Financial Intermediaries and Interest Rate Risk: II

By Sotiris K. Staikouras

The current work extends and updates the previous survey (Staikouras, 2003) by looking at other aspects of the financial institutions' yield sensitivity. The study starts with an extensive discussion of the origins of asset-liability management and the subsequent work to identify effective ways of measuring and managing interest rate risk. The discussion implicates both regulatory and market-based approaches along with any issues surrounding their applicability. The literature is enriched by recognizing that structural and regulatory shifts affect financial institutions in different ways depending on the size and nature of their activities. It is also noted that such shifts could change the bank's riskiness, and force banks to adjust their balance sheet size by altering their maturity intermediation function. Besides yield changes, market cycles are also held responsible for asymmetric effects on corporate values. Furthermore, nonstandard investigations are considered, where embedded options and basis risk are significant above and beyond the intermediary's rate sensitivity, while shocks to the slope of the yield curve is identified as a new variable. When the discount privilege is modeled as an option, it is shown that its value is incorporated in the equities of qualifying banks. Finally, volatility clustering is further established while constant relative risk aversion is not present in the U.S. market. Although some empirical findings may be quite mixed, there is a general consensus that all forms of systematic risk, risk premia, and the risk-return trade-off do exhibit some form of variability, not only over time but also across corporate sizes and segments.

I. INTRODUCTION

Financial intermediaries and banks in particular play a pivotal role in economic development and welfare. They are key players in the allocation of capital and, hence, in stimulating growth. There is actually an established relationship between the GDP growth per capita and bank credit. In the United States, financial institutions are heavily regulated aiming to ensure the safety of the economic system by limiting both the likelihood and magnitude of these institutions' failures. The social cost of bank[1] failures has induced the government to provide forms of support and protection. The Federal Deposit Insurance Corporation (FDIC) explicitly guarantees the principal of bank deposits (up to a limit) and U.S. regulators, through their closure policies, have implicitly insured all deposits in large banks. The international banking community, via the Basel Committee, has also put forward a number of proposals to strengthen the solvency of the global banking system. Among the committee's various concerns is the measurement and management of the banks' exposure to interest rate fluctuations. The latter, inherent in the very

[1] When discussing the banking industry, the paper refers to all depository institutions such as thrifts (savings and loan associations, savings banks), commercial banks, and credit unions.

nature of the banks' business, is one of the main exposures the industry faces both at a domestic and international level.

The risks that banks and financial intermediaries are exposed to stem mainly from the special functions[2] that these institutions perform, as well as the volatility in modern financial markets. One of the unique tasks these institutions fulfill is the asset transformation function. In acting as asset transformers, they create financial products whose value added to their clients is the alteration of financial risk. While performing their asset transformation function, financial institutions unavoidably mismatch their assets and liabilities, and subsequently expose themselves to interest rate fluctuations and many other risks. The Federal Reserve's monetary policy underpins the movements in market yields and remains an integral part of interest rate volatility. One of the most vivid examples in the U.S. history is the financial turmoil in the Savings and Loan (S&L) industry. The crisis had been brewing during the 1980s and the newly appointed government, in February 1989, announced its plans to rescue the stricken S&L sector. It was not long before the U.S. taxpayer realized that the initial estimate of $50 billion had risen to $153 billion. The latter refers to the cost incurred between 1986 and 1995, which was the most expensive period of this crisis.[3]

The origin of the phenomenon has become known as the balance sheet mismatch, a direct result of the asset transformation and maturity intermediation functions. When the S&L started funding their operations by offering competitive market rates, an indefensible gap opened up between their sources and uses of funds. In other words, the S&L industry failed to tackle the risk inherent in the funding of long-term fixed-rate mortgages by means of short-term deposits. The 1979 monetary policy ignited a long-lived and devoted attention of academics and policymakers for measuring and managing interest rate risk. Toevs (1983) reports that during 1979–80 the volatility in net interest income (NII) of large U.S. commercial banks was three times more than the one experienced during 1977–78, while Ohlson, Simonson, Reber, and Hempel (1980) report an increased bank margins' sensitivity attributed to the recent market conditions. It is, therefore, obvious that while the traditional credit risk exposure still remains one of the major risk factors, institutional debacles caused by interest rate fluctuations are not unusual.[4]

[2] For an excellent discussion on the specialness and the risks of financial intermediaries, the interested reader is referred to Gup and Kolari (2005) and Saunders and Cornett (2006).

[3] For more information on the S&L crisis, which started in 1979, the reader is referred to Curry and Shibut (2000). The S&L turmoil was triggered by the shift in monetary policy (October 6, 1979) that concentrated primarily on interest rates to one that attempted to control inflation. The Fed directed the trading desk to focus on monetary aggregates, letting the federal funds rate move more freely, which resulted in high interest rate volatility. For instance, in September 1979, the target range was 11.25% to 11.75%, while by December 1980 the Federal Open Market Committee's (FOMC) target rate was between 15% and 20%. The FOMC is the body through all important monetary policy decisions are made. It consists of the seven members of the Board of Governors along with the presidents of five district Federal Reserve banks. For other discussions related to bank management, see Gardner, Mills, and Cooperman (2000) and Gup and Kolari (2005).

[4] During the 1980s, one of the well-known fiascos in the industry is the case of First Bank System in Minneapolis (*Wall Street Journal*, Dec. 20, 1988). The interested reader is also referred to Sinkey (1983) for the case of First Pennsylvania Bank.

The importance of concentrating on market yields is discernible in various fronts. Interest rates have shown considerable volatility over the years and represent a large component of the U.S. Government's stock of marketable debt. Changes in interest rates play a profound role in the economy through their impact on the values of assets and liabilities of individual investors/corporations, as well as on a number of other economic variables, particularly those involved in monetary policy, debt management, asset pricing, analysis of contingent claims, and assessment of the accuracy of market implicit forecasts. Moreover, interest rate volatility does not appear to affect only corporations with nominal assets, but commercial and industrial firms such as utility companies [O'Neal (1998), Staikouras (2003)], and deposit rate regulation changes seems to have an impact on thrift values (Dann and James, 1982). Finally, examination of interest rate volatility facilitates the analysis of yields, volatility in debt instruments, estimation of liquidity premia, and provides the basis for investigation of portfolio returns.

One of the main challenges in this study is to explore certain aspects of the financial services industry's interest rate sensitivity. Yet, there are a number of papers focusing on the interest rate risk exposure of financial institutions, but examine the subject from different perspectives. For instance, in the context of consolidation within the banking industry Esty, Narasimhan, and Tufano (1999) find that acquirers are more liability sensitive than targets, but none of them is better positioned under different interest rate cycles.[5] Mei and Wang (2000) use a multifactor model for gauging the risks in emerging markets and relate bank excess risk premia to economic freedom and corruption level. Others examine the effect of tax shields[6] on risk taking by financial institutions (Gurel and Pyle, 1984) and show that, under a competitive loan market, the existence of these tax shields can lead banks to restrict their balance sheet maturity gap. Cross-country analysis and nonfinancial portfolios are also considered (Ferson, 1989; Prasad and Rajan, 1995), and the link of derivatives with interest rate risk is explored (Morgan, Shome, and Smith, 1988; Hirtle, 1997; Schrand, 1997). Elsewhere, the market risk exposure is higher during interest rate peaks (Booth, Officer, and Henderson, 1985) and deregulation (Books, Faff, and McKenzie, 1997), while others rebut the belief that bank stocks are different from industrial firms (Beedles and Buschmann, 1981), which is in contrast with recent findings by Viale, Kolari, Fraser, and Sorescu (2005). Hellwig (1994) argues that in the absence of additional moral hazard, unregulated[7] competition among banks will contribute toward the

[5] Practitioners often assert that the volume and pricing of deals is often higher in low-yield periods. This is partially supported by their findings.

[6] In the U.S., banks have many opportunities (foreign tax credits, investment tax credits, investment in tax-exempt securities) to shield current income against federal and state taxation. Note that Gurel and Pyle's model does not consider the hedging provisions of derivative instruments.

[7] It may be true that regulatory restrictions on lending and financing in the banking industry could possibly lead to a concentrated balance sheet without necessarily guaranteeing the "safeness" of the institution. For instance, real estate lending is always subject to market value risk. It is also worth remembering the interaction of interest rate risk and its by-products such as credit exposure. Hellwig suggests that potential credit risk can be avoided by transferring interest rate risk to depositors through securitization. The latter will void the counterparty risk and insure depositors' liquidity needs. See

efficient allocation of interest rate risk. The above studies introduce the variety of perspectives from where the phenomenon is examined, as well as the importance of assessing market and interest rate risk.

The present study enriches the literature by looking above and beyond[8] the findings of Staikouras (2003). The latter mainly concentrates on the theory behind the risk exposure of financial intermediaries, the justification of the leverage-adjusted duration gap, and introduces various applications of the two-index asset-pricing model. The current work looks at the theories on measuring and managing interest rate risk along with the origins of the asset-liability management (ALM) process. It further discusses the research related to the balance sheet optimization and considers the impact of regulatory and structural shifts in the economy on equity returns and profitability. Nonstandard approaches of measuring the net worth's exposure to yield changes and the use of conditional volatility frameworks in capturing the equity return-generating process of financial intermediaries are also analyzed. It is worth emphasizing, however, that in many cases it is difficult to classify papers under just one heading, but a conscientious effort is made based on the general objective/analysis of the research involved.

In what follows, Section II discusses some market-based facts of the interest rate risk exposure and touches the surface of the proposed Basel II framework. Sections III and IV go through the ALM literature along with the issues surrounding the net worth immunization. The next three parts, namely Sections V, VI, and VII, respectively, look at the impact of market cycles and monetary policy regimes on financial institutions; the nontraditional frameworks in explaining the stock return changes as a result of interest rate fluctuations; and the use of heteroskedasticity-consistent models in exploring the equity-yield relationship. Finally, Section VIII concludes the paper and provides an overview of the issues addressed, while the appendix provides a brief summary of the studies discussed.

II. INTEREST RATE RISK AND MARKET REALITIES

Changes in the regulatory framework, monetary policy, and market environment have crafted a prominent presence for interest rate risk. The advent of the phenomenon dates back in 1973, in the U.K., where a tightening of monetary and fiscal policy, along with the first OPEC oil price shock, caused interest rates to rise and saw property and stock market prices plummeting. The situation prompted a Bank of England-led life boat rescue for a number of "secondary" banks,[9] and

Saunders and Cornett (2006) for an excellent exposition of the securitization topic. The role of bank regulation has also been extensively debated (Benston and Kaufman, 1996; Dow, 1996; Dowd, 1992, 1993, 1994, 1996).

