



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Stress-Test Model Development

Promontory worked with a large credit card bank to develop, test, and deploy new models of losses, revenue, and bank capital for stress-testing purposes.

The Client Engaged Promontory to:

- Recommend and develop new projection models for card losses, pre-provision net revenue, and bank capital to be used for Dodd-Frank Act stress testing
- Meet industry best practices for large card portfolios and help the bank develop individual account-level modeling capabilities

Our Approach:

Promontory recommended, built, and deployed a combined approach of account-level models, portfolio- and bank-level models, and a capital model with new stress-test results. Specifically, we:

- Recommended and developed a transitions-modeling approach to default projection using national and local economic variables, credit scores, and account data for delinquency/default/payoff performance
 - Developed the bank's available account-level data into a large panel data set
 - Estimated 35 transition models relating account delinquency and default transitions to macroeconomic and account data
 - Used the transition models to produce stress-scenario and baseline projections of the card portfolio's probability of default
- Recommended and developed a portfolio-level model approach to card loss severity (LGD) using available loss and recovery data and economic data back to 2001
 - Estimated a time-series loss-severity model and produced stress- and base-scenario projections
 - Benchmarked model results against account-level charge-off data
- Recommended and developed a portfolio-level approach to modeling exposure at default by regressing historical portfolio-balance growth dating back to the early 1990s against economic variables reflecting past recessions and recoveries
 - Estimated a time-series portfolio-balance model and produced stress- and base-scenario projections
- Aligned the resulting portfolio estimates of PD, loss given default, and EAD, and produced and tested portfolio-loss scenario projections from the expected-loss equation $EL = PD * LGD * EAD$
- Recommended and developed a bank-level model approach to the components of PPNR using historical bank data and economic variables
 - Estimated a time-series net-interest income model and produced stress- and base-scenario projections
 - Estimated a time-series noninterest income model and produced stress- and base-scenario projections
 - Estimated a time-series noninterest expense model and produced stress- and base-scenario projections
- Implemented all models into the bank's capital model by incorporating model results, bank financial data, and management assumptions, and produced new stress-test results

Key Outcome:

Promontory built, tested, and deployed a robust, compliant, and feasible stress-testing approach using the client's available historical data (including portfolio-level and account-level data), consistent with industry best practices and modeling standards.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Fair-Lending Statistical Analysis

Promontory helped a bank holding company to verify and better understand pricing patterns in dealer markups on indirect auto loans that raised potential fair-lending concerns in supervisory screening.

The Client Engaged Promontory to:

- Apply methods similar to those of the regulator to replicate and confirm the results of its statistical analysis
- Conduct a full analysis of the data to better understand and fully consider the nature of any disparities between borrowers based on prohibited classes such as race or ethnicity

Our Approach:

- Replicated the regulator's statistical analysis to confirm the findings
 - Created proxies for race and ethnicity following the Consumer Financial Protection Bureau's Bayesian improved surname geocoding methods
 - Associated these proxies with loans at the bank and its subsidiary
 - Performed statistical analysis of the bank's indirect auto lending, including its subsidiary, using the race and ethnicity proxies based on BISG to parallel the regulator's analysis
 - Fit linear and logistic regression models to the data to replicate the basic statistical results of the regulator regarding disparities in loan pricing
 - Identified disparities very similar to those reported by the regulator for the bank's indirect auto lending
 - Conducted a separate, corresponding analysis of loans with co-applicants, and reached conclusions that are qualitatively the same as those based on all loans
 - Undertook additional analysis and applied multivariate regression to further examine the apparent differences in pricing for certain protected classes
 - Considered various factors (e.g., geography, borrower credit characteristics, vehicle characteristics, aspects of the financing transaction, and time-varying market conditions, including seasonality) that influence loan pricing and the possible effects of dealer location and other dealer-specific factors
 - Examined differences between aggregate portfolio-level results and the results for specified sub-portfolios (e.g. dealer-level analysis)
 - Found that the main factor contributing to differences in pricing for indirect auto lending at the bank is that different dealers charge different markups; race and ethnicity did not show a statistically significant relationship to dealer markup once dealer-specific differences in the level of markups on indirect auto loans were taken into account
 - Constructed additional models with an interaction term, interacting the dealer identifier with the BISG proxy for hispanic in a regression to investigate the possibility that individual dealers might still exhibit disparities in markup by race or ethnicity, and the extent to which these disparities might vary across dealers
 - Found that the overall effect of ethnicity on dealer markup is not significantly different for different dealers
- Delivered robust technical report describing our analytical work and several paragraphs summarizing the analysis and results for use in a letter transmitting the report to regulators

