

Kamakura
Corporation

KAMAKURA

RISK INFORMATION SERVICES

Kamakura Public Firm Models

Version 5

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I. Introduction

The Kamakura Public Firm Models provide investors, investment managers, dealers, traders, lenders, and auditors a simple, objective means of assessing the credit quality of credit-risky public firms. Credit quality is measured in terms of the probability of default of a credit-risky firm.

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

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

Individual firms are re-evaluated and updated daily based on financial information, macroeconomic factors, industry specific attributes, and market based trading inputs. Kamakura's Public Firm Models provide estimates of the full term structure of default probabilities of an individual firm based upon current public information about the firm, its economic environment, and the current risk of the public firms in its industry. The maturities that are available are 1 month, 3 months, 6 months, 1 year, 2 years, 3 years, 5 years, 7 years, and 10 years. The Public Firm Models are part of Kamakura Risk Information Services (KRIS), a Web-based information service available by subscription.

The Kamakura Public Firm Models provide unique advantages and superior results to credit market participants. Each firm is evaluated in the context of its industry sector. In addition to incorporating endogenous variables, such as financial ratios, some of the models also incorporate exogenous variables, such as economic conditions and industry risk, as recommended in Working Paper 126 of the "Bank for International Settlements," authored by Linda Allen and Anthony Saunders and as required by many financial institutions regulators, such as the U.S. Supervisory Capital Assessment Program implemented in 2009.

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The world's best performing quantitative credit modeling technology

KRIS
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.

II. Benefits of the Kamakura Public Firm Models

| | |
|---|---|
| Objective Credit Quality Measurement | The Public Firm Models are statistical and option theoretic models measuring credit quality based upon objective relationships between observed default behavior and firm attributes, economic conditions, and industry risk or between market expectations embedded in equity prices and firm characteristics. |
| Modern Default Correlation Technology | The KRIS service includes the only pair wise correlations available in the industry for any model, any maturity, and any pair of companies 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. |
| Future Economic Expectations | The Public Firm Models incorporate market equity price information that reflects investor expectations about the future performance of individual firms and their default potential. |
| Maximum Utilization Of Historical Data | The multi-period statistical estimation approach incorporated into Kamakura's Jarrow Chava and Jarrow Hybrid Models maximizes utilization of historical default, financial, and economic data observations 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 Public Firm Models have shown historically high performance in predicting firm defaults across a wide range of credit-risky firms. |
| Future Credit Quality Prediction | Users of the Public Firm Models can estimate the default probability of a firm at a future point in time by incorporating estimates of firm characteristics and economic conditions at that time. |
| Business Cycle Related Default Correlation | Default probability correlations provided for the Jarrow Chava and Jarrow Merton Hybrid Models are correlated through dependent behavior of underlying economic explanatory variables. |
| Low Cost Credit Analysis | The 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 Public Firm Models to a large number of credit-risky firms at a reasonable cost. |
| Portfolio Analysis System Compatibility | Default probabilities obtained from the 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. |
| Daily Updates | Default probability, default correlation, implied ratings, and implied spreads are updated daily based on company specific financial information, observed market prices, changes in macroeconomic variables, and other factors. |

III. Applications

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

Investment management firms can use the Public Firm Models to identify potential trading opportunities. Default probabilities produced by each of the Models can be used to rank firms with the same agency credit rating based on estimated default probabilities. For example, firms with the highest default probabilities assigned a 'BBB' credit rating can be identified, as shown in the Ranking Page diagram.

Default probabilities produced by the 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 Public Firm Models to satisfy their requirements for a Probability of Default (PD) model for their public firm clients under the Basel II and proposed Basel III guidelines for both the Foundation and Advanced versions of the Internal Ratings Based approaches. Since the Public Firm Models describe relationships between firm defaults and

Applications of the Kamakura Public Firm Models

Comparing And Ranking Firm Creditworthiness

Compare firm default probabilities to determine relative creditworthiness of public firms

Modeling Correlated Default in CDOs and Portfolios

Use firm default probabilities and default correlations to more realistically model "tail risk" from default in CDOs and portfolios of bonds or loans

