

Anatomy of Risk Management Practices in the Mortgage Industry: Lessons for the Future

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Executive Summary

Not since the Great Depression has there been a contraction in the U.S. housing market of such scale. With much attention given already to complex mortgage securities, their risks and impacts on financial markets, this study examines the underlying loan manufacturing process that greatly contributed to excessive risk building across portfolios and mortgage securities alike. Particular attention is focused on the dynamics behind risk taking within mortgage firms leading up to the collapse in housing in order to understand what drove these firms to the brink and what lessons can be learned.

No single factor was responsible for the significant expansion of credit and mortgage products during the period leading up to the mortgage crisis. However, there are indications that greater risk-taking could be attributed to the following factors:

- An over-reliance on performance metrics not adjusted for risk which would lead management toward riskier products
- Data and analytical limitations and blind spots that led risk managers to grossly underestimate credit losses
- Cognitive biases among senior business managers that over time led them to take greater risks, and in the process reduced the effectiveness of risk management practices
- Incentive problems leading to regulatory actions that wound up not being in the best interest of the taxpayer.

Some of the questions the study seeks to answer include:

- How did the proliferation of mortgage products such as option ARMs come about so quickly?
- How did risk layering factor into decisions to originate, hold and sell mortgage products?

- What were the competitive forces weighing on mortgage originators and how did the governance process work in some institutions and not in others?
- What were the market forces underlying risk decisions and how did early warning systems and leading indicators woefully underestimate risk in such a significant way?
- What explains some of the regulatory responses to firm risk taking during this period?

Why did so many mortgage companies fail? These companies did not abandon standard economic conventions such as profit maximization. Many mortgage specialists sought to improve their attractiveness to investors by seeking growth opportunities. With a sustained period of strong home prices and low credit losses serving as a backdrop to business strategy, cognitive biases allowed senior managers to build up a false sense of security by expanding into a variety of new and ultimately riskier products. Armed with toolkits that did not appropriately differentiate between mortgage product risks, and with estimates of losses that appeared to be within reason, management teams were confident that expanding the credit risk envelope by relaxing underwriting standards across a broad spectrum of mortgage products was in the best interest of shareholders.

Through portfolio simulation analysis, this study demonstrates how greater risk taking could occur. Optimal mortgage investment decisions based on return on equity (ROE) rather than risk-adjusted return on capital (RaRoC) metrics are shown to lead to very different outcomes, due to ROE measures tending to support higher levels of riskier assets. Further, the simulation results shed light on how management biases noted earlier can greatly limit the effectiveness of standard risk management practices such as concentration limits and reinsurance.

One of the study's original contributions reaches across the field of behavioral economics to explain risk management decisions leading up to the crisis. Short-term incentive structures may have contributed to poor risk decisions, however, a variety of cognitive biases may also have contributed by lowering management loss aversion, encouraging management to follow competitors into riskier products and discounting the information and stature of risk management teams.

A number of important lessons for the mortgage industry, regulators and investors emerge from the study. These include the need for a comprehensive focus on development of industry-wide data and techniques for measuring risk; implementation of risk-adjusted return measures for firm objective-setting; individual performance assessment; and greater introspection on the part of management teams to validate external information against a stated risk vision.

1. Introduction: Findings and Recommendations

“Innovation has brought about a multitude of new products, such as subprime loans and niche credit programs for immigrants. Such developments are representative of the market responses that have driven the financial services industry throughout the history of our country ... With these advances in technology, lenders have taken advantage of credit-scoring models and other techniques for efficiently extending credit to a broader spectrum of consumers ... Where once more marginal applicants would simply have been denied credit, lenders are now able to quite efficiently judge the risk posed by individual applicants and to price that risk appropriately. These improvements have led to rapid growth in subprime mortgage lending; indeed, today subprime mortgages account for roughly 10 percent of the number of all mortgages outstanding, up from just 1 or 2 percent in the early 1990s.”¹

— ALAN GREENSPAN

Looking back to the early part of the last decade, most mortgage industry experts, including regulators and bank management teams would have echoed the comments of the Fed Chairman. The future for housing markets burned bright in the years leading up to 2006 with advances in quantitative risk assessment, information technology and financial engineering. The reality since has been much different, and leaves the industry grasping for answers as to how a systemic failure of nearly unprecedented magnitude could have occurred given all of the technical advances and developments in managing risk that occurred over this period.

At the center of the events shaping the mortgage industry were the risk management practices of the various institutions responsible for originating, servicing and securitizing mortgage loans. This study focuses on understanding the risk management processes in place at the largest mortgage lenders before the housing crisis; specifically what contributing factors may have limited the value risk managers provided to their firms and shareholders and what lessons can be passed on to future risk managers. Much discussion has ensued over the effect the originate-to-distribute model that transferred risk away from originating firms had in fueling excessive risk taking. The fact that many large mortgage portfolio

lenders expanded their held-for-investment portfolios and retained large positions in senior tranches of mortgage securities before the crisis, and afterward experienced heavy credit losses suggests that other forces were at work beyond the originate-to-distribute model. A deeper look inside risk management structure and governance processes of these firms is warranted.

Although many explanations have been offered since the crisis for its origins, this study isolates attention on four in particular that appear to have contributed to excessive risk-taking behavior at many mortgage institutions. Specifically, the factors of interest to this study are:

- A lack of risk-adjusted return metrics that would have better differentiated risk among mortgage products and led to better investment decisions
- A number of deficiencies in data, processes and analytics leading to under-informed views of risks, particularly those associated with new products
- Management biases influenced by a sustained period of benign economic conditions that lowered management aversion to risk, leading to actions that marginalized risk management recommendations
- Incentive conflicts that limited the effectiveness of safety and soundness regulators.

This study contends that expansion into riskier products by mortgage firms that subsequently suffered large credit losses was a strategy intended to grow the franchise and along with it the attractiveness of the firm to investors. Over time investors discounted the growth potential for mortgage specialists for a variety of reasons. Commoditization of prime mortgages via the conforming securitization market, for example, helped keep mortgage borrowing costs and net interest spreads low. Products with higher margin potential such as option ARMs and HELOCs provided these companies alternatives to originating conventional conforming mortgages as echoed by WaMu's former Chairman and CEO:

“Finally, in the mortgage lending space, this is an area where we have had to make a major adjustment in our core business model. We have elected to move away from the commoditized business — which we define as conforming 30-year fixed-rate mortgages — and to emphasize higher-margin products like option ARMs, Alt-A lending, subprime, and home equity lending. So we are in a period of transition where we are decreasing efforts in the commoditized part of the business and increasing these other parts. That’s giving us the opportunity to materially adjust our cost structure, so I view 2006 as a year of transition as we make all of those changes. Then I think we’ll be very well positioned for double-digit growth in that business beginning next year.”²

To better understand how performance metrics and management growth objectives could lead mortgage executives toward high-risk strategies, consider the price/earnings ratio (P/E). Despite well known limitations, P/E ratios remain an important metric for investors in assessing a firm's growth prospects.

A key input to the P / E ratio is return on equity (ROE). The higher the ROE, the higher the P / E ratio, when all else is constant. Finding ways for management to boost the attractiveness of a stock to investors as evidenced by higher P / E ratios (signaling future growth prospects) would naturally be an important strategic objective, absent other considerations. With a stable product mix that exposes the firm to comparable risks, the use of an ROE metric may provide a satisfactory representation of the firm's overall risk-return profile. However, in an effort to grow, the firm would need to identify investments exceeding its required return, allowing it to expand into new products and activities that enjoy higher net interest margins.³ If the firm bases ROE on the amount of regulatory capital required to hold the asset and there is no product-specific difference in regulatory capital for mortgages, higher risk assets would be targeted for investment since the net income would be higher than for a lower risk mortgage but the required capital would be identical.⁴ A better approach would be to introduce economic capital into the risk-return framework in order to more accurately reflect the underlying risks of different assets. Further discussion of this issue will reveal that implementation of such metrics, while possible, is not a trivial exercise for most institutions. Implementing such a strategy thus requires an appreciation and understanding of the deficiencies in standard ROE measures used by management and a commitment to develop the required data and analytical infrastructure to build appropriate risk-adjusted return metrics.

Another critical issue affecting the level of risk taking in the mortgage industry was the modeled expectation and distribution of future losses arising from new and existing products. Over the decade preceding the mortgage crisis, significant advances in methodology and computational power enabled credit risk management to enjoy considerable improvements in the ability to quantify prospective credit losses. However, five important factors seriously undermined the analytical advantages of these new techniques: data integrity; material changes in the economic environment; new mortgage products; structural changes in borrower and counterparty behavior; and an overconfidence in models and their impact on operational credit risk processes. These factors in combination contributed to credit losses across product types that have turned out to be significantly higher than risk management estimated.

Considerable consolidation in the mortgage industry took place over the years leading up to the crisis, which brought with it challenges in information technology units to ensure that data could be merged with other data across the company, aggregated and reported on in a consistent fashion. Impacting mortgage data integrity were platform integration issues from acquisitions, incomplete and inaccurate data due to underwriting errors and data errors due to misrepresentation on loan files.

Problems with both hardware and software configurations along with differences in variable definitions would plague a number of companies' efforts to mine their loan level databases. Beyond these technical issues, however, the costs in terms of manpower and systems to develop internal risk views can be prohibitive to smaller institutions and difficult even for larger institutions considering such projects.

An example of where changes in underwriting practices created unintended consequences regarding data was the advent of reduced documentation loans. Since borrowers under a number of these programs

were allowed to state their income and in some cases had no income requirement, this practice vastly distorted a key risk factor in the prediction of mortgage default. Without a true estimate of a borrower's income, measures such as debt-to-income ratios (DTI) would become less predictive in statistical default models over time. This would lead to further relaxation of historically critical determinants of borrower capacity for mortgage repayment such as DTI in underwriting. Borrower misrepresentation of income, whether intentional or not, thus influenced the predictive power of traditionally important risk factors. Similarly, imposition of origination fees on investor-owned properties incited many borrowers to report the property as their primary residence in an effort to avoid higher costs. This behavior would also diminish the accuracy of the data used in modeling this risk factor. Appraisal fraud reduced the predictive power of loan-to-value (LTV). Over time, knowledge of FICO determinants led to gaming of credit scores, reducing their predictive power.

The period of mortgage product expansion was accompanied by abnormally strong house price appreciation across most MSAs fueled in part by relatively low interest rates. This favorable economic environment contributed to a period in which mortgage default rates were very low by historical standards. As a result, the economic environment tended to bias loss estimates downward in a real sense. This contributed to further mortgage expansion and vast understatement of potential losses due to risk layering and the expansion of nontraditional mortgage products such as option ARMs and piggyback HELOCs. The development of new products and the expansion of risk parameters on existing products came at perhaps the worst time. With virtually no historical experience with these new risk combinations and that which existed largely coming from a benign economic environment, risk models would have little hope to accurately reflect expected loss, let alone loss levels during an extreme event such as the financial crisis.

The fourth factor contributing to model error was in part an outcome of continued product relaxation and increased leverage of borrowers and counterparties. As underwriting standards on income documentation and LTV loosened, allowing for both limited or no income verification and low equity stakes in the property, traditional borrower sentiment toward home ownership changed. Renters were increasingly able to become homeowners with little downpayment and with creative cash flow structures that provided short-term payment capacity. As long as home prices continued to rise, a borrower in such a situation could refinance out of one loan and into another, or sell the property without loss. But once home prices peaked, particularly for those purchasing their home at or near the top of the cycle and possessing limited equity in the property, borrowers became stranded in the home with few alternatives. In such cases, borrowers ruthlessly exercised their default option as historically important ties to the home were outweighed by excessive payment burdens coupled with negative equity in the home.⁵ At the same time, widespread lapses in controls of counterparties as evidenced by a spike in mortgage fraud aggravated a growing credit problem.

The commoditization of prime mortgages from securitization ushered in an era of advanced credit modeling using complex loan-level multivariate statistical models that, despite their analytical

elegance, facilitated a false sense of security in the level of risk taking. It also may have contributed to unintended underinvestment in traditional risk processes such as quality control, appraisal management, default and portfolio management. Greater confidence in the validity of quantitative risk assessments coupled with a sustained period of strong economic conditions ushered in a period where traditional credit risk processes would be increasingly ceded to advancements in financial engineering and technology.

While over-reliance on certain performance metrics and analytical models drawing upon data with significant deficiencies contributed to misguided business and risk strategy in a number of cases, the situation was exacerbated by deficiencies in corporate governance with respect to risk-taking strategy and risk infrastructure development. Establishing a strong risk culture where business managers and risk managers share common objectives and attitudes toward risk is critical toward addressing deficiencies in modeled outcomes, data and metrics. Undoubtedly an intangible factor, the credibility and stature of risk management in the business is directly related to firm attitudes and perceptions of the effectiveness and contributions of risk management to promoting the success of the franchise. Willingness of senior management to set the tone for a strong risk culture throughout the organization has been recognized as a key factor in promoting successful risk management strategies.⁶ As a primary line of defense against excessive risk taking, risk management functions by virtue of their purpose can engender skepticism among business managers of the value of such activities since the business manager feels accountable for managing the profit/loss (P/L) of the business, which includes taking risk.

Facilitating such views among business managers about risk management are differences in the type of information used and analyzed by both groups. Risk managers tend to focus on measuring uncertainty, in particular generating views of expected and unexpected losses which are dependent on key assumptions and methodologies not always well understood by business.

Specifically, key metrics for risk managers such as expected and unexpected loss are unobservable and highly dependent upon the validity and representativeness of underlying data and models. By contrast, business managers readily have available a host of observable metrics such as volume and market share, P/L, competitive intelligence and historical losses. When risk and business managers come together to develop a business strategy, metrics that are easily observed and hence are viewed as having greater certainty tend to carry greater weight in determining the direction of the business and risk taking. These deliberations are made even more difficult for risk managers when the culture and stature of risk management in the organization are not well-developed.⁷ The effectiveness of risk management to persuade skeptical business managers about prospective levels of risk thus may be undermined by the uncertainty surrounding different risk outcomes. Simply put, business managers armed with reams of data on the profitability and market opportunity of their product set have an informational advantage over risk managers attempting to portray a range of potential outcomes based on limited data. The possibility of losses well outside recent experience can also influence business

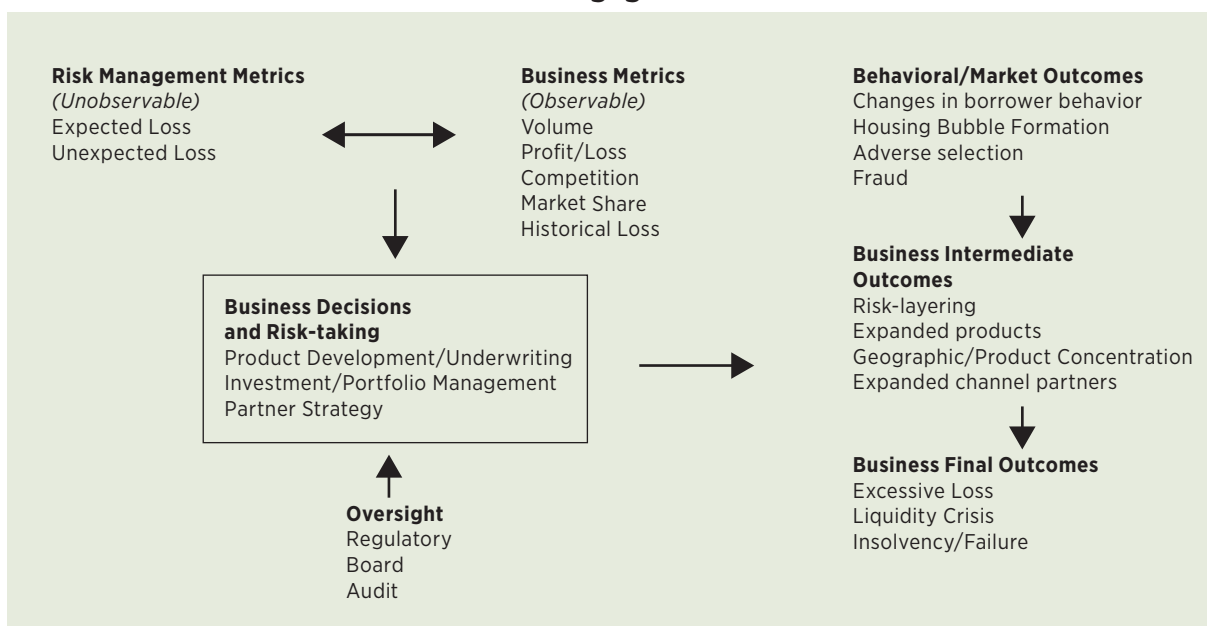
decisions. Certainly during the years leading up to the mortgage crisis in 2007, the better than average economic environment and unusually low credit losses masked future losses. Cognitive biases on the part of senior business managers based on a sustained period of low credit losses may have dampened their aversion to loss and so influenced their interactions with risk managers.

