Integrated Asset-Liability Management: An Implementation Case Study

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This chapter discusses integrated asset-liability management, a new management perspective that is evolving at the more innovative financial intermediaries in response to problems caused by the older functional management perspective. The older perspective calls for an organization to be structured into functional units (e.g., marketing, asset management, etc.), the decisions of which are coordinated by a corporate plan based on a macroeconomic forecast. Growing disenchantment with the accuracy of macroeconomic forecasting in the face of a more complex and volatile capital markets environment has led some financial intermediaries to begin implementing a new management perspective. This new management perspective, termed integrated asset-liability management (or more simply, integrated ALM) calls for an organization structured into integrated units that include all the functional activity related to a line of business. The integrated staff makes decisions regarding the product(s) in the business line with the help of computer models that represent both the assets and liabilities associated with the business line, characterize the uncertainty of the future business environment, and produce strategies for structuring the assets and liabilities of the business line in ways that are profitable across a range of alternative future environments. In short, the older functional management perspective calls for functional units to make decisions using profitability calculations based on a single-scenario planning forecast, while the newer integrated ALM perspective calls for business units to make decisions using risk-adjusted or hedged profitability calculations based on multiple-scenario projections.

Alternatively, the chapter may be read as a discussion of the technical and organizational issues raised by the use of modern financial simulation

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and optimization techniques in the management of financial intermediaries. The conceptual discussion is illustrated with an extended case study of a large financial intermediary that has implemented elements of integrated ALM in response to a number of problems that arose during the years a functional management perspective was in wider use.

The chapter is divided into three sections. The first section introduces the basic issues involved in managing a financial intermediary and identifies the problems associated with the functional perspective in handling these management issues. The concepts of integrated ALM are outlined and the section concludes with a discussion of the challenges facing a financial intermediary's implementation of integrated asset-liability management.

The second section describes FNMA (the Federal National Mortgage Association, more commonly known as Fannie Mae) and its three major business activities: mortgage insurance, REMIC underwriting, and mortgage investment. The description focuses on the general features of each kind of activity that make them distinctive businesses.

The third section uses the conceptual management discussion and the outline of FNMA's major business activities as background for an account of how certain business problems associated with the functional management perspective led to the adoption of elements of the integrated asset-liability management perspective. This implementation case study focuses on issues related to managing interest rate risk in the mortgage investment business, managing default risk in the mortgage insurance business, managing marketing risk in the REMIC underwriting business, and managing the allocation of capital across different businesses.

1 Integrated ALM as Innovative Management

The evolution of management perspectives can be seen as an innovative management response to business problems. The individual concepts combined in the newer perspective have almost always been well developed and accepted techniques. The problems with the older perspective have often been understood in theory, but have not become manifest. It is usually the occurrence of a major business problem that triggers the critique of the older management perspective and the introduction of new management techniques. Unless there is an unusually high degree of internal management initiative, the newer management perspective evolves through the piecemeal implementation of new management techniques introduced to solve concrete

problems arising under the older management perspective. It may take some time before there is a realization that a series of these new management techniques have combined to produce a new management perspective or system that is fundamentally different from the older perspective.

This section describes the major tasks involved in managing a financial intermediary, the older functional management perspective and its problems, and the concepts and challenges of the newer integrated asset-liability management perspective.

1.1 Managing a Financial Intermediary

Financial institutions serve as intermediaries in the capital markets between ultimate savers and ultimate investors. This intermediation involves issuing liabilities that savers or other intermediaries buy to hold as assets. These liabilities are financial securities that promise a future schedule of cashflow. A liability's scheduled cashflow may be certain or it may be contingent in the sense that it depends on the occurrence of certain future events. Liabilities with contingent cashflows are inherently risky because a potential buyer does not know which future events will occur. Other things equal, a buyer will expect to pay less for an intermediary's liability the more inherent risk it possesses.

A financial intermediary typically uses the proceeds of the liability's sale plus equity capital to buy assets, which are the liabilities of investors or other intermediaries. The cashflow of these assets are used to pay the liability's scheduled cashflow. Any asset cashflow remaining after the payment of the liability cashflow is profit for the financial intermediary. If the asset cashflow is not sufficient to pay the scheduled liability cashflow, then the losses of the financial intermediary may create doubts about the credibility of the liability's scheduled cashflow. Other things equal, potential buyers will expect to pay less for an intermediary's liability the less credible is the payment of its scheduled cashflow.

Since most financial intermediaries issue liabilities with contingent cashflow schedules and buy assets with contingent cashflow schedules, the future profitability of the intermediary is potentially quite uncertain. The basic management objective for a financial intermediary is to sell liabilities and buy assets in a way that the net cashflow or profit is both substantial relative to equity capital and consistent across the range of contingent events that affect future asset and liability cashflow.

Most financial intermediaries sell liabilities that are quite varied in their

scheduled cashflow, and therefore, are bought by quite different groups of customers. Obviously, such a multi-product financial intermediary faces additional coordination tasks that make for a more complicated management problem than faced by a single-product intermediary. At the corporate level, the management objective is to allocate the intermediary's equity capital across the individual product or business lines in a way that satisfies both shareholders and regulators.

If a financial intermediary is managed so that it is relatively profitable in a wide range of event environments, then its liabilities will command a relatively high price and its profitability will be reflected in a relatively high price for its equity shares. On the other hand, a poorly managed intermediary that experiences uneven profitability and/or losses will be forced to sell its liabilities at relatively low prices and experience a relatively low price for its equity shares. If the credibility of a poorly managed intermediary erodes far enough, it can experience a run and liability buyers can experience losses resulting from a failure to pay scheduled cashflow. But more often the losses have fallen on taxpayers when insolvent intermediaries have been closed by government agencies that insure their liabilities.

This view of the management problem facing financial intermediaries has been developed in more detail by Holmer and Zenios (1995). Their analysis uses a less familiar vocabulary that describes the productivity of alternative management technologies using terms more often employed in reference to manufacturing companies. Such terminology is consistent with a flow-of-funds economic framework even though it makes financial intermediaries seem similar to manufacturing companies. The use of such terminology serves the useful purpose of suggesting parallels between recent management changes that are well understood in the manufacturing sector, but less well appreciated in the financial sector.