Key Outcome:

Promontory's analysis found no evidence of statistically significant disparities in dealer markups on indirect auto loans, once differences in average markups across dealers were correctly taken into account.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

AML TMS Services

Promontory helped a medium-size commercial bank evaluate, document, develop, and implement a management plan for enhancing its anti-money-laundering transaction-monitoring system and governance procedures.

The Client Engaged Promontory to:

- Review the bank's AML TMS and provide a management plan for updating it to comply with regulatory requirements
- Develop, document, and implement a robust, quantitative methodology for tuning TMS rule thresholds to control AML risk in accordance with statutory requirements
- Conduct seminars to explain the underlying theory justifying the methodology and how to apply the methodology in practice using data on alerts and alert dispositions

Our Approach:

- Conducted a comprehensive review of the bank's AML TMS and developed a management plan for creating an AML TMS and governance procedures
 - Provided recommendations for developing sufficient documentation of the AML TMS
 - Verified that the AML TMS was implemented as intended and provided recommendations for correcting minor gaps
 - Enhanced the coverage of rules used to monitor and identify suspicious transactions by adding specific transaction codes and creating separate targeted rules and, in some cases, distinct thresholds for business and individual accounts and incoming and outgoing transactions
 - Established the concept of a "productive alert" to be used in alert review and threshold tuning
 - Provided robust model-validation documentation and recommendations, including a management plan for the bank to collect data on alerts and alert dispositions, develop an outcomes-based testing methodology, and apply the methodology to tune all thresholds
- Played a key role in the development of the AML TMS
 - Developed and documented a comprehensive methodology for tuning thresholds tailored to the bank's AML TMS to help ensure tuning efforts are consistent with regulatory expectations
 - Reviewed alerts for a one-year look-back period, assigned productive and nonproductive dispositions to those alerts, and documented the procedures followed
 - Applied the tuning methodology using the alert-disposition data and provided documentation of the analysis, including recommendations for adjusting thresholds for all of the bank's existing rules, as well as rules based on the account- and transaction-type segmentation analysis
 - Conducted seminars to explain the theoretical underpinnings of the methodology and provide step-by-step instructions on how to apply the methodology in practice

Key Outcome:

Promontory partnered with the bank to develop and implement a roadmap for creating a robust, compliant, and cost-effective AML TMS and governance program. Through educational development, we helped the bank successfully apply the tuning methodology and governance program going forward.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Model Governance

Promontory helped trade-association member banks to better understand the range of industry practices and acquire insight into how their peers were addressing new regulatory guidance on model-risk governance (Federal Reserve SR 11-7 and OCC Bulletin 2011-12).