Assisting Credit Approval Decisions

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

Monitoring Changes In Firm Creditworthiness

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

Simulating Credit-Risky Firm Defaults

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

Estimating Credit-Risky Firm Credit Spreads

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

Valuing Credit-Risky Firm Obligations

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

Comparing Credit-Risky Trading Opportunities

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

Simulating Credit-Adjusted Cash Flows And Income

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

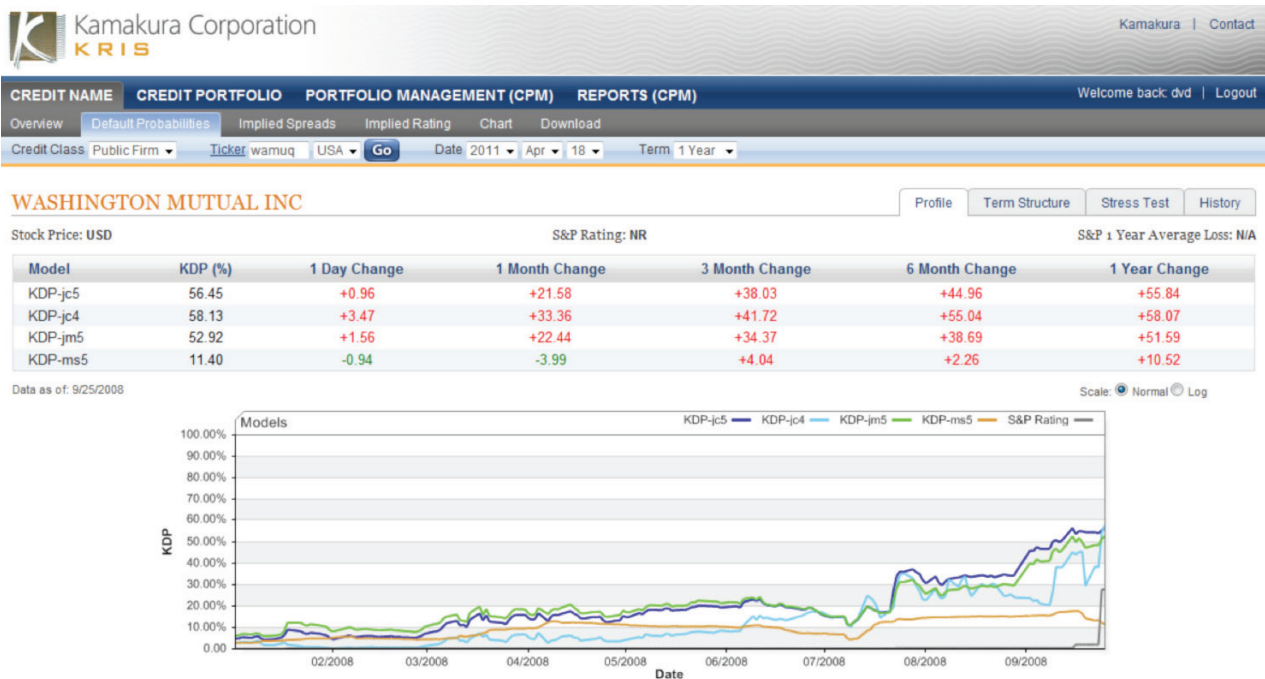
Measuring Portfolio Stochastic Cash Flow And Income

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

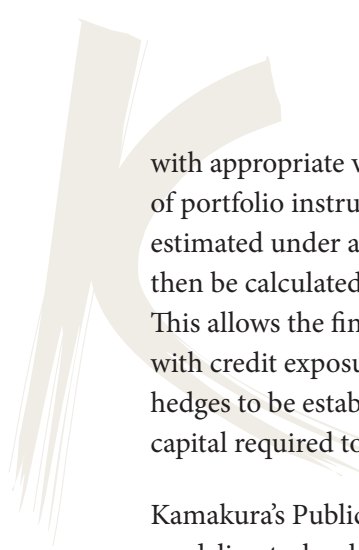
firms' characteristics and economic conditions, they can be objectively tested for statistical significance and predictive power. The results of these tests are available to Public Firm Model clients in the KRIS Version 5 Technical Guide, which has been reviewed with the Federal Reserve Board, the Federal Reserve Bank of New York, the Office of the Comptroller of the Currency, the FSA in the United Kingdom, the Bank of England, the Bank of Japan, and many other regulators around the world. 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. Shown below are the 1 year default rates for Washington Mutual, which failed on September 25, 2008.