1.2 Functional Management Problems

In a multi-product financial intermediary organized and managed under a functional perspective, the central coordination tasks are performed by the annual corporate plan, which is based on a single-scenario macroeconomic forecast of interest rates and other business conditions. Functional units — for example, those that specialize in marketing (i.e., selling liabilities) and manufacturing (i.e., buying assets) financial products — all make decisions using the corporate plan as expectations. In addition to its business forecast element, the corporate plan usually includes guidelines for marketing (e.g.,

pricing rules) and manufacturing (e.g., asset allocation rules and return targets). For an intermediary with an established set of financial products operating in a relatively stable business environment, this mode of operation works reasonably well.

The problems associated with this functional management perspective become apparent when an intermediary's environment becomes more volatile or when it begins offering new financial products in response to competitive pressures.

The problem with reliance on a corporate plan in a more volatile business environment is that functional unit decisions, which are collectively profitable in the forecasted scenario, can become unprofitable if the scenario that actually does occur differs substantially from the forecast. If the macroeconomic and corporate forecasting models were quite accurate in practice, then this would be only a hypothetical problem. But, in fact, the macroeconomic models at the core of most corporate planning models, have a poor record at forecasting major shifts in the business environment. The models' repeated failures to forecast major movements in interest rates and other aspects of the business environment and the resulting disenchantment with macroeconomic modeling in both financial and non-financial businesses have been described recently by Passell (1996).

For financial intermediaries, perhaps the most stressful problems caused by making decisions based on inaccurate forecasts have been associated with major shifts in interest rate levels. The substantial increase in interest rates during the early 1980s, as well as the smaller, but sharp rise during 1994, exposed a wide range of problems among different kinds of intermediaries. Assets bought to cover contingent liability cashflow turned out to be insufficient in the altered interest rate environment. The resulting runs and regulatory closures involved large losses. There were noticeable losses in the insurance industry and local governments, but the major losses occurred in the thrift industry as described by Kane (1989) and White (1991).

In addition to problems caused by inaccurate forecasts, a financial intermediary operating under the functional management perspective is prone to introducing new financial products that are poorly designed.

The new product difficulties experienced by manufacturing businesses that are organized into separate functional units are widely appreciated. The traditional design process involving sequential activities by engineering, manufacturing, and marketing staff, has been found to be too slow and unreliable in producing new products that are demanded by customers at a price that permits profitable manufacturing.

Some established financial intermediaries that have developed new products while organized in functional manner have experienced similar difficulties. For example, several decades ago the life insurance industry introduced the guaranteed investment contract (GIC) product. While certainly attractive to customers, subsequent experience with the product suggests that insufficient attention was paid to how it could be manufactured profitably in a wide range of interest rate environments. Life insurance companies experienced substantial losses for years as a result of this poorly designed new product.

In addition to these problems at the product level, financial intermediaries have also had difficulties at the corporate level, where the management task is to allocate equity capital among the different products in a way that promotes high and steady profits. Increased regulatory pressure for capital adequate to buffer against risks has been an additional problem for intermediaries employing a functional management perspective. Use of a single-scenario plan leaves financial intermediaries ill-equipped to respond to regulatory requests for risk estimates that are based on financial performance across many scenarios representing a wide range of future business environments. In addition, the inability of single-scenario forecasts to represent risk may also be considered a problem by shareholders, who have an interest in not only high, but also stable profits.

1.3 Concepts of Integrated ALM

As the business environment has become more volatile over the past few decades, innovative financial intermediaries have identified elements of the older functional management perspective as the cause of their business problems and have changed their mode of operation in ways that reflect the newer integrated asset-liability management perspective.

A key realization was that reliance on an error-prone, single-scenario economic forecast with functional units making rule-based decisions in light of that forecast was just too risky for the more volatile business environment. "As a result, most big companies today are giving short shrift to economic forecasting and focusing instead on reducing their exposure to risk," according to Passell (1996). This shift is evident in both the manufacturing and the financial sectors, because all firms face the same pressure from shareholders, who prefer a stable profit stream over a volatile profit stream if the average levels of the two profit streams are the same. The pressure to shift from forecast-based decisions to hedging-based decisions has been even stronger

for financial institutions that have been pressured by regulators who insure their liabilities.

This new focus on risk management has had far-reaching effects on both the technical and organizational aspects of operations at financial intermediaries.

The major technical ideas used in the integrated ALM perspective were developed independently over the course of the past half century. Methods for characterizing attitudes towards risk and making decisions in the face of uncertainty were formalized beginning in the 1940s as described by von Neumann and Morgenstern (1947). Monte Carlo simulation methods were developed extensively during the 1940s and 1950s as described by Hammersley and Handscomb (1964). The basic techniques of portfolio optimization by means of risk diversification were developed during the 1950s and 1960s as described by Markowitz (1959) and by Mossin (1968). The development of modern finance theory, which produced both analytic and computational methods for assessing the value of contingent cashflows as well as numerous other advances, began in the 1970s as described by Black and Scholes (1973) and by Merton (1992). Ideas from these research areas form the key technical elements of integrated ALM. They began to be practical management techniques beginning in the 1980s because of the continuing advance in the power of computers of all sizes ranging from supercomputers to desktop workstations.

These technical ideas are combined in the integrated ALM perspective in specific ways that facilitate management at both the product level and the corporate level.

At the individual product level, these technical ideas are employed to develop tools that allow management to simulate the profitability of a set of product design, pricing, and funding decisions across many scenarios, each one of which represents an alternative future business environment. Monte Carlo simulation methods are used to generate the contingent cashflows for assets and liabilities and modern finance theory is used to price the assets and liabilities at both the beginning and end of the assumed horizon or holding period. The result of the simulation is a scenario distribution of return on equity (ROE) or some other profit measure. Given the management's expectations and aversion to risk, each scenario is assigned an occurrence probability and expected utility theory is used to calculate the certainty-equivalent ROE or other risk-adjusted profit measure. Since the assets, liabilities, and equity capital associated with the product or business line are considered a leveraged portfolio, the final step is to use the mapping

from one set of decisions to a value for certainty-equivalent ROE to perform a portfolio optimization which identifies the particular set of design, pricing, and funding decisions that produce the highest product certainty-equivalent ROE.

