

Kamakura
Corporation

KAMAKURA

RISK INFORMATION SERVICES

Kamakura Sovereign Default Service

Version 5.0

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I. Introduction

Kamakura Sovereign Default Service offers significant benefits to organizations that require a testable and reliable means for analyzing the credit quality of sovereign countries:

- Methodological benefits include objective quantification of country default risk, use of information incorporating future expectations of country default, and maximum utilization of available data.
- Operational benefits include low cost credit analysis across a large number of sovereign credits and high quality predictions of default likelihood.

The Service provides estimates of the full term structure of default probabilities of a country based upon current public information about the country, its economic environment, and current macro-economic conditions. The Service includes a full term structure of default probabilities across a wide range of maturities, and is fully complementary to the public firm default probabilities offered as part of Kamakura Risk Information Services (KRIS) since November 2002.

The Service provides investors, investment managers, dealers, traders, lenders, and auditors a simple, objective means of assessing the credit quality of sovereign borrowers. Credit quality is measured in terms of the default probability of a country's government at various time horizons, all of which are updated daily as part of the service (an add-on delivered via the same KRIS web site, www.kris-online.com, as the KRIS Public Firm Default Models).

The Service provides unique advantages to credit market participants, providing superior results over agency ratings whose liabilities have become increasingly obvious as the credit crisis of 2007-2008 has unfolded. Each sovereign is re-evaluated daily from economic, financial and political perspectives. In addition to incorporating financial ratios and measures of repayment capabilities which capture sovereign financial and macroeconomic performance, the Service also incorporates market-based and political risk inputs that capture the unique aspects of sovereign defaults.

II. Benefits of the Kamakura Sovereign Default Service

Objective Credit Quality Measurement	The KRIS Sovereign Default Service models measure credit quality based upon objective relationships between observed default behavior and country attributes, economic conditions, and political risk.
Modern Default Correlation Technology	The KRIS Sovereign Default Service includes the only pair wise correlations available in the risk management industry for any model, any maturity, and any pair of countries, companies, or a “mixed pair” of one corporate and one country in the full KRIS universe. It is no longer necessary to make the dangerous assumption that all companies in a portfolio have the same pairwise correlation. It is also no longer necessary to make the simplistic and obviously false assumption that no corporate can have lower default risk than its country of domicile, as Toyota and Japan so ably illustrate.
Future Economic Expectations	The KRIS Sovereign Default Service incorporates domestic equity market price information that reflects investor expectations about the future performance of individual firms and the country’s economy in general.
Maximum Utilization Of Historical Data	The multi-period statistical estimation approach incorporated in the Jarrow Chava Sovereign Models maximizes utilization of historical default as well as financial and economic data observations often excluded in other models. This allows correct modeling of sovereign risk throughout the business and credit cycle.
High Performance Default Prediction	Default probability estimates provided by the KRIS Sovereign Default Service have shown historically high performance in predicting country defaults across a wide range of geography, points in time, and political infrastructure.
Future Credit Quality Prediction	Users of the KRIS Sovereign Default Service can estimate the default probability of a country at a future point in time by incorporating estimates of country characteristics and economic conditions at that time.
Business Cycle Related Default Correlation	Sovereign default probability correlations provided for the Jarrow Chava Sovereign Models are correlated through dependent behavior of underlying economic explanatory variables. The stock market returns of Uruguay and Argentina, for example, are correlated and this leads to a correlation in the default probabilities of the two countries.
Low Cost Credit Analysis	The KRIS Sovereign Default Service offers 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 countries and the use of a quantitative model allows users to apply the KRIS Sovereign Default Service Models to a large number of sovereign counterparties at a reasonable cost.
Portfolio Analysis System Compatibility	Default probabilities obtained from the KRIS Sovereign Default Service Models can be consistently and directly incorporated in portfolio valuation, cash flow and net income analyses in the enterprise-wide Kamakura Risk Manager software system.

III. Service Applications and KRIS Public Firms Model

Service applications range from relatively simple analyses of country creditworthiness to credit-adjusted valuation, cash flow and net income analyses of a country's obligations in the context of a large sovereign, corporate, small business and retail portfolio.

Investment management firms can use the Service to identify potential trading opportunities. Default probabilities produced by each of the models can be used to rank countries and firms with the same agency credit rating based on estimated default probabilities. For example, countries and firms with the highest default probabilities assigned an 'AA' credit rating can be identified, as shown in the Ranking Page diagram.