Figure 1.1 provides a simplified depiction of key mortgage decision-making processes. This issue of observable and unobservable metrics brought to decision making is illustrated between risk and business managers. To keep the discussion tractable, decision making centers on three major areas that ultimately contributed to greater risk taking and hence high mortgage losses at some major lending institutions: product development, investment and portfolio management and counterparty or channel management.

Expansion of credit risk parameters in effect created a set of new products as borrower behavior changed. Product development and underwriting are intertwined in designing what types of mortgages will be originated and /or purchased by the company. Experience with existing products is used as a key input to understanding the performance of new products along with additional analysis on new features of the proposed product. A false sense of security with new products originated prior to 2007 occurred as a result of better than average economic conditions coupled with a lack of information regarding subtle but real changes in borrower behavior. Historical data and the best analytical models would not be able to detect such structural changes. As a result, riskier products could be justified based on a perceived certainty that they would meet important business objectives. As underwriting standards relaxed, riskier attributes were combined to a greater extent, creating historically high levels of risk layering. This additional “tail” risk would ultimately result in high credit losses.

Figure 1.1

How Information and Process Affects Mortgage Decision Outcomes



Concurrent with product development were decisions on what products a firm would retain in portfolio or sell, as well as the mix of products and attributes. The relative lack of geographic and product diversification by a number of the largest mortgage lenders in hindsight seems shocking, but at the time could be rationalized by investment opportunity costs and relative value. For instance, a company's retail footprint is an important driver of geographic concentration. For lenders originating in relatively strong markets such as California and Florida at the time, the prospective benefits from continued origination in these markets outweighed the concentration risks building up over time in light of a perception that conditions would remain benign. While occasional regional volatility in housing markets was known and quantified, observed house price appreciation and correlation between markets could influence portfolio decisions. For example, faced with originating a mortgage in the Midwest where home prices were stable and low, versus in Los Angeles where the market experienced double digit appreciation over several years, continued origination in L.A. seemed a better option. For risk managers, building a strong empirical case for concentration risk limits was daunting in the face of limited and changing information from which to draw strong conclusions that would resonate with business managers.⁸

In order to grow the business, retail origination channels were often augmented by correspondent and broker business and also with bulk purchases of mortgages from other originators. Counterparty risk assessments suffered from the same informational issues as those for assessing loan risk, namely strong economic conditions masking potential risks building up among counterparties. While risk managers had empirical evidence to show that these channels were riskier than retail originations due in part to such issues as adverse selection and weaker process controls, the ability to shut down individual counterparties was limited by a lack of direct incontrovertible evidence against a poor performing counterparty to sufficiently offset the business argument that such actions would have long-term deleterious competitive effects on production. Also, shutting down wholesale originations often would have exacerbated geographical concentrations, as originations would have been limited to the retail footprint.

In an effort to ensure an appropriate balance between risk and business goals, various levels of internal and external oversight existed for mortgage lending institutions. Internal and external audit functions provided objective and independent views of risks, and regulated depositories also faced ongoing scrutiny from examiners. At the highest level of the firm, boards of directors and their committees were expected to discuss and raise issues to management regarding risk taking and controls. Being further removed from the day-to-day risk management activities, they relied greatly on the views that business heads and risk managers provided. Limited data being plugged into models that missed important structural changes occurring in borrower behavior and markets would simply have been passed on to these oversight groups. As a result, the effectiveness of oversight activities to provide balance in risk taking was compromised by informational limitations. Safety and soundness regulation was also an important part of the oversight process, and incentive problems arising from conflicts

of interest in the form of structural governance practices, agency funding structure and other forms may have limited the effectiveness of regulators to impose tougher sanctions against firms with poor risk management practices.

Referring once again to the schematic, informational and governance issues favored business models where concrete outcomes could be more easily ascertained, promoting market-driven objectives along with greater risk taking. This risk taking would be argued to be well understood given data at the time. As discussed, favorable economic conditions that lessened senior management loss aversion, an inability to provide an unequivocal view of prospective risk by risk management units and ongoing changes in market participant behavior contributed to greater risk taking.

Piecing together this picture of what compromised many mortgage businesses is what the rest of this study is about. First, it establishes a working model for framing portfolio and product selection decisions. Throughout the study scenarios from a portfolio optimization framework are reviewed. The study then surveys evidence supporting the proposition that informational disadvantages placed risk managers on an unequal footing in real-time business strategy discussions. The analysis looks at the tools and data used by risk managers to form their decisions and establishes that favorable economic conditions prior to the crisis artificially lowered estimates of expected losses. Further, losses associated with new products and combinations of risk factors would likewise be underestimated by the models as the effects from risk layering and borrower behavioral changes could not be picked up easily in the models. Understanding the different perspectives and metrics between risk and business managers and the key assumptions behind each of these views provides insight into the decision-making process and how it shaped greater risk taking based on market-driven objectives.

A related area of focus of the study is on the governance, culture and business strategy dynamics at mortgage lenders during the period before the crisis. We discuss cognitive bias that influenced senior management risk taking and the effectiveness of risk management teams. While very limited hard data exist to draw empirical conclusions, important insights on some of these issues can be gained from various external disclosures being made at the time by senior managers and regulators. As described above, the combination of informational limitations on risk managers and a governance structure and culture that may have tipped decisions in favor of business-driven strategies is central to explaining a general phenomenon of greater risk taking in the industry.

That the industry took on significant risk is clearly evidenced by the mortgage losses sustained since 2007 and the number of mortgage lenders that went out of business. Documenting these outcomes is less instructive to this analysis than understanding important structural and participant behavioral changes going on in the mortgage market during the period. How these changes were overlooked by risk and business managers as well as regulators and investors is critical to identifying solutions for making better decisions in the future. Specifically tied to risk management informational challenges was the difficulty in determining the effects of borrower psychology toward homeownership, the

advent of a housing bubble and counterparty risk issues on the risk profile of the firm. We explore these linkages directly and present recommendations on building a better risk management framework.

Notes

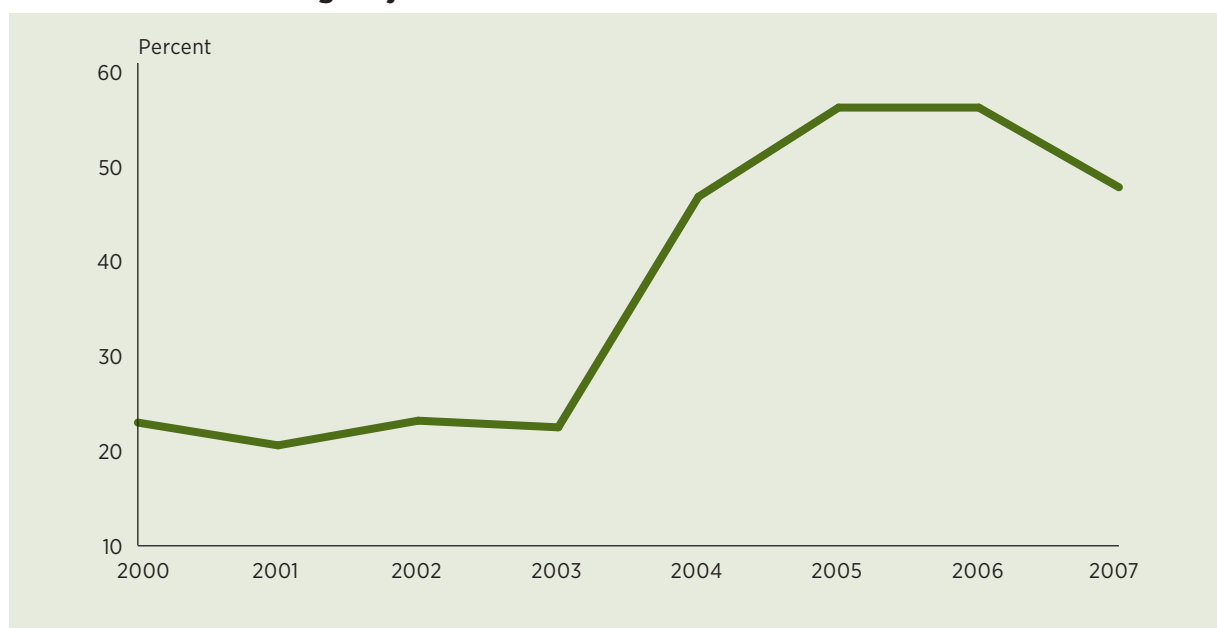
1. Greenspan, Alan (April 8, 2005). "Consumer Finance," Federal Reserve System's Fourth Annual Community Affairs Research Conference. Federal Reserve Board.
2. Jack Milligan, "The WaMu Way," *Bank Director Magazine*, Q3 2006.
3. Other activities might include whether to securitize a pool of mortgages versus retaining the assets on-balance sheet.
4. During the years leading up to the crisis a leading view was that in the case of prime residential mortgages, regulatory capital was more likely to be binding on banks than economic capital. See Calem and Follain, 2007.
5. Guiso, Sapienza, and Zingales, "Moral and Social Constraints to Strategic Mortgage Default," NBER Working Paper, July 2009.
6. Golub, Bennett W., and Conan C. Crum, "Risk Management Lessons Worth Remembering from the Credit Crisis of 2007-2009," p. 4, white paper.
7. A number of studies have found linkages between strong corporate culture and firm risk-taking. Griffen et. al, "Cultural Values and Corporate Risk Taking," October 2009, unpublished manuscript.
8. Geographic correlations were not stable during the period which generated considerable problems in understanding risk concentration.

2. A Model for Mortgage Risk Taking: Growth, P/E and the Fallacy of ROE

The mortgage industry and the secondary market for mortgages underwent considerable transformation in the period from 2003–2007, as illustrated by the rise in private label securities issued over this period (Figure 2.1). In addition to increased investor demand for such products that helped fuel the growth of this segment of the market, mortgage originators faced a dilemma wherein commoditization of prime conforming mortgages and differential regulatory capital standards made origination and sale of these safer loans to the GSEs less attractive.

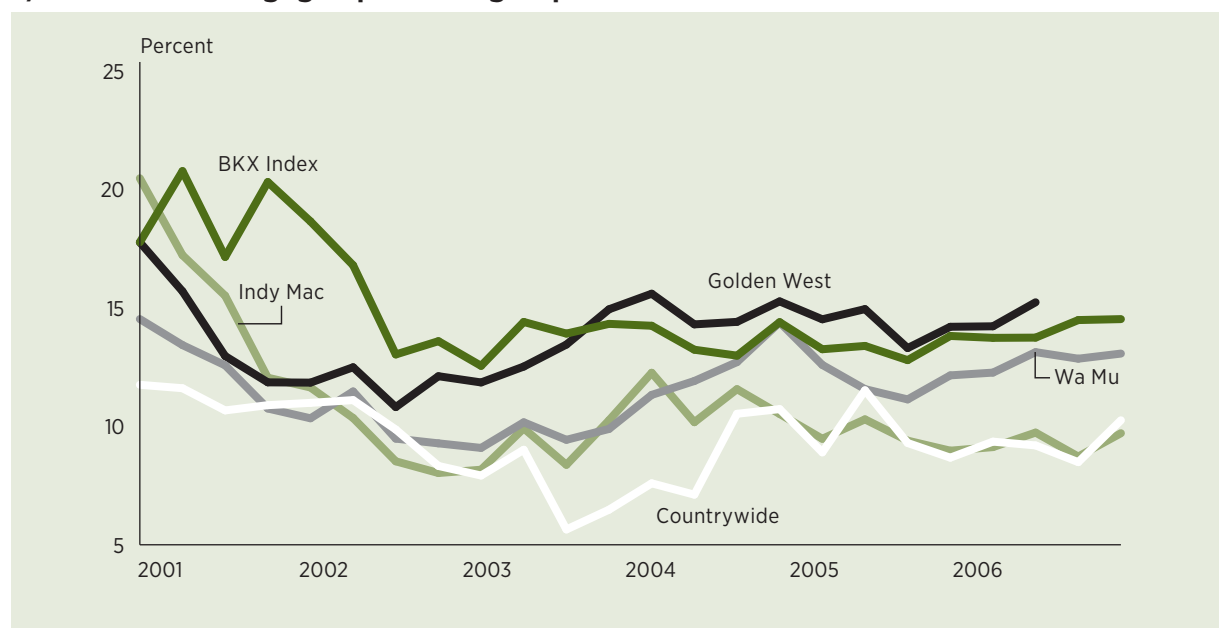
Long-term growth for originating institutions would come from other innovative changes in product structure and operations, allowing for these firms to maintain or improve their growth prospects and hence their attractiveness to investors. This problem is further exacerbated for those institutions

Figure 2.1
Market Share of Non-agency Securitization



Source: Anderson, Capozza and Van Order, *Deconstructing a Mortgage Meltdown: A Methodology for Decomposing Underwriting Quality*.

Figure 2.2
P/E Ratios of Mortgage Specializing Depositories



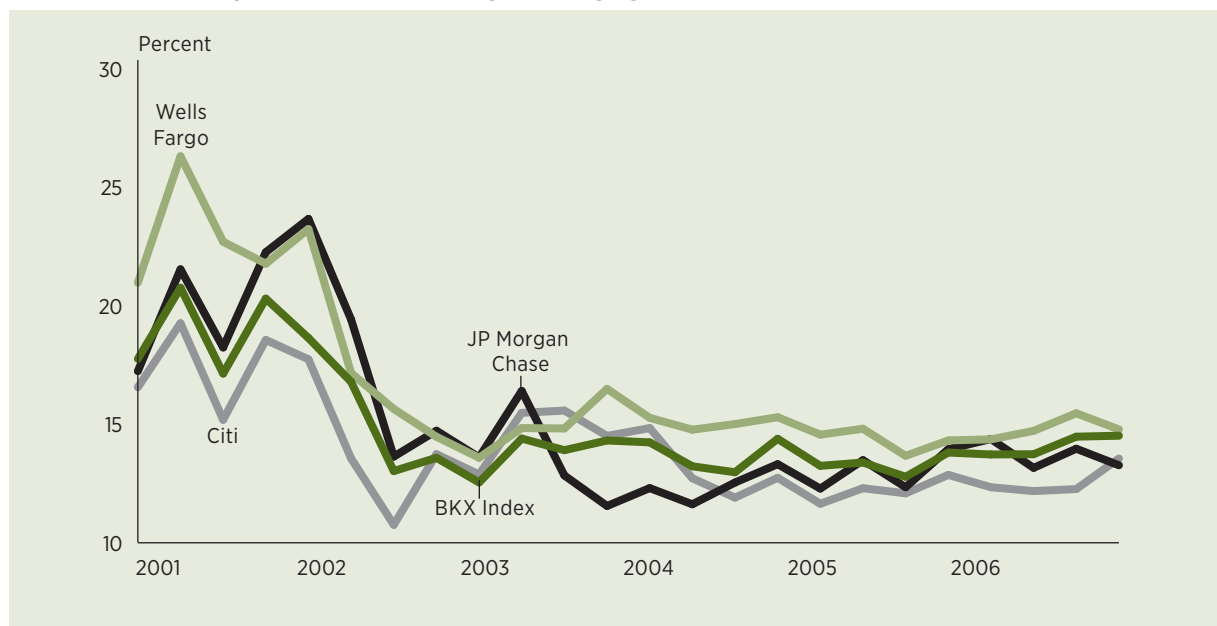
Source: Bloomberg data.

specializing in mortgage lending, such as mortgage companies or thrifts. Because of a relative lack of product diversification in an industry saturated with mortgage lenders and the GSEs, growth opportunities were limited when compared to financial institutions with more diversified businesses.

One way a firm can improve their attractiveness to investors as a company with growth prospects is to improve their P/E ratio.⁹ Figure 2.2, for example, plots P/E ratios for mortgage specializing depositories against the KBW bank index P/E ratios. With the exception of Golden West, the P/Es of the other large mortgage specialists were well below the bank index P/Es for the 2001–2006 period. By comparison, the P/E ratios of major banks with significant mortgage businesses were more tightly clustered around the KBW index P/Es that ranged in the mid-teens for much of this period (Figure 2.3). Long-term survivability for some mortgage specialists with lower than average P/Es was questionable. The market may have been signaling that the growth prospects of mortgage specialists might not be attractive relative to other more diversified financial services companies.