[8] Please note that none of the studies reported in the previous survey (Staikouras, 2003) are discussed here. This does not lessen their importance at all, but simply aims to avoid any repetition and overlapping between the two surveys. Wherever necessary the current work refers to specific sections in the previous review to establish the pertinent links.

[9] The secondary banks were established in the 1960s. Unlike the mainstream banks, which relied on relatively cheap, stable retail deposits, secondary banks use the growing wholesale money market to fund long-term loans to property developers and construction firms. The rise in interest rates contributed

it is today remembered as the secondary banking crisis. It is actually accurate to note that the origins of the secondary banking crisis are traced slightly earlier, in 1971, when competition and credit control took place as a result of financial liberalization. These reforms led the banks to lower loan rates quite sharply and bid more aggressively for deposits. When the government tried to control inflation by raising interest rates and reducing government expenditure, these banks saw their balance sheets flagging.

The final straw came in the late 1970s and early 1980s when the bank and thrifts' crisis hit the U.S. market, with the consequences being felt by the taxpayers and the economy as a whole for over a decade. The extent of the turmoil grew to be a major threat for the U.S. financial system and one of the most expensive financial sector crises the world has ever seen. Kane (1989) adeptly reviews the crisis and documents the causes and the severity of the problem. It is estimated that the thrifts' underwriting by the financial industry and the U.S. taxpayer cost an extraordinary $153 billion (Curry and Shibut, 2000). Curry and Shibut report that 19% of this cost was borne by the industry and the remaining 81% by the ordinary U.S. taxpayer. It is worth noting that the aforesaid cost does not include the goodwill litigation costs associated with FIRREA (Financial Institutions Reform, Recovery and Enforcement Act of 1989) as many cases have not been concluded yet. The debacle was essentially attributed to unmanaged asset-liability gaps that subsequently led to interest rate risk exposures and losses from lending to and investing in the U.S. commercial real estate sector.

The popularity of assessing and managing interest rate risk, or asset-liability management (ALM) in its broader sense, came as a result of the advent of money market certificates in 1978, the Federal Open Market Committee (FOMC) policy change in 1979, and the phasing out of Regulation Q in 1980. Each of these three events has changed, in their own way, the norm in which banks operate and manage their assets and liabilities (Gardner and Mills, 1981). As a consequence of the S&L debacle, the financial institutions' industry and the academic community have paid very close attention to the yield curve risk of the banking sector. The discipline of ALM has gone through enormous changes since its inception in the early 1970s. During that time, and in subsequent years, ALM begun slowly to bypass the dominance of the accounting perception and cash flow matching, and started instituting the use of advanced analytical techniques, quantitative finance tools, as well as sophisticated pricing formulas and hedging strategies.[10] Thus, the early 1980s witnessed the mark-to-market awareness, transfer-pricing, enterprise value and net income forecasting being undertaken with greater care and becoming vital features of the banking world.

to a sudden souring of the urban real estate market, which had been booming for 18 months, in late 1972. The interested reader is referred to Heffernan (2005) for detailed discussions on this and other issues related to the modern banking industry.

[10] For various aspects of the financial risk management process see Uyemura and Van Deventer (1993), Van Deventer, Imai, and Mesler (2005) and The Kamakura Corporation (1998). For an excellent exposition and discussion of the quantitative aspects of financial risk management see Kevin Dowd (1998).

There are a number of angles from where the interest rate risk exposure can be identified. Even if balance sheet matching occurs, bank income may still fluctuate as yield-sensitive assets and liabilities could have different repricing periods. This can be further magnified due to timing differences in the repricing between on- and off-balance-sheet instruments. The aforesaid cases become even more complicated when imperfect correlation in the adjustment of the yields earned and paid is introduced (i.e., basis risk of different base rates). Financial institutions also face the existence of implicit interest expenses,[11] as well as the fact that there are assets and liabilities (some types of retail loans and savings deposits) whose pricing is adjusted at will.[12] Another dimension of the interest rate risk is the slope of the yield curve, which could have differential effects on an institution's assets and liabilities. That is, the financing of short- and long-term assets with medium-term liabilities exposes the bank to a possible increased curvature of the yield curve. Furthermore, banks are subject to interest rate risk through the use of instruments incorporating embedded options with various call or put provisions. For instance, residential mortgages provide the borrowers with a prepayment or a call option on the house, which when exercised results in an unexpected change in cash flows and asset values for the lending firm.[13] The above are also associated with possible changes in the noninterest income, where depleting a pool of loans/mortgages curtails any fee income associated with lending activities.[14] Another source of yield exposure, usually ignored in the literature, is the rate at which market participants discount the lenders' expected cash flows,[15] which subsequently magnifies the institutions' vulnerability to interest rate surprises. Finally, the homogeneity of banks (same customers and similar marginal costs of funds) and their interdependence (participation in the network of interbank lending and deposit relationships) may further create exposures not easily isolated and/or captured by a standard model.

It is noticeable from the discussion so far that the bank's yield exposure comes in different forms with their effects sometimes offsetting or reinforcing each other. At the same time, and taking into account market realities, it is proven impossible to isolate and hedge every aspect of such risk. Even if it was feasible to do so, then

[11] It is worth noting that implicit interest expenses (building new premises, hiring new staff etc.) may not change as a result of interest rate changes. Consequently, the cost of liabilities may change less than the expected return on assets.

[12] It is sensible to mention that in these cases pricing decisions are also affected by the competition in the markets concerned as well as customers' expectations and behavior.

[13] Note that the refinancing does not need to be done at another bank to have an impact on the original provider of the loan. Whenever the refinancing occurs, the fact remains that the loan is unexpectedly repriced and the gap is inevitably changed. One could argue that this kind of risk is not very big for money centers, as they have lower levels of mortgage loans and more frequently engage in loan securitization and other hedging devices.

[14] There may be some cash inflows from accelerated loan run-offs and possible refinancing fees, but in the long-run cash flows from loan run-offs will decline as the new mortgages will carry lower rates than the original ones.

[15] This is important, especially in cases where market participants over/underestimate the discount rate, and we call it the market rate misspecification hypothesis.

intermediaries would risk potential variability in exchange for higher expected returns. As a result of the complexity of such exposure and its inherent nature in the bank's activities, the Basel Committee[16] through the Bank for International Settlements (BIS) has introduced a capital charge for it. The latter has been further reinforced by market practices during the late 1980s. In the early 1990s, the trend to alter the balance sheet composition of the U.S. banking sector is evident. A risk substitution (interest rate for credit) policy may hide behind such balance sheet re-composition. A look at the U.S. commercial banks, between 1988 and 1993, unveils an increase in Treasury investments—over 35%—and mortgage-backed securities while loans are declining (Houpt and Embersit, 1991; Neuberger, 1992, 1993).

The various arguments and discussions are further complemented by empirical findings focusing on global data and examining cross-country/region cases. A cross-continent examination, using data from the largest banks in the U.K., U.S., Canada, Germany, and Japan, is undertaken by Madura and Zarruk (1995). The research shows that when domestic rates are used, the U.S. is the only group with insignificant long-term yield coefficient, while the U.K. and Canadian banks are the only portfolios sensitive to short-term rates.[17] The effect of long-term international yields is insignificant only for the non-U.S. banks, while none of the short-term proxies are found significant. Overall, the exposure to domestic interest rates is higher when compared to international rates. Non-U.S. banks are more yield sensitive than their U.S. counterpart. It is argued that despite the globalization of financial markets country-specific characteristics expose banks to different risks and opportunities. Among these characteristics may be the cost of capital, the business clientele, the operational activities, and the regulatory environment. In a cross-European analysis, financial and industrial firms from France, Germany, Switzerland, and the U.K. are examined by Oertmann, Rendu, and Zimmermann (2000). The majority of non-financial firms exhibit a positive correlation with the interest rate index and in some cases the correlation is insignificant. In general, the banks with the higher sensitivity in global interest rates are found in Germany and the U.K., whereas Swiss international banks and insurers are mostly affected by domestic rates. For the regional Swiss banks the results are inconclusive, while French regional banks display a negative reaction to both domestic and international rate

[16] For examples and discussions regarding the implementation of the various Basel Agreements, the interested reader is referred to Heffernan (2005), Gup and Kolari (2005), and Saunders and Cornett (2006). Heffernan (2005) also extends the discussion to a global framework regarding bank structure and regulation. In the United States, the Federal Reserve Board on January 19, 1989, adopted requirements implementing the Basel Accord for state banks that are members of the Federal Reserve System and for bank holding companies.

[17] The choice of short-term versus long-term interest rates has been the center of discussion in many studies. Short-term rates are more volatile and may have unique effects on stock returns. On the other hand, long-term rates are more stable and any change may elicit a stronger signal to the market than a similar change in short-term rates. One could further argue that the interest rate factor should be a holding period return, since both the dependent and the market variables are measured in this way. Unal and Kane (1987) and Song (1994) find equity sensitivity only to long-term bond returns, while Staikouras (2005) finds significant coefficients for the 3-month T-bill discount rate.

movements, though the reaction to the latter is more pronounced. International banks in the U.K. are mostly influenced by international rate movements. Market risk premia are found positive and significant for Germany, Switzerland, and the U.K. Surprisingly, there is no evidence for market risk premium in France. The results for the interest rate risk premia are generally weak and less categorical (in line with Ehrhardt, 1991). Some technical aspects of the abovementioned research are provided in the Appendix, Panel 6.

The international market practice of "dealing" with interest rate risk evolves around what has come to be known as the Basel II Accord. Although various parts of the agreement have been revised, the section on market risk, where interest rate exposure belongs, has not been altered since 1998. To conserve space, and due to the availability of this material, the general framework can be broadly described as follows. First, banks categorize their fixed income securities in three different bands according to the credit quality, namely government, qualifying and nonqualifying instruments. For a security to be qualified it must either (a) be investment graded by at least two credit rating agencies, or (b) if unrated, be of comparable investment quality by the reporting bank and the issuer has securities listed on a recognized stock exchange. Second, specific risk and general market risk charges are calculated for each position in each time band. That is, every position is multiplied with a certain weight to derive the applicable capital charge. The specific risk (weights ranging from 0% for government to 8% for nonqualifying) reflects declines in the liquidity or credit quality of the trading book, while the market risk (its weight) is represented by the product of modified durations and interest rate shocks. Third, basis risk is taken into account through disallowance factors for (a) the different market charges within the same maturity band (vertical offsets – 10% factor), (b) the different market charges within the same maturity cluster [horizontal offsets – 40% (30%) factor for less than (more than) 12 months maturity], and (c) the adjacent and distant maturity clusters (horizontal offsets – 40% and 100% respectively). Finally, all these charges are added together to produce the total capital charge.