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

Uses of the KRIS Sovereign and Public Firm Models

Comparing and Ranking Firm Creditworthiness

Compare country and firm default probabilities to determine relative creditworthiness

Modeling Correlated Default in CDOs and Portfolios

Use country and firm default probabilities and default correlations to more realistically model "tail risk" from default credit-risky portfolios

Assisting Credit Approval Decisions

Reduce credit losses by incorporating default probabilities into credit approval processes for countries and public firms

Monitoring Changes in Creditworthiness

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

Simulating Credit-Risky Defaults

Use default models to simulate the timing of potential defaults of credit-risky countries and public firms on a realistically correlated basis

Estimating Credit-Risky Credit Spreads

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

Valuing Credit-Risky Obligations

Use credit-risky country and public firm credit spread models and instrument valuation models to estimate bond and loan values

Comparing Credit-Risky Trading Opportunities

Compare pricing of credit-risky sovereign and public firm debt priced using estimated default probabilities vs. observed market prices

Simulating Credit-Adjusted Cash Flows and Income

Use default models and instrument cash flow and income models to estimate future credit-adjusted cash flow/income

Hedging Portfolio Value and Cash Flows

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

Measuring Portfolio Value at Risk (VaR)

Use KRIS default models, correlations and instrument valuation models to estimate the probability distribution of credit-adjusted portfolio value

Measuring Portfolio Stochastic Cash Flow and Income

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

Estimating Portfolio Regulatory and Economic Capital

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

Banking firms can use the Service and KRIS Public Firm Models to satisfy their requirements for a Probability of Default (PD) model for sovereign and public firm clients under the Basel II guidelines, and for both Foundation and Advanced versions of the Internal Ratings Based approaches. Since the KRIS Sovereign and Public Firm Models describe relationships between country or firm defaults and their characteristics and economic conditions, they can be objectively tested for statistical significance and predictive power. The results of these tests are available to KRIS Sovereign Default Service clients in the KRIS Sovereign Default Service Version 5.0 Technical Guide.

The KRIS Public Firm Technical Guide Version 4.1 has been extensively reviewed with regulatory agencies around the world. The same testing regime is followed in the KRIS Sovereign Default Service Technical Guide. These test results and documentation are expressly designed to satisfy the Basel II requirements for an internal validation process to assess the performance of the bank's internal rating and risk quantification systems consistently and meaningfully. Sovereigns and corporates can be ranked by riskiness using the KRIS web site:

KRISTM Kamakura Risk Information Services Tuesday, January 24, 2006

[KRIS Home](#) [Analysis](#) [History](#) **[Ranking](#)** [Risk Map](#) [Correlations](#) [Portfolio](#) [Business Mortality](#)

Portfolio:
 Model:
 Term:
 Country:
 Rating:
 Sector:

Ranking [Download](#)

Record 1 to 12 of 160

Ticker	Company Name	Country	Rating	KDP (%)	1 Day Chg	1 Mo Chg	3 Mo Chg	6 Mo Chg	1 Year Chg
6701	NEC CORP	JPN	BBB	4.11	+0.20	+0.13	-0.68	-0.36	-0.21
6502	TOSHIBA CORP	JPN	BBB	3.49	+0.32	+0.57	+0.28	-0.17	-1.29
CTC	CIA DE TELECOMS DE CHILE SA	USA	BBB	3.36	+0.11	+0.25	+0.40	+0.32	+0.27
CNP	CENTERPOINT ENERGY INC	USA	BBB	2.71	+0.11	-0.04	-0.36	+0.27	-1.81
LHA	DEUTSCHE LUFTHANSA AG	DEU	BBB	1.97	+0.01	-0.15	-0.59	-0.86	-0.84
NCP	NEWS CORP	USA	BBB	1.89	0.00	+0.04	-0.46	-0.06	-0.23
EMC	EMC CORP/MA	USA	BBB	1.83	+0.03	+0.34	+0.23	+0.26	-0.32
TSN	TYSON FOODS INC -CL A	USA	BBB	1.69	-0.06	+0.43	+0.46	+0.43	+0.23
MAT	MATTEL INC	USA	BBB	1.57	-0.01	+0.02	-0.13	-0.25	+0.24
XEL	XCEL ENERGY INC	USA	BBB	1.54	-0.01	-0.08	-0.25	-0.18	-0.61
EX	VIVENDI UNIVERSAL SA	FRA	BBB	1.45	-0.01	+0.16	0.00	+0.20	+0.11

Dealers and other participants in the capital and derivatives markets will find the KRIS Sovereign and Public Firm Models useful in the analysis of both long-term credit risk and short-term settlement risk of counterparties to their trades. Default probabilities for their counterparties can be combined with measures such as potential future exposure to provide an estimate of expected credit losses across their trading books.