Lower P/E ratios made these firms appear cheaper, meaning that they were takeover targets. If executives could not earn a higher return on invested capital, they would be replaced through a takeover by executives who could. This message was consistently and convincingly hammered home by Wall Street analysts to every increasingly anxious CEO and CFO. Taking the growth strategy to extremes, the largest thrift in the U.S., WaMu, grew significantly through acquisition in the years preceding the crisis with management attention given to improving stock performance as evidenced in the following observation:

Figure 2.3
P/E Ratios of Major Banks with Large Mortgage Businesses



Source: Bloomberg data.

“WaMu’s acquisition spree, along with its plan to open branches in metro areas from coast to coast, was meant to transform the stodgy Northwest thrift into a national consumer-banking powerhouse. And it worked, for a while. By 2002, WaMu was the sixth-largest financial institution in the country. The stock hit its all-time high of \$46.55 on Nov. 23, 2003.”¹⁰

That Golden West exhibited relatively strong P / E performance over the period is notable for a couple of reasons. A thrift institution focused on the West Coast market and largely California, Golden West exhibited for a number of years a host of strong risk management and operational controls that allowed it to enjoy an extended period of low credit losses over different economic conditions, low interest rate risk and a high level of efficiency. Golden West featured neg-am mortgages prominently in the firm’s originate-for-portfolio strategy, taking such precautions as marketing these loans to creditworthy and financially strong borrowers. In addition to tight underwriting controls, its reliance on in-house appraisals also allowed Golden West to control appraisal quality directly. Other large mortgage specialists with lower P/E multiples such as Countrywide, WaMu and IndyMac were drawn to option ARM products at that time.

Using a simple model of mortgage net income and standard relationships of ROE to P / E ratio for a firm, it is possible to demonstrate the tradeoffs facing mortgage lenders during this period. The P / E ratio for a company can be defined as follows:

$$\frac{P}{E} = \frac{DPR}{k - ROE(1 - DPR)}$$

where P = stock price, E = earnings per share, DPR = dividend payout ratio, k = market capitalization rate and ROE = return on equity.

Using a Modern Portfolio Theory approach, the objective function of the mortgage institution is to minimize the standard deviation of returns subject to a target portfolio ROE. This is defined below as:¹¹

$$\begin{aligned}
 &MIN \\
 &\sigma_p^2 = \sum_{i=1}^2 w_i^2 \sigma_i^2 + \sum_{i=1}^2 \sum_{j=1}^2 w_i w_j \rho_{ij} \sigma_i \sigma_j \\
 &st \\
 &ROE_p = \sum_{i=1}^2 w_i ROE_i \\
 &RC_p = w_i RC_i + w_j RC_j = 1 \\
 &0 \leq w_i, w_j \leq 1
 \end{aligned}$$

Where ρ is the correlation coefficient between prime and subprime loans, σ_i and σ_j represent the standard deviation of returns for both products and w_i are the weights associated with asset type i . The optimal allocation decision is not dependent upon the ultimate disposition of each asset. Specifically, this framework could be extended to decide whether to hold an asset for investment (HFI) or securitize and sell with no loss in generality of relative asset allocations. This best execution analysis would take into account other factors such as the relative cost of transferring the credit risk, contractual obligations and servicing costs, among other considerations beyond the scope of this study.¹²

To ease the exposition, assume an institution faces just two mortgage investment choices: either a prime (low risk) or subprime (high risk) loan. With the economic capital per dollar of asset for each investment denoted as EC_p and EC_s and regulatory capital for prime and subprime investments as RC_p and RC_s , the firm's ROE and risk-adjusted return on capital (RaRoC) would be defined for each investment:

$$\begin{aligned}
 ROE_p &= \frac{[R_p - EL_p - (1 - RC_p)i_d]}{RC_p} \\
 ROE_s &= \frac{[R_s - EL_s - (1 - RC_s)i_d]}{RC_s} \\
 RaRoC_p &= \frac{[R_p - EL_p - (1 - EC_p)i_d]}{EC_p} \\
 RaRoC_s &= \frac{[R_s - EL_s - (1 - EC_s)i_d]}{EC_s}
 \end{aligned}$$

where R_p and R_s are the per dollar revenues for each loan net of operating costs, EL_p and EL_s is expected loss per dollar of asset and i_d is the cost of debt. Note that a critical input to both formulas is capital, either regulatory or economic.

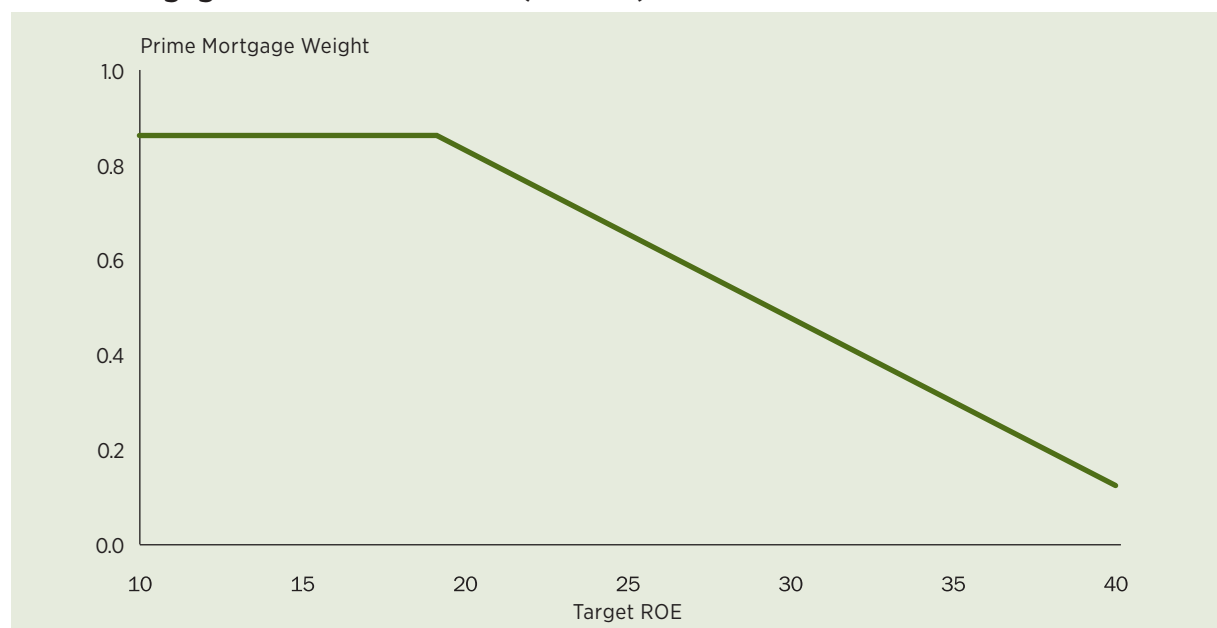
For the firm, it is well established that a higher ROE will generate a higher P / E ratio. However, faced with different product alternatives, a lender could easily make the wrong investment decision using an ROE-based framework where regulatory capital is binding over economic capital.¹³ Calem and Follain were able to demonstrate that in situations where regulatory capital exceeds economic capital for an asset, the firm's optimal decision is to reduce the share of this asset as leverage decreases and increase the share of assets where the capital requirement is nonbinding. While the focus of their analysis was on impacts from regulatory capital arbitrage among Basel II adopters and non-adopters, the approach can be adapted to explore allocation decisions between mortgage types for an individual institution. Regulatory bank capital standards for institutions did not sufficiently differentiate between the relative risks of different mortgage products such as prime and subprime loans. For example, the leverage ratio for both products of an adequately capitalized firm is 4 percent for a prime and subprime mortgage. However, the economic capital for each product could be quite different. Over the long-run, a prime mortgage might have economic capital levels lower than 4 percent while a subprime mortgage could exceed the leverage ratio. As a result, relying on an ROE definition that uses regulatory capital could yield much different portfolio strategies than a risk-adjusted return on capital metric that uses economic capital. To better understand the investment tradeoffs between metrics, a simple portfolio optimization model was developed. Key assumptions as well as products specific returns for this model are shown in Table 2.1.

Assuming the correlation between prime and subprime mortgages is zero as a baseline and varying target portfolio ROEs from 10–40 percent, the percentage allocation of the portfolio to prime mortgages is shown in Figure 2.4. As target returns are raised for the firms, the percentage of prime loans decreases, reflecting the additional return needed by the riskier product to achieve the desired level of return.

Table 2.1
Key Inputs and Product Returns

	Prime Mortgages Percent	Subprime Mortgages Percent
Coupon Rate	6.0	9.0
Cost of Debt	5.0	5.0
Expected Loss	0.5	2.5
Economic Capital	2.0	11.0
Regulatory Capital	4.0	4.0
Net Income EC	0.6	2.0
Net Income RC	0.7	1.7
Standard Deviation of Returns	1.5	3.5
ROE	17.5	42.5
RaRoC	30.0	18.6

Figure 2.4
Prime Mortgage Portfolio Allocation (Percent)



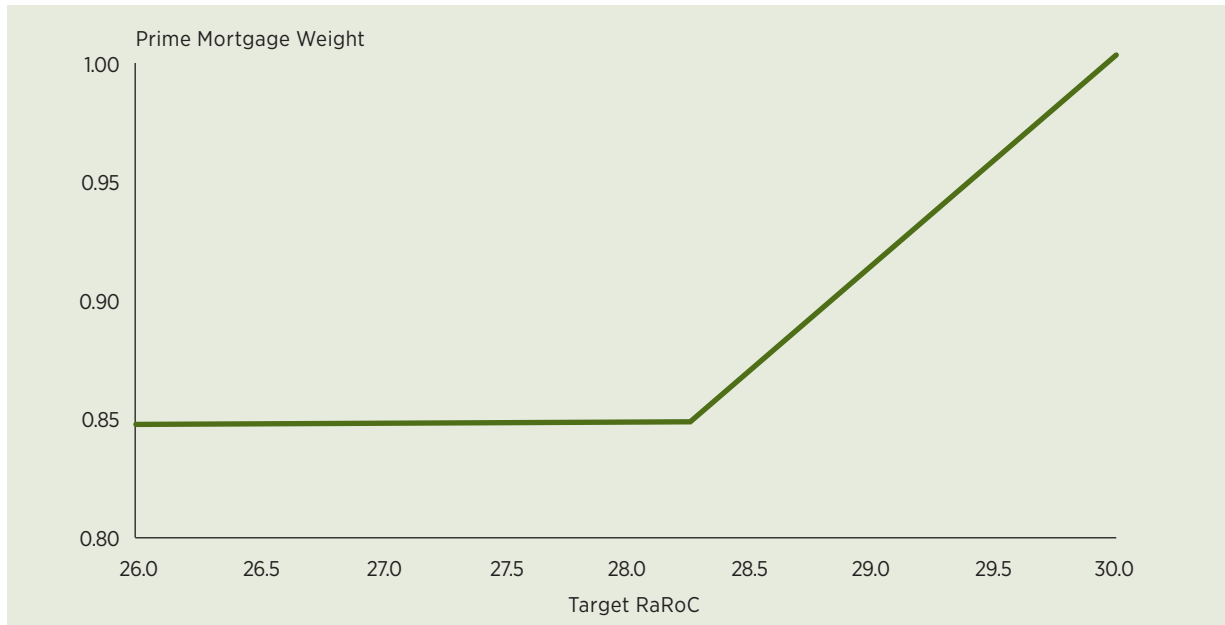
Switching to a RaRoC-based metric for portfolio allocation has dramatic effects on both the level of target returns and the allocation between investments as illustrated in Figure 2.5. Note that target returns above 30 percent using a RaRoC definition are not feasible based on the returns shown in Table 2.1. More important, however, note that the allocation to prime mortgages is higher, in the comparable range of 26–30 percent.

In this scenario, the allocation to prime mortgages rises with target RaRoC, reflecting the higher risk-adjusted return to these loans than to subprime. While the subprime loan carries higher net income (just over 2 percent) than the prime loan (0.6 percent), the economic capital allocated to subprime is 5.5 times higher for the subprime loan (11 percent) than for the prime loan (2 percent). Clearly, decisions based on a return measure that do not reflect risk capital will result in misleading and potentially higher risk portfolio allocations.

Compounding the potential for errors in portfolio allocation are empirically based results on other key assumptions such as expected loss and product correlation. As will be seen in Section 3, this simple portfolio allocation framework will demonstrate the impact data and model limitations can have on shaping portfolio allocation and basic risk management strategy.

That RaRoC measures have been around for many years poses the question of why didn't mortgage firms adopt the more accurate view of risk-adjusted return when developing their portfolio strategy? The simple answer is that developing reliable estimates of economic capital for mortgages is data and analytically intensive beyond the capabilities of all but the most technically sophisticated institutions.¹⁶ During the last decade, the largest banks were developing processes to generate risk-based capital results in response to regulator required Basel II standards. However, those models

Figure 2.5
Prime Mortgage Portfolio Allocation (Percent)



and requirements had not come on line for banks during the boom period of mortgage origination. Due to a lack of capabilities for developing economic capital-based models, largely due to poor data availability and the underlying complexity of such models, profitability measures tended to be simple ROE calculations, using regulatory required capital as the definition of capital. Thus, in the absence of risk-based capital requirements that differentiate mortgage risk by underlying risk attributes, a decision-making framework intended to maximize ROE and with it improve the attractiveness of the firm to investors led managers to make the wrong decisions on which loans to originate. Looking forward, mortgage lenders should abandon simple ROE-based metrics in favor of risk-adjusted return metrics. From an analytic perspective, this requires firms to invest in data and technologies allowing them to compute reliable estimates of economic capital. As will be seen next, such capabilities are not easily deployed.

Notes

9. P/E ratio is one of several metrics firms can use for equity valuation, and the results from the above discussion may be generalized across other measures such as earnings per share.

10. Drew De Silver, *Seattle Times*, "Reckless Strategies Doomed WaMu," 10/25/2010.

11. Replacing ROE with RaRoC and RC with EC in the equations provide the risk-adjusted return model scenario.

12. For example, differential risk weights between prime whole mortgage loans (50 percent) and mortgage-backed securities issued by the GSEs (20 percent) present other capital arbitrage opportunities for mortgage originators to sell GSE-eligible loans rather than hold on balance sheet.

13. To estimate economic capital, a credit loss distribution would need to be developed from the mortgage performance history and an estimate of unexpected loss could be made based on a management imposed tolerance for losses at some level of confidence.

14. Calem and Follain, "Regulatory Capital Arbitrage and the Potential Competitive Impact of Basel II in the Market for Residential Mortgages," *Journal of Real Estate, Finance and Economics*, (2007), 35:197-219.

15. In addition to a leverage ratio defined as the ratio of core capital to assets, banks were also subject to risk-based capital requirements, which applied broad weights (e.g., 50 percent for whole mortgages) against asset types. Basel II was not implemented for banks which over time has expanded the application of specific risk attributes to measure required risk capital.

16. In addition, the analytical complexity involved in developing estimates of economic capital can be challenging to put into understandable terms for nontechnical management audiences.

3. Data and Model Limitations

Ensuring that the proper metrics differentiating risks are applied in decision making is only one aspect of a process that enables a bank to mitigate excessive risk taking. Another is measuring expected and unexpected losses with some degree of accuracy. Such capabilities are highly dependent on having sufficient and accurate data to build these views of risk. Moreover, models used in isolation from other information such as that gathered from experienced underwriters from post-origination loan reviews can provide a level of over-confidence in the analytics that is unwarranted. Each of these issues will be explored in some detail to reveal insight into how banks viewed risks during the boom period and what steps can be taken to avoid these traps in the future.

To understand the importance of data and models to mortgage risk-taking, consider again the simple portfolio allocation decision framework from the previous section. Two specific examples illustrate how management could come to decisions that result in non-optimal risk taking. In the first example, the impact of product correlation assumptions is demonstrated. The second example focuses on how model-based loss estimates can contribute to different product allocations.

Understanding the correlations between products is clearly important to portfolio allocation even if a formal optimization exercise is not used by a firm. Mortgage product correlations can differ due to the tenor of the underlying asset, geographic location and other features. For example, the value of a fixed-rate 30-year mortgage will generally be more sensitive to changes in interest rates than a short-term ARM, simply due to differences in interest rate risk profiles. Also, loan performance can and will vary depending on the local housing market and may have countervailing portfolio effects. Home prices in southern California, for example, could experience a decline at the same time mortgages in Indianapolis may hold steady or increase. In that case, asset correlations may tend to be negative, and in the portfolio optimization decision framework, that would tend to favor a diversified portfolio. To some extent, the product itself could be closely associated with a specific region of the country, such as option ARMs on the West Coast which would accentuate the geographic correlation effect. Over time, the assumption (presumably based on some empirical information) that products generally exhibit negative correlation

could lead to different decisions than if correlations were zero or positive. One of the defining features of the recent mortgage crisis was the fact that mortgage markets across the country experienced a systemic downturn. Normally, some markets tend to underperform at the same time others perform well or remain flat. The systemic mortgage crisis introduced positive correlations.