One important implication of this way of combining the technical ideas is that all decisions relevant to a product or business line are interdependent. The product design decision has implications not only for the pricing of the liability, but also for the kind of asset acquisition strategies that could profitably fund the liability. The pricing decision must take into account both the inherent risk of the product relative to competing securities available in the capital markets and the sales proceeds that will be available for buying the funding assets. And the kind of assets selected to fund the liability has implications for the design and pricing of the product. In other words, it would be difficult to compartmentalize decision-making regarding the design, pricing, and funding of a financial product since decisions in all these areas affect the risk-adjusted profitability of the product.

At the corporate level, these technical ideas are employed to develop an equity capital balance sheet which can be simulated and optimized in a manner similar to each product line's balance sheet. The assets on this corporate balance sheet represent each product or business line to which equity capital is allocated. The corporate balance sheet is simulated under the same set of scenarios used in the individual product balance sheet simulations. The scenario return distribution associated with each asset on the corporate balance sheet is the scenario ROE (or other profit measure) generated by a dollar of equity capital invested in that product or business line. For each allocation of available capital across the products or business lines, the scenario ROE for total corporate capital can be calculated and converted into a corporate certainty-equivalent ROE. The optimization of this corporate balance sheet is accomplished by finding the allocation of equity capital that maximizes the corporate certainty-equivalent ROE.

Also, this kind corporate equity capital balance sheet can be used to analyze the risks facing a financial intermediary that is operating under some kind of risk-based capital regulation. It is vital to have a single framework that permits management to estimate how different decisions affect average profit and profit variability from the perspective of both shareholders' expectations and regulators' rules.

Implementation of these sorts of technical ideas produces a need for organizational changes at both the product management level and the corporate management level.

At the product level, the interdependence of design, pricing, and funding decisions calls for an integrated product team rather than separate functional units. Under integrated ALM the ongoing use of product portfolio simulation and optimization tools replaces the functional perspective's decentralized application of operational rules-of-thumb in light of the corporate plan's forecast. The nature of the technical decision-support tools calls for a tightly integrated staff responsible for all decisions related to a product or business line. This is true for existing products and even more so for new financial products where understanding the interdependencies among the design, pricing, and funding decisions is particularly important to the success of the new product.

Recent trends in the manufacturing sector — especially among firms facing frequent new product introductions — provide an organizational model for financial intermediaries implementing elements of integrated ALM. Innovative manufacturing firms have had success with the concurrent engineering approach that involves establishment of a product team that combines marketing, engineering, and manufacturing staff. This approach speeds up the new product introduction cycle largely by providing the integrated team an opportunity to consider the interdependencies of all the different decisions simultaneously rather than sequentially by different functional units.

For a financial intermediary that is implementing technical aspects of integrated ALM for management of a product or business line, the obvious organizational corollary is to establish a group that integrates staff from several functional areas and appoint a group manager that is responsible for all decisions related to that product or business line. It is the responsibility of that group and its manager to use the technical simulation and optimization tools in a way that internalizes the interdependencies of all the decisions. The group and its manager are evaluated based on the prospective certainty-equivalent ROE of the product or business line rather than on retrospective profitability, which can be influenced by good or bad luck in the realization of the business environment. The use of a prospective, risk-adjusted performance measure is essential if the potential future implications of current decisions of a product group manager are to be assessed by top management.

These organizational ideas are consistent with those of the business reengineering movement as described by Hammer and Champy (1993), for example. The objective of reengineering is to redesign the work process in a way that provides quality products produced in a cost-effective manner by taking advantage of the automation possibilities presented by modern

computer systems. The computer-based technical tools of integrated ALM provide the automation opportunities for reengineering the financial product management process.

This description of the technical and organizational aspects of integrated asset-liability management is developed in more detail by Holmer and Zenios (1995).

1.4 Challenges of Integrated ALM

The adoption of elements of the integrated ALM perspective by innovative financial intermediaries indicates that some top managers believe that, all things considered, it is likely to produce better results than would the older functional management perspective. While judged better, it is not perfect in the sense that that there are no problems or challenges associated with integrated ALM. It has been chosen because its problems have been judged less difficult to live with than the problems associated with the functional management perspective. This section concludes with list of some of the challenges facing top managers who decide to implement changes inspired by the integrated asset-liability management perspective.

The technical challenges are mostly related to development and use of the portfolio simulation and optimization tools that form the technological core of integrated ALM. Depending on the nature of the financial product, such a simulation-optimization model can be quite complex conceptually and this complexity may present substantial computational demands. The conceptual complexity requires staff with substantial skills in both applied finance and software development since appropriate tools are almost never available on the market and hence need to be designed, constructed, and maintained by internal staff. The computational demands can often be met by creating tools that distribute processing across a network of workstations. This is far less expensive than buying a supercomputer, but the equipment savings requires skilled staff to develop the distributed-processing tool and to maintain a reliable network of workstations.

Once a simulation-optimization model has been developed for a product or business line, most financial intermediaries are likely to experience challenges in providing the asset and liability data necessary to support the model's calculations. More broadly, much of the data required to support the integrated ALM perspective will be new, and therefore, effort will be required to extract these new data from existing operational computer systems. These data problems are not conceptually difficult, but may require

substantial effort to solve depending on the state of the intermediary's operational computer systems. This data collection challenge may be viewed as an example of the problems associated with the development of any new decision-support database.

After the development of the simulation-optimization model and implementation of the process by which its decision-support database is updated, problems associated with determining the best way to use the model in daily decision making remain to be solved. There are conceptual as well as practical problems involved in determining how the model can best be used to support management decision making. Many of these problems can be solved by staff training on the theoretical concepts and practical use of the model. Other problems are more difficult to handle because they are related to how staff are organized and how their performance is measured. These organizational challenges require strong leadership from the top managers who are initiating the shift from the functional management perspective to the integrated ALM perspective.

The organizational challenges are mostly related to the fact that the highly interdependent product decisions that once were made in separate functional units loosely coordinated by the corporate plan, are now best made in product groups. It would be difficult to overestimate the problems involved in transforming an organization consisting of functional units into one where all decisions regarding a product are the responsibility of a product group and its manager. To accomplish this transformation, there is no substitute for a clearly thought out reorganization plan and the commitment of top managers with substantial leadership skills. Such a reorganization may be implemented over a period of years, but no matter what the pace, it will face the following issues at a minimum.