The aforesaid process is known as the BIS standardized approach. Banks in the BIS member countries are allowed to use either the above method or an internal ratings-based (IRB) approach such as RiskMetrics models, stochastic simulations[18] etc. If IRB is chosen, it is subject to regulatory audit and certain constraints. The Basel II agreement is part of the ongoing effort of BIS to measure on a regular and consistent basis the bank's exposure to various risks. Despite the various amendments and enhancements of the original 1993 Basel I agreement, Basel II still remains the subject of analysis by academics and practitioners alike.[19] An

[18] A thorough exposition of the quantitative aspects of financial risk management can be found in Dowd (1998).

[19] Robinson (1995) finds that the yield effect is greater in the post-Basel period, but no explanation is provided (in contrast to Allen and Jagtiani, 1997; Benink and Wolff, 2000). One could argue that banks have changed their asset-liability structures and become more sensitive possibly due to a risk substitution policy. Note that the original regulatory scheme covers only credit risk.

extensive discussion of the BIS proposals, however, remains beyond the scope of the present study.

III. ASSET-LIABILITY MANAGEMENT

Asset-liability and gap management (Kaufman, 1972; Clifford, 1975a,b; Bierwag and Kaufman, 1977; Baker, 1978a,b,c,d,e, 1980, 1986; Binder, 1979, 1980a,b, 1981; Brewer, 1980; Gardner and Mills, 1981) appeared originally in the 1970s, where interest rates surprises were not something common.[20] With the U.S. monetary policy change, in 1979, a number of studies started reexamining the tools and strategies available to banks and thrift institutions to tackle interest rate risk (Rosenblum, 1980; Aspinwall, 1982; Biderman, 1982; Lindhart and Klinzing, 1982; Bierwag and Kaufman, 1985). Frederick Macaulay's concept of duration[21] has paved the way for the "right approach" to the asset-liability management (ALM) problem. Since then, duration and its application to balance sheet immunization have been examined to the point of exhaustion in the area of ALM. Some technical aspects of the research discussed in this section are summarized in the Appendix, Panels 1–4.

The literature discusses and overviews the immunization process, proposes pertinent liability strategies, and examines daily incremental gap measures (Rosenblum, 1981; Binder and Lindquist, 1982). The latter calls for the use of programmed simulations as the number of increments could be large. Potential problems with intra-period measures are alleviated with the maturity tranch approach, which measures subinterval imbalances of the overall gap period. Neither academics nor practitioners can dispute the importance of the duration gap, but sensibly argue that its applicability may not be feasible (Haley, 1982) or optimal (Jaffee, 1986). The main argument is that future cash flows are stochastic and contractual claims and obligations are directly affected by movement in interest rates. In addition, the bank's "optimal size" can also change if interest rates increase as a result of an increased credit demand. Thus, the principle of a standardized gap is typically promoted (Baker, 1980; Dew, 1981,1982), which takes into account the relative volatilities of a wide spectrum of assets and liabilities to a benchmark financial instrument.

Despite the simplicity and data accessibility underlying the gap approach, one should bear in mind that the model does not take into account (a) the time to repricing within the gap period, (b) changes in the NII's risk exposure as time passes, (c) the possibility of default or credit risks, as many bank accounts particularly on the asset side are exposed to, (d) the balance sheet's market value variations, and (e) that assets and liabilities do not experience similar yield changes. Furthermore, the literature remains silent on what happens to the instruments with option

[20] Between 1934 and 1980, there were 209 prime rate changes, of which 175 took place from 1971 onward. Apart from their frequency, their size was also considerably large. For instance, on April 17, 1979 the prime rate was 12% rising to 15.75% on November 16, 1979. The following year, on April 16, 1980 the prime rate began a landslide that carried it to 11.5% by June 23, 1980.

[21] Ingersoll, Skelton, and Weil (1978) provide an evaluation and review of the duration measure.

provisions, the assets/liabilities that are not repriced, and the sensitivity of "non-rate-sensitive" accounts. With respect to the latter, a change in interest rates can force loans to be prepaid and/or time deposits to be withdrawn,[22] or possibly pay a higher implicit return through the provision of additional free banking services. Lastly, the analysis abstains from market frictions such as transaction costs and taxes, which complicate matters further.

Aiming to improve the gap approach as a technique for managing interest rate risk, Simonson and Hempel (1982) highlight the importance of market values. This approach is consistent with the way that most managers, regulators, and market analysts operate. It is concluded that the level, volatility, and shape of the yield curve, and the nonsensitive portion of the balance sheet can have a significant effect on the value of financial institutions. Toevs (1983) reviews the standard gap management model and presents a duration gap formula to protect the NII. Market values are examined and a duration-based approach is proposed to hedge, either simultaneously or independently, earnings (NII) and bank capital. Kaufman (1984) and Bierwag and Kaufman (1985) have made significant contributions to the literature as they take into account not only the bank's capital, but also propose duration gap approaches to target a wide range of financial variables. Their work addresses concerns of shareholders, bank managers, as well as regulators. The above studies are further corroborated by Brewer (1985) and French (1988). It is worth remembering that studies concentrating on net income assume that any gains/losses due to changes in interest rates are recognized immediately. Financial intermediaries, however, do so only when securities are sold before maturity.[23] The following table depicts the various forms of single-factor duration gap models proposed in the literature.

Although the many proofs and derivations available are competently approached, there are issues that both academics and practitioners still face. Increases in interest rates may be due to changes in the supply of funds by the Central Bank. Immunization is a difficult strategy to pursue in practice. For instance, the shape of the yield curve changes with time, and the assumption of flat rates is unrealistic. The importance of risk-free is overstated as financial institutions do take advantage of yield spreads among corporate bonds and make use of other instruments such as convertibles and derivatives. The duration of the balance sheet is not constant as time passes and market conditions change. Thus, frequent rebalancing or restructuring[24] is costly and time consuming. Note that the value of the various gap

[22] Note that if these reactions are seasonal, then one can address them in a proposed model. The difficulty arises when these actions are the result of a spread between the contractual and a market return.

[23] The examples mirror the definition of economic income, which despite its "controversy" portrays an accurate estimate of the intermediary's income condition.

[24] In the context of bond portfolio management, Bierwag, Kaufman, and Toevs (1983) illustrate how sequential hedging protects against multiple rate changes. Moreover, Bierwag, Kaufman, and Toevs (1979), Bierwag and Toevs (1982), and Bierwag and Kaufman (1985) show the usefulness of duration and immunization strategies to depository financial institutions. All these papers formed the cornerstone and paved the way of what was later to become one of the most discussed issues in the literature of financial institutions management.

Table 1. Single-Factor Duration Gap Approaches

Target Variable	Formula	Immunization
Net worth	$\Delta E = -(D_A - D_{Lg}) \times A \times \Delta r/(1+r)$	$DG = (D_A - D_L\, g)$
Net income (*NI*)	$\Delta NI = [-(w_A D_A - w_L D_L) - E/NI] \times NI \times \Delta r/(1+r)$	$DG = (w_A\, D_A - w_L\, D_L) - E/NI$
Net interest income (*NII*)	$NII = RSA\,[(1+r_a)^{ta}\,(1+i_a)^{1-ta} - 1] - RSL\,[(1+r_l)^{tl}\,(1+i_l)^{1-tl} - 1]$	$DG = MVRSA\,(1-D_{RSA}) - MVRSL\,(1-D_{RSL})$
Net worth to asset ratio	$\Delta\,(E/A) = -(D_A - D_L) \times g \times \Delta r/(1+r)$	$DG = (D_A - D_L)$
Net income to asset ratio	$\Delta\,(NI/A) = \{-[w_A - (1+r_A)^{-1}]\,D_A - w_L D_L - E/NI\} \times NI/A \times \Delta\,\mathrm{r}/(1+\mathrm{r})$	$DG = [w_A - (1+r_A)^{-1}]\,D_A - w_L\,D_L - E/NI$

Δ : change, A : assets, L : liabilities (excluding equity), E : net worth, g : L/A (leverage),
r : current interest rate or contractual yield for assets/liabilities when subscript is provided,
DG : duration gap, D : duration, $w_A : r_A / (1+r_A) \times A/NI$, $w_L : r_L / (1+r_L) \times L/NI$, RSA : rate sensitive assets, RSL : rate sensitive liabilities, t : fraction of the year until payment day, i : expected yield upon repricing, $MVRSA$: market value of rate sensitive assets, $MVRSL$: market value of rate sensitive liabilities.

It is obvious that the NII is subject to a change when the expected yield changes, which can be simply expressed as ΔNI = (RSA – RSL) $\times$ Δi. Net interest income refers to book income from the balance sheet. Net income is not an annual cash flow, but is defined as economic income. The latter takes into account spread income and marking to market effects when interest rates change. The derivations of these models are available from the author upon request or see Toevs (1983), Bierwag and Kaufman (1985), and Staikouras (2003) for further discussions.

formulas is purged after the change in interest rates, as the bank is no longer immunized and restructuring is necessary to account for the next interest rate change. Furthermore, a number of ALM approaches have assumed that changes in interest rates is the only source of uncertainty, "ignoring" that future cash flows are stochastic, demand/supply conditions in the industry change, and/or simply the management of the firm may not be appropriate. The latter complicates the matter further, as profitability and managers' compensation are positively correlated.

Regulatory bodies and government agencies have also proposed their own models of measuring the yield exposure of financial intermediaries. Neuberger (1992, 1993) briefly reviews the notion of interest rate risk and compares the Fed's approach with the Office of Thrift Supervision (OTS) regulatory framework. It is concluded that the OTS approach is more rigorous and finds that the interest rate risk exposure of U.S. banks is not excessive. Note that the results are based on the aggregation of bank balance sheets and omission of off-balance sheet items. A review of the Fed's basic model[25] against the one designed by the OTS is provided by Wright and Houpt (1996). Statistics indicate that the former can be used in monitoring an institution's yield sensitivity and provide a general idea about the magnitude of risk for most intermediaries. It is worth noting, however, that some rough assumptions should be made when using the simplified model. The OTS is probably the most sophisticated model by calculating exact changes in present values, rather than using buckets, and considering non-flat yield curves and default risk. Academics have competently and clearly illustrated all the issues surrounding the repricing approach.[26] Brewer (1985) proposes the use of the derivative instruments as an alternative to balance sheet restructuring, which partially[27] alleviates the balance sheet mismatch. In a similar vein, Lam (1989) addresses the deficiency of repricing gaps, the need for separating the investment from the trading portfolio, and the flexibility of using interest rate futures as a hedging instrument. Nonetheless, these macro-hedges have to be monitored and adjusted as banks' assets and liabilities, and subsequently the gap may often be subject to a change along with market conditions.