The KRIS Sovereign and Public Firm Models service also offers estimates of the correlation between the default probabilities of pairs of firms, countries, or a mix of countries and firms. Subscribers can identify a collection of countries and firms for which default probability correlations are required and can obtain an estimated correlation matrix for this collection, as shown in the KRIS Correlation Page diagram:

KRIS™ Kamakura Risk Information Services Tuesday, January 24, 2006

KRIS Home Analysis History Ranking Risk Map **Correlations** Portfolio Business Mortality

Model Term

Correlations

Select a Portfolio

Or enter up to 10 tickers below.

Ticker	Country	Company Name	Ticker Lookup
<input type="text"/>	<input type="text" value="USA"/>		
<input type="text"/>	<input type="text" value="USA"/>		
<input type="text"/>	<input type="text" value="USA"/>		
<input type="text"/>	<input type="text" value="USA"/>		
<input type="text"/>	<input type="text" value="USA"/>		
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<input type="text"/>	<input type="text" value="USA"/>		
<input type="text"/>	<input type="text" value="USA"/>		

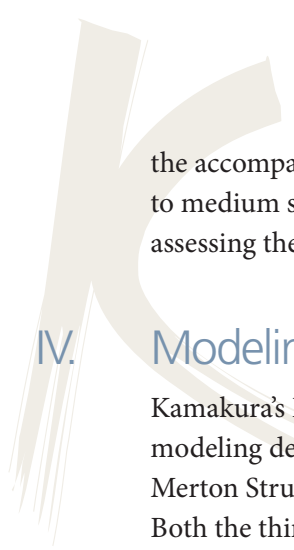
Ticker 1	Country 1	Ticker 2	Country 2	Correlation
ANZ	AUS	BHP	AUS	0.3839
ANZ	AUS	CML	AUS	-0.1584
ANZ	AUS	DJS	AUS	0.5300
ANZ	AUS	EDS	USA	-0.3363
ANZ	AUS	FGL	AUS	0.4316
ANZ	AUS	NAB	AUS	0.6419
ANZ	AUS	NCM	AUS	0.8052
ANZ	AUS	NCP	USA	0.1058
ANZ	AUS	QAN	AUS	0.6940
ANZ	AUS	WBC	AUS	0.8912

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#)

All types of organizations with credit-risky portfolios can apply the Sovereign and Public Firm Models as a basis for credit-adjusted portfolio risk measures, such as Value at Risk or Earnings at Risk. Users can combine default probabilities from the Public Firm Model with appropriate valuation, cash flow and net income models such as Kamakura Risk Manager.

For various types of portfolio instruments, the 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 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 sovereigns and public firms to be measured and allows macro-factor portfolio hedges to be established on a consistent basis. The risk measures also provide a basis for estimating the economic capital required to offset potential economic losses for a portfolio of sovereign and public firm obligations.

KRIS Sovereign and Public Firm Models are based on advanced statistical and option pricing modeling technology that maximizes the use of available information and provides a high level of predictive performance. Some of the technical details of the Model are described in



the accompanying diagram. Together with Kamakura's Business Mortality Model for small to medium sized companies, these models offer subscribers a comprehensive solution to assessing the creditworthiness of the entire spectrum of credit-risky firms and sovereigns.

IV. Modeling Default Probabilities

Kamakura's Public Firm Models currently offer four different quantitative approaches to modeling 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). Both the third generation (version 3.0, released in October 2004) and the fourth generation (version 4.1, released January 9, 2006) of the Jarrow-Chava models are available on the web site at the request of the KRIS client base. All approaches incorporate information on the market prices of firm equity and interest rates so that current market expectations are fully reflected in the default probability estimates. The availability of multiple Public Firm Models provides subscribers with theoretically sound alternative views on the likelihood a particular firm will default.

