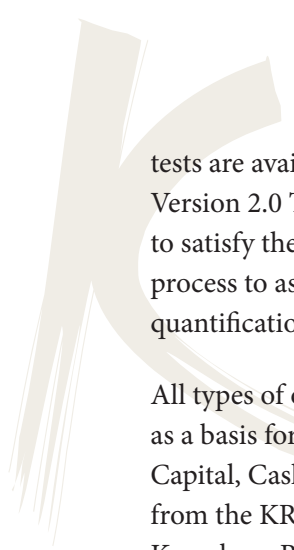
Use non-public firm credit models and correlations to estimate the probability distribution of credit-adjusted portfolio value

Measuring Portfolio Stochastic Cash Flow And Income

Use non-public firm credit, correlation and instrument models to estimate the probability distribution of credit-adjusted portfolio cash flow/income

Estimating Portfolio Regulatory And Economic Capital

Use non-public firm credit-adjusted portfolio value distribution to estimate regulatory/economic capital requirement for the portfolio



tests are available to Non-Public Firm Model clients in the KRIS Non-Public Firm Model Version 2.0 Technical Guide. These test results and documentation are expressly designed to satisfy the Basel II and III and Solvency II requirements for an internal validation process to assess the performance of the banks' and insurance firms' internal rating and risk quantification systems consistently and meaningfully.

All types of organizations with credit portfolios can apply the Non-Public Firm Models as a basis for credit-adjusted portfolio risk measures, such as Value at Risk, Economic Capital, Cash Flow at Risk or Earnings at Risk. Users can combine default probabilities from the KRIS Models with appropriate valuation, cash flow and net income models like Kamakura Risk Manager and KRIS Credit Portfolio Manager. For various types of portfolio instruments, the future losses, future value, cash flows and net income of a portfolio can be estimated under alternative simulated stochastic scenarios. The required risk measures can then be calculated using the resulting future losses, future value, cash flow and net income distributions. This allows the financial risk of large portfolios of loans, derivatives and other instruments with credit exposure to non-public firms, public firms, sovereigns and retail borrowers to be measured. It allows macro-factor portfolio hedges to be established.

IV. Modeling Default Probabilities

The KRIS Non-Public Firm Models are fully complementary to the four different quantitative approaches available in KRIS for modeling public firm default probabilities: two versions of the Jarrow Chava Model (KDP-jc), the Merton Structural Model (KDP-ms), and the Jarrow Merton Hybrid Model (KDP-jm). The KRIS Non-Public Firm Model also uses the Jarrow-Chava approach which we explain below. Both the fourth generation (version 4.1, released in January 2006) and the fifth generation (version 5.0, released September, 2010) of the Jarrow-Chava public firm models are available on the KRIS web site. All of these approaches incorporate information on market prices of public firm equity and interest rates, so that current market expectations are fully reflected in the default probability estimates. The fifth generation Jarrow-Chava public firm models are important inputs to the KRIS Non-Public Firm Model. The availability of multiple KRIS Public Firm Models provides subscribers with theoretically sound alternative views on the likelihood a particular firm will default, and Kamakura will take the same approach with subsequent versions of the KRIS Non-Public Firm Model.

The Jarrow Chava Model

The Jarrow Chava Model is a statistical hazard model that relates the probability of firm default to several explanatory variables. The explanatory variables include firm financial ratios, other firm attributes, industry classification, interest rates and information about firm and market equity price levels and behavior in the case of public firms. KRIS Non-Public Firm Model achieves a striking level of accuracy by using nine input variables derived from the KRIS Public Firm Model for public firms in the same country, industry sector, and industry sub-sector. Both KRIS Non-Public Firm Model and the KRIS Public Firm models incorporate multiple equations, based on logistic regression, for forecasting default at different forward time intervals, conditional on survival to that point in time. These equations share similar inputs but they have different weightings depending on the time horizon. The current and forward conditional default probabilities are combined to derive the full default term structure out to four years for the KRIS Non-Public Firm Model and out to ten years for the KRIS Public Firm Models.