The Client Engaged Promontory to:

- Facilitate a series of forums with model risk management professionals from a wide range of banks operating in the U.S.
- Enable professionals from member banks to share current practices and challenges encountered in the new guidance

Our Approach:

Due to the exchange of knowledge that occurred during the trade-association forum, Promontory produced significant thought leadership. Specifically, we:

- Leveraged industry perspectives gained during forum discussions to draft a white paper on model risk management practices and issues that the trade association raised with banking regulators
- Worked with the same group on a narrower subset of the identified challenges in model risk management to identify and document points of commonality and divergence, frame a set of key questions, and develop a thoughtful discussion of those key questions
- Scheduled and convened meetings with U.S. banking regulators to discuss the industry group's views and seek clarification and feedback

Key Outcome:

Member banks benefited from their peers' experiences and, in some cases, adopted new practices that enhanced programs for model risk management. The coordinated approach to engaging regulators allowed members to present a combined view on challenging aspects of supervisory expectations, and receive consistent feedback on some of the key issues.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Model Governance

Promontory helped a major credit-rating agency evaluate, revise, and document its model-governance framework to comply with new regulatory requirements.

The Client Engaged Promontory to:

- Evaluate, revise, and document its framework for model risk management to bring it into compliance with regulatory expectations
- Validate a significant backlog of models in a manner that conformed to the new standards

Our Approach:

- Interpreted new regulatory requirements and advised on the development of a framework for model risk management that complied with those new requirements and encompassed sound industry practices
- Introduced risk-sensitive model governance throughout the framework for model risk management, allowing the firm to greatly increase the efficiency of resource allocation for model risk management while meeting regulatory expectations
 - Developed an initial model-risk-tiering scorecard, led cross-functional seminars to finalize the scorecard design in line with the agency's own risk appetite, and led the calibration of the scorecard, thereby producing a risk-tiering process to support risk-sensitive model governance while creating transparency in risk tiering for both internal and external stakeholders
- Drafted a full suite of governance policies and detailed procedures, as well as templates for model-development and model-validation documentation, working collaboratively with risk management, business, analytical, and IT functions
- Worked with risk management and business representatives to establish a comprehensive model inventory, reflecting a more robust model definition

Key Outcome:

Promontory helped the client develop a robust, compliant, and feasible framework for model risk management with less disruption than initially anticipated.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Model Validation

After assisting a major credit-rating agency in enhancing its framework for model risk management, Promontory helped the client comply with new regulatory expectations by conducting an extensive model-validation project to address a large backlog of models.

The Client Engaged Promontory to:

- Perform and document validation activities for over 540 models, spanning a wide variety of model types, regions (e.g., U.S., EMEA, Asia/Pacific, and Latin America), business areas (e.g., sovereign, corporate, structured credit, residential mortgage-backed securities, asset-backed securities, public finance, insurance, and project finance), and risk tiers (e.g., high, medium, and low) over a period of approximately 11 months

Our Approach:

Promontory worked with the agency to understand the enhanced regulatory expectations, develop and implement a revised framework for model risk management, and conduct subsequent validation activities. Specifically, we:

- Deployed a team of approximately 70 quantitative-validation experts, grouped into teams focusing on models of similar structure, application, or complexity
- Applied a robust project-management framework, including a layered quality-assurance process to effectively handle changing client expectations and to ensure the consistency of validation approaches across teams
- Delivered robust validation reports and workpapers developed using a small set of customized templates, each tailored to a possible model-risk tier and business-product type and targeted at meeting internal requirements and regulatory expectations at the same time
- Established a standardized process for interacting with model owners and in-house model-validation leadership, including pre-close and closing meetings to allow the client to “own” the final work product

Key Outcome:

Promontory validated the model backlog in a timely and cost-effective manner, allowing the agency to focus on establishing internal model-risk capabilities to meet both supervisory and internal requirements, and to benefit from a library of robust validation examples.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Enhancing Model Documentation

Promontory worked with a global bank to improve its judgmental modeling approaches and supporting documentation for the Comprehensive Capital Analysis and Review.

The Client Engaged Promontory to:

- Recommend improvements to forecasts created for CCAR and Dodd-Frank Act stress tests for over 20 international retail portfolios that previously lacked high-quality statistical models.
- Create documentation to properly describe the approaches and address prior regulatory and validator criticisms.