Each product or business line group and its manager need to have performance measures by which the results of their work will be judged by top management. The kinds of prospective risk-adjusted performance measures that are consistent with the integrated ALM perspective are often unfamiliar to managers who have experience with retrospective measures. Beyond this acceptance problem, periodic reviews of product group managers that take place in a timely fashion will produce additional demands on the staff responsible for gathering data and operating the model.

The remaining two organizational challenges mentioned here are problems likely to be faced by the financial intermediary's top management in their coordination of the decisions made by several product groups or business lines. Unlike the challenges mentioned above, I am not aware of broadly

accepted solutions to these problems. If they are unsolved problems, their description can be viewed as an attempt to formulate management research topics.

The first of these product group coordination challenges arises when the scenario ROE distribution of one group is potentially negatively correlated with the scenario ROE distribution of another product group. Consider the simplified situation in which the first group can make one of two sets of product decisions called A and B. The A decisions produce a scenario ROE distribution that is not correlated with the scenario ROE distribution of the second group and has a relatively high certainty-equivalent. The B decisions produce a scenario ROE distribution that is negatively correlated with the scenario ROE distribution of the second group, but has a certainty-equivalent that is not as high as that produced by the A decisions. Suppose the strength of the negative correlation causes the certainty-equivalent ROE for the two groups considered together to be higher when the first group makes the B decisions than when it makes the A decisions. When the first group makes the B decisions, it can be said that it is a natural hedge for the scenario ROE distribution of the second group. How can the corporate-wide benefits that would result from the first group making the B decisions, which are suboptimal from the myopic view of the first group, be made apparent to the manager of the first group? And, if a scheme were devised to send the correct signal to the first group, how should the benefits of the natural hedge be allocated across the product groups?

The second of these product group coordination challenges arises when top management allocates capital across the several product groups or business lines. From the shareholders' point of view the objective of this allocation of equity capital should be to achieve a desirable corporate-wide scenario ROE distribution. What exactly that desired distribution will look like depends on the diversification opportunities available to shareholders in the capital markets. From the regulator's point of view the objective of this allocation of equity capital should be to reduce the probability of insolvency, and therefore, the likelihood that the regulator would have to make good on its insurance of the financial intermediary's liabilities. Since the regulator has few, if any, diversification possibilities, there is little reason to believe that these two different points of view on proper capital allocation will imply similar allocations. This problem could be conceptualized as a complex dual objective optimization problem, but currently most regulated financial intermediaries grapple with this difficult problem using more *ad hoc* methods.

2 FNMA as a Financial Intermediary

This section provides a short description of FNMA (the Federal National Mortgage Association or Fannie Mae) and its three major business lines. The description includes short accounts of FNMA's mortgage insurance business, its REMIC (real estate mortgage investment conduit) underwriting business, and its mortgage investment business. These accounts are intended to provide background information for the subsequent section's discussion of how FNMA has introduced elements of integrated asset-liability management to solve past business problems.

FNMA is a United States government-sponsored enterprise that is chartered by an act of Congress, owned by shareholders, and regulated by OFHEO (the Office of Federal Housing Enterprise Oversight, which was established in 1993). FNMA was created in the 1930s with the objective of providing financial products and services in the secondary mortgage market that increase the availability and affordability of housing for low-, moderate-, and middle-income Americans.

2.1 Mortgage Insurance Business

FNMA does not directly extend mortgage loans to home buyers. Rather than operate in the primary market, its role is to maintain a secondary mortgage market by engaging in different kinds of transactions with the financial intermediaries that make mortgage loans to individual home buyers. One important kind of secondary-market transaction involves FNMA insuring a group of mortgage loans against payment delay or default by the home buyer and pooling that group of mortgage loans into a single-class mortgage-backed security (MBS). The ownership of the MBS may be shared between several investors, with the total monthly payment proportional to each investor's ownership share and the mixture of a given month's principal and interest the same for each investor.

This transaction may be thought of as creating a structured balance sheet with the liabilities consisting of the single MBS and the assets consisting of numerous home mortgage loans. All the monthly (scheduled and prepaid) principal payments and most of the monthly interest payments from the mortgage loans are passed from the home buyers, through the financial intermediary that services the loan and through FNMA, to the investors who own fractions of the MBS. The MBS agreement calls the servicer to remove a small fraction of the interest payments each month as a charge for

the administrative costs incurred in servicing the loan. And FNMA removes a small fraction of each month's interest payments as an insurance premium — that is, a charge for insuring the amount and timing of the mortgage principal and interest payments to MBS investors.

A substantial fraction of home mortgage loans have been pooled into insured MBS by FNMA or its main competitor, FHLMC (the Federal Home Loan Mortgage Corporation or Freddie Mac), which is also a government-sponsored enterprise. This pooling and insuring activity has the important capital market effect of facilitating the sale of mortgage loans by the originators to investors whose liabilities are better suited to long-term mortgage assets than are the short-term liabilities of most mortgage originators. Decades ago before the current high volume of MBS creation, mortgage originators such as banks, S&Ls, and other thrift institutions, typically held fixed-rate mortgage loans as long-term assets even though they created a severe duration mismatch with their short-term deposit liabilities. The rise in interest rates during the 1970s and early 1980s exposed this problem and resulted in widespread regulatory closures of insolvent financial institutions. Now the remaining mortgage originators are more likely to convert their loans into MBS and sell the MBS to investors with longer-term liabilities such as pension funds and life insurance companies. These investors find MBS much more desirable than a group of individual loans because of the administrative simplicity of dealing with a bulk security that can be easily traded and because of the credit enhancement provided by the insurance. After the MBS creation and sale, the originator is left with the loan servicing responsibilities. But even that responsibility and the associated servicing fee can be sold to other companies that specialize in providing this kind of computer-intensive administrative service. This leaves the mortgage originator with the option of specializing exclusively in the business of underwriting loans for an origination fee.