To illustrate the impact of correlation changes on portfolio decisions, consider three alternative correlation scenarios: –0.5 percent, 0 percent, and +0.5 percent. Varying target ROEs and RaRoCs in the same ranges as before, the following tables provide results of the correlation sensitivity analysis to product portfolio selection. Not surprisingly, as correlations between prime and subprime mortgages move in a positive direction, the tendency would be to allocate more of the portfolio to prime mortgages. Focusing attention on understanding the potential for structural changes in housing markets that could result in sudden shifts in asset correlations would be of major importance to ensuring more accurate portfolio decisions are made.

Similarly, the impact of errors in expected losses (as well as estimates of economic capital) clearly could affect returns as well as portfolio allocation. To illustrate this, assume that the target ROE is 22 percent and the product correlation is –0.5. Assuming expected losses of 0.5 percent and 2.5 percent for prime and subprime, respectively, the allocation to prime mortgages is 75.3 percent. If instead, expected losses are 50 percent higher, then the allocation to prime mortgages turns out to be 89.3 percent. The difference in allocations reflects the shift in relative ROE between products as a result of the much higher effect of the loss multiple on subprime expected losses. The simple assumption that

Table 3.1
Prime Mortgage Allocation Sensitivity to Changes in Asset Correlation (ROE-based)

Target ROE (Percent)	ρ	Prime (Percent)
10	–0.5	75.3
	0	84.5
	0.5	100.0
15	–0.5	75.3
	0	84.5
	0.5	100.0
20	–0.5	75.3
	0	84.5
	0.5	90.0
25	–0.5	70.0
	0	70.0
	0.5	70.0
30	–0.5	50.0
	0	50.0
	0.5	50.0

Table 3.2
Prime Mortgage Allocation Sensitivity to Changes in Asset Correlation (RaRoC-based)

Target RaRoC (Percent)	ρ	Prime (Percent)
26	-0.5	75.3
	0	84.5
	0.5	100.0
28	-0.5	82.4
	0	84.5
	0.5	100.0
30	-0.5	97.8
	0	97.8
	0.5	100.0

losses increase proportionately across the two products could also be relaxed, in which case expected losses on products with heavy risk layering and limited historical experience could result in higher loss multiples than prime loans. While this example is illustrative only, it points to the importance that data and models have on providing a reasonable approximation of mortgage losses over time.

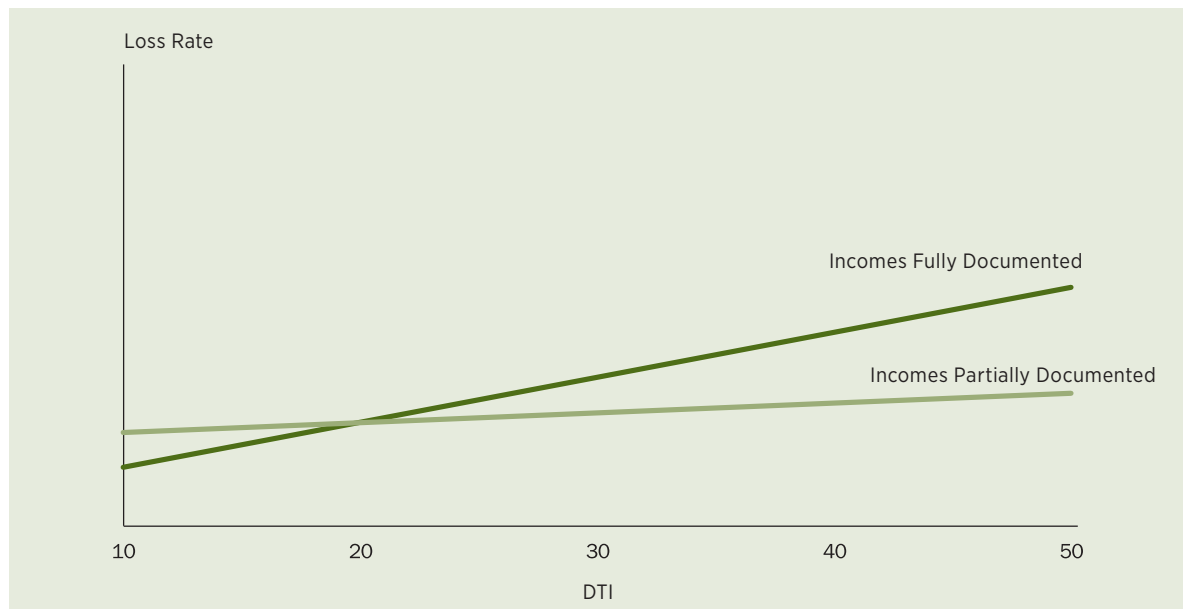
Data Integrity

Access to the right data is perhaps one of the most challenging exercises in model development. Mortgage firms that grew through acquisition faced challenges of data integration across platforms that are more complex than for firms that grew organically. Nevertheless, all firms face issues with data integrity and the recent past has exacerbated this problem. For instance, the proliferation of stated documentation programs, wherein incomes were no longer verified, have spillover effects into other variables of interest such as debt-to-income ratio (DTI). A simple example illustrates this concern. In Figure 3.1, the statistical relationship between mortgage loss and DTI is depicted as the solid line. Once mortgage standards allow borrowers to state their incomes, the likelihood of understating DTI tends to dampen the resulting statistical relationship as higher income borrowers (lower DTIs) exhibit higher default rates due to the fact that this group's data are tainted by those overstating their incomes. This can effectively wash out the DTI effect altogether in terms of statistical importance or at least reduce its contribution to explaining default. Similar effects are associated with other variables such as occupancy type.

Further compounding errors was the inability of the data or the models to pick up the increase in mortgage fraud that became prevalent during the period. Suspicious Activity Report filings (SARs) rose 870 percent between 2002 and 2008.¹⁸ Contributing factors to the significant rise in filings include repurchase and buy-back demands, insurance claims and foreclosures and early defaults.

Figure 3.1

Relationship of Loss to DTI under Alternative Income Documentation Standards (Percent)



The importance of accurate and representative data to identify, measure and manage risk cannot be overstated. In fact, the lack of good data severely handicaps risk management teams and can lead to disastrous results. Mortgage firms should strive to establish systems and data warehousing capabilities that produce a consistent set of loan-level data that can be aggregated across various sub-portfolios quickly. Even with Basel II, some models used for determining regulatory risk-based capital are limited to a handful of risk factors in a concession to consistency in measurements across the portfolio. This could greatly limit the ability to understand critical risk drivers that impact performance over time. For many mortgage firms that grew by acquisition, platform integration issues resulted in opaque balance sheets and clouded measures of risk exposure. For example, well before its failure, it was known that WaMu had not done an effective job at system integration across the businesses it had acquired.¹⁹

Beyond the technical infrastructure requirements associated with data management lie other potential pitfalls for risk management teams faced with managing the risk of new product offerings. First, as new products and risk attributes are combined, historical mortgage performance may not be reflective of future performance even controlling for macroeconomic factors. And as market conditions change they can also introduce parameter instability into default estimates. For example, Deng, Xudong, Yao and Rosenblatt developed default models using 2003-originated subprime loans to predict default performance of 2006 subprime loans.²⁰ They found that their models under-predicted defaults of the 2006 cohort by as much as 40–45 percent. Further, they found that the actual default rates of the 2006 loans were four times greater than what was predicted using the 2003 data. For risk management modeling groups, reliance on statistical analysis during a period of significant structural changes required a great deal of vigilance around fine-tuning and updating risk models. Lang and Jagtiani also concluded that heavy over-reliance on backward-

looking statistical models not augmented by qualitative factors led many modelers astray.²¹ Even where model performance is tracked periodically, the lag in observing mortgage default outcomes poses challenges to maintaining model accuracy.

One notable example of where this has occurred is with the credit rating agencies. S&P for example has recently revised a new set of risk multipliers for mortgages across a wide number of risk attributes, acknowledging that its previous estimates required significant updating based on the latest performance data.²² In their study they assert, for example, that interaction effects between FICO and LTV are now taken into account, reflecting the nonlinear relationship of these variables. Unfortunately these model updates came far too late in the assessment of risk for these firms, for the mortgage industry and for investors.

It should be noted that Fannie Mae and Freddie Mac were widely acknowledged to have the best data, in terms of having long-time series on characteristics and performance, substantial quality control efforts to ensure accuracy of these data and construction and maintenance of research data warehouses that facilitated advanced analytics. However, given the magnitude of their losses, it is clear that good data and analytics are necessary but not sufficient conditions for survival. Other forces such as management attitudes about risk taking and inherent biases toward uncertainty and market conditions at the time appear to have been at work as will be seen in Section 4.

Economic Environment

Beyond changes in underlying risk parameters, another contributing factor to default model inaccuracy was the relatively benign economic environment from which to draw meaningful inferences of stress losses. The period leading up to the crisis was marked by relatively low interest rates, strong employment and, as it turned out, abnormally high home price appreciation across most of the country. Models using such macroeconomic conditions as key inputs to explain mortgage default and prepayment were biased toward lower loss estimates as a result. Recent research by Anderson, Capozza and Van Order decomposes the contribution of economic conditions and changes in underwriting quality on mortgage foreclosures. They claim that economic conditions such as low interest rates and strong home price appreciation significantly masked the underlying risks building up over time. They found that isolating for these factors, the secular decline in underwriting in general between 1990–2004 would have caused about a four times greater rate of foreclosure by 2004 than what materialized. And their findings extend to the 2005–2007 period as well.²³

Beyond affecting the parameter estimates of default models, the period of abnormally strong economic conditions greatly distorted underlying stochastic processes of home prices and /or interest rates used to simulate different loss outcomes. Figure 3.2 provides a stylized representation of the results from 10 simulations of home price changes over time. The underlying drivers of the stochastic processes include drift and volatility parameters that are usually specified from

some historical period of interest. For instance, a simple model of house price changes could be represented by the following expression:

$$\frac{\Delta HPI}{HPI} = \mu \Delta t + \sigma \varepsilon \sqrt{\Delta t}$$

Where HPI represents the house price change index, μ is the drift rate of home prices, σ is the volatility of home prices, t represents time and $\varepsilon \sqrt{\Delta t}$ represents the stochastic process describing how house prices change over time. Clearly, if the drift and volatility parameters are based on a period of strong home price appreciation across most markets, the result could be a set of simulated house price paths that are more tightly clustered, with the implication that estimates of mortgage tail events could be much lower than realized over time. This is illustrated in Figure 3.2 as the difference between the solid and dashed lines. The solid line indicates a general softening in home prices over time as reflected by a set of house price parameters based on a more favorable period of appreciation than one indicated by the dashed line, where greater path dispersion and more negative scenarios could lead to a more pessimistic outlook.

Mortgage Products and Risk Layering

Technological advances such as statistically based automated underwriting created the ability to instantly parse the individual contributing risk factors to loan default. As the demand for nonprime mortgages ratcheted up and GSE market share waned, changes in the definition of prime mortgages took shape (Figure 3.3). Prime mortgages had typically been defined as meeting the underwriting guidelines of Fannie Mae and Freddie Mac. But in the years preceding the mortgage crisis, the GSEs

Figure 3.2
Illustrative 10 Path HPI Simulation on Path Dispersion

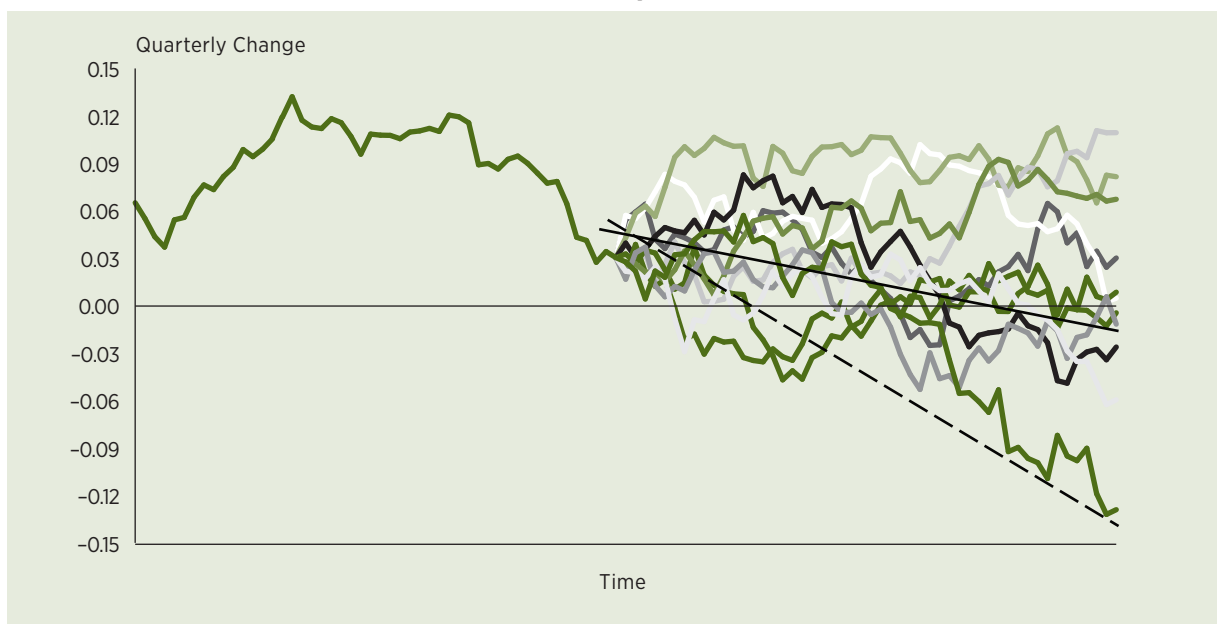
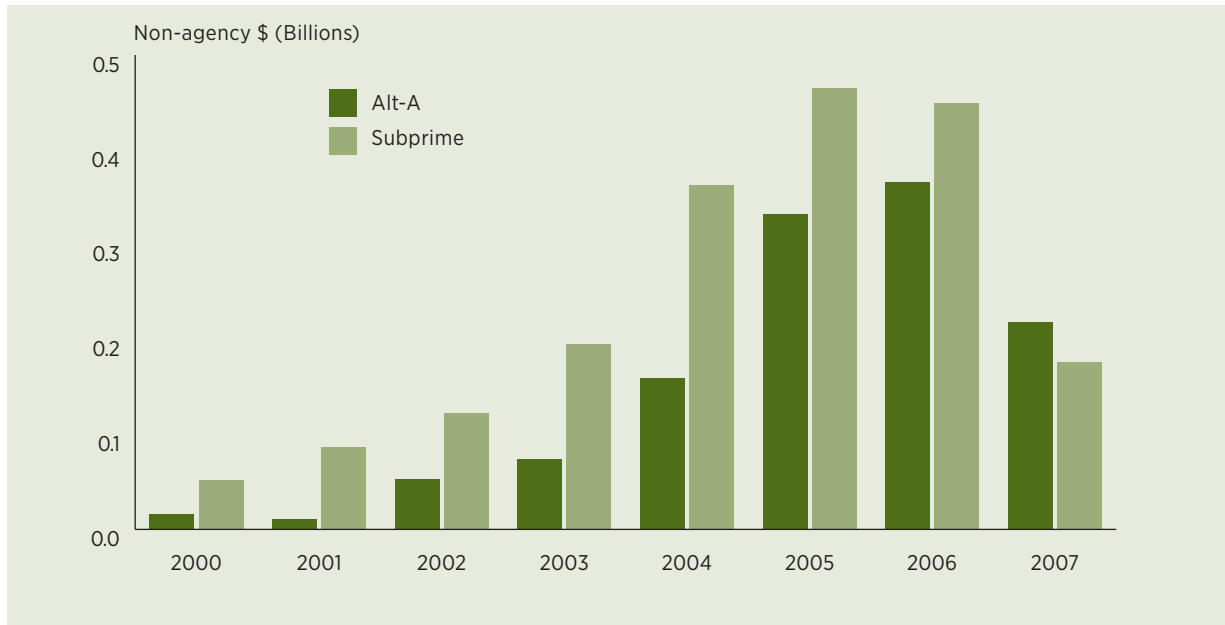


Figure 3.3
Number of Subprime and Alt-A Originations by Cohort Year



Source: GAO analysis of LP data.

loosened their underwriting standards and stepped down the risk spectrum into loans with risk characteristics just beyond prime or A-quality that over time became known more generally as Alt-A products. Fannie Mae's Expanded Approval program exemplified their efforts to enter this segment of the mortgage market. Because no single attribute could precisely define an Alt-A mortgage, a variety of definitions abounded. Typically an Alt-A loan had some form of reduced documentation, lower credit scores and/or higher LTVs along with other risk factors that were outside general agency guidelines.