Our Approach:

- We first sought to produce a list of key principles in model documentation and expert-judgment approaches.
 - A list of principles was shared with all teams to help them see the goal and need for improvement in their approach and documentation.
- We next reviewed the list of models developed for each portfolio and the portfolio's prior-year CCAR forecasting method (judgmental approach or champion statistical model).
 - We focused on advising each team to create a sound methodology by adhering to the principle of conservatism and selecting validated models that demonstrated some viability as being appropriate for use.
 - In finalizing the approaches, we often considered several inputs and the level of the forecasts compared to historical measures.
- We helped create the documentation describing and supporting the approaches by focusing on key principles of documentation and adhering to SR 11-7 guidance.
 - We improved the documentation standards by writing a more comprehensive and in-depth description and justification of the approach.
 - We also enhanced the documentation to address prior regulatory and validator feedback; in particular, we helped ensure that common issues across the portfolios were addressed in a consistent way.

Key Outcome:

Promontory supported the bank in producing reasonable and conservative forecasts and comprehensive model documentation, consistent with industry best practices.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Model Risk Management

Promontory helped a major European investment bank enhance the governance, validation, and implementation of its internal model for initial margin, or IM. The bank chose to apply our model risk management framework for all models in the bank.

The Client Engaged Promontory to:

- Develop an action plan to remediate regulatory findings related to the oversight and implementation of its IM calculations.
- Help the bank enhance its IM calculation and related processes, model governance, model validation, IT systems, and business-process controls to meet customer needs and U.S. and European regulatory expectations.

Our Approach:

- Promontory deployed a diverse team of experts to interpret regulatory expectations and develop and implement an action plan to enhance the bank's IM calculation processes and model risk management framework. Specifically, we:
 - Interpreted the regulator's findings and relevant U.S. and European guidance and regulations.
 - Created a reference standard combining all related guidance and regulations and conducted a gap analysis of current policies, processes, and analytics against the standard.
 - Prioritized gaps and worked with client stakeholders to set timelines resulting in a comprehensive, well-documented, and achievable action plan that the regulator quickly approved.
- Our team managed implementation of the action plan over eight months. Promontory:
 - Developed or enhanced a full suite of model risk management framework documents, including a model risk management policy and implementing procedures compliant with both U.S. (Federal Reserve "SR 11-7" and the inter-agency swap-margin rule) and EU (Capital Requirements Regulation and European Market Infrastructure Regulation) supervisory expectations.
 - Developed a model risk-tiering scorecard and completed initial scoring of the first set of models.
 - Improved the original IM model validation and led change validation to add a product to IM model coverage, accelerating regulatory approval.
 - Enhanced the IM model's governance and back-testing procedures.
 - Established standards, procedures, and tools to monitor concentration and wrong-way risks.
 - Ensured all commitments were delivered on time and met regulatory expectations.

Key Outcome:

The bank successfully remediated the regulatory findings on time; improved its IM calculations (resulting in a significant reduction in margin disputes and errors); and established a firmwide model risk management framework and organization, as well as a road map for full compliance of the target model inventory with the framework.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Enhanced Effective Challenge

Promontory worked with a large regional bank to enhance its independent validation function's effective challenge of the bank's stress-testing models.

The Client Engaged Promontory to:

- Ensure that the scope of the validation was sufficient and properly tailored to the specific model undergoing validation.
- Evaluate the effective challenge provided by the validation function, identifying strengths and weaknesses.