Dealers and other participants in the capital and derivatives markets will find the 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 Public Firm Models service also offers estimates of the correlation between the default probabilities of pairs of firms. Subscribers can identify a collection of firms for which default probability correlations are required and can obtain an estimated correlation matrix for this collection, as shown in the Correlation Page diagram.

All types of organizations with credit-risky portfolios can apply the Public Firm Models as a basis for credit-adjusted portfolio risk measures, such as Value at Risk, Economic Capital, or Earnings at Risk. Users can combine default probabilities from the Public Firm Models



with appropriate valuation, cash flow and net income models like KRM. 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 public firms to be measured and allows macro-factor portfolio hedges to be established. The risk measures also provide a basis for estimating the economic capital required to offset potential economic losses for a portfolio of public firm obligations.

Kamakura's 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 technical specifications below. Together with Kamakura's Sovereign Default Service, these Models offer subscribers a comprehensive solution to assessing the creditworthiness of a wide array of credit-risky entities.

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 fifth generation (version 5.0, released in September 2010) 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 of these approaches incorporate information on 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

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, macroeconomic factors, 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. Originally developed by Kamakura's Director of Research, Robert Jarrow, the Jarrow Chava Model provides an objective, statistically reliable method of predicting potential firm defaults. The Federal Deposit Insurance Corporation of the United States announced as early as December 2003 that it was adopting the methodology incorporated in the Jarrow Chava Model for its Loss Distribution Model for the bank and savings and loan insurance funds. A large number of bank regulators around the world now subscribe to KRIS. Both the fourth and fifth generation 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 out to ten years.

Merton Structural Model

The Merton Structural Model uses option pricing methods 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. Robert Merton, winner of the Nobel Prize in Economic Sciences in 1997, originally developed this model. In version 5.0, the Merton inputs are used with weightings optimized using logistic regression.

Jarrow Merton Hybrid Model

The Jarrow Merton Hybrid Model is a statistical hazard model that relates the probability of firm default to the same explanatory variables as the Jarrow Chava Model, but it also incorporates the default probability of the Merton Structural Model as an additional explanatory variable. In this model, firm default can occur randomly at any time with an intensity determined by the explanatory variables. Kamakura offers this Model to combine the default prediction capabilities of the associated models. Forward default probabilities and the full term structure of default are derived in the same fashion as for the Jarrow-Chava models.

V. Kamakura Default Probability Correlations

The tens of billions of losses in the CDO market during 2007-2009 made it clear to most observers that the Merton copula approach was deeply flawed. The Wall Street Journal reported as early as August 12, 2005 about the very large hedge fund losses that occurred in

DEFAULT CORRELATIONS

Enter up to 10 tickers

| Ticker | Country | Company Name |
|--------|---------|------------------------------|
| c | USA | CITIGROUP INC |
| bac | USA | BANK OF AMERICA CORP |
| wfc | USA | WELLS FARGO & CO |
| nab | AUS | NATIONAL AUSTRALIA BK |
| bmo | CAN | BANK OF MONTREAL |
| rbs | GBR | ROYAL BANK OF SCOTLAND GROUP |
| f | USA | FORD MOTOR CO |
| ibm | USA | INTL BUSINESS MACHINES CORP |
| msft | USA | MICROSOFT CORP |
| goog | USA | GOOGLE INC |