From FNMA's perspective, these transactions comprise a mortgage insurance business. As in any insurance business, premiums constitute income and claims constitute expenses. The delay between premium receipt and claim payment permits investment of premium proceeds and the earning of addition investment income on these reserve assets and on the equity capital assigned to this business line. The key management activities involved in conducting this business are establishing and enforcing loan underwriting guidelines for the mortgage originators, developing a pricing schedule for MBS transactions that involve a variety of loan types, and determining an investment strategy for the reserve assets. The underwriting guidelines may

be thought of as direct regulation of the kinds of mortgage loans that are eligible to be insured, while the pricing schedule may be viewed both as risk-based insurance premiums and as financial incentives that influence the kinds of mortgage loans that are actually converted into MBS. Since the possibility of mortgage prepayment makes premium income uncertain and the claims associated with mortgage defaults or payment delays are highly uncertain, the prospective profit and return on equity generated by an MBS transaction is sensitive to movements in interest rates in the national capital markets and to movements in prices in local housing markets. And, of course, the pattern of reserve asset investments can substantially influence some aspects of this profit sensitivity.

2.2 REMIC Underwriting Business

Despite its considerable advantages over individual mortgage loans, the MBS presents problems for investors who want assets with certain target durations. The monthly principal payments generated by a fixed-rate MBS can be spread over several decades unless a sharp fall in rates produces a large volume of prepayments as home owners refinance during a short period of time. The response to this demand for mortgage securities with more targeted durations was the collateralized mortgage obligation (CMO), the first one of which was issued in 1983 by FHLMC. The federal tax status of these multiple-class securities was clarified in the tax reform of 1986, which created a type of CMO called a real estate mortgage investment conduit (REMIC). For an account of the development of pre-REMIC CMOs, see Parseghian (1987).

The REMIC is a legal trust whose assets are MBS and whose liabilities are multiple classes of bonds, the interest and principal payments of which are determined by the timing of the MBS cashflow and by the rules of the trust. The rules are fixed, which means that the trust can be thought of as a completely passive asset-liability management scheme that passes on to investors in the different bond classes all the interest-rate risk inherent in the underlying MBS collateral and trust rules. These rules can be relatively straightforward or quite complicated depending on how the REMIC is designed to channel the MBS cashflow to interest and principal payments on each REMIC bond class. Residual cashflow is paid to owners of the REMIC's equity class.

Both the number of REMIC bond classes and the complexity of the rules that channel MBS cashflow to the classes increased considerably during the

1980s. The early issues consisted of only three or four classes and a simple sequential principal payment rule. In such a simple issue, all the MBS principal would be paid to the first bond class until it was completely retired. Then all the MBS principal would be channeled to the second bond class, which had been receiving fixed-rate interest payments while the first class was being paid down. This kind of sequential principal payment rule creates bond classes with very different durations, some of which are suitable for investors with relatively short duration liabilities (e.g., banks) and others of which are suitable for investors with relatively long duration liabilities (e.g., pension funds).

By the 1990s, a typical REMIC issue would consist of one or two dozen bond classes of great variety. Some classes would have coupon interest rates that floated according to formulas that sometimes magnified the movement in the underlying index interest rate; others would have simple fixed rates. Some classes would have their principal payments governed by trust rules that stabilized their timing and duration as long as MBS prepayments remained within a certain range; others served as prepayment shock absorbers making their duration quite sensitive to the uncertain timing of MBS prepayments. In other words, the trust rules did nothing to change the contingent nature of the MBS cashflow, but did produce REMIC bond classes with a wide variety of contingent cashflow characteristics.

The high volume of REMIC issuance by FNMA and FHLMC during the late 1980s and early 1990s produced a situation in which about two-thirds of all MBS had become REMIC collateral by 1994. This development has had important capital market effects. The more extensive tailoring of the contingent cashflow characteristics of REMIC bond classes (relative to those of the MBS collateral) provides investors with a wider range of assets with which to match their liabilities. And the high demand for MBS as REMIC collateral has caused a relative increase in their prices, enabling mortgage originators that securitize their loans to offer home buyers lower rates.

From FNMA's perspective, the issuance of REMICs comprises a large, but specialized securities underwriting business. The fees generated by this underwriting business arise from selling the REMIC bond classes and equity class for more than the cost of purchasing the MBS collateral that constitute the REMIC's assets. Other than the administrative costs associated with making the monthly principal and interest payments and providing REMIC investors with tax statements, there are no costs to REMIC issuance after the trust has been endowed with its MBS collateral. Since the MBS are relatively standardized and trade in a relatively active market, the key to

high underwriting fees is structuring the bond classes in a way that they can be sold at relatively high prices to the different kinds of investors for which they have been designed. This requires extensive knowledge of the investment objectives of a wide variety of potential investors as well as maintenance of trading relationships with all the investors. These requirements mean that the two key management activities involved in conducting this business are designing the REMIC bond classes and then marketing the REMIC bonds to investors.

2.3 Mortgage Investment Business

FNMA helps maintain a secondary mortgage market by also engaging in mortgage investment transactions that are completely different from the securitization activities involved in the mortgage insurance and REMIC underwriting businesses. The mortgage investment business involves buying mortgage securities and holding them as portfolio investments. Most of the funds used to buy the portfolio's mortgage assets are obtained by issuing FNMA liabilities such as bonds. The remaining funds represent the portion of FNMA's equity capital that has been allocated to this business line. While most of the portfolio's assets are individual mortgage loans that have been purchased from originators, some of the portfolio's assets are MBS and REMIC bonds that have been purchased on the open market.

The purchase of mortgage securities for portfolio investment helps maintain a secondary mortgage market in at least two significant ways. First, it provides mortgage originators with sales opportunities for small amounts of loans that in larger volume would be appropriate for MBS pooling. And second, it provides originators a sales outlet for unusual kinds of loans for which there is not yet an MBS market. In both these ways, the mortgage investment business contributes to the overall objective of increasing the availability and affordability of mortgage funding.

From FNMA's perspective, these mortgage investment and liability issuance transactions comprise a classic portfolio management business. Since the cashflow of the assets in highly contingent on future interest rates and prepayments and the portfolio is large and highly leveraged, there is a substantial challenge involved in the asset-liability management of the interest rate risk potential of the portfolio. The key management activities involved in conducting this business are deciding what mortgage assets to buy and what kind of bonds to issue. An additional important management decision is the mixture of debt and equity funding of the mortgage assets.