V. Kamakura Default Probability Correlations

The Wall Street Journal reported on September 12, 2005 about the very large hedge fund losses that occurred in May when GM and Ford were downgraded. Many traders held long positions in the bond and short positions in the common stock, a common hedging strategy for those who believe that the Merton model of risky debt is an effective hedging tool. Unfortunately the Merton implication that stock prices and debt prices move in the same direction is true only about half the time (see van Deventer and Imai, *Credit Risk Models and the Basel Accords*, John Wiley & Sons, 2003) and traders suffered large losses from this kind of strategy in the GM and Ford cases. The copula method, which is based on the Merton approach, was widely blamed for seriously aggravating the losses which were incurred in the collateralized debt obligation market during the 2007-2009 credit crisis.

For this reason, KRIS default probability models explicitly link the macro-economic factors which cause the correlated rise and fall in default risk over the business cycle to individual firm default probabilities via logistic regression, eliminating the need to rely on the Merton approach. Kamakura Risk Manager and KRIS Credit Portfolio Manager, however, can perform simulations of losses, values, cash flows and net income using either the copula approach or the macro-factor driven approach for all types of counterparties. KRIS Non-Public Firm subscribers who also subscribe to the KRIS Public Firm Model can view pair-wise correlations in default probability movement for any pair of the 29,900 public firms in 37 countries on KRIS. As of August 2011 total number of pair-wise default correlations available on KRIS is 6.26 billion, which is the product of $(29,900 \times 29,899)/2$ pairs times 2 models and 7 maturities.

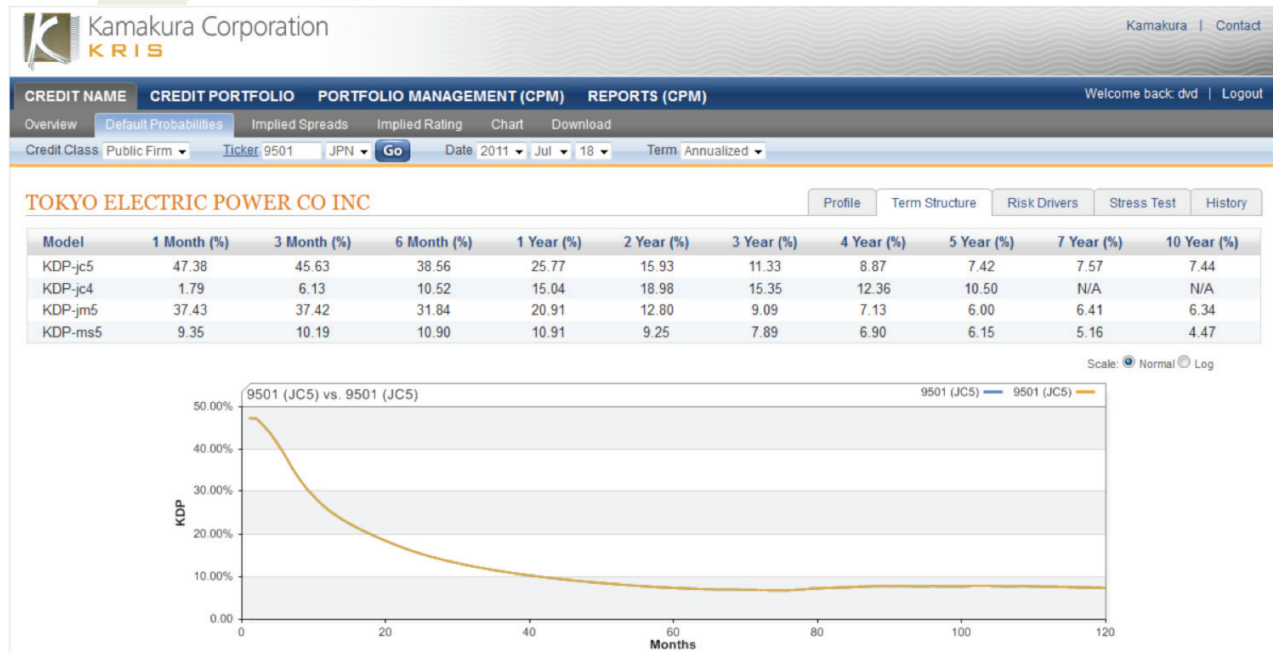
DEFAULT CORRELATIONS

Enter up to 10 tickers

Ticker	Country	Company Name
c	USA	CITIGROUP INC
rbs	GBR	ROYAL BANK OF SCOTLAND GROUP
bir	IRL	BANK OF IRELAND
7203	JPN	TOYOTA MOTOR CORP
mi	ITA	MILANO ASSICURAZIONI
	USA	
	USA	
	USA	