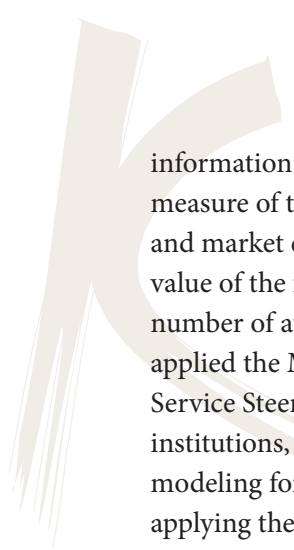
The Jarrow Chava Model

Originally developed by Kamakura's Director of Research, Robert Jarrow, with co-author Sudheer Chava, the Jarrow Chava Model provides an objective, statistically reliable method of predicting potential sovereign or firm defaults. The Jarrow Chava Model is a statistical hazard model that relates the probability of sovereign or corporate default to several explanatory variables. The explanatory variables in the sovereign context can include financial ratios, interest rates, stock price index changes, political risk variables and others. In a corporate context such models can include explanatory variables like firm financial ratios, other firm attributes, industry classification, interest rates, and information about firm and market equity price levels and behavior. In this model, firm default can occur randomly at any time with an intensity determined by the explanatory variables.

In December 2003 the Federal Deposit Insurance Corporation of the United States announced its adoption of the methodology incorporated in the Jarrow Chava Model for its Loss Distribution Model for the bank and savings and loan insurance funds. The KRIS Sovereign Default Service Jarrow-Chava models incorporate multiple equations for forecasting default at different forward time intervals, conditional on survival to that point in time. These equations share the same 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.

Merton Structural Model

The Kamakura Sovereign Default Service employs the reduced form approach to sovereign default modeling. In the KRIS Public Firm Default Service, we also employ a modern version of the 1974 Merton model of risky debt. The Merton structural model of corporate default uses option analogies to relate the probability of firm default to its financial structure and