3 FNMA's Movement to Integrated ALM

This final section presents accounts of how FNMA introduced elements of integrated asset-liability management to solve business problems that have arisen over the course of the 1980s and 1990s. The first account focuses on the large financial losses experienced by the mortgage investment business during the early 1980s and on the subsequent shift to integrated management of the interest rate risk inherent in that business. The second account discusses the creation of the mortgage insurance business in the early 1980s in response to the problems in the mortgage investment business and the subsequent development of integrated techniques to manage the credit risk inherent in that business. The third account examines the development of the REMIC underwriting business following the 1986 tax reform, the collapse in underwriting volume following the sharp rise in interest rates during 1994, and the management options available to deal with this collapse. The last account focuses on early 1990s changes in the management of corporate equity capital that were introduced in response to an increase in the scope and intensity of regulation.

3.1 Investment Business Management Changes

According to OFHEO (1995, Historical Data Tables), FNMA earned $162 million in 1979 and ended the year with a balance sheet that consisted of $49.8 billion in mortgage assets, $1.5 billion in other assets, and $48.4 billion in debt outstanding. At the end of the 1970s, FNMA had issued no MBS and the CMO/REMIC had not yet been invented. The book value of its equity capital was about $1.5 billion. All profits were being generated by the mortgage investment business, which was the only line of business being pursued by FNMA.

The rise in interest rates early in the 1980s created a severe problem for FNMA since its mortgage investment business (like that of most thrifts) was not well structured at that time. According to Holmer (1994, page 5), the duration of FNMA's fixed-rate mortgage assets was estimated to be 62 months in 1980, while the financing debt had an estimated duration of 26 months, producing a duration gap of 36 months. The rise in rates left FNMA with a negative net interest income on its mortgage portfolio and overall losses of about $200 million in both 1981 and 1982. Smaller losses were experienced in 1984 and 1985. The book value of equity capital dropped by more than a third and did not surpass its 1979 value until the

end of 1987.

Following the 1981 change in corporate leadership, FNMA solved this mortgage investment business problem in two stages. The first stage continued to use functional management techniques including a corporate planning model that produced a forecast of the mortgage portfolio's expected return on equity given macroeconomic forecasts of interest rates and mortgage origination volume. The first-stage innovation was the introduction as a management goal of asset and liability duration matching. The new duration matching strategy was supported by a simulation model — inherited from the 1970s — that used a number of *ad hoc* interest rate scenarios to estimate the duration of mortgage assets and financing debt. This model was also used to gauge the desirability of mortgage investments by estimating for each scenario the internal rate of return of a debt-financed mortgage investment considered on a stand-alone basis in isolation from the existing portfolio.

The mortgage portfolio's duration gap was reduced from its 1980 value of 36 months to 8 months in 1987 and to 3 months at the end of 1990 through a combination of measures aimed at decreasing the duration of mortgage assets and increasing the duration of financial liabilities. The asset duration in 1990 had decreased to 41 months (from 62 months in 1980) through the acquisition of both adjustable-rate mortgages, which first appeared in the early 1980s, and 15-year fixed-rate mortgages. The liability duration in 1990 had increased to 38 months (from 26 months in 1980) through the issuance of longer term non-callable bonds.

Once the mortgage portfolio had become roughly duration matched, the limitations of the first-stage management techniques became apparent. These techniques presented at least three key problems that prevented effective management of the trade-off between the portfolio's expected ROE and risk. First, expected return was measured in ROE percentages and risk was measured in duration gap months, which raised difficult questions about how to integrate the two into a comprehensive risk-adjusted measure of prospective portfolio performance. Second, the desirability of new transactions was analyzed on a stand-alone basis in isolation from the existing portfolio of mortgage assets and debt, making it impossible to gauge the effect of a transaction on the portfolio's performance. And third, the stand-alone analysis of new transactions operated in a what-if mode rather than using optimization methods that could systematically find the combination of transactions that most improve the portfolio's performance.

During the late 1980s, FNMA began development of a new simulation-

optimization model that could overcome these problems. The ALMS (Asset-Liability Management Strategy) system, whose conceptual design and computer implementation are described in detail by Holmer (1994), uses Monte Carlo simulation, modern finance, expected utility, and optimization techniques to find the combination of assets and liabilities that maximize the expected utility of the portfolio's holding-period ROE distribution across future interest rate scenarios. After a prototype met expectations, a multi-user, distributed-processing version of the system was developed using a client-server architecture with a relational database management system running over a network of Unix workstations.

This production version of the ALMS system became operational company wide in the early 1990s and its use led to a number of important changes in the conduct of FNMA's mortgage investment business.

From the earliest prototype days, the ALMS system's portfolio analysis results played a major role in rationalizing FNMA's shift toward callable debt financing of its mortgage investments. The use of expected utility theory and the certainty-equivalent ROE concept, which combines the expected return and interest-rate risk of a portfolio in a rigorous fashion, allowed senior management to characterize portfolio risk reduction that involved issuing higher-coupon callable debt as an activity that increased risk-adjusted ROE. Use of the certainty-equivalent ROE concept became routine among FNMA financial managers and the concept was used in presentations to Wall Street equity analysts and shareholders. As a result, FNMA moved from having no callable debt financing of its mortgage assets in the 1980s to being one of the world's largest corporate issuers of callable debt in the 1990s.

As the production version of the ALMS system was being implemented across the company, FNMA undertook for other reasons a comprehensive review of its computer operations. The consultants who were assigned this task were advocates of organizational reengineering concepts and were puzzled by the mismatch between the new integrated asset-liability management tool and the old functional management structure and staff organization. The company-wide availability of the ALMS system and the reengineering perspective of the consultants focused senior management on the question of how best to use the new tool. After several years of staff reorganization, the organization of the mortgage investment business has become more integrated and focused on use of the ALMS system as its analytical tool. By the mid-1990s the older models had fallen out of use and the group that had been responsible for developing the corporate plan disappeared.

3.2 Insurance Business Management Changes

FNMA entered the mortgage insurance business in 1981 in an attempt to reduce its reliance on the mortgage investment business, which was losing money. At that time the business was dominated by FHLMC which engaged in mortgage insurance but not mortgage investment activities. The management strategy was obvious: start a new business line that could generate profits to offset losses in the existing business line and expand the new business line by turning a monopoly into a duopoly.