One of the earliest models measuring income gap sensitivities is the one proposed by the Federal Home Loan Bank Board (FHLBB), but the approach engulfs a number of assumptions that may not reflect market realities. Gilkeson, Hudgins, and Ruff (1997) put the FHLBB model under the microscope. In general, it seems to capture a significant part of interest rate risk, while adjusting the repricing point other than at the beginning of the period significantly improves the model's predictive power. When the level of interest rates is high the gap model performs best, which might be the result of low price volatility during a high interest rate

[25] This approach uses Call Report data, but no data are available for coupon rates, off-balance sheet positions, and/or trading portfolios. Call Reports provide no details on the type of loans or securities contained in each time band.

[26] Saunders and Cornett (2006) provide a detailed discussion on this topic.

[27] This is due to the imperfect correlation between spot and futures markets (basis risk). Moreover, there are cash flow (margin calls) and accounting (FASB 80) uncertainties when hedging with futures.

environment. The authorization of the adjustable mortgage lending and financial futures trading was a very important decision taken by the FHLBB in 1981. Unfortunately, the timing of their advent was not ideal. Researchers have reviewed the ALM process and provided a framework for evaluating liquidity, default, and interest rate risk. They have reinforced the importance of futures instruments and supported their use as a new component of ALM (Nagle, 1981; Jaffee, 1981; Shaffer, 1991). Simulations have shown that the S&L crisis could have been milder, had the above actions been introduced earlier (Christian, 1981). Moreover, future contracts are more effective as a hedging tool in a rising interest rate environment, while the opposite is true for the adjustable mortgage lending. Goldfarb (1987) proposes an optimal hedging strategy under conditions of loan prepayment sensitivity. It is worth noting that before the S&L crisis the FHLBB/FSLIC (Federal Savings and Loan Insurance Corporation) had never necessitated an official assessment of interest rate risk.

Studying the banking industry, one comes across two main schools of thought regarding bank behavior. The first one is the hedging hypothesis, where the objective is to immunize the bank's balance sheet against yield changes. Although the rational behind such hypothesis is sound, it fails to tie hedging behavior to the underlying objective function of the decision maker.[28] The second approach is the one based on the micro-aspects of the banking firm, where the maximization of a utility function (wealth) is the primary objective of the institution. Ho and Saunders (1981) extend the current literature by integrating the above theories into a new framework. They show that balance sheet hedging is a rational response to interest margin uncertainty, which results from the interplay between volatile rates and asset-liability structural interrelations. More specifically, the study explores the determinants of banks' net interest margin (NIM).[29] The analysis corroborates the existence of spreads, which subsequently depend on bank competition, risk aversion, interest rate volatility, and transaction size. When size is taken into account, small banks exhibit an average transaction spread of 33 basis points higher than that of the large banks. This difference is attributed to the market structure rather than risk aversion and/or transaction size. Based on Ho and Saunder's work, Allen (1988) considers the existence of loan heterogeneity and, hence, the product substitution effect within a competitive market. Under this framework, spreads are reduced (portfolio effect) and manipulation of transaction demands surfaces, while banks maintain a more active role in managing their inventory risk exposure. It is worth mentioning, however, that theories based on the randomness of deposits

[28] Michaelson and Goshay (1967) implicitly assume that the objective is to minimize the risk of shareholders' wealth.

[29] Regarding the interest rate effect on NIM, English (2002) shows that commercial banks have limited their risk exposure. These findings may well mirror the shorter-term asset mix of commercial banks relative to thrifts, as well as the extensive use of hedging instruments. An interesting extension of this study could be the cross-currency effects of interest rate changes i.e., a U.S. bank with considerable euro assets/liabilities.

(cash inflows) and the stochastic arrival of loan demands come in contrast with the ALM approach, simply because any lending activity is effectively constrained by the sources of funds.

The differential behavior of banks grouped by asset size is examined by Graddy and Karna (1984). The empirical findings suggest that (a) large banks accept considerably more spread risk than smaller banks, (b) small banks' NIM is inversely related to changes in the firm's growth rate, (c) growth is associated with lower sensitivity ratios[30] (RSA divided by RSL), and (d) growth has little impact on the NIM of large banks. The adjustment period[31] for large banks (over $300 million assets) is approximately one year compared to over five years for small banks (less than $50 million assets). The adjustment periods, however, mirror the environment where these banks operate. In fact, financial intermediaries experienced regulatory and institutional constraints on their liabilities during that period. Morgan and Smith's (1987a) work is extended by McNulty, Morgan, and Smith (1991). The former shows that a correlation between interest rates and loan demand results in non-zero gap positions;[32] while the latter estimates the minimum risk maturity gap for thrift institutions. The findings suggest (a) the presence of volume risk resulting from low mortgage demand as yields increase, (b) the existence of positive risk gaps for up to one-half of the sample, and (c) a large cross-sectional variation in the estimated minimum gap ratios.

Houpt and Embersit (1991) briefly review the main approaches to evaluating interest rate risk and propose a duration-based method. The measure under consideration—economic value model (EVM)—classifies assets, liabilities, and off-balance sheet items according to their contractual maturity or repricing date and their cash flow characteristics. These positions are then weighted by a risk factor that approximates their modified durations. The sum of all weighted positions would be the measure of interest rate risk exposure. It was only recently that the Basel Accord (1988) was introduced and thus limited field testing was available. Using a full interest rate circle, Sierra and Yeager (2004) examine the EVM's consistency against the bank's actual performance. The overall findings are supportive as rising rates hit liability-sensitive banks (as identified by EVM) more when compared to their financial gains obtained during periods of falling rates. It is worth noting, however, that despite the usefulness of the EVM, the approach is not directly applicable to money center banks (over $1 billion assets).

[30] Olson and Simonson (1982) also clearly state that the impact of the sensitivity ratio on the NIM depends not only on its relative value, but on the absolute funding gap as well. In the context of balance sheet planning, Baker (1980) explains that banks might be expected to increase their sensitivity ratios when their gaps are actually small. This could be the result of uncertainty in the primary securities market, which raises the demand for fixed deposits and loans in the banking industry.

[31] The length of time necessary to equate the actual to the desired sensitivity ratio by altering the balance sheet. The adjustment period is similar to Ho and Saunders (1981).

[32] The literature also shows that under a positive gap immunization is achieved, if loan defaults are positively correlated with interest rates (Morgan and Smith, 1987b). On the other hand, a negative gap can reduce risk when optional loan prepayments are considered (McNulty, 1987). Jilk (1985) shows that when interest rates change, asset and liability rates change unequally resulting in a nonzero optimal gap.

The latter being frequent users of off-balance sheet items are subject to examination on a frequent basis and devote considerable resources and more sophisticated approaches in measuring and managing interest rate risk. Thus, regional banks may find the EVM a reliable alternative for measuring and modeling their interest rate risk exposure.

IV. BALANCE SHEET CHARACTERISTICS AND MISMATCH EFFECTS

The previous discussion is further extended here and essentially both parts complement the analysis from Section V in Staikouras (2003). The 1970s was characterized by high and volatile interest rates as well as a downward sloping yield curve; while the 1980s engulfed a particularly unstable interest rate cycle. Thus, these two decades provide a fertile terrain for analyzing the market yield exposure of financial intermediaries. Some technical aspects of the research discussed here are summarized in the Appendix, Panel 5.

Mismatching assets and liabilities is a reality that all financial intermediaries face, which inevitably could benefit or damage an institution's financial status depending on the movements of exogenous economic factors. Banks and other intermediaries can employ on- and off-balance sheet hedging techniques to broadly protect their income. Based on canonical correlation analysis,[33] it is argued (Simonson, Stowe, and Watson, 1983) that U.S. banks with over $300 million assets do not practice on-balance sheet hedging. Mean values of rate-sensitive balance sheet items (proportions), which are all subject to repricing/rolling over within a 12-month period, are examined. The data reveals that the gap is bigger for large banks than money center banks (MCB). For MCB though, the link between equity and liquidity is not present,[34] while equity decreases as size increases. Market practice has also witnessed an extreme variation in NIM as a result of the classic banking borrow-short lend-long policy. The variation in the NIM is further studied by Hanweck and Kilcollin (1984). Contrary to the maturity composition argument,[35] the analysis suggests that during periods of rising interest rates small banks, and to a lesser degree medium-sized banks, experience increases in their NIM. That is, there is a positive and statistically significant relation between the endogenous factor (prime rate) and the NIM. On the other hand, large banks appear to be unaffected by changes in market yields. It is worth noting that the analysis is conducted over a small sample period, which also coincides with the ending of Regulation Q. The empirical work is further enriched by exploring the impact of positive and negative gaps on the market value of bank equity. Based on portfolios

[33] In general, this approach relates two sets of variables. Unlike regression analysis, this approach considers the covariance within a set of dependent variables. The latter can be rectified, however, under regression analysis.

[34] This could be the result of large banks accessing money market funds more easily and thus relying less on marketable securities. The overall conclusion of the paper supports earlier work by Pyle (1971) regarding the interdependence of assets and liabilities.

[35] The argument is that small banks are negatively affected as rates rise due to their negative gaps.

ranked by the gap size (rather than its sign), Tarhan (1987) finds bank returns to "suffer" equally regardless of the gap size. The results are supported by using surprises in either money supply or interest rates.

Allowing for time-varying interest rate sensitivity, Kwan (1991) examines both the equity's yield exposure and the impact of balance sheet mismatch on equity returns. Maturity mismatch and stock return sensitivity are found to be positively related, but the maturity of the interest rate variable has to "match" the balance sheet duration mismatch. An interesting version of the maturity mismatch, as a proxy for interest rate sensitivity, is employed by Akella and Greenbaum (1992). The speed at which the revenues and costs respond to interest rate innovations is used as duration proxy. The study shows that the adjustment of revenues to unanticipated interest rate changes is slower than the adjustment of costs. Therefore, as in the case of negative gaps, stock returns are adversely affected by unexpected upward movements in short-term rates. Although the work by Grammatikos, Saunders, and Swary (1986) focuses on FOREX gaps, they report foreign currency portfolios exhibiting negative returns to unexpected interest rate changes during the late 1970s. The coefficient of variation from the interest rate surprises is also much larger than that for the unexpected exchange rate changes. Contrary to the above, Viale, Kolari, Fraser, and Sorescu (2006) report insignificant bank-specific risk factors such as gap and loan loss provisions. In an earlier study, Brewer and Lee (1985) reinforce the significant interest rate risk factor, but it is assumed that interest rate sensitivity is stationary over the period analyzed.