One important outcome for risk management was that as underwriting standards changed, it limited the ability of prior mortgage experience to explain default. In other words, as lenders began expanding the risk envelope, historical performance could no longer be relied upon as ultimately predictive of future loan performance. One good example is negative amortizing (neg-am) mortgages. These loans had been in existence for two decades or more in states such as California, initially marketed to financially savvy borrowers who were looking for financial flexibility in their liabilities to better align with their income streams. But lenders originating neg-am ARMs began mass marketing the products to segments less able to understand and manage the risks of these products. Thus, utilizing neg-am performance from previous origination cohorts to explain the expected losses on mass marketed neg-ams would not reflect the risks of what were essentially new products. Beyond that issue, the impact of one of the riskiest features of these loans, namely ARM reset that could lead to payment shock was difficult to tease out of the historical data. For one, interest rates over the estimation periods during which the new neg-ams were originated remained relatively low, reflecting monetary policy of the time period. As a result, statistical inferences on payment shock were usually augmented with adjustments to risk

factors specified in the models based on what-if style sensitivity analysis for lack of additional data for historical statistical modeling purposes. The relationship of changes in interest rates and default were muted during this period, hence the limited ability of any statistical estimate to accurately capture the effect of payment shock.

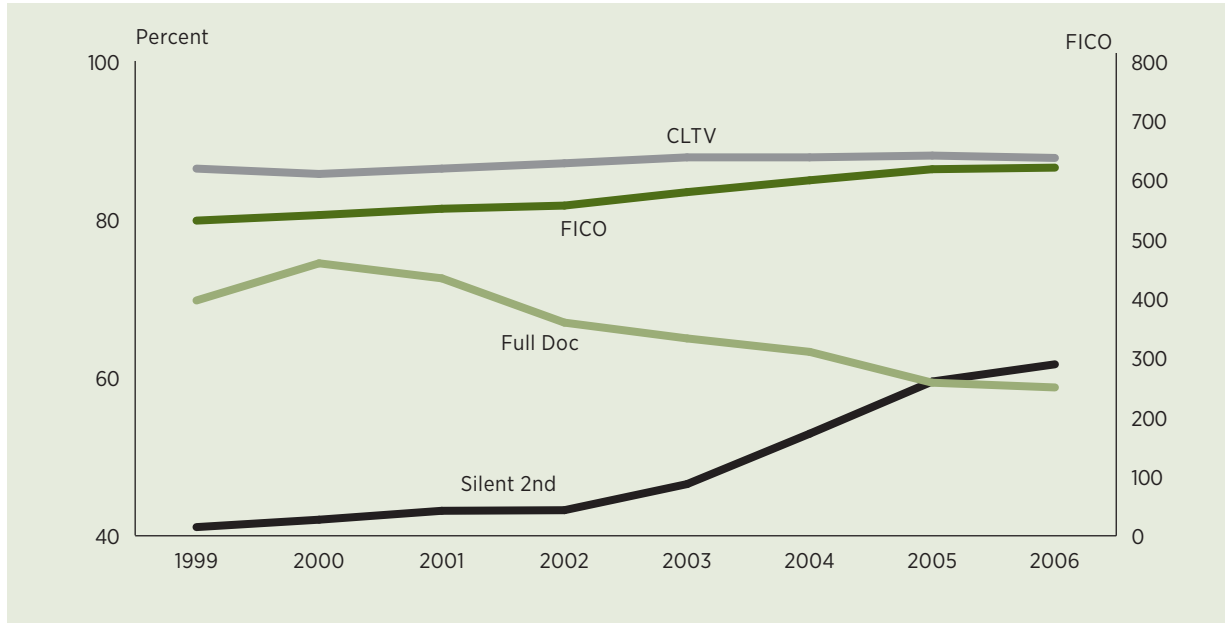
An important development that would exacerbate losses eventually for lenders was the sharp rise in risk layering. Risk layering is simply the practice of combining risky elements of a borrower's profile in the underwriting process and allowing them to be deemed acceptable credit quality. As underwriting standards deteriorated, significant changes were introduced both in the composition of mortgage characteristics and the underlying consumer behavior, so that traditional relationships did not reflect the performance of the new products being originated.

To demonstrate the concept of risk layering, consider two ARM mortgages. The first is a standard 5/1 hybrid ARM underwritten to a borrower with a 700 FICO, 80 percent LTV, 35 percent DTI and a loan amount of \$400,000. Furthermore, the borrower is a wage earner that produces W-2 statements and so is able to fully document their income. The second loan is an option ARM, but in this instance it is for a loan amount of \$1,000,000, the borrower has a FICO score of 640, the first lien mortgage has an 80 percent LTV and a piggyback HELOC is added for an additional 10 percent. The borrower, while still salaried, elects to take advantage of a streamline documentation program and state their income and assets. Finally, the borrower is qualified at a 35 percent DTI based on the teaser rate of 1 percent, but their actual DTI is 50 percent if the contractual note rate is used to qualify. Clearly, based on the individual risk characteristics of the loans, the second loan exhibits a much higher default propensity. The combination of reduced FICO together with a simultaneous second lien, a higher loan amount and stated income, stated asset documentation presents incremental default risk beyond the individual risk factors. Even if both loans were assumed to be option ARMs, the historical data would not have been able to pick up the interaction of the incremental risk across attributes. As a result, the combined risk of this new and riskier segment adds a measure of risk beyond those individual factors alone.

As depicted in Figure 3.4, subprime loan underwriting criteria along several risk dimensions expanded between 1999–2006. In particular, combined LTVs (CLTV) increased over time as the percentage of loans with silent second liens attached to the property also increased. At the same time, the percentage of loans with full documentation declined. The combination of these factors relaxing over time illustrates the evolution of risk layering during the mortgage boom. An analysis by Fitch illustrates the impact of risk layering on delinquency for specific product segments such as subprime (Figure 3.5), however, it was pervasive across product types.

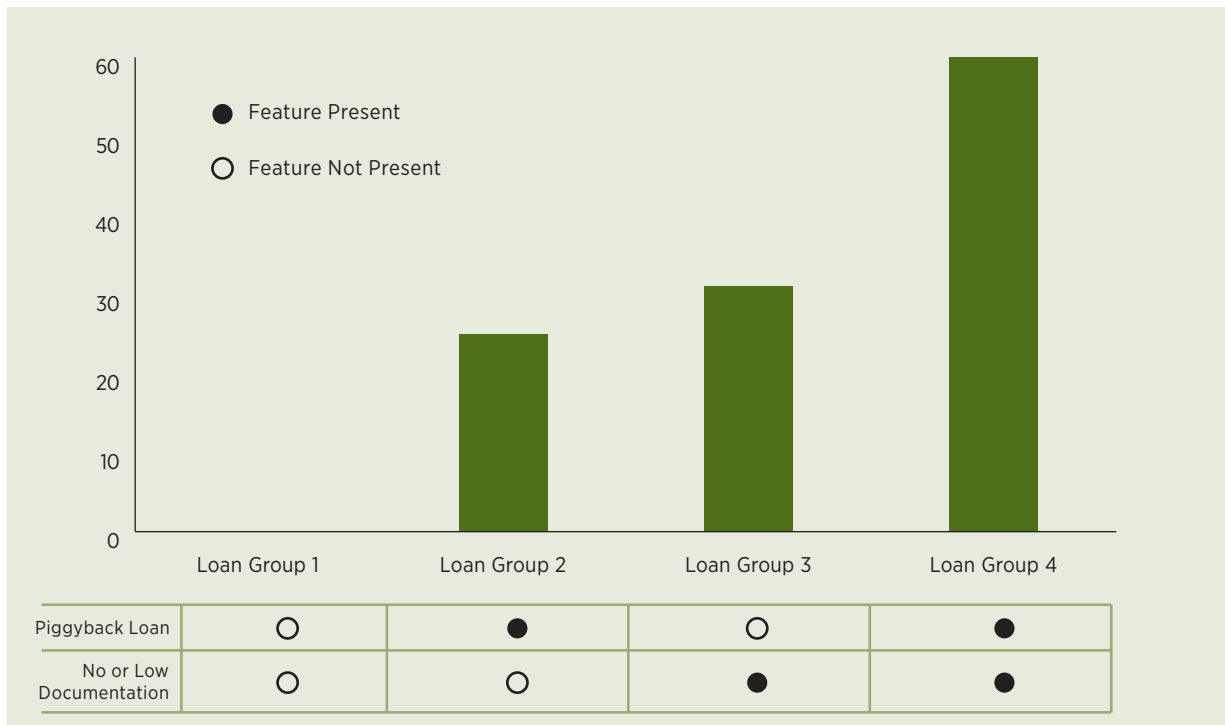
Again, part of the problem is that relaxation of underwriting effectively creates a new product type that has little to any historical performance against which to assess long-term credit risk. In the case of option ARMs, although products such as neg-am COFI ARMs had been in place for many years, particularly on the West Coast, these products had traditionally been marketed to

Figure 3.4
Underwriting Characteristics of Subprime Mortgages



Source: Loan Performance Data 2007 as reported in Ashcraft and Schuermann, 2008.

Figure 3.5
Relative Increase in 60+ Delinquency (Percent)



Source: Fitch Ratings.

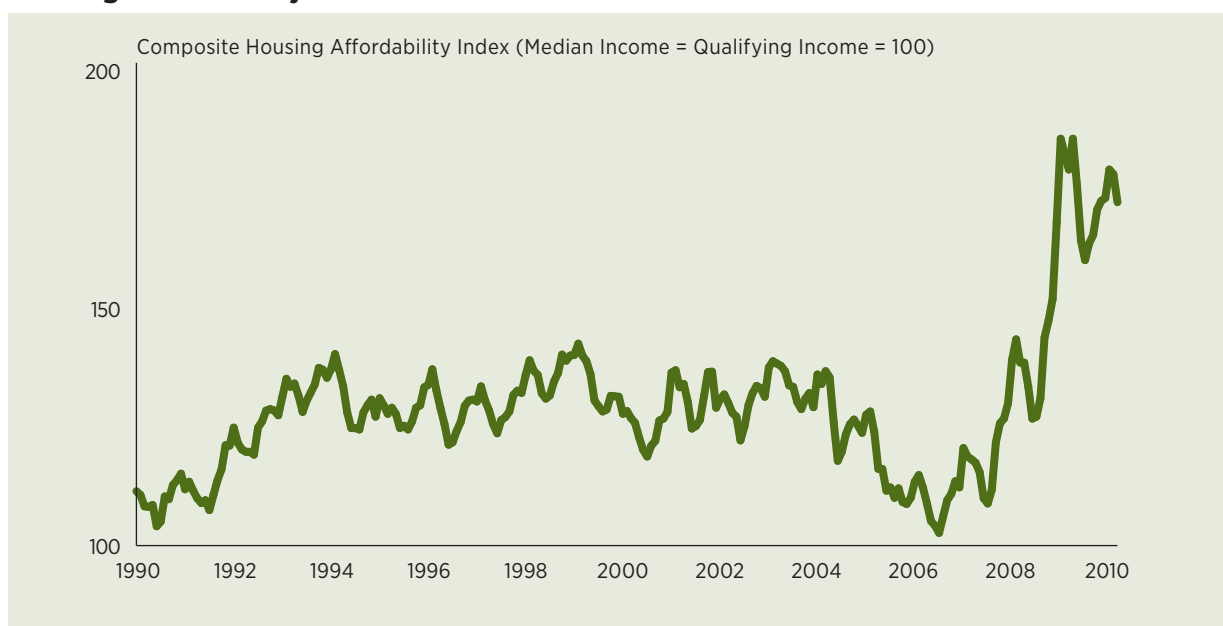
more financially sophisticated borrowers. An option ARM can in fact be an effective product for borrowers who value financial flexibility, but more importantly demonstrate their ability to handle and manage this additional product complexity. As products such as option ARMs grew in their attractiveness to lenders over time, mass marketing of such mortgages undermined the product's performance as it became more an affordability product rather than one offering flexibility to well-heeled borrowers with specialized financial needs. The danger was this transition into a product for broad application.

Fueling the movement toward greater risk layering was the affordability problem. As reported by the National Association of Realtors, the trend in the Housing Affordability Index leading up to the crisis had steadily declined, suggesting that the median income borrower was not able to keep pace with the costs of homeownership over time until the latter part of 2006 (Figure 3.6).

As investor appetite for mortgage securities rose through this period, and as resulting product offerings took various forms, these market changes artificially boosted home prices, further putting pressure on lenders to find product combinations that could help borrowers get into increasingly costly homes.

An important lesson to come out of this period is that risk layering creates a gap in understanding the long-term risk profile of these new product combinations and in effect morphs a standard product into something altogether different. With that in mind, risk managers armed with little empirical basis to generate reliable estimates of the incremental risk posed by risk layering must rely on alternative ways to gauge and manage risk taking. One such way is to develop early warning measures of the level of risk in the portfolio or in originations.

Figure 3.6
Housing Affordability Trends

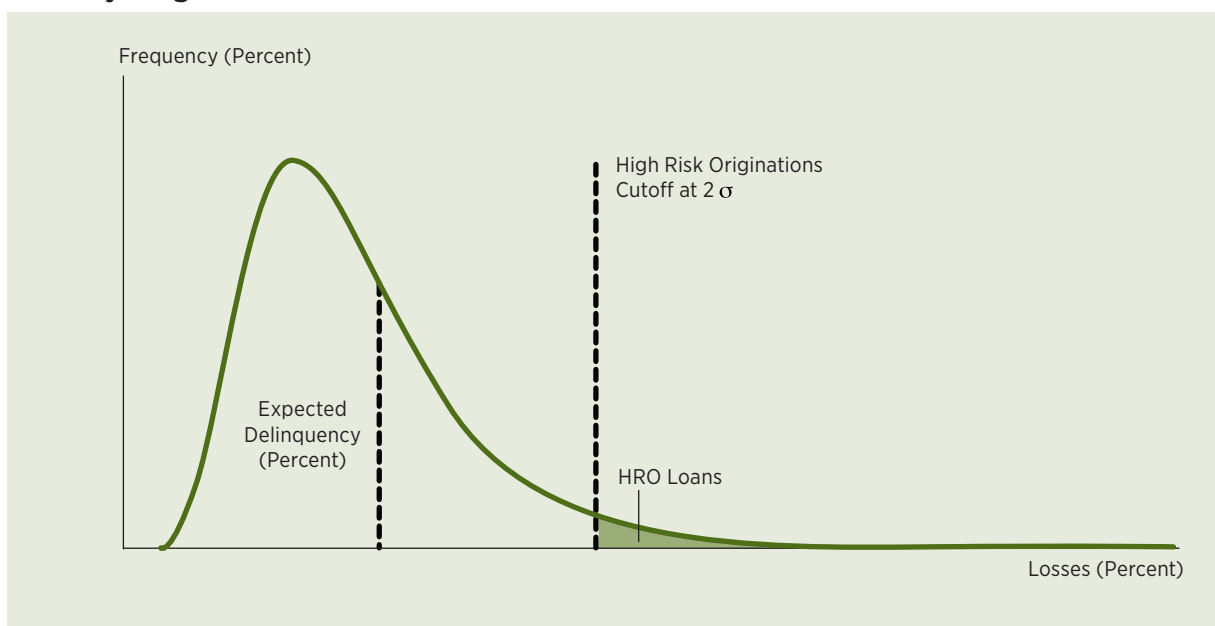


Source: National Association of Realtors.

To illustrate the concept, assume that a mortgage lender originates on average 1,000 loans per month and has developed or licensed an underwriting scorecard that estimates expected delinquency rates for each mortgage based on each loan's risk attributes. Based on the earlier discussion, even the underwriting scorecard or default model will be unable to pick up the incremental risk of specific risk combinations; however, it will be able to assess the direction and level of overall risk for new originations and the portfolio over time. Suppose in each month, we estimate the average expected delinquency rate on new originations as 100 bps (this could be on an annualized or cumulative basis). Having an estimate of the delinquency propensity for each loan allows the risk manager to generate a monthly distribution of the delinquency profile of the originations. With that distribution, we can estimate the concentration of high risk assets amassing in originations and /or the portfolio over time. Define high risk originations (HRO) as loans that have expected delinquency rates that are X standard deviations over the average expected delinquency rate. Assume HRO loans are defined as having expected losses two standard deviations above the average and that turn out to be associated with loans having expected delinquency rates over 300 bps. In any given month, therefore, we might find that out of 1,000 loans five percent meet the HRO definition based on historical experience. Typically, the distribution of mortgage delinquency is not the traditional normal distribution but rather skewed toward the right in the manner illustrated in Figure 3.7.