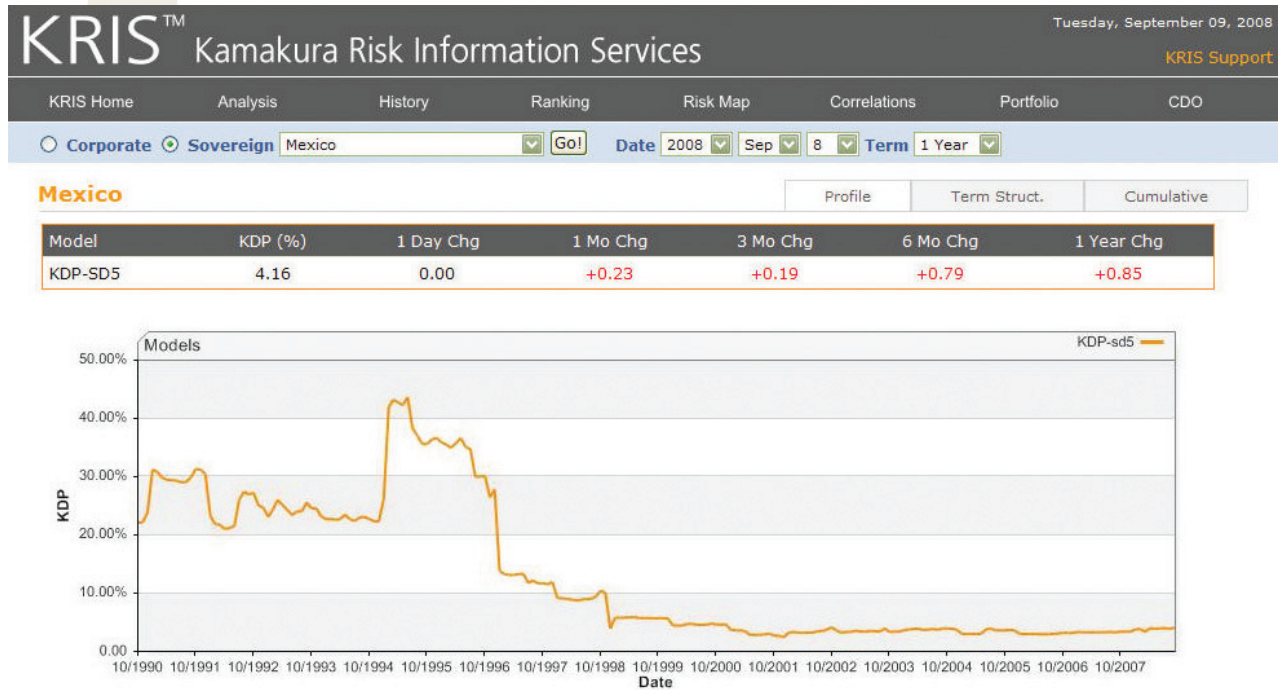


information about the firm's market price of equity. The explanatory variables include a measure of the firm's outstanding debt, its market valuation, and information about firm and market equity price behavior. In this model, firm default occurs when the market value of the firm's assets decline below a threshold related to the firm's outstanding debt. A number of authors, among them Dr. Dale Gray of the International Monetary Fund, have applied the Merton concepts to sovereign default assessment. Kamakura's Sovereign Default Service Steering Committee, made up of many of the world's most sophisticated financial institutions, is considering the potential merits of the Merton approach for sovereign default modeling for version 6.0 of the KRIS Sovereign Default Service. One major obstacle in applying the Merton methodology to the case of a country is that a country has no observed equity price and no obvious default threshold, the crossing of which would lead creditors receiving a claim on country assets. Distinguishing between government assets and liabilities and a country's assets and liabilities is the key to a potential implementation of the Merton approach for sovereigns in version 6.0.

V. Kamakura Sovereign Default Probability Correlations

The Wall Street Journal reported on August 12, 2005 on the substantial hedge fund losses that occurred in May 2005 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 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. For this reason, KRIS users asked Kamakura to develop pair-wise default probability correlations that go far beyond the basic Merton/Copula approach. The KRIS web site now offers pair-wise default correlations for all companies in the universe for all maturities and for all models. This same correlation service will be available for the pair-wise correlations between any two sovereign countries and any pair that consists of one sovereign and one public firm. As of May 2008, the KRIS web site includes coverage of more than 20,000 companies in 30 countries. The total number of pair-wise default correlations available on KRIS after sovereigns are factored in exceeds three billion.

VI. Kamakura Sovereign Default Service Subscriber Information



Service Subscribers obtain default probability estimates in the same two ways as subscribers to the KRIS Public Firm Default Service:

1. Via the KRIS web site which provides individual country inquiry and Excel download capability by entering a country code into a web browser, similar to that shown above for Mexico.
2. File transfer protocol (FTP): Kamakura's KRIS power users employ this technology to download the entire KRIS sovereign default probability history back to 1980 in order to scan for arbitrage opportunities. Most power users download new default probabilities daily.

The Service initially includes one model, the Sovereign Jarrow-Chava reduced form model version 5.0. Over time, the Service will provide users with the same "multiple models" view of sovereign default risk as present in Kamakura's Public Firm Models.

TECHNICAL SPECIFICATIONS

Model Type

Statistical hazard rate ("reduced form") model using logistic regression on a historical default database

Default Database

More than 160 sovereign defaults from 1980 to the present. Defaults are defined as the earliest to occur of five specific credit events, consistent with the Basel II requirements.

Explanatory Database

More than 24,000 observations beginning in 1980.

Model Test Results and Parameters Fully Disclosed

The KRIS Sovereign Default Service Technical Guide includes ROC accuracy ratios, forward ROC accuracy ratios, van Deventer and Wang test for cyclical consistency of expected and actual defaults, and complete out of sample test results.

Statistical Estimation Methodology

Multi-period logistic regression with macro-factor inputs

Statistical Performance

All regression parameters statistically significant at the 95% level

VII. About Kamakura Corporation

Founded in 1990, Kamakura Corporation is a leading provider of risk management information, processing and software. Kamakura has been a provider of daily default probabilities and default correlations for listed companies since November, 2002. Kamakura launched its collateralized debt obligation (CDO) pricing service KRIS-CDO in April 2007. Kamakura is also the first company in the world to develop and install a fully integrated enterprise risk management system that analyzes credit risk, market risk, asset and liability management, transfer pricing, and capital allocation. Kamakura has served more than 185 clients ranging in size from \$3 billion in assets to \$1.6 trillion in assets. Kamakura's risk management products are currently used in 27 countries.

Kamakura has world-wide distribution alliances with Fiserv (www.fiserv.com), Unisys (www.unisys.com), and Zylog Systems (www.zylog.co.in) making Kamakura products available in almost every major city around the globe.



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