A large part of the interest rate risk literature has concentrated more on the equity performance and less on the role of balance sheet characteristics (see the section on nominal contracting hypothesis, Staikouras, 2003). The latter are linked to financial leverage, noninterest income, noninterest liabilities and the proportion of income generated by repriced assets. Fraser, Madura, and Weigand (2002) examine the role of the aforesaid attributes in determining the yield exposure of the banking sector. The interest rate sensitivity is found to be invariant to the bank's size. Cross-sectional regressions reveal that the interest rate risk exposure is reduced when banks are less leveraged, make more loans, and have more demand deposits. On the other hand, noninterest income proved to be a contributing factor to the bank's yield exposure. In a similar vein, Green (1998) develops a bank interest rate management model assuming two different classes of loans and deposits. He concludes that the gap adjusts passively to bank interest rate decisions and is negatively correlated with the market loan rates. Loan rates are also inversely related to outstanding loans.[36]

The empirical and theoretical work has frequently embraced the leverage-adjusted duration gap, but fewer studies have mentioned the role of convexity

[36] Green's proposition is clearly at variance with the existing approaches on bank behavior. However, his model explains the behavior of U.K. banks, since 1971, becoming net borrowers as interest rates rise. Actually, the use of money markets under these conditions substantiates the term liability management (Green, 1987).

gap, especially when embedded options are considered. That is, the balance sheet of banks and insurance firms can be viewed as containing call options on the asset side and puts on the liability side. For instance, financing of these institutions comes in the form of deferred annuities, guaranteed investment contracts (GIC), and certificates of deposit (CD)/demand deposits where the lender can put (sell) these instruments back to the writer prior to maturity should interest rates rise. On the other hand, financial institutions hold large amounts of debt-related instruments such as mortgages and loans, which can be called (bought) by the borrowers should interest rates fall. Using a hypothetical institution, Lee and Stock (2000) show that convexity mismatch is significant because the embedded calls make the assets' convexity negative, while the puts enhance the positive convexity of liabilities. The latter implies that even if duration matching takes place, the existence of negative convexity gaps could lower the market value of net worth. In other words, an increase (decrease) in interest rates will reduce (raise) asset values (liabilities), but leave liabilities (assets) relatively stable. A convexity-hedging strategy is then brought forward where the institution could hold a put option on the asset side and a call option on the liability side.[37] A number of financial intermediaries finance putable corporate bonds by issuing callable liabilities, or they engage in caps, floors, and collars on their variable balance sheet items.

Another interesting theme is the disproportionate effect of the 1980s volatile period on different industries. Through a competent analysis Brewer, Mondschean, and Strahan (1993) show that differences on balance sheet structures have "insulated" insurers more than depository firms. Five areas are provided where insurers have done relatively better than S&L and probably have reduced moral hazard. That is, insurers (a) have more capital, (b) have smaller portions of their liabilities subject to a government guarantee, (c) experience greater monitoring by their peers, (d) have creditors with less confidence in their government guarantees, and (e) are subject to greater market discipline from uninsured creditors. Moreover, a number of policy schemes are suggested including (i) regulators increasing market discipline by encouraging life insurers to issue GIC, (ii) state guaranty funds create fewer incentive problems than deposit insurance by encouraging self-monitoring to minimize the potential cost of insurance failures, (iii) government backing makes life insurance attractive and thus insurers should pay for accessing such guarantees, and (iv) premium tax offsets[38] should be eliminated. The effect of mismatched balance sheets on the thrift's equity values is further examined by Lumpkin and O'Brien (1997) illustrating that the thrifts' portfolio revaluations, due to yield changes, have little explanatory power for their equity values. The link between interest rates and equity values is not attributed to nominal contracting. Overall, long-term bond and property returns are quite important in determining

[37] The limited upside capital gain for callable bonds is attributed to their negative convexity. Thus, if assets have positive convexity and liabilities exhibit negative convexity, then yield shocks (either positive or negative) are likely to raise the value of net worth.

[38] Premium tax offsets for the costs of resolving failures tend to lead to less industry monitoring because surviving life insurance firms can pass a large portion of the costs onto taxpayers.

equity values above and beyond the market portfolio (in line with Johnston and Madura, 2002).

Despite the fact that balance sheet structures can make a difference regarding an institution's yield sensitivity, the results of such research may not have direct practical applications. Highlighting, for instance, the importance of noninterest items implies restructuring of the balance sheet, which simply may not be feasible. That is, increasing demand deposits is not something that banks currently practice, and as such the source of funds has been surpassed by time and savings deposits as well as nondeposit borrowings. Reliance on noninterest income can only be achieved to a certain level—without ignoring the main bank business. Furthermore, the level of capital among financial institutions is usually between 6% and 9%, with the differences among banks being marginal. Although equity acts as a safety net, substituting equity for debt will certainly alter the cost of funds equation. It is also decisive to discriminate between being sensitive and being able to absorb losses. A bank can have a low level of capital, but is less sensitive due to competent management, hedging strategies, and/or proper supervision of its financial statements. Therefore, there are still a few questions to be considered before a conclusion is drawn. For instance, do we suggest major or marginal changes with respect to on-balance sheet restructuring? Do we actually achieve much from what we call immunization? Even if we assume that any on-balance sheet restructuring is implemented, then do we still have a banking institution? In other words, does the firm still perform the same intermediation and asset transformation functions, or have we actually changed its core business nature?

V. MARKET CYCLES AND STRUCTURAL SHIFTS

Considerable attention has been paid to the U.S. market during the Fed's shift in operating procedures and the subsequent crisis of the S&L industry. It is known by now that the policy of the Federal Reserve Bank has changed three times since 1974. A large strand of the literature has examined whether deregulation has altered the risk profile and/or behavior of financial intermediaries. Gavin and Kydland (2000) provide an empirical justification for distinguishing among regime periods, but they raise questions regarding the validity of the derived results, especially when these are used to build equilibrium models. Furthermore, looking at the role of business cycles in conjunction with economic changes, balance sheet structures and management policies could also shed light into the bank's yield sensitivity. The current section aims to complement and extend the review provided in Section VI—event studies—in Staikouras (2003). Some technical aspects of the following papers are summarized in the Appendix, Panel 7.

There is a range of approaches available for testing the effect of regulatory changes in the business arena. The Goldfeld–Quandt switching regression method (GQSRM) is one of such tools. Under the null hypothesis of no regime-switch, the maximization of a likelihood function is sought for a number of possible regimes, subject to any constraints. The effect of variations in market, interest, and

residual risk are then examined across the identified regimes. Such a framework is employed by Kane and Unal (1988) to show that information flow differentially affects intermediaries depending on their size and nature of their activities. Equity's yield sensitivity varies significantly only for the super-regional banks. S&L doubled their market and unsystematic risk during 1981, while during 1983 these risks were reduced and interest rate risk surfaced. It is concluded that during the 1980s intermediaries became riskier and exhibited time-varying yield sensitivity. However, their sample consists of large banks and monthly data, which reduce the power of the tests. Elsewhere, Wetmore and Brick (1994) divide their sample based on certain events (stock market crash Oct. 20, 1987; Bank of New England's problematic real estate loans Nov. 27, 1989; closing of the Bank of New England/other state banks and the Gulf War Jan. 7, 1991) and find that as interest rate risk declines, FOREX exposure comes to light. Rate sensitivity is found only for the first period, while all forms of systematic risk remain unstable.

Looking at the literature, firm characteristics such as size have been taken into account to explain the impact of economic changes on certain businesses. With that in mind, Madura and Schnusenberg (2000) divide their sample into pre-/post-October 1979 and post-August 1987. The results suggest that that the Fed's actions convey valuable information, while the asymmetric effect of interest rate changes is considerably prominent when rates fall. The simultaneous effect of federal funds and discount rates seems to contain no additional information. Finally, it is the larger banks that benefit more when interest rates decrease, with the phenomenon being more distinct during the first two periods. Banks with a high capitalization rate were also less sensitive to rate changes prior to 1987. Mitchell (1989) develops and estimates models to measure both the income and capital loss due to structural shifts in the economy. The first set of results indicates that the proportion of long-term assets and liabilities is smallest (largest) at large (small) banks, while unresponsive items appear to be larger in liability portfolios than in asset portfolios for all sizes. Medium banks seem to experience the largest change in terms of altering their asset-liability structures, followed by changes made by small banks in their liability portfolios. It is also observed that after 1979 all banks tend to reduce the size and term to maturity of their long-term balance sheet items. The latter implies that income becomes more interest sensitive (an average of 7 bp for a 10-bp increase in interest rates) while market values adjust faster. This is probably the result of high demand for short-term variable instruments which forces banks to accommodate such demand and "remain hedged." The above results are corroborated by Graddy and Karna (1984) and Hanweck and Kilcollin (1984) who found NIM to change by average of 4 bp for every 10-bp increase in interest rates. During the early 1980s, and unlike large banks, medium banks faced the biggest exposure to yield changes while small banks were only slightly affected. In line with Santoni (1984) negative gaps are responsible for the reduction in equity values during that period of monetary policy changes. Overall, it seems that changes in the balance sheet structure have altered the maturity intermediation function, which implies shifting part of the bank's interest rate risk onto its customers.

Economic environment and market cycle play an important role on an institution's financial performance. Thus, one could easily argue that there might be a link between business cycles and the bank's interest rate sensitivity. The fixed income theory documents the nonsymmetrical response of prices to upward and downward yield changes. An interesting issue raised is whether such asymmetry is period-dependent. To test this hypothesis, Brewer and Lee (1990) use three (two) economic upswings (downswings) to find that such asymmetry varies over the business cycle, but is less volatile than market risk. It is argued that in periods of business expansions, the increased demand of deposits, loans, and securities will tend to enhance the bank stock returns. On the other hand, in periods of economic recessions, the demand of bank products will fall and the loan portfolios will deteriorate, causing earnings and returns to shrink. An issue with practical implications and of research interest is the determination of profits. Do profits solely depend on margins (spreads) or could one observe differential interest rate effects (i.e., loans *vs* deposits) on profits? Within this framework, Hancock (1985) shows that bank profitability is linked to a high interest rate climate while the spread's effect is asymmetric. It is also interesting to note that Kohers and Nagy (1991) find the Index of Leading Economic Indicators (reflecting loan demands, productivity, and money supply) to be insignificant during the downturn phase of the economy, but not the S&P500. Recessionary periods exhibit twice as large interest rate coefficients as those found during expansion. Their results are in line with Chen and Chan (1989) who use dummy variables for the up- and down-cycle periods, while extending their analysis by partitioning their sample into different interest rate phases. The findings suggest that S&L are more sensitive to falling rates, while banks are more sensitive to increasing rates. When the overall sensitivity is examined, S&L proved to be much more sensitive than banks across all interest rate cycles. The results can be reasonably explained by the different duration structures of their assets as well as the larger duration gap of S&L. The obvious implication is that S&L may take advantage (increase profits) of rate cycles by widening their negative gaps during periods of interest rate cuts. On the other hand, banks seem to be less flexible in adjusting their spreads, hence their inability to take advantage of falling rates to offset losses from a rising interest rate period. The use of linear splines is not supported by the data. It is also observed that during the late 1980s (deregulation period) the S&L seem to behave more as bank-like firms with respect to their yield sensitivity. In a similar vein, Jensen and Johnson (1995) show that stocks exhibit a significantly greater return and lower volatility in periods following discount rate decreases than in periods following rate increases. They conclude that the stock market patterns cannot be easily attributed to changes in interest rates.