The shaded area signifies the percentage of that month's originations that are designated high risk. Loans meeting this definition would typically consist of loans with the highest combinations of risk. While the measure of HRO does not indicate the actual delinquency rates observed on the originations, it does provide an indicator of origination mix risk changes that can be tracked easily each month and compared against historical HRO levels. Ideally, the risk manager would create a time series of HROs from its production to establish a baseline indicator. Assume that over the last five years, the

Figure 3.7
Risk Layering: A Loss Distribution View



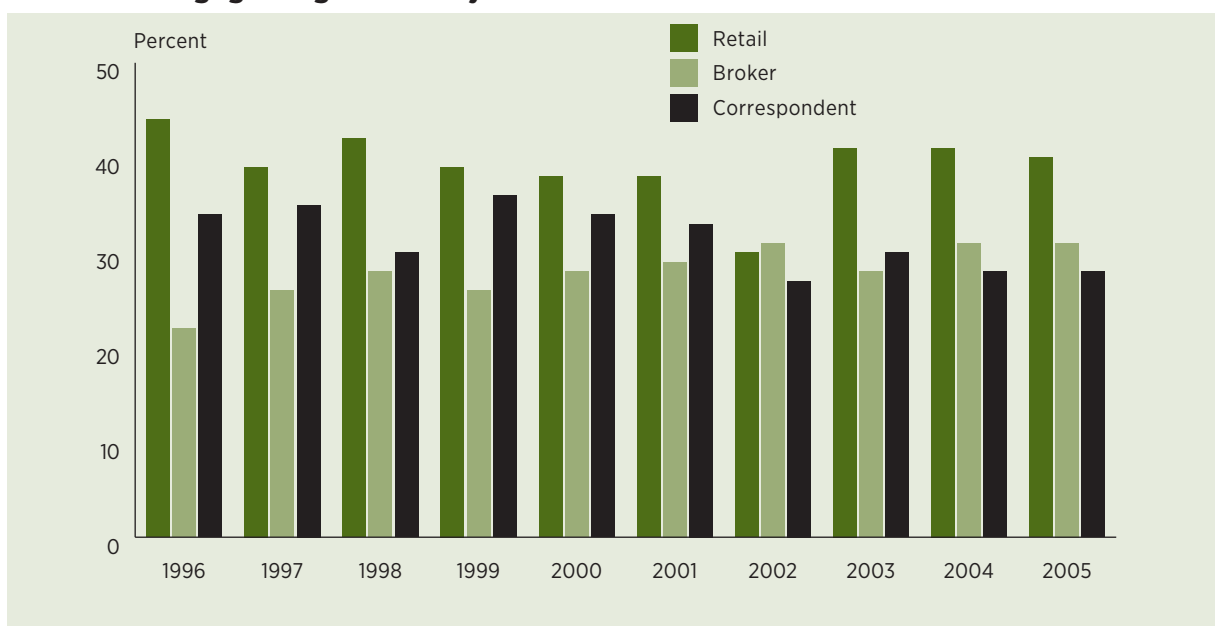
percentage of HRO loans originated each month has been tightly clustered around five percent. A range of four to six percent could be implemented for the coming year such that any movements away from this range would trigger a deep dive analysis into important drivers explaining those trends. Trends showing percentages of HRO in excess of six percent could be a signal that product channels may be experiencing some adverse selection as mix risk increases, which could lead to tightening of various product underwriting characteristics in order to ensure that the HRO percentage comes back in line with expectations.

This approach to managing the origination pipeline can also be applied to the portfolio and can easily be applied to product sub-segments such as first and second liens. Further, such a metric is easy to explain to the business, is based on empirical analysis, easy to implement and easy to take action against. While the HRO metric is characterized as a delinquency measure, it could easily be adapted into an expected loss result by incorporating loss severity into the calculations.

Borrower and Counterparty Behavior

While retail channels of mortgage firms during the decade leading up to the mortgage crisis continued to comprise the largest percentage of originations, the growth of correspondent and broker originations during this period was apparent (Figure 3.8). From 2001–2007, broker-originated mortgages accounted for about a third of all originations. As demand for mortgages increased over the past decade, a number of lenders began sourcing loans through channels other than their retail branches. These included mortgage brokers and correspondent lenders. In addition, several lenders grew their business by purchasing loans in bulk. Much has been written in the popular press recently on anecdotal examples

Figure 3.8
Share of Mortgage Originations By Production Channel



Source: *Inside Mortgage Finance*, MBA calculations.

of higher incidence among brokers of underwriting deficiencies and fraud than in retail originations, and there have been a few empirical studies of this issue that stretch back a decade or more.

Not surprisingly, third-party originated loans (TPO) are riskier than retail channel loans controlling for all other loan risk characteristics. A study conducted by Jiang, Nelson and Vytasil found that broker-originated loans had delinquency rates 50 percent higher than those of retail-originated mortgages. Further, they also found that three-quarters of this difference in performance was due to borrower loan characteristics. The remaining 25 percent of the difference in delinquency between retail and broker origination was attributed to unobserved heterogeneity, or effects not otherwise attributable to specific factors in the model. The researchers contend that this could be evidence of greater adverse selection potential by brokers. Jiang, Nelson and Vytasil claim that the incentive structure for mortgage brokers created a classic principal-agent problem where brokers were compensated to originate loans on behalf of a mortgage lender but did not bear any risk associated with the loan after it was originated.

As it relates to mortgage risk management, the statistical finding that TPO channels posed higher risk was known and built into default models and had the potential for being priced for in upfront fees. While origination channel is a factor that technically could be subject to a concentration limit, the practical business reality of imposing a hard limit on the share of broker originations was hard to digest for business managers who were looking to grow their business. A softer and still effective approach to managing TPO risk is to screen the quality of TPOs according to some metrics such as loss history, putback rate, profitability over some period of time and other criteria. One issue that arises with TPO screening processes is the business discussion that ensues when a business partner must be informed that they are being turned away or that only higher quality business will be bought by the lender.

The strong relationship between negative equity and mortgage default is well established in mortgage literature. Increasing evidence of so-called strategic defaults on mortgages adds another dimension to the problem of estimating mortgage defaults using historical data. One study found, for example, that following the crisis, more than a quarter of all defaults were characterized as strategic in that the borrower made a choice to default rather than continue to pay on an upside-down loan.³² Further, of those surveyed in this study that knew of someone who had strategically defaulted on their mortgage, 82 percent were more likely to default on their own loan. The social stigma of mortgage default would be one factor considered by a borrower in weighing the prospect of walking away from a home. Media effects that have recounted individual stories of borrower distress as well as the extent of the foreclosure trauma experienced across the country may be a factor in promoting greater defaults and softening the social cost of default.

Other evidence supporting a shift in borrower attitudes toward default can be seen in a recent study of borrower payment hierarchy by TransUnion.³³ In their study, TransUnion found that in 2008, the percentage of borrowers who were delinquent on their mortgage but current on their credit card account exceeded those who were current on their mortgage but delinquent on paying their credit card. This

trend provides critical insight into borrower behavioral changes toward the mortgage payment. In prior studies, the mortgage payment tended to be the debt first paid by consumers, reflecting in part the emotional tie the borrower has with their home. But as down payments declined leading up to the crisis and as home prices fell afterward, the degree of negative equity in the property, combined with media effects may be tilting the internal calculus of borrower default toward turning in their keys. This may be one of the most insidious unintended consequences of the mortgage crisis and the subsequent policy response, and will further undermine the accuracy of loss estimates based on historical data.

Issues with data and models described in Section 3 caught many risk management teams by surprise, despite their efforts. Advances in computer hardware and software for processing enormous loan level databases and sophisticated quantitative credit models could not ensure accuracy of loss estimates. To some degree, the growing emphasis on quantifying credit risks using rigorous statistical methods may have eroded the effectiveness of more mainstream qualitative information such as insights gathered from quality control groups, credit portfolio management and appraisers. In some sense, an over-confidence in models and methods during this period underscores the need for balance in the use and integration of qualitative and quantitative-based risk techniques.

Notes

17. In this case, due to differential pricing between investor-owned and owner-occupied properties, some borrowers may claim they are owners rather than investors to avoid the higher upfront fees imposed.

18. FINCEN, Filing Trends in Mortgage Loan Fraud, February 2010.

19. Shawn Tully, Fortune, “What Went Wrong at WaMu.” “Washington Mutual built itself into America’s biggest mortgage bank almost overnight. But this year, POW! Profits are getting hammered, and the CEO is apologizing to Wall Street,” August 9, 2004.

20. Deng, Xudong, Yao and Rosenblatt, “Model Stability and the Subprime Mortgage Crisis,” working paper, June 2009.

21. Lang, William W., and Julapa A. Jagtiani, “The Mortgage and Financial Crises: The Role of Credit Risk Management and Corporate Governance,” *Atlantic Economic Journal*, 2010.

22. Standard and Poor’s, “RMBS: Methodology and Assumptions for Rating U.S. RMBS Prime, Alternative A and Subprime Loans,” September 2009.

23. Anderson, Capozza and Van Order, *Deconstructing a Mortgage Meltdown: A Methodology for Decomposing Underwriting Quality*.

24. Hull, John C., *Options, Futures, and Other Derivatives*, Pearson Prentice-Hall, p. 259, 7th edition, 2008.

25. Fannie Mae, 2009 Third Quarter Credit Supplement, November 5, 2009. Freddie Mac, Third Quarter 2009 Financial Results Supplement, November 6, 2009.

26. Mark Adelson, Nomura Fixed Income Research, “A Journey to the Alt A Zone,” June 3, 2003.

27. As reported in GAO, Home Mortgage Defaults and Foreclosures, Recent Trends and Associated Economic and Market Developments, Briefing to the Committee on Financial Services, U.S. House of Representatives, October 10, 2007.
28. LaCour-Little, Michael and Gregory H. Chun. "Third Party Originators and Mortgage Prepayment Risk: An Agency Problem?" *Journal of Real Estate Research*, 17 (1999): 30. 55–70 and Anshasy, Elliehausen, and Shimizaki, "Mortgage Brokers and the Subprime Mortgage Market."
29. Jiang, Nelson, and Vytlačil, "Effects of Origination Channel and Income Falsification on Mortgage Delinquency."
30. Putbacks refer to loans that subject to post-origination quality control review have deemed to be deficient from an underwriting quality standard by the lender and hence are put back to the lender under standard rep and warrant terms.
31. TransUnion, 2010, TransUnion Payment Hierarchy Study, 2010.
32. Guiso, Sapienza and Zingales, *Moral and Social Constraints to Strategic Mortgage Default*, July 2009.
33. TransUnion, 2010 *TransUnion Payment Hierarchy Study*, 2010.

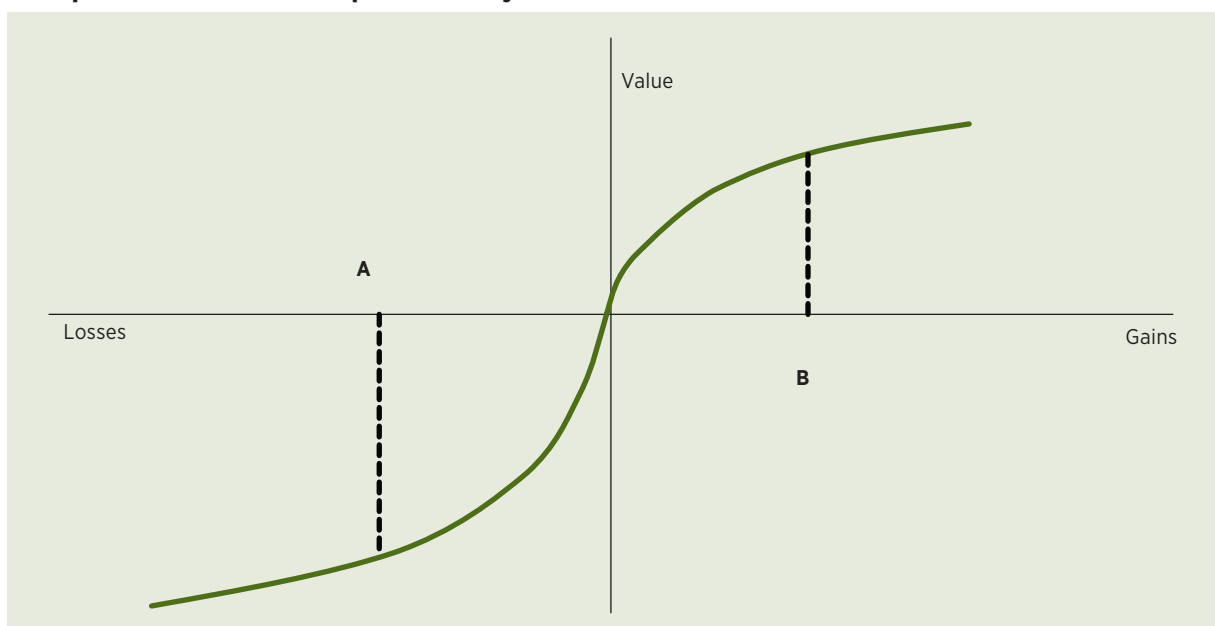
4. Governance, Corporate Culture and Risk Taking: A Behavioral Economics Approach

Application of appropriate performance metrics reflecting mortgage risk, data and analytics to quantify risks as shown in the previous sections can significantly influence mortgage investment decisions and risk taking. Risk taking is also greatly affected by a firm's corporate governance which encompasses the processes, structure and behavioral dynamics of its senior management team, including attitudes and actions toward risk management units — all manifestations of the corporate risk culture. Certainly a focus on short-term management incentives at the expense of long-term shareholder value played some role in decisions to take on concentrations of riskier mortgage products. Much has been written about incentives and risk taking, however, management attitudes and behavior may have played a major part in decision making at these firms.

Drawing from theories developed from the field of behavioral economics, we explore some specific examples where behavior and attitudes of senior management may have exerted strong influence over risk management and risk taking. In this section, the focus is on three specific forms of cognitive bias: a lowering of loss aversion due to sustained favorable economic conditions, herd mentality and uncertainty bias. In addition, issues relating to incentive problems that lead regulators to act with less vigor toward excessive risk taking are reviewed.

The complexity of the mortgage business and the decisions facing management teams cannot be reduced to a single theory. Rather, this section leverages the seminal work by Kahneman and Tversky on prospect theory to describe management decisions about risk taking and also their work on cognitive biases.³⁴ An essential feature of prospect theory is that asymmetries between gains and losses to an investment exist, providing insight into the utility-choice model where investors are classified as either risk averse, risk neutral or risk takers. What Kahneman and Tversky claimed was that investors more heavily weight losses over gains (compare losses at A to gains at B in Figure 4.1). This means that investors could at times be both risk takers (gamblers) and risk averse (buyers of insurance). Extending this theory to financial decision making, Barberis, Huang and Santos maintained that investors have greater sensitivity over

Figure 4.1
A Representation of Prospect Theory



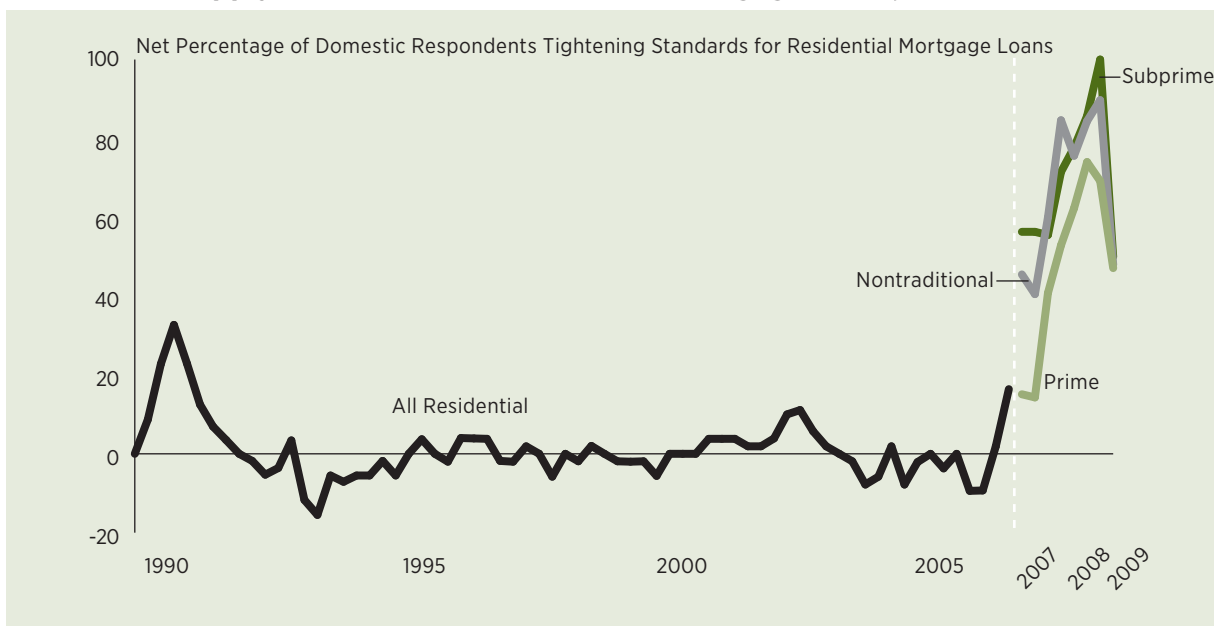
losses than to profits that reflect their loss aversion and that the level of loss aversion is directly related to prior financial performance.³⁵

Similarly, and importantly for this study, over an extended period of time where gains were realized, they claimed investors would become less averse to losses. Hence, over a lengthy period of strong home prices and low defaults, senior management at mortgage firms, along with investors and equity analysts, may have become less loss averse leading up to 2006–2007. This could explain further expansion of underwriting guidelines across mortgage products as depicted in Figure 4.2.