Our Approach:

Promontory enhanced the independent validation function's effective challenge for over 30 of the bank's stress-testing models by recommending specific validation activities and tests and evaluating the effectiveness of the validation reports. Specifically, we:

- Provided a pre-validation scope memo with recommendations for specific validation actions and tests for each model under review.
 - Developed a template for the scope memo with a detailed outline for the potential validation activities.
 - conceptual soundness, process verification, and performance and outcome analysis.
 - Reviewed model-development documentation and determined critical elements of the modeling framework for testing.
 - Highlighted the high-priority validation activities and tests.
 - Provided a scope memo with detailed and specific recommendations for validation activities and statistical tests for
 - Conducted follow-up discussions on recommendations with validators to answer questions.
- Provided a post-validation evaluation of the effective challenge provided by the validation function as evidenced by the validation report.
 - Developed a template for the report evaluation with a detailed outline for the validation activities.
 - Noted specific examples of strong validation practices and provided suggestions to enhance weak practices.
 - Reviewed the development documentation, validation report, and Promontory's pre-validation scope memo.
 - Assessed whether the report provided an effective challenge for the model with a summary of the critical support for the challenge.
 - Evaluated validation findings and assessments and noted whether we agreed with the validation assessments.
 - Conducted follow-up discussions with validators concerning our assessment.
- Provided technical editing for the validation reports to improve readability and clarity.
- Gave a presentation to developers, validators, and management at the end of the engagement on lessons learned and suggestions for enhancement.

Key Outcome:

Promontory worked with the client throughout the validation process to ensure the appropriate scope for validation testing, evaluate and improve the validation report, and enhance and document the effective challenge provided by the bank's model-validation team.



PROMONTORY, AN IBM COMPANY
QUANTITATIVE SOLUTIONS CASE STUDY:

Developing a Liquidity Stress-Test Model

Promontory worked with a large credit card bank to develop a quantitative model for liquidity stress testing.

The Client Engaged Promontory to:

- Develop a liquidity stress-testing framework and scenarios for examining contingent liquidity events, an LST model for examining the quantitative implications of the scenarios, and the bank's liquidity risk appetite statement and plan for contingency funding.
- Help the bank revise its liquidity risk management program in accordance with supervisory feedback and best practices.

Our Approach:

Promontory worked with the bank to develop three LST scenarios; developed assumptions for credit card purchases, payments, and losses for two of the scenarios; and built a new LST model for calculating the expected length of time in which the bank could meet its funding needs, cash surpluses and deficits, and funding concentrations under each scenario. Specifically, we:

- Developed statistical models for credit card purchases, payments, and loss rates.
- Recommended and implemented assumptions for cash outflows and constraints on cash inflows, including:
 - Runoff in brokered deposits and asset-backed-security notes.
 - Limits on rolling over and issuing new brokered deposits and ABS notes and rolling over conduit lines.
 - Cash outflows to maintain seller's interest.
 - Dividend payments triggered by the capital ratio.
 - Credit card purchase, payment, and loss rates.
- Recommended and implemented assumptions for mitigating actions, including:
 - Drawing down cash and selling highly liquid assets.
 - Rolling over maturing and issuing new brokered deposits and ABS notes.
 - Rolling over maturing conduit lines and additional borrowings up to the committed amounts.
 - Borrowing from the bank's parent and the Federal Reserve discount window.
- Developed and tested a new LST model that produces pro forma balance sheets and income and cash-flow statements, capital ratios, and liquidity risk metrics based on structural dynamics for:
 - Balances, runoff, rollover, new issuance, and interest payments for brokered deposits and ABS notes.
 - Credit card loan balances and cash flows associated with baseline and stressed forecasts for credit card purchases, payments, and loss rates.
 - Trust conduit lines, including cash flows required for interest payments and to maintain seller's interest and service the trusts, as well as rollover and payoff of maturing lines and additional borrowing up to committed amounts.
 - Dividend payments to and capital infusions from the parent triggered by the model's internal capital-ratio dynamics.
 - Additional borrowing as needed from the committed line with the parent and the Federal Reserve discount window.
- Developed custom liquidity risk metrics and recommended assumptions for the bank's liquidity risk appetite based on the simulation results produced by the LST model.

Key Outcome:

Promontory developed and tested a robust LST approach using the client's historical data that was consistent with industry best practices and addressed regulatory feedback.