Analysis using Canadian data reveals an increase in systematic risk during periods of deregulation and innovation (Adjaoud and Rahman, 1996). The sample appears to be sensitive to interest rate changes, but stock returns are covariance nonstationary with respect to any benchmark variable. Conditional correlation between the Canadian returns and the market index varies in tandem with aggregate

market volatility. Research provides evidence of temporal instability in systematic risk, which subsequently casts doubt on the validity of the constant coefficient model (Kane, and Unal, 1988; Kwan, 1991; Neuberger, 1991). Another question raised is whether deregulation announcements have a systematic effect (risk) on equity returns. Looking at the German market, Kaen, Sherman, and Tehranian (1997) investigate the impact of the discount and Lombard rates[39] on bank stocks, as they identify 27 rate change announcements. The findings indicate that increases (decreases) in rates are associated with negative (positive) abnormal returns. Large absolute abnormal returns are linked to rate changes not preceded by changes in the prior week's REPO rate. Finally, excess returns are larger upon rate decreases. This asymmetric behavior is also documented in the U.S. market (Born and Moser, 1990; Madura and Schnusenberg, 2000). Based on empirical findings one could argue that the announcements are not fully anticipated. This is probably the way Bundesbank communicates its future policy directions and aligns those rates with current market conditions.

When examining the differential effects of various monetary policies, it is worth mentioning that in some markets, such as the U.S., the phenomenon intersects with the wide acceptance of off-balance sheet instruments and carefully designed hedging strategies. The latter could alter some of the econometric findings not expected to be present under traditional economic theories or market behavior. Ehrhardt (1991) shows that yield exposure declined in the 1980s, but reinforces its nonstationary nature. It is argued that while the short-term and long-term rates have clear-cut signs for the pre- and post-1980 period, the medium-term rate sensitivity shifted from negative to positive. During the late 1970s and early 1980s, major deregulating changes, like the removal of credit directives, the introduction of a tender system in government bonds, and the free floating of the Australian dollar occurred in the Australian banking sector. Faff and Howard (1997) find the Australian banking portfolio to be sensitive only to long-term interest rates (in line with Akella and Chen, 1990; but not with Madura and Zarruk, 1995) and only for a certain period (1983–87). Akella and Chen (1990) attribute the diverse empirical findings to different econometric specifications, the choice of interest rate variable (and its transformations), the frequency of the data employed, as well as the structural shifts in the monetary policy (in line with Staikouras, 2006). Between 1974 and 1979 an increase in the short-term rates had a negative effect on stock returns (positive for 1980–84); while long-term interest rate sensitivity was found to decrease after 1980, implying that the banks were better hedged. The previous work is extended (Faff and Howard, 1999) by using a switching regression model for three sub-periods, named the pre-deregulation period (1978–83), the deregulation period (1984–87) and the post-deregulation period (1987–92). The returns exhibit sensitivity to long-term rates only for the first two subperiods, which

[39] These are the two credit facilities provided by the Bundesbank. The discount rate is the lowest rate at which German banks can borrow from their Central Bank, and (unlike the U.S.) it is a permanent source of financing. The Lombard facility is the equivalent of the discount window in the U.S. and acts as an emergency funding facility. Lombard rates are always above discount rates.

coincide with the introduction and implementation of the new policies. However, there is an element of instability for the impact of long-term rates across periods. The results for the short-term rates are less convincing, while the shape of the yield curve (long-term minus short-term rates) does not seem to be a significant driver of equity returns. Finally, when size is taken into account, large banks and finance firms are more sensitive than small banks. The absence of interest rate sensitivity for the last subperiod possibly suggests that Australian banks have reacted to the regulatory change by implementing more efficient risk management practices.

Overall, the above studies either conducted in the U.S., Canada or in other continents unveil pretty much the same picture. When monetary policy aims to influence money supply and growth, interest rate volatility peaks and depositories become vulnerable depending on their size, charter-type, and contingent procedures in place. Innovations and regulatory reforms have led intermediaries to revise their risk management practices and in some cases introduce new ones. During periods of statutory and financial developments the demand and supply for certain products change the asset-liability structure of financial intermediaries. In conjunction with their risk management measures, reducing the gap, adjusting market values faster—through short-term capital budgeting, risk substitution policies and/or off-balance-sheet hedging could be one of the many alternatives available.

VI. NONSTANDARD MODELING APPROACHES

The majority of the literature has concentrated on traditional methodologies and has employed certain estimation processes. Among others, correlation analysis, the CAPM, the two-index model as well as conditional versions of the APT have been applied. Yet, there is a strand in the literature that does not follow the conventional approaches of measuring interest rate risk. The following studies employ different frameworks, diverting from mainstream research, without overlooking the yield exposure of financial intermediaries. Some technical aspects of the research discussed here are summarized in the Appendix, Panel 8.

A very interesting and intuitive approach is proposed by two studies (Unal and Kane, 1988; Kane and Unal, 1990) in what they call the statistical market value accounting model (SMVAM). By readdressing the literature, they combine accounting values of equity with capital market information to estimate the value of hidden (unrecorded) capital. The latter mirrors the divergence between accounting and economic value of capital, which is subsequently decomposed into on-balance-sheet misevaluation and neglected off-balance-sheet items. These two factors are used to explain the variation in the yield and market sensitivities of the bank's equity. The overall finding is that between banks of different sizes and S&L, the latter exhibit more market and interest rate risk regardless of the period examined (in line with Chen and Chan, 1989). Using the Goldfeld–Quandt's switching regression method (GQSRM) mid-1977 is identified as the time of "regime change."[40] The

[40] This mainly supports the idea that the change in the Fed's policy was the result of economic and political factors rather than being considered as an exogenous event affecting the stock prices of U.S. financial institutions.

first set of results verifies the deceptive nature of accounting representations of economic capital. Interestingly, and unlike medium-sized institutions, large banks' off-balance-sheet positions seem to hedge market variation only prior to 1978, whereas after that the relationship disappears. Large and medium banks' unbookable equity exhibits a positive correlation with interest rates, but for the former the link faded away in the 1980s. In other words, this correlation implies that the unbookable value of the FDIC guarantees offset much of the interest-induced losses on equity. This is probably the outcome of increased deposit insurance guarantees as a result of the Fed's shift in monetary policy and deposit rate deregulation. For small banks, market and interest rate sensitivities did not change significantly over the sample period.

Using a very different approach Born and Moser (1990) explore the role of discount window operations by the Fed. The discount privilege is modeled as an option whose value is linked to the equity returns of participating banks. They identify 27 unexpected discount rate announcements[41] which are used as events that trigger abnormal returns. The latter are derived from a regression that takes into account through dummies: (a) the changes in the discount rate, and (b) the increases or decreases during the same period. The results unveil significant excess returns for discount rate increases during the pre-1979 period, while significant abnormal returns for both increases and decreases were found in subsequent years. It is also worth remembering that the post-1979 period is characterized by a larger variance of the spread between the discount and the federal funds rate. Overall, the hypothesis that the discount window is valued and incorporated in the equity returns of qualifying banks cannot be rejected.

Elsewhere, a micro-banking model aiming to optimize the behavior of the international banking firm and derive sensitivity coefficients is proposed by Choi, Elyasiani, and Kopecky (1992). In order to define the macro variables as the systematic risk factors, loan and deposit rates are considered as deterministic while exchange and interest rates are stochastic.[42] Their multifactor model incorporates intercept and slope dummy variables (money center, January/October 1979, January 1981). They document that (a) the sign of the interest rate depends on the net short-term domestic lending position (usually negative for large banks), (b) the presence of interest rate risk became obvious after 1979, (c) the interest rates' deregulation increases market risk as banks acquire riskier assets, (d) market and interest rate risk do not discriminate on the basis of the money center status, and (e) MCB are more affected by FOREX risk than non-MCB. This is probably the result of their high involvement in international lending. The aforesaid work is further extended by Wetmore and Brick (1998). Essentially, they account for fluctuations

[41] The total number of announcements comes up to 63. The unexpected announcements are defined as changes not proceeded by advance notice in the *Wall Street Journal* during the two-week period prior to the announced change.

[42] In other words, the bank possesses perfect information about the former (local prices) and imperfect information about the latter (market prices). This assumption about the accuracy of pricing information is consistent with competitive markets.

in income due to imperfect co-movements between the return on rate-sensitive assets and the cost of rate-sensitive liabilities (basis risk). The findings indicate significant interest rate sensitivity prior to 1987, while market and FOREX risk appeared in the late 1980s and early 1990s, especially for MCB. From 1994 onward, all banks exhibited a significant basis risk factor regardless of their size. When the basis risk hedge ratio is regressed against a proxy for balance sheet composition,[43] then large (small) changes at the level of commercial/industrial loans compared to the level of core deposits are found to enhance (reduce) the basis risk exposure of the bank. The results have a practical intuition as interest rates rose during 1994 along with the level of industrial and commercial loans. Furthermore, market practices usually indicate that financial institutions adjust their loan yields much faster than their core deposit rates when market rates change. In a recent study, Wetmore (2003) adds an extra variable, namely the embedded option risk of loan refinancing and early deposit withdrawals,[44] which subsequently causes changes in asset-liability values/structures. There is little support for the long-term interest rate variable, while the embedded option risk is found to be significant for at least regional and super-regional banks and in some subperiods for MCB.