The main challenges facing FNMA in starting this new mortgage insurance business were establishing mortgage loan underwriting guidelines and creating procedures to determine guarantee fee quotations for mortgage originators interested in transforming loans into MBS. A functional management structure was implemented to handle these start-up challenges. The credit policy group developed underwriting guidelines for the new MBS business and the marketing group broadened its loan buying activities to include pooling mortgage loans into MBS. Guarantee fee quotes were developed informally in reference to FHLMC quotes. Representatives of these groups met regularly to coordinate actions and consider non-routine MBS transactions.

The expected challenges of starting a new business line were compounded by early problems with Texas and Alaska mortgage defaults. After the sharp drop in crude oil prices during the mid 1980s, the economies of Texas and Alaska collapsed leading to substantial declines in house prices in those areas. As mortgage interest rates dropped, many homeowners in those areas found themselves paying high rates on houses that were worth as little as half the mortgage loan amount. The ensuing wave of mortgage loan defaults placed considerable pressure on the start-up business line. Management responded by tightening underwriting guidelines and by initiating the development in the finance group of a Monte Carlo simulation model that would determine guarantee fee levels that would produce a target rate of return on MBS comprised of mortgage loans with different risk attributes.

Development of the Financial Analysis Simulation Model began in 1985 and continues to be directed by Mike Goldberg, a vice president in the finance group. The model was originally based on mortgage prepayment rate and default probability equations estimated with data on Federal Housing Administration mortgages. Using Monte Carlo methods and a short- and long-rate stochastic process from the finance literature, the model estimates the minimum guarantee fee that generates a target risk-adjusted internal

rate of return on the cashflow associated with a particular pool of mortgage loans that is being proposed as an MBS security. Later during the 1980s, corporate data on the prepayment and default history of various types of mortgage loans were used to estimate the prepayment and default probability equations. At the beginning of the 1990s, the model was moved off the mainframe onto Unix workstations and work began on preparing corporate data so that they could be used to estimate the parameters of a stochastic process for house prices. By the mid 1990s, this statistical research had advanced to a stage that allowed the model to recognize regional differences in the parameters of house-price stochastic process.

Beginning in the early 1990s, the internal inefficiencies of the functional organization of the mortgage insurance business and competitive pressures from FHLMC lead to major changes in the mortgage insurance business. The reengineering consultants recommended an approach in which the central-office meetings of the functional group staff representatives would be replaced by integrated regional-office marketing staff querying an internal, on-line guarantee fee quotation system. This system provides a range of risk-based guarantee fee quotes for a very large number of different mortgage pool types, thus providing marketing staff with a quick indication of the appropriate bargaining range for a wide variety of different kind of MBS transactions.

By the mid-1990s, this internal re-engineering effort had expanded to focus on the nature of business relations between FNMA and mortgage originators. FNMA has begun to offer a variety of software products and network services that automate a wide range of mortgage origination activities including the application of underwriting guidelines, credit checks, and property appraisals. FHLMC is also beginning to offer similar software and network connections to mortgage underwriters. These initiatives are significant enough to characterize as the beginnings of a re-engineering of the mortgage origination industry in the United States. For a more detailed discussion of this effort, its effect on mortgage originators, and the possible risks for FNMA and FHLMC, see the regulatory discussion by OFHEO (1995, pages 1–7). Given the existence of the internal guarantee fee quotation system and this initiative to re-engineer the business relationship between FNMA and mortgage originators, the next logical step would be to consider extending some version of the on-line guarantee fee quotation system directly to mortgage originators. Whether FNMA management would consider this development to be advantageous is unclear, but it is rapidly becoming technologically feasible.

These model development and re-engineering activities draw the attention of staff in many nominally separate groups to the task of developing the automated system through which FNMA interacts with mortgage originators. The focal point of all this activity are the staff that actually develop the software components of the system. Regardless of the nominal organizational structure, the credit policy, finance, marketing, and information systems staff who develop this system have become an integrated work group. It is the technological imperatives created by the use of computer-based management and decision-support tools, which incorporate all the functional aspects of the business decisions, that drives the organization toward functional integration.

FNMA's entry into this new business line has proven successful over the past decade and a half. FNMA's share of MBS outstanding grew from 0% in 1980 to 48% in 1990 and 51% in 1994, according to figures supplied by OFHEO (1995, Historical Data Tables). And this new business volume is reasonably profitable since the mortgage insurance business contributes a substantial fraction of FNMA's earnings.

3.3 Underwriting Business Management Changes?

FNMA entered the REMIC underwriting business following the tax law changes of 1986. The volume of REMIC bonds underwritten grew from nothing in 1985 to nearly $211 billion during 1993, then dropped according to OFEHO (1995, page 45) to an annual rate of $5 billion during the first quarter of 1995 following the rise in interest rates during 1994. During the 1986–1993 initial expansion phase of the business, FNMA essentially subcontracted the two main management activities of the business — REMIC bond design and marketing — to Wall Street investment banking firms. The underwriting profits, which are generated by selling the REMIC bonds for more than the cost of the REMIC's MBS collateral, are split between the investment banking firm and FNMA. During these years the business grew rapidly and made a non-trivial contribution to FNMA's profits.

As described above, the bond classes of a typical REMIC vary considerably in their interest rate risk. Since the basic mortgage prepayment risk is complex and the REMIC trust rules have typically become quite complicated, there is a substantial challenge involved in assessing the nature and degree of interest rate risk inherent in many REMIC bonds. It seems clear in retrospect, that a two-tier REMIC market arose during the late 1980s and early 1990s. In the upper tier of the market, REMIC bonds were purchased

by investors who either bought low-risk bonds or knowledgeably bought higher-risk bonds. This latter group in the upper tier typically quantified the interest rate risk of REMIC bonds using modern finance models, which allow them to determine if a bond is priced fairly given its risk attributes and to ascertain whether the particular kind of interest rate risk exhibited by a bond is compatible with the overall risk exposure of the portfolio to which it would be added. In the lower tier of the market, REMIC bonds were purchased by less knowledgeable investors who typically bought higher-risk bonds without the advantage of a model's assessment of their fair price or risk attributes. Buyers in the lower tier of the REMIC market fall into two classes: smaller institutional investors (e.g., small pension funds or local governments) and individual investors. REMIC bonds were sometimes designated as "retail classes" by the investment banking firms if the marketing strategy was to sell these bonds to individual investors. To the extent that REMIC bonds were able to be sold in the lower tier for higher prices than in the upper tier of the market, this REMIC bond design and marketing strategy lead to higher underwriting profits than would a strategy of marketing solely to upper-tier investors.