Looking at Figure 4.2, the ten years leading up to 2007 show a pronounced trend toward relaxed underwriting standards for residential mortgages where the net percentage that tightened credit remained at single-digit levels for most of the period. Reliance on performance metrics such as ROE and analytics that underestimated losses distorted the eventual outcomes and fueled changes in management loss aversion over time. A recent study by Moody's reported that the bankruptcy examiner for Lehman Brothers found a number of deficiencies in risk taking at the firm, including a relaxation of the firm's risk appetite and methodology in calculations for its growth strategy.³⁶ Consequently, managers became accustomed to expectations of low mortgage losses with an extremely low probability of any systemic risk event and this may have manifest into a willingness to expand guidelines over time. Once the risks became apparent, management aversion to losses kicked in and mortgage underwriting standards tightened significantly starting in 2007, but by then it was too late.

Other decisions and interactions between risk management teams and business management in hindsight appear inconsistent with rational profit-maximizing behavior and may be explained by other examples of cognitive bias. For example, what explains actions taken by management

Figure 4.2
Measures of Supply and Demand for Residential Mortgage Loans, 1990–2009



Source: Federal Reserve Board — Senior Loan Officer Survey on Bank Lending Practices Chart Data.

to marginalize risk management teams and otherwise discount proposed actions to reduce risk concentrations? While stories of alleged misfortunes of risk managers abound in the popular press, the outcomes of loosened underwriting and a surge in riskier products suggest that risk governance issues may have played a role in undermining the focus of mortgage firms on disciplined origination practices. Most important, this behavior appears at all types of firms, regardless of size, sophistication or time in business.

An all too familiar theme regarding the experiences of risk managers during the period is echoed by a senior underwriter at New Century: “Risk managers at New Century were viewed as a roadblock rather than a resource in many instances.”³⁷ Yet firms that had for many years enjoyed strong reputations as effective risk management organizations such as Fannie Mae and Freddie Mac during the pre-crisis years also appeared to increasingly turn a deaf ear toward risk management objections to higher risk products. For instance, in testimony to Congress, Calomiris stated:

“Those warnings about lax underwriting standards were ignored because senior management feared that a tightening of standards would (1) hurt current profits, (2) lead to a broad market pullback from subprime and Alt-A lending because of the key role of Freddie Mac in setting market standards for these instruments, which would lead to widespread complaints by market participants and (3) that such a pullback would harm Freddie Mac materially because of the political and regulatory ramifications of failing to be perceived as sufficiently committed to the promotion of affordable housing.”³⁸

What could explain such behavior on the part of senior management to take actions that ultimately placed their firms at risk? First, a lower aversion to loss established through a period of favorable economic conditions in the housing market provides a possible explanation. In addition, certain cognitive biases toward risk management may have combined with management views on loss-taking to create a tendency to view risk managers as overly conservative and inefficient. Risk management processes and personnel have both direct costs (salaries, IT, etc.) and indirect costs (foregone business). These costs looked high relative to their potential gain during the boom, but in hindsight, ended up looking inconsequential relative to the costs of poorly performing loans during the bust. Risk management was after all, the first line of defense in guarding against excessive risk taking and thus would be perceived as not enabling the business to reach its full growth potential. Limiting both the size and stature of the risk management organization would have made sense to senior management based on a lower aversion to losses.

Facilitating development of certain biases toward risk management are the differences in information content between business, risk and finance units. Risk management functions provide estimates of uncertain outcomes such as expected losses or stress capital for example. Business and finance managers typically rely on deterministic models and outcomes such as market share, production and revenue growth. Cognitive biases can arise from divergent views and interpretations of key assumptions and inputs to the risk manager's models. For example, if home prices are a major driver of mortgage loss, risk managers need to hold a view of what direction and level home prices would take over the time period in question. Past home price performance that has been strong over a sustained period of time could lead senior managers to discount risk manager loss expectations. This could directly influence various risk management activities such as loan loss reserving, reinsurance and credit policy, among others.

The extension of prospect theory to explaining changes in loss aversion and subsequently decisions regarding the role and scope of risk management in the organization has merit; however, it does not answer how a large group of firms could follow each other in a course of actions that would lead to the failure of most of these institutions. Models of herd behavior may provide some insights into how risk taking can increase dramatically as evidenced by the growth of such nontraditional products as option ARMs. The five largest holders of these products shown in Table 4.1 are no longer in business or operating as independent firms. The relative risks of these products are considerable, looking at Table 4.2. Option ARMs are projected to experience lifetime losses between three and five times that of prime hybrid ARMs or prime fixed-rate 30-year mortgages. As mentioned earlier, Golden West had considerable experience with their version of the option ARM for many years as well as relatively good credit performance in the 1990s despite some periodic market downturns. Other lenders such as those in Table 4.1 sought to emulate the Golden West experience as a way of expanding the business model described earlier. Originally intended for financially sophisticated borrowers with variable cash flow patterns, the option ARM eventually became marketed more

broadly and with greater expansion of credit terms, resulting in the expected performance seen in Table 4.2.

Shiller's work on herd behavior and information provides a useful model for explaining the widespread adoption of the option ARM and its credit expansion over time by a number of lenders.³⁹ Shiller notes two different ways that herd behavior can arise; one through "informational cascades" and the other through conversation analysis. In Banerjee's model that examined informational cascades in promoting herd behavior, people gain information in sequence from others that have preceded them in the process.⁴⁰ Imperfect information provided to one person can, in this model be responsible for the entire group making a decision leading to a bad outcome. This can arise if an individual rationally ignores their own information in place of that of others who preceded him. Applying such a construct to option ARMs could easily explain the behavior of the management of these firms to adopt and expand the terms of business on these products over time based on imperfect market intelligence. Shiller also references conversation-based theory to explain herd behavior. Patterns of conversation, for instance, which might arise from discussions between mortgage brokers, sales

Table 4.1
Option ARM Concentrations 2004–2007 of Top 5 Originators

Company	Option ARM Investment (\$ Billions)
Wachovia	122.0
WaMu	52.9
Countrywide Financial	25.4
Downey Savings	6.9
Indy Mac	3.5
TOTAL	210.7

Note: Wachovia includes Golden West option ARMs.

Table 4.2
Option ARM Expected Cumulative Loss Performance

Origination Year	Prime Hybrid ARM	Prime Fixed- Rate 30	Option ARM	Option ARM Loss Multiples Over Prime ARMs	Multiples Over Prime Fixed-Rate
2003	0.37	0.12	1.86	5.03	15.50
2004	2.40	0.97	5.29	2.20	5.45
2005	10.28	5.69	21.79	2.12	3.83
2006	15.56	9.09	41.57	2.67	4.57
2007	18.50	11.13	44.50	2.41	4.00
Total	9.46	5.98	28.53	3.02	4.77

Source: JP Morgan, *Securitized Products Weekly*, March 12, 2010.

staff and management regarding the competition's perceived success with a mortgage product could influence decision making. Discussions suggesting that highly successful mortgage sales agents might defect to other lenders offering more attractive product offerings could likewise enter into the conversational process and lead to potentially riskier outcomes for the firm. Consider Chuck Prince's rationale for Citigroup's leveraged lending activity:

“And if you are not engaged in business, people leave the institution, so it is impossible to say in my view to your bankers we are just not going to participate in the business in the next year or so until things become a little more rational. You can't do that and expect to have any people left to conduct business in the future.”⁴¹

Figure 4.3 illustrates changes in risk taking during a mortgage cycle as a product evolves over time. During the early boom phase, economic conditions are favorable and product risk is minimal. Credit underwriting standards are strong as evidenced by limited risk layering (percentage of losses in the tail of the loss distribution (HRO1)). During this period profitability remains stable. As the boom progresses, underwriting standards begin to soften across risk attributes leading to higher risk layering. This leads to a rightward shift in losses such that the tail of the loss distribution denoted by HRO2 enlarges relative to HRO1. Expected profitability also accelerates as new fees are charged for incremental risk. Delinquencies also rise, but are muted by strong economic conditions. By the latter stages of the boom, the product has experienced considerable expansion across many risk attributes such that the amount of risk layering during the period denoted by HRO3 is well above that of the early boom phase. Delinquencies begin rising rapidly as conditions weaken and profitability declines as a result. By the time the boom is over, the once relatively low-risk product perhaps oriented toward a particular borrower niche has morphed into a mass-marketed high-risk product. This is what happened with negative amortization ARMs.

Figure 4.3
Changes in Risk Layering, Delinquency and Profitability Over the Mortgage Cycle

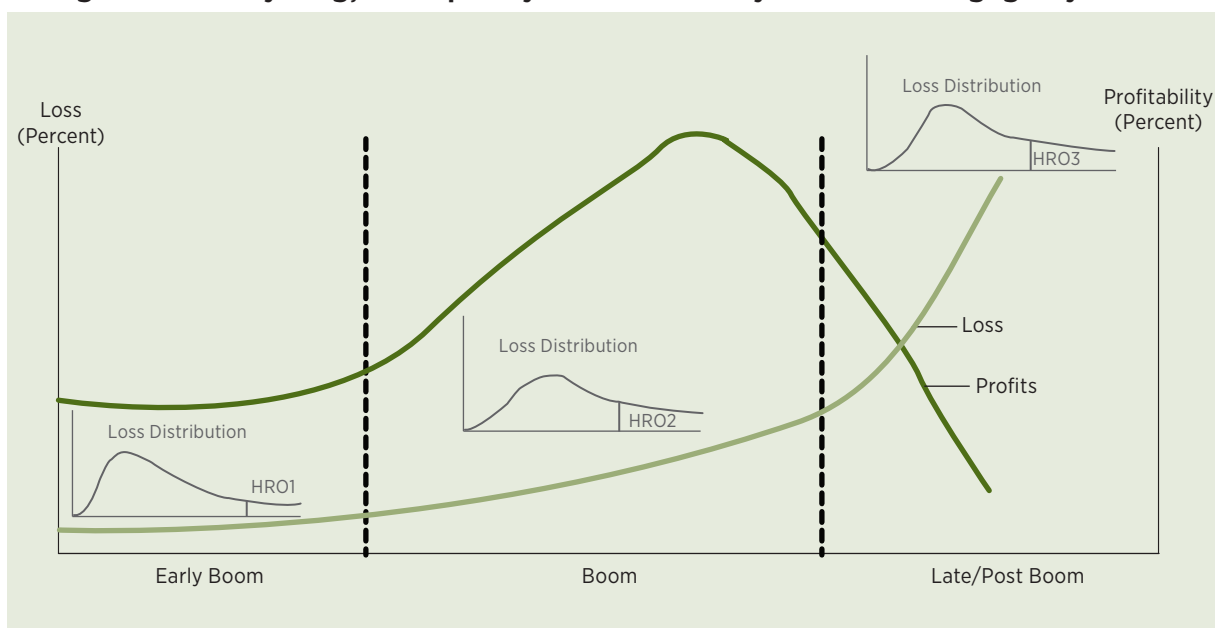


Table 4.3**Share of California and Florida Mortgages of Major Mortgage Lenders**

Company	California (Percent)	Florida (Percent)	Combined (Percent)
WaMu	50	13	63
Countrywide	43	7	50
IndyMac	71	7	78

Source: WaMu 8/11/2008 10-K, Countrywide 2/29/2008 10-K, IndyMac 3/31/2008 10-K

To reinforce the ways cognitive bias by senior management could manifest itself through greater risk taking, consider another scenario from the mortgage portfolio investment model described in Section 2. A standard approach to limiting risk exposure is to impose a concentration limit. Concentration risk refers to the buildup of portions of a portfolio or business that overexposes the firm to risk that goes beyond individual loan risk.

Concentrations can develop geographically, by product, channel or other combination the risk manager deems important. Rapid growth rates in certain segments or markets are consistent with the development of asset bubbles. However, ascertaining when such trends portend adverse consequences for those firms holding the average portfolio is difficult at the time these trends are forming. Coincident with these buildups is the possibility that the relative risk underlying these segments could be changing as well and the latest data would be unlikely to pick that up contemporaneously.

Consider one of the most recognizable concentrations at work in undermining mortgage portfolios, coastal housing markets. As home prices collapsed over the last several years, markets such as California and Florida suffered disproportionately relative to other areas of the country. Three of the largest mortgage lenders during the period preceding the crisis, WaMu, Countrywide and IndyMac had large physical presences in California and Florida, as illustrated in Table 4.3. By contrast, California accounts for about 10 percent of U.S. housing stock and 17 percent of the total value of the housing market.⁴²

All three lenders are now out of business. Concentration risk by itself did not bring these firms down, but had these portfolios been more representative of the U.S. market it may have mitigated their rapid deterioration. In addition to an asset bubble forming in certain housing markets, California, Florida and a number of other states also witnessed a higher proportion of riskier mortgage products. In the case of California, for affordability reasons, neg-am mortgages (referred to as option ARMs by lenders), increased in popularity and had been, as mentioned earlier, used for many years in California. When these portfolios built up over time in markets where product risk was also rising disproportionately, it exacerbated the concentration risk of these portfolios.

Table 4.4
Prime Mortgage Allocation by Subprime Limit

Subprime Limit as Percent of EC	Prime Weight (Percent)
100	75.3
60	78.6
50	84.6
40	89.2
30	90.0
20	95.6
10	Infeasible

How could it be then that these firms did not see the risks these concentrations posed to their survival? The answer can be partly explained by cognitive biases where management loss aversion was softened by a boom period in the mortgage industry. Using the assumptions as before in the portfolio optimization framework, a new constraint is imposed on the percentage of economic capital allocated to the subprime product. In the original model no such constraint was imposed on either product. Assuming a target ROE of 20 percent and a product correlation of -0.5 , the percentage of prime mortgages that meet the constraints for varying subprime limits are shown in Table 4.4.

Not surprisingly, as the limit on the percent of subprime allocation of economic capital declines, the percentage of prime mortgages rises. In this simulation, the relative return to prime mortgages (17.5 percent) against the target ROE along with its return variability enabled the firm to maintain a target 20 percent ROE across all but the 10 percent limit scenario. Imposing that 10 percent restriction would have required the firm to relax its target ROE. Imposing such a restriction on the riskier product could be in conflict with the ongoing good fortunes of the firm by leading the manager to adopt a lower aversion to loss as mentioned earlier. As a result, cognitive bias could have played a role in key risk mitigation activities.

Another example of how such biases could influence risk strategy is with portfolio reinsurance. Credit enhancement in the form of mortgage insurance (either primary or pool) or reinsurance can be extremely important to effectively managing the mortgage portfolio's risk profile within designated tolerances. Successful positioning of the economic benefits of credit enhancements when markets are performing well and losses are low can be difficult. Similar to the discussion above, the costs associated with securing insurance can be perceived as too high given expectations about future losses, again supported by a sustained level of low losses that influence management's loss aversion.

Management of mortgage firms is not alone in projecting cognitive biases. Regulators are just as susceptible to such biases. Looking back over a sustained period of strong economic growth, regulators found it difficult to identify excesses in the housing market until shortly before it collapsed,

as demonstrated by Chairman Bernanke's comment: "House prices have risen by nearly 25 percent over the past two years. Although speculative activity has increased in some areas, at a national level these price increases largely reflect strong economic fundamentals."⁴³ This belief then that abnormally high rates of house price appreciation were attributed to prevailing economic conditions would have been reflected in regulatory actions at the time. For example, the interagency guidance on nontraditional mortgages was enacted in September 2006, well after the origination of these mortgage products peaked.