The variety of financial products and regulatory policies within the financial services industry understandably exposes these institutions to different kinds and levels of risk dictated by the type of charter they hold. Such market segmentation combined with different structural changes in the industry may change our perception regarding the risk-return profile of these institutions. To this end, Allen and Jagtiani (1997) examine the impact of the above issues on the risk profile of banks, insurance, securities, mutual funds, and other financial intermediaries. The analysis explores the level of exposure, the pricing of pertinent risks, and the relationship between the quantity of risk and the size of the risk premium as measured by capital market data. The latter has important financial implications when comparing the return compensation provided by a firm and their peers within the industry. The results suggest the existence of market segmentation for both risk levels and premiums. The interest rate risk exposure does not always seem to be significant (across firms/time), since it only appears to affect insurance firms and in some cases banks[45] and other institutions. This is further complicated when positive signs appear for security firms and insurers. On the other hand, securities firms have the highest market exposure with lower risk premium, indicating an inverse relationship between quantity and price of risk. Interestingly, banks

[43] This is measured as: (the difference of commercial-industrial loans from one year to another *less* core deposits of the current year) / total assets.

[44] This is represented by the Refinancing Index published by the Mortgage Bankers Association of America. The index signals when mortgagors feel that there is a sufficient change in rates to justify refinancing their loans.

[45] Insignificant coefficients for the interest rate index, during the late 1980s and early 1990s, may well portray the comfort of hedging this type of risk through the use of the derivative markets. This is in line with the banks' motivation and pattern of engaging in off-balance-sheet instruments during 1984–1991 (Jagtiani, Saunders, and Udell, 1995). The insignificant coefficients for this period are in line with the results of Benink and Wolff (2000) who employ survey data.

exhibit the highest interest rate risk premium implying that capital markets may not recognize the federal safety net. Finally, the shift in monetary policy (1979) and the Basel requirements (1988) have forced banks to increase their market risk-taking activity, while insurance firms' interest rate risk premium has elevated significantly.[46] Overall, despite the tightening of regulatory restrictions, banks have increased their risk-taking as their charter value declined a behavior possibly consistent with the moral hazard argument (Hellwig, 1994; Brewer, Mondschean, and Strahan, 1993).

The insurance industry is admittedly a group within financial institutions with their own unique characteristics and peculiarities. Thus, valuation of insurance equity provides a fertile territory for research as well as an intellectual challenge. It is well established by now that a large number of financial institutions are either directly or indirectly involved in the real estate market. This is mainly the result of direct investment in the property market, purchase of debt-related property instruments such as mortgages and/or their involvement in hedging/speculative vehicles such as credit forward contracts.[47] Within this framework Johnston and Madura (2002) introduce the relevance of a third factor, namely the fluctuation in the real estate market. The study is applied in different segments of the insurance industry using both time series and cross-section analysis. The P&C firms are the most affected by the general market conditions, while health insurers followed by life have the greatest exposure to the property market. The yield effect is not that prominent and in many cases appears with a positive sign (in line with Allen and Jagtiani, 1997). The health insurance firms seem to be the ones affected by the interest rate risk, while cross-section analysis, aiming to test the role of capital,[48] reveals no significant coefficients.

Finally, in an attempt to pave the way for a new research track, Viale, Kolari, Fraser, and Sorescu (2006) adeptly challenge the traditional Fama and French (1993) three-factor model as a general vehicle of asset pricing. They meticulously analyze the U.S. financial and nonfinancial sector and provide some solid and interesting results. The idiosyncratic nature of the financial intermediaries' equity return function is confirmed. They identify an alternative in the standard yield changes, namely the surprises in the slope of the yield curve. The return-generating process of the banking sectors is not well described by the conventional size and book-to-market proxies, as previously suggested for nonfinancial stocks. Moreover, investors do not seem to be compensated, in an APT sense, for the risk taken

[46] Allen, Jagtiani, and Landskroner (1996) argue that with the introduction of credit risk-adjusted assets for the determination of capital requirements, banks and insurance firms levied a cost for their credit exposure but implicitly subsidized their interest rate risk.

[47] These are hedging devices against a decline of the credit quality of a borrower (an increase in default risk on a loan) after the loan rate is determined and the loan is issued. Insurers are the common buyers and banks are frequent sellers. Moreover, Robinson and Klemme (1996) provide evidence that stock returns of BHC highly involved in mortgages are more sensitive to changes in the spread between long- and short-term yields.

[48] It is known that leverage magnifies earnings and thus the return on capital. Thus, a higher level of capital reduces the degree to which a given level of income relative to assets is converted into a return on networth.

in investing on those stocks (in line with Flannery, Hameed, and Harjes, 1997, but contrary to Allen and Jagtiani, 1997 and Staikouras, 2005). Significant/non-significant prices of risk may well be related to the errors-in-variable (EIV) problem inherent in the two-step approach (although care has been taken to correct the EIV issue), or it could be attributed to the different methodological/econometric frameworks employed across researchers and time periods (Staikouras, 2006). The implications of their work are visible in various fronts such as calculation of abnormal returns, performance valuation, financing decisions, capital budgeting planning, supervision of financial conglomerates, and ultimately, for monetary policy purposes.

VII. TIME VARIATION AND CONDITIONAL VOLATILITY PROCESSES

Another insightful econometric approach, examining the interaction between financial stock returns and economic/financial risk factors, resides in the conditional volatility family of techniques. The framework is well suited, as it naturally leads to an examining of the interaction between volatility and sources of information. The main argument in support of such a methodology is the market reality of clustering returns, which is the main characteristic captured by models of conditional volatility. Under this approach, volatility is essentially parameterized as a function of information arrival (last period's news) and past volatility (old news).[49] The persistence of past news, however, remains an empirical issue within an efficient market. When conditional heteroskedasticity is present, but not correctly modeled, the parameters from an OLS regression will still be unbiased but inefficient. The nonlinear maximum likelihood estimator will produce greater efficiency gains. Some technical aspects of the research discussed in this section are summarized in the Appendix, Panel 9.

Based on the conditioning nature of market and interest rate risk, Song (1994) employs a conditional volatility approach (an ARCH model) to investigate whether these risks had changed in the 1980s. Since the error structure of the model is not straightforward and without prior information regarding the error distribution, the generalized method of moments (GMM) approach is deemed appropriate. The findings suggest that market risk became higher after 1981 and was generally more volatile than interest rate risk, which increased after 1982. Overall, the intermediary's yield exposure does not seem to respond to the Fed's changing policy in any significant manner. When banks and S&L are compared, there is no big difference between the two.

An issue of considerable academic and practical importance is whether investors are being compensated for the risk they undertake when investing in various stocks. Compensation comes in the form of a risk premium proportional to a firm's exposure to the particular risk factor. Flannery, Hameed, and Harjes (1997) estimate

[49] The news is proxied by the last period's forecast error or unexpected shock. The conditional lagged volatility can be also expressed as $h_{t-1} = a_0 + a_1 u_{t-2}^2 + \beta_1 h_{t-2}$ which in turn is a function of past news through the "news" coefficient (a_1).

separate univariate GARCH-M specifications, for market and interest rate data, and obtain volatilities and innovations to be later employed as exogenous factors in a system of equations. The findings support the pricing of the market factor and its time variation, while constant relative risk aversion (CRRA)[50] is not supported by the data. The pricing of the interest rate factor is weak, as it is only significant for subperiods with high interest rate volatility and remains time variant. When concentrating on commercial banks and thrifts, the results remain the same for the wide-market factor, but no compensation is provided for the interest rate risk exposure (contrary to Allen and Jagtiani, 1997). Although the analysis is comprehensive and thorough, the two-step estimation process employed maintains consistency of the parameters at the expense of efficiency. The latter comes as a result of overlooking parameter restrictions and cross-asset correlations. Using simultaneous estimations of beta sensitivities and prices of risk, Staikouras (2005) finds significant premia for both market and interest rate variables in the U.K. financial sector.

The empirical work is further broadened by capturing the effect of interest rate volatility[51] on bank excess returns through equity volatility. Lagged conditional interest rate volatility has a negative effect on the equity volatility of large banks and MCB as shown by Elyasiani and Mansur (1998). In other words, when interest rates are volatile, bank returns will stabilize (their volatility decreased) in the following period—probably because banks seek ways to hedge themselves against increased uncertainty. Volatility changes due to the 1979–82 monetary changes are higher for large banks, lower for MCB, and insignificant for regional banks. Overall, return volatility is time dependent and sensitive to monetary policies, while shocks show highly persistent effects. Time-varying yield premia are also analyzed by Tai (2000) who employs a cross-modeling comparison to test the robustness of previous findings. By considering an extra risk factor, namely the FOREX exposure, estimates are provided via a GMM, a kernel pricing, and a multivariate GARCH in mean (MGARCH-M) approach. Two interesting findings emerge: (a) the interest rate factor is the only risk priced under GMM (contrary to Flannery *et al.,* 1997, but in line with Allen and Jagtiani, 1997 and Staikouras, 2005), and (b) unlike interest rate risk, world market risk is significant for regional banks, while FOREX risk is significant for large and regional banks under the kernel framework. On the other hand, the MGARCH-M estimation shows significant time variation of yield and FOREX risk premia with the evidence being weaker for the market risk premium regardless of the institution's size. Note that this approach avoids the problems of the two-step procedure. Decomposition of the total time-varying risk premium unveils that its major component is the interest rate risk, while conditional volatilities are proportional to the bank portfolio size.

Finally, the MGARCH-M framework is further employed by Faff, Hodgson, and Kremmer (2005) who look at the Australian market. The yield effect has changed

[50] CRRA implies that each factor's risk premium is strictly proportional to its conditional volatility.
[51] It is important to note that volatility engulfs both systematic and unsystematic risk. Thus, shocks to the diversifiable part of total risk should not be associated with an increase in risk premia.

over time, as large banks' excess returns exhibit a positive correlation with interest rates in the pre-deregulation phase (pre-1983), with the correlation being reversed in the post-deregulation period (post-1990). Long-term interest rate changes do not seem to affect the equity returns' volatility. This is probably the result of a less controlled market, moving to a competitive arena along with the presence of hedging devices. In the post-deregulation period, volatility at the right end of the normal yield curve has a significant impact on the variance of small banks' returns —except for finance firms. The findings also suggest that the trade-off between risk and return is time variant. For instance, the risk-return trade-off is generally significant for financial firms and large banks, while small banks price total risk in the pre- and post-deregulation stages, but not during the deregulation phase.