Ticker 1	Country 1	Ticker 2	Country 2	Correlation
7203	JPN	bir	IRL	0.7990
7203	JPN	c	USA	0.8107
7203	JPN	mi	ITA	0.1128
7203	JPN	rbs	GBR	0.8217
bir	IRL	c	USA	0.7285
bir	IRL	mi	ITA	0.3886
bir	IRL	rbs	GBR	0.7638
c	USA	mi	ITA	0.1079
c	USA	rbs	GBR	0.9690
mi	ITA	rbs	GBR	0.1503

VI. KRIS Default Probability Subscriber Information



KRIS subscribers use KRIS default probability estimates in two ways:

- The KRIS web site provides individual firm inquiry and Excel download capability by entering a non-public firm's financial and industry information into a Web form displayed in a browser. The example above shows the term structure of default for a public firm, Tokyo Electric Power, on July 18, 2011 as it struggled with the credit risk trigger by the March 11, 2011 earthquake and tsunami-related damage to the Fukushima Dai-Ichi Nuclear Power Plant.
- The second method for using the KRIS default probability service is by file transfer protocol (FTP). Kamakura's KRIS power users make use of this technology to download the entire KRIS default probability history back to 1990 in order to scan for arbitrage opportunities. Most power users download new default probabilities daily.
- The initial design of the KRIS screens for the KRIS Non-Public Firm Model have triggered a raft of suggestions from clients and these suggestions are being implemented at high speed by the KRIS team.



TECHNICAL SPECIFICATIONS

Model Type

Statistical hazard rate (“reduced form”) model implemented via a series of logistic regressions to create a term structure of default probabilities for each non-public firm. Default probabilities are displayed for maturities of 1, 2, 3, and 4 years.

Explanatory Database

The KRIS Non-Public Firm Model, Version 2.0, was constructed on a multi-national default data base consisting of 2.866 million annual observations and 41, 199 defaults spanning the 2001-2009 period. The KRIS Public Firm Model, Version 5.0, supplies 9 explanatory variables to the KRIS Non-Public Firm Model.

Model Test Results and Parameters Fully Disclosed

The KRIS Non-Public Firm Model, Version 2.0, Technical Guide includes ROC accuracy ratios, forward ROC accuracy ratios, van Deventer and Wang test for cyclical consistency of expected and actual defaults, the Falkenstein and Boral tests for default probability bias, and complete out of sample test results.

Statistical Estimation Methodology

Multi-period logistic regression with inputs that include company financial statements, other attributes, macro-economic factors, and public firm default probabilities from the relevant country, industry sector and industry subsector.

Statistical Performance

Default probability accuracy for the KRIS Non-Public Firm Model is superior to all but the very best public firm models offered by Kamakura Risk Information Services.

VII. About Kamakura Corporation

Founded in 1990, Honolulu-based Kamakura Corporation is a leading provider of risk management information, processing and software. Kamakura has taken Credit Technology Innovation Awards from Credit Magazine each year since 2008. In 2010, Kamakura was the only vendor to win 2 innovation awards, one each with distribution partners Fiserv and Thomson Reuters. Kamakura, along with its distributor Fiserv, was ranked number one in asset and liability management analysis and liquidity risk analysis in the RISK Technology Rankings in 2009. Kamakura Risk Manager, first sold commercially in 1993 and now in version 7.3, was also named in the top five for market risk assessment, Basel II capital calculations, and for “risk dashboard.” Kamakura was also ranked in the RISK Technology Rankings 2008 as one of the world’s top 3 risk information providers for its KRIS default probability service. The KRIS public firm default service was launched in 2002, and the KRIS sovereign default service, the world’s first, was launched in 2008. KRIS default probabilities are displayed for 4000 corporates and sovereigns via the Reuters 3000 Xtra service and the Thomson Reuters Eikon service. Kamakura has served more than 200 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 34 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 and many other countries in Asia.

Kamakura has world-wide distribution alliances with Fiserv (www.fiserv.com), Sumisho Computer Systems (<http://www.scs.co.jp/english/>), Unisys (www.unisys.com), and Zylog Systems (www.zsl.com) making Kamakura products available in almost every major city around the globe.



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