One way to interpret the collapse in REMIC underwriting volume following the 1994 interest rate rise is that the substantial losses incurred by lower-tier investors drove up the REMIC bond prices in that tier enough to eliminate the profit on most REMIC underwritings. Given this interpretation of the development of a two-tier REMIC market, FNMA is currently facing a difficult business problem for which the solution is not obvious. The loss in underwriting profits is non-trivial, but it is not clear whether a change in the way the REMIC underwriting business is managed would solve the business problem.

One management strategy is to make no changes in the current practice of delegating REMIC bond design and marketing decisions to the Wall Street investment firms. This could be the best strategy if one thinks that other factors (e.g., a relatively flat yield curve) are the main causes of the collapse in REMIC underwriting volume. The no-change strategy could also be best if one thinks that the memories of 1994 losses will fade and REMIC bond prices will rise in the lower tier of the market enough to make most REMIC underwritings profitable. Even if these developments do not materialize, low REMIC underwriting volumes have a silver lining: the lack of REMIC collateral demand lowers the prices of MBS making them more profitable from the point of view of the mortgage investment business. Whether the no-change strategy is best depends on the alternative management strategies

available to FNMA.

The strategy of not delegating REMIC bond design and marketing to Wall Street investment firms is clearly not viable. To handle these tasks effectively, FNMA would have to develop extensive advisory and trading relationships with investors who consider REMIC bonds as just one of many kinds of portfolio investments. This would require enormous effort in an area where FNMA has no substantial experience. Even if these difficulties could be somehow overcome, this no-subcontracting strategy still leaves open the question about how to deal with the two-tier REMIC market, which the analysis above suggests is at the heart of the business problem facing FNMA.

One alternative strategy is to continue to delegate REMIC bond design and marketing activities, but to impose some structure on the kinds of bonds that can be designed and marketed. This strategy would require each REMIC bond to be an example of one of several dozen generic types of REMIC bond. The working hypothesis behind this strategy is that lower-tier investors over reacted to the 1994 losses because the risk they face in buying REMIC bonds is unknown since they have no access to sophisticated pricing and risk models. By ensuring that all REMIC bonds were of know generic types, it becomes possible to produce and sell the kinds of financial models not now available to lower-tier investors. The main reason why such models are not available on the market is that the constant "innovation" of new kinds of REMIC bonds means that models become out-dated quickly and the cost of keeping them up to date is able to be borne only by larger upper-tier investors. Whether such models were sold by third-party vendors or by FNMA itself, the availability of such models could reduce to fear of currently unknown interest rate risk in the lower tier and actually lead to a rise in REMIC bond prices in that tier.

It is too early to know how FNMA will try to solve this business problem. FHLMC also faces the same problem. The competition between the two may generate pressure for innovative solutions to the problem. If either firm gives serious consideration to this regulated-subcontracting strategy, many of the same kinds of technical and organization issues associated with earlier introductions of modern quantitative finance modeling techniques will have to be dealt with.

3.4 Capital Allocation Among Businesses

Since the early 1990s a number of developments have lead to changes in how FNMA decides to allocate equity capital among each of its major busi-

ness lines. Several forces have lead to the increasing use of modern finance techniques to support these management decisions — the intellectual momentum generated by the earlier adoption of an integrated asset-liability management approach in the mortgage investment and mortgage insurance businesses, the arrival of new set of top managers, an increase in regulatory pressure to be adequately capitalized, an increase in political pressure to expand business activities that serve lower-income home buyers, and the continuing pressure to increase profits and raise the firm's stock price.

By the mid 1990s, FNMA had identified a manager for each business line or activity and developed a quarterly assessment procedure employing prospective measures of the profitability and risk associated with capital invested in each business line. The ALMS system, which was originally developed to support integrated asset-liability management of the mortgage investment business, has been extended to help support this assessment procedure. The logical momentum of earlier integrated asset-liability management efforts and the desire by the new top management team to organize things differently both contributed to the adoption of this kind of capital allocation procedure.

Another powerful force that continues to force changes in the way FNMA allocates equity capital is the development of capital regulations by OFHEO, the new regulator of FNMA and FHLMC. The advent of explicit capital standards has lead to a number of changes in the quantitative models used to support decision-making in the mortgage insurance and mortgage investment businesses. The regulations are not final and as they evolve, the simulation and optimization models used by FNMA will continue to the revised so they can support decision making in the more regulated environment.

While the impetus to adopt or enhance integrated asset-liability management techniques has often come from unanticipated business problems or from increased regulatory and political pressure, the use of these modern finance techniques has enabled FNMA not only to deal effectively with the problems and pressures, but also to provide its shareholders with a more compelling case about why they should invest.

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The case studies also indicated that Mexico, Australia, and Korea have solid legal and regulatory frameworks for PPPs designed to promote investments in infrastructure. The federal government of Mexico established several measures to promote infrastructure investment through domestic sources of funding at a time when the global financial crisis weakened the international credit market.Â Recent initiatives In May 2014, COAG agreed to implement an asset recycling initiative. Under the initiative, the Australian Government has made $5 billion available to State and Territory Governments that sell assets and reinvest the proceeds into new infrastructure. To simplify the asset liability management case study and the learning plan we will assume that contractual maturity of assets and the re-pricing of assets is the same in all instances. This means that the rate gap, reset gap, price gap and maturity gap are all equal and will have the same values. In later posts, we can relax this assumption. Handbook of Asset and Liability Management, Volume 2: Applications and Case Studies (Handbook of Asset and Liability Management) (Handbook of Asset and Liability Management). 685 Pages Â· 2007 Â· 7.28 MB Â· 8,670 DownloadsÂ· English. by Stavros A. Zenios & William T. Ziemba.Â of engineering asset management as presented at the Eight World Congress on Engineering Asset M An Introduction to Banking: Liquidity Risk and Asset-Liability Management. 384 PagesÂ·2011Â·3.56 MBÂ·2,530 DownloadsÂ·New! : Liquidity Risk and Asset-Liability Management Moorad Choudhry|Oldrich Masek Anger Management Best Practice Handbook: Controlling Anger Before it Controls You, Anger Management.