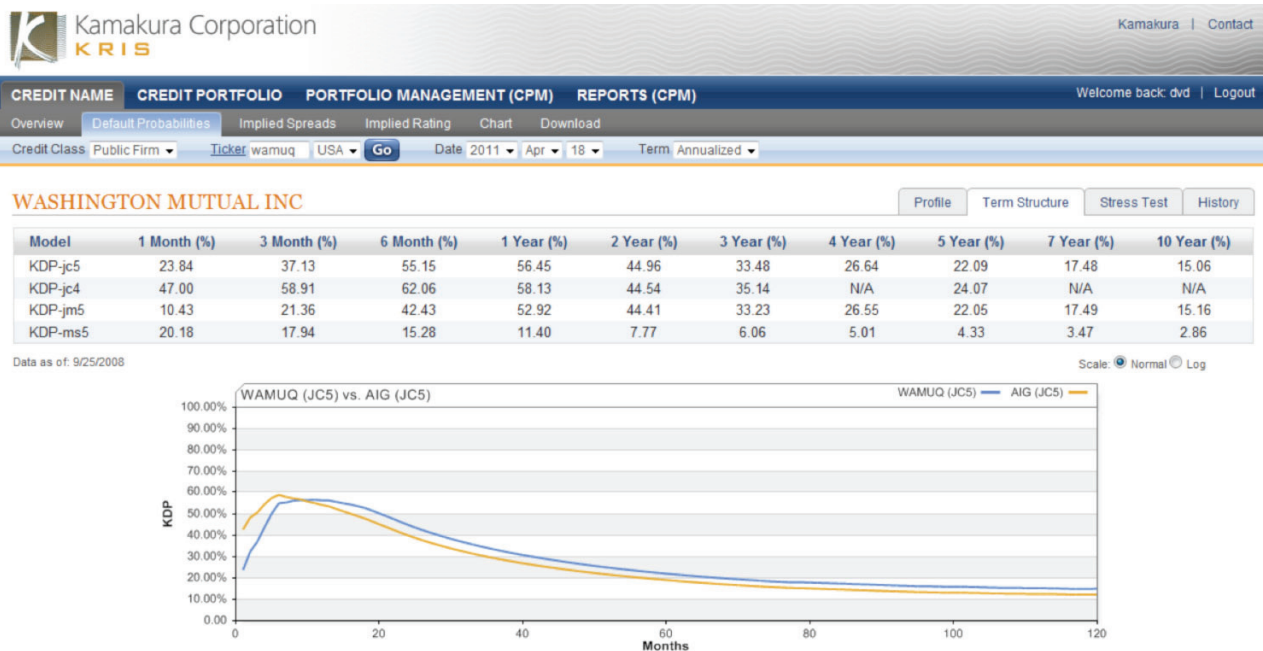
Reset

| Ticker 1 | Country 1 | Ticker 2 | Country 2 | Correlation |
|----------|-----------|----------|-----------|-------------|
| bac | USA | bmo | CAN | 0.5672 |
| bac | USA | c | USA | 0.9705 |
| bac | USA | f | USA | 0.4564 |
| bac | USA | goog | USA | 0.5017 |
| bac | USA | ibm | USA | 0.4349 |
| bac | USA | msft | USA | 0.5109 |
| bac | USA | nab | AUS | 0.3993 |
| bac | USA | rbs | GBR | 0.9351 |
| bac | USA | wfc | USA | 0.9469 |
| bmo | CAN | c | USA | 0.6835 |
| 1 | | | | |

Download KDPs Download Correlations

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 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. Kamakura Risk Information Service (KRIS) users asked Kamakura to develop pair-wise default probability correlations that go far beyond the basic Merton/Copula approach. The KRIS web site offers pair-wise default correlations for all companies in the universe for all maturities and for all models. As of April 2011, the KRIS web site includes coverage of 30,000 companies in 37 countries. The total number of pair wise default correlations available on KRIS is more than 32.4 billion.

VI. Default Probability Estimates Subscriber Information



Subscribers may obtain default probability estimates in two ways:

- The KRIS web site provides individual firm inquiry and Excel download capability by entering a firm's financial and industry information into a Web form displayed in a browser, as shown above for the term structures of default for Washington Mutual and AIG.
- 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.



TECHNICAL SPECIFICATIONS

Model Type

Statistical hazard rate (“reduced form”) model with conditioning variables (Jarrow Chava and Jarrow Merton Hybrid Models)

Asset value option pricing (“structural”) model with firm debt and equity market variables (Merton Structural Model)

Default Database

More than 2,000 defaults in North America through December, 2008 with expansion to other regions in progress (Jarrow Chava and Jarrow Merton Hybrid Models)

Explanatory Database

More than 1.7 million observations beginning in 1990 in North America (Jarrow Chava and Jarrow Merton Hybrid Models) and a research data base back to 1963

Model Test Results and Parameters Fully Disclosed

KRIS 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, 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 7.2, 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 \$3 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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