In addition to cognitive bias as a partial factor explaining regulatory activity in the period leading up to the crisis, other incentive conflicts may have also played a role. For example, the appointment of regional Federal Reserve Bank board members from banking institutions illustrates the delicate balance needed to ensure that regulatory actions taken toward financial institutions present no conflicts of interest or jeopardize taxpayer interests. Further, lessons that should have been learned as far back as the thrift crisis resonate tragically today. Although Kane, for instance, was focused on how forbearance policies enacted during the thrift crisis survive, the theme that they deliver benefits to regulators that can create conflicts of interests and principal-agent problems has application to safety and soundness regulation today.⁴⁴ For example, Kane argued that implicit wages in the form of non-pecuniary benefits accrue from career sustainability and influence that may be realized from the authority vested in the regulatory agency.

Specifically, in the case of the Office of Thrift Supervision (OTS), the federal regulatory agency charged with overseeing the nation's thrift industry, in the years 2006–2008, three of its largest institutions either failed or merged with other non-thrift acquirers.⁴⁵ A recent report by the FDIC investigating the regulatory oversight of WaMu found lapses in OTS management's supervision of WaMu and cited the agency for failing to act early enough in addressing significant safety and soundness issues.⁴⁶ OTS is supported by fee assessments imposed on its regulated institutions. At the time of its failure, WaMu represented 21 percent of the agency's assessment base. The loss of assessments from the failure of IndyMac and the mergers of Countrywide and Golden West, certainly had significant financial impacts on OTS. In hearings before the Senate Permanent Investigations Committee, documents obtained by the Committee reveal that OTS management referred to WaMu's chief executive as "my largest constituent asset wise."⁴⁷ Facing continued erosion of its regulatory base, it would not be hard to imagine how this could potentially impact decision making.

Notes

34. Kahneman, Daniel and Amos Tversky, "Prospect Theory: An Analysis of Decision Under Risk," *Econometrica*, XLVII, 1979, 263–291.

35. Barberis, Nicholas, Ming Huang and Tano Santos, "Prospect Theory and Asset Prices," *Quarterly Journal of Economics*, CXVI, 2001, 1–53.

36. Moody's, *Weekly Credit Outlook*, March 15, 2010, 9–10.

37. Patricia Lindsay, Former Vice President, Corporate Risk, New Century Financial Corporation, Testimony to the Financial Crisis Inquiry Commission, April 7, 2010.
38. Charles Calomiris, Testimony to the Committee on Oversight and Government Reform, U.S. House of Representatives, December 9, 2008.
39. Shiller, Robert J., "Conversation, Information and Herd Behavior," *American Economic Review*, 85:2, May 1995, 181-185.
40. Banerjee Abhijit V., "A Simple Model of Herd Behavior," *Quarterly Journal of Economics*, August 1992, 107:3, 797-817.
41. Charles Prince, Testimony before the Financial Crisis Inquiry Commission, April 8, 2010.
42. FHFA, Mortgage Market Note, "Recent Evidence on Housing and Mortgage Market Conditions in California," May 27, 2009
43. Chairman Ben Bernanke, Testimony Before the Joint Economic Committee, October 20, 2005.
44. Kane, Edward, *The S&L Insurance Mess: How Did It Happen?*, 1989.
45. This included the acquisition of Golden West by Wachovia in May 2006, the announcement of the acquisition of Countrywide Financial Corp. by Bank of America in January 2007 and the failure of IndyMac Bank in July 2008.
46. FDIC, Office of the Inspector General, "Evaluation of Federal Regulatory Oversight of Washington Mutual Bank," April 2010.
47. John M. Reich, OTS Director, email dated Wednesday, May 2, 2008.

5. Lessons Learned

Not surprisingly, there is no single recommendation that would have prevented the mortgage crisis given the complexity of the issue. It would be overly simplistic to blame the crisis on avaricious business executives, weak boards and risk managers using bad models and bad data. Instead, the causal factors are more subtle. Looking back, each factor could be linked to the crisis in some way, however, the combination of factors intensified the magnitude of the event. Informational uncertainties will never be eliminated, yet there are specific actions that could be taken to better align risk and business manager interests.

The current mortgage crisis was precipitated by a number of interrelated factors creating the perfect storm of events that few in the industry forecast until it was too late.

This study identifies four factors responsible for greater risk taking by large mortgage lenders during the period preceding the crisis:

- Reliance on performance metrics not appropriately adjusted for risk
- Data and analytical limitations that led to underestimation of credit losses
- Cognitive biases among senior management that led to
 - lower aversion to risk due to perceptions of continued low losses based on prior experience
 - poor risk management culture and stature organizationally
 - herd behavior in development and expansion of riskier products
- Incentive problems that limited the effectiveness of regulatory agencies to respond to excessive build ups of risk concentrations

Mortgage specializing institutions perhaps faced greater challenges as they were attempting to develop a sustainable business model that would appeal to investors. Finding ways to boost earnings and share

prices was dependent on exploiting operational efficiency and improving profit margins by broadening the product set beyond prime conforming mortgages, which were marginally profitable. Broadening the product set effectively meant taking more credit and/or interest rate risk. In an environment that had experienced a period of low interest rates, stable and low unemployment rates and strong home prices across the country, taking on incremental risk may not have seemed irrational. Other institutions such as Golden West had demonstrated that development of niche products such as option ARMs could result in favorable views by investors. Following such an example and “enhancing” the product by marketing it more broadly may also have made good business sense at the time.

Compounding this flawed logic however was the application of ROE-like metrics that did not adequately differentiate between product risks. As shown in the portfolio simulations, using such metrics for developing product and investment strategy could lead to riskier products being originated. The analysis also showed that significant limitations in data and/or analytics could greatly influence the results and also lead to riskier lending practices over time. Further complicating matters, differences between risk management and business and finance unit information sets may have played a role in discounting credit risk estimates provided by risk managers. Specifically, risk management estimates of loss uncertainty may have been received with greater skepticism by business and finance managers that were used to relying on more deterministic models and results.

Looking back, there are clearly a number of important lessons regarding the key functions of risk management that should be learned and implemented as well as potential corrective actions that could be taken to guard against such failures in the future.

Lesson 1: Utilize measures of risk-adjusted returns to create appropriate incentives for employees and management.

Much has been written on executive compensation and its impact on excessive risk taking during the period leading up to the crisis. Although such metrics are difficult to implement, firms should make risk-adjusted return on capital measures a major component of performance-based pay. In that way, both production and risk management units share a common goal that balances risk and reward.

Lesson 2: Invest in data integrity and analytics, but realize the limitations of models that rely upon historical data.

Risk and business managers must apply a healthy dose of skepticism to empirical results based on prior history. By now, this is a lesson learned the hard way and one that is well researched. As quantitative methods for assessing default risk advanced in the last decade, they brought with them a false sense of security to the extent that they could accurately represent the risks being taken by the firm. As has been shown, models are incomplete representations of markets and human behavior, even with the best data. Models augmented by stress testing and scenario analysis and expert judgment turn

out to have the best chance of reflecting potentially bad outcomes. Modelers in many cases used state-of-the-art methods, benchmarked their results against external models and other sources and went to great pains to scrub the data that was used, however, reliance on statistical models that are backward-looking can be misleading during periods of structural change. If risk managers assume that all models are wrong, then they must focus on refining their analytic views with other evidence such as from quality control reviews and other forms of due diligence. Consequently, greater emphasis on qualitative risk management findings from quality control, loan reviews and collateral reviews should be made in developing quantitative-based views of risk.

Lesson 3: Relaxation of underwriting standards can morph standard products into a new product set with limited or no performance history.

Risk layering of once standard mortgage products in effect created a new and riskier product set that the best of analytical insights would have trouble assessing with available historical data. Option ARMs also exemplify this problem. Option ARMs as described, started as products oriented toward financially sophisticated borrowers. As the product was more widely distributed to borrowers, the ability to draw strong inferences from the existing data became difficult and was to some degree masked by favorable economic conditions. Stress testing these riskier subsets is critical to understanding potential performance, but even these analyses cannot provide complete confidence in the level of risk being originated. That is because the best data available will tend to understate these risks and compound them even in estimates of extreme outcomes such as in economic capital. Strict position and/or concentration limits on new product segments should be featured as part of the credit risk management process. Development of early warning metrics to track high-risk concentrations would enable risk managers to stay abreast of significant changes in origination and portfolio mix over time.

Lesson 4: Corporate governance and culture must change to prevent management from being misled by cognitive biases.

Risk managers may have been effective in identifying risks, however, many firms appeared tone deaf to these subject matter experts. If senior management had elevated the risk officer position to one that had direct or even indirect reporting to the risk committee on the board of directors, it may have helped staunch some of the risk taking that occurred. Further, executive management must inculcate a culture of risk management where all employees actively are on guard for risks that exceed the risk appetite of the company. One way to incent depository institutions to build strong risk functions and culture is for FDIC to strengthen risk-based assessments on deposit premiums reflecting the strength of the risk management organization and quality of the firm's risk infrastructure.

By blindly following the herd, the largest mortgage originators effectively competed themselves out of business. Reliance on information gathered from brokers and sales staff regarding the competition

can be valuable to firms, however, the information obtained needs to be carefully vetted against specified corporate objectives. A clear vision of what risks the firm is willing to take must be part of the strategic roadmap, and deviations from that plan must be accompanied by sound analytics and information even if short-term losses of market share and key individuals are likely. A corollary to this recommendation is that risk vision and therefore business strategy must take a long-run view into account in shaping risk direction.

Lesson 5: Aspects of safety and soundness regulation that impose possible conflicts of interest must be restructured.

Regulators must be more aware of the risk management culture of a firm and require management to address perceived deficiencies in developing a truly independent risk organization. They also have an important role to play in recognizing and managing systemic risks that build up beyond the view of any individual institution. In fact, it may be rational for individual institutions to take on risks individually, at the same time that the system could be better off if such risk taking were reduced.

Senior management may have been lulled into believing that they could take greater risks without experiencing significant losses based on a period of unprecedented growth in the housing market marked by low credit losses. These results were effectively a mirage, masking serious structural changes in the market. Greater leverage by borrowers taking advantage of new products requiring less documentation of income, demonstrated credit experience and lower downpayments eroded historical attachments to housing as a home rather than an alternative investment vehicle. Likewise, arrangements with third party originators allowed adverse selection to take place, but as long as markets performed, these problems would not surface in the minds of many senior managers. The difficulty lies in spotting these changes and abnormal market behavior. Careful monitoring of market trends, gauging the pulse of other firms not engaged directly in the same product offering and other intelligence should be used to guide management away from excessive risk taking.

This study has focused on how mortgage companies can improve their approaches to risk management. However, many of the themes developed here apply equally well to regulators and investors. Unfortunately, the mortgage industry appears to have a short-term memory problem. Only removed about 20 years from the last major housing event, the thrift crisis, we should know that precipitous systemic events in housing can have lasting effects on the overall economy. It is incumbent more than ever that management teams and boards of directors take serious stock of the governance processes, risk infrastructure and culture of their firms to ensure that such events as transpired over the last decade are not repeated.

References

- Adelson, Mark, Nomura Fixed Income Research, “A Journey to the Alt A Zone,” June 3, 2003.
- Anderson, Capozza and Van Order, “Deconstructing a Mortgage Meltdown: A Methodology for Decomposing Underwriting Quality,” Working Paper.
- Anshasy, Elliehausen, and Shimizaki, “Mortgage Brokers and the Subprime Mortgage Market,” Proceedings, Federal Reserve Bank of Chicago, 2005.
- Ashcraft, Adam B., and Til Scheuermann, “Understanding the Securitization of Subprime Mortgage Credit,” Federal Reserve Bank of New York Staff Report, Staff Report no. 318 March 2008.
- Banerjee Abhijit V., “A Simple Model of Herd Behavior,” *Quarterly Journal of Economics*, August 1992, 107:3, 797-817
- Barberis, Nicholas, Ming Huang and Tano Santos, “Prospect Theory and Asset Prices,” *Quarterly Journal of Economics*, CXVI, 2001, 1-53.
- Chairman Ben Bernanke, Testimony Before the Joint Economic Committee, October 20, 2005.
- Calem and Follain, “Regulatory Capital Arbitrage and the Potential Competitive Impact of Basel II in the Market for Residential Mortgages,” *Journal of Real Estate, Finance and Economics*, (2007), 35:197-219.
- Calomiris, Charles, Testimony to the Committee on Oversight and Government Reform, U.S. House of Representatives, December 9, 2008.
- Deng, Xudong, Yao and Rosenblatt, “Model Stability and the Subprime Mortgage Crisis,” working paper, June 2009.
- De Silver, Drew, “Reckless Strategies Doomed WaMu,” *Seattle Times*, 10 / 25 / 2010.
- Fannie Mae, 2009 Third Quarter Credit Supplement, Nov. 5, 2009.

FDIC, Office of the Inspector General, “Evaluation of Federal Regulatory Oversight of Washington Mutual Bank,” April 2010.

Federal Reserve Board of Governors, January 2009 Senior Loan Officer Opinion Survey.

FHFA, *Mortgage Market Note*, “Recent Evidence on Housing and Mortgage Market Conditions in California,” May 27, 2009.

FINCEN, *Filing Trends in Mortgage Loan Fraud*, February 2010.

Freddie Mac, Third Quarter 2009 Financial Results Supplement, Nov. 6, 2009.

GAO, Home Mortgage Defaults and Foreclosures, Recent Trends and Associated Economic and Market Developments, Briefing to the Committee on Financial Services, House of Representatives, Oct. 10, 2007.

Golub, Bennett W. and Conan C. Crum, “Risk Management Lessons Worth Remembering From the Credit Crisis of 2007–2009,” white paper, 2009.

Greenspan, Alan (April 8, 2005). “Consumer Finance.” Federal Reserve System’s Fourth Annual Community Affairs Research Conference. Federal Reserve Board.

Griffen, Dale W., Kai Li, Heng Yue, Longkai Zhou, Cultural Values and Corporate Risk-Taking, October 2009, unpublished manuscript.

Guiso, Sapienza, and Zingales, Moral and Social Constraints to Strategic Mortgage Default, NBER working paper, July 2009.

Hull, John C., *Options, Futures, and Other Derivatives*, Pearson Prentice-Hall, p. 259, 7th edition, 2008.

Inside Mortgage Finance, 2009.

Lindsay, Patricia, Former Vice President, Corporate Risk, New Century Financial Corporation, Testimony to the Financial Crisis Inquiry Commission, April 7, 2010.

Jiang, Nelson, and Vytlačil, “Effects of Origination Channel and Information Falsification on Mortgage Delinquency,” Working Paper, 2009

JP Morgan, *Securitized Products Weekly*, March 12, 2010.

Kahneman, Daniel and Amos Tversky, “Prospect Theory: An Analysis of Decision Under Risk,” *Econometrica*, XLVII, 1979, 263–291.

Kane, Edward, *The S&L Insurance Mess: How Did It Happen?*, Cambridge, Mass.: MIT Press, 1989.

LaCour-Little, Michael and Gregory H. Chun. “Third Party Originators and Mortgage Prepayment Risk: An Agency Problem?” *Journal of Real Estate Research*, 17 (1999): 55–70.

Lang, William W., and Julapa A. Jagtiani, “The Mortgage and Financial Crises: The Role of Credit Risk Management and Corporate Governance,” *Atlantic Economic Journal*, 2010.

Milligan, Jack, “The WaMu Way,” *Bank Director Magazine*, Q3 2006.

Moody’s, *Weekly Credit Outlook*, March 15, 2010, 9–10.

National Association of Realtors, *Housing Affordability Trends*, 2009.

Prince, Charles, Testimony before the Financial Crisis Inquiry Commission, April 8, 2010.

Reich, John, OTS Director, email dated Wednesday, May 2, 2008

Shiller, Robert J., “Conversation, Information and Herd Behavior,” *American Economic Review*, 85:2, May 1995, 181–185.

Standard and Poor’s, “RMBS: Methodology and Assumptions for Rating U.S. RMBS Prime, Alternative A and Subprime Loans,” September 2009.

Thomas and Pearle, “Exclusive: WaMu Insiders Claim Execs Ignored Warnings, Encouraged Reckless Lending,” ABC News, October 13, 2008.

TransUnion, *2010 TransUnion Payment Hierarchy Study*, 2010.

Tully, Shawn, *Fortune*, “What Went Wrong at WaMu.” “Washington Mutual built itself into America’s biggest mortgage bank almost overnight. But this year, POW! Profits are getting hammered, and the CEO is apologizing to Wall Street,” August 9, 2004.

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