VIII. CONCLUDING REMARKS

The interest rate risk exposure of financial intermediaries has been the subject of research by many theoretical and empirical papers. Some of them have focused on the theory of financial intermediation and the industry's inherent risks, others have explored diverse methodological frameworks to demonstrate their applicability, while many have concentrated on the testable implications of various theories and hypotheses. The first survey on the fluctuations of equity values in response to market yield changes appeared in a previous volume of this journal (Staikouras, 2003). Yet it has been unfeasible to enfold all aspects of the equity-yield relationship within one study. The primary objective of the current research has been to enrich and complement the aforesaid review, and together serve as a comprehensive summary and current benchmark for further research. These two surveys have discussed over 200 pertinent studies, and their findings have been summarized and categorized in reference to their research intentions.

The origins of interest rate risk, primarily in the banking industry, along with the implementation of ALM procedures and advanced quantitative techniques are explored. Four factors seem to be held responsible of such yield exposure: (a) the intermediary's balance sheet mix, (b) the direction of interest rates, (c) the volatility of interest rates, and (d) inappropriate/non-existent off-balance sheet hedging platforms. In a few instances, case studies demonstrating the threat and consequences of ignoring the importance of interest rate risk analysis/management are discussed and the surrounding facts are provided. The immunization process is explored and various accounts are targeted depending on the goals and preferences of the bank's management. The paper further discusses the inadequacy of traditional practices, the impracticality of simultaneously hedging multiple accounts, and the increasing demand to resort to off-balance sheet items, sophisticated hedging strategies, and advanced quantitative analysis. These come as a result of the considerable changes in modern financial markets that have taken place both at an institutional and global level.

Both papers delve into the role of monetary regimes and market cycles on the performance of financial intermediaries. The review shows that the effect of

information flow, resulting from regulatory and financial changes, is size and charter-type dependent. Apart from the size and the type of each institution, empirical work also confirms the asymmetric effect of interest rate changes with the benefits being reaped by larger banks when rates decrease. Similar results are provided by various studies in different markets across the world. As a result of such asymmetry the conventional balance sheet mix changes with efforts being made to narrow the gap. The latter, during the late 1970s and early/mid-1980s, took a prominent place in the history of financial institutions when structural changes hit the U.S. market. Throughout that period S&L seem to be much more sensitive than banks across all interest rate cycles. On the other hand, it is documented that toward the late 1980s interest rate risk declined with evidence of a surfacing FOREX exposure, especially for money center banks. Contrary to the previous findings, S&L now behave more like banks in terms of their yield sensitivity.

The review extends the previous work by incorporating the findings of nonconventional approaches, which have either amended/expanded the traditional asset pricing models or employed different methodological frameworks. There is a general consensus that market values are more relevant to corporate safety, as accounting representations of economic capital are quite deceptive. When intermediaries are eligible to purchase reserves at below market rates (discount privilege), it is actually shown that equity markets do value that option and incorporate it in the stock price. During the late 1990s, the determinants of the return-generating process were further stretched to incorporate the uncorrelated movements of balance sheet returns and costs, as well as the embedded options in many balance sheet items. More recently, the slope of the yield curve is suggested as a more appropriate factor than the simple yield changes, while the conventional size and book-to-market factors fail to price bank stocks. Consistent with previous results, risk levels and premiums are determined by market segments, although, in some cases, banks reveal soaring yield premiums. The latter may come in contrast to the provision of the federal safety net, but increased risk-taking activity is also present, which may be related to the moral hazard argument. The insurance equity returns seem to be affected by the movements in the property market, while their interest rate risk exposure is less clear-cut.

The last strand of research deals with modeling equity returns with nonconstant volatility. The latter is found to be proportional to the size of bank portfolios, while the risk-return trade-off exhibits temporal instability and charter-type dependence. Compensating investors for undertaking systematic market risk seems to produce positive results, albeit not for the interest rate index. In general, time variation for all systematic risk factors and their associated risk premia is statistically established. Interestingly, when comparisons are made between each factor's risk premium and its conditional volatility, the element of proportionality (CRRA) is absent at least in the U.S. market. Finally, last period's yield volatility has a stabilizing effect on the next period's equity returns, which could be the result of the bank's conscientious effort to reduce uncertainty.

IX. APPENDIX: Research Summary on Financial Institutions' Yield Exposure

	Period	Sample	Key Variables[a]	Methodology[b]	Extra Factors[c]
Panel 1. ALM Overview					
Clifford (1975a,b)	These papers explore the various aspects of the asset-liability management arena.				
Bierwag and Kaufman (1977)	They propose various ways of dealing with the institutions' interest rate risk				
Brewer (1980)	exposure, including on- and off-balance sheet hedging techniques. The issues are				
Jaffee (1981, 1986)	looked from the intermediary's as well as from a regulator's perspective.				
Nagle (1981)	Apart from the available ALM techniques, they do recognize and discuss				
Christian (1981)	the various obstacles in "immunizing" profits and equity market values.				
Rosenblum (1981)	The studies usually concentrate on the thrifts and banking institutions.				
Gardner and Mills (1981)					
Binder (1979, 1980a,b, 1981)					
Dew (1981, 1982)					
Haley (1982)					
Aspinwall (1982)					
Biderman (1982)					
Bierwag and Toevs (1982)					
Binder and Lindquist (1982)					
Lindhart and Klinzing (1982)					
Goldfarb (1987)					
Lam (1989)					

Panel 2. ALM Cases	
Kaufman (1972) Baker (1978a,b,c,d,e, 1980, 1986) Rosenblum (1980) Neuberger (1992, 1993) Curry and Shibut (2000)	This group of researchers examines various ALM issues, surveys some real-life cases and looks at their implications for the market and the taxpayer. The research engulfs issues related to monetary policy changes and deregulation, while statistical figures and analysis are also provided. They identify ways of how problems could have been avoided, and propose risk-avoiding channels for the future.
Panel 3. ALM & Immunization	
Bierwag, Kaufman, and Toevs (1979) Simonson and Hempel (1982) Toevs (1983) Kaufman (1984) Bierwag and Kaufman (1985) Brewer (1985) French (1988)	The work here is devoted to deriving the necessary conditions for immunizing financial intermediaries against interest rate fluctuation. The authors focus on the equity value—from a market point of view, the equity to asset ratio—from a capital adequacy perspective, and the net interest income and NII to asset ratio—from a profitability side.

(*Continued*)

APPENDIX: (*Continued*)

	Period	Sample	Key Variables[a]	Methodology[b]	Extra Factors[c]
Panel 4. ALM Empirical Issues					
Ho and Saunders (1981)	1976–1979	53 banks	Quarterly NIM, noninterest revenues/expenses/reserves, net loan charge-offs, volatility of various market rates	Cross-section	° / *AL*
Graddy and Karna (1984)	1975–1980	98 banks from the 7th Federal Reserve District	Semi-annual NIM, rate-sensitive assets/liabilities, asset growth, Fed funds rate	Two-stage least squares	° / *AL*
Morgan and Smith (1987a,b)	Development of a multi-period model for the optimal maturity intermediation/lending decisions				
Allen (1988)	Extending the Ho and Saunders (1981) model				
Shaffer (1991)	Proposing the use of off-balance sheet hedging				
Neuberger (1991)	1979–1990	84 large banks	Monthly return 30-year govt. bond	OLS, Cross-section	°
Houpt and Embersit (1991)	Proposing a duration based model for evaluating interest rate risk				
McNulty, Morgan, and Smith (1991)	1984–1988	50 thrifts from the 4th FHLB District	Quarterly balance sheet/income data, short-term rates	OLS	*AL*
Robinson (1995)	1973–1994	PI/ 48 banks	Quarterly 3-month T-bill rate, 10-year T-bond rate, spread (bond–bill), ROA, operating revenues/expenses	OLS, Cross-section	*AL*
Wright and Houpt (1996)	Review of regulatory models measuring interest rate risk exposure				
Robinson and Klemme (1996)	1983–1995	Compustat Bank holding companies	Quarterly 3-month T-bill rate, 10-year T-bond rate, spread (bond–bill)	OLS	Ø

Gilkeson, Hudgins, and Ruff (1997)	1984–1988	450 FHLBB-regulated thrifts	Quarterly yields, maturity, repricing data, gap measure, 3-month T-bill rate	OLS, Cross-section	° / *AL*
English (2002)	1979–2001	10 OECD industrial countries	Annual bank interest income/expense, assets, capital, various market yields	Cointegration, Cross-country analysis, OLS	*AL*
Sierra and Yeager (2004)	1998–2002	About community 6,000 banks	Quarterly averages of nonperforming loans, asset growth, asset size, Fed's rate sensitivity measure	OLS, Cross-section, matched-pair and correlation analysis	° / *AL*
Panel 5. Balance Sheet Mismatch					
Simonson, Stowe, and Watson (1983)	Dec. 1979	175 very large banks (assets > $1 billion), 260 large banks (assets > $300 million)	Rate-sensitive assets, rate-sensitive liabilities	Canonical correlation analysis	
Hanweck and Kilcollin (1984)	1976–1981	P/ Large, medium, small banks	Semi-annual/quarterly prime rate, 3-month CD, NIM, dummies	OLS, GLS	° / *AL*
Grammatikos, Saunders, and Swary (1986)	1975–1981	15 MCB	FOREX, Euro-currency interest rate, FX gap measure	Risk-return decomposition	
Tarhan (1987)	1979–1982	P/ 15 banks large gap, 15 banks medium gap, 16 banks small gap	Weekly/daily 3- and 6-month T-bill rate, 1-year T-bill rate, expected money supply change, gap measure	OLS, SURE	Ø / ✓
Kwan (1991)	1976–1982	51 banks	Monthly returns 3-month T-bill, 20-year T-bond, gap measure	Random coefficient model, SURE	✓

(*Continued*)

APPENDIX: (*Continued*)

	Period	Sample	Key Variables[a]	Methodology[b]	Extra Factors[c]
Akella and Greenbaum (1992)	1973–1987	30 banks	Quarterly returns short-term T-bills, revenue/cost rate	OLS, SURE	✓ / *AL*
Brewer, Mondschean, and Strahan (1993)	1972–1991	P/ Banks, S&L, life-insurance	Monthly returns 20-year govt. bond	OLS	
Lumpkin and O'Brien (1997)	1984–1992	41 thrifts	Monthly returns 3-month T-bill, 2-, 7- and 30-year bonds, REIT index, dummies, gap measure, deposit insurance premium, changes in book values	OLS, Maximum likelihood, Cross-section	✓ / *AL*
Green (1998)	Development of a two-tier pricing model for interest rate risk management				
Lee and Stock (2000)	Proposing balance sheet duration and convexity hedging				
Fraser, Madura, and Weigand (2002)	1991–1996	P/ 6 MCB, 47 large banks, 34 medium banks, 29 small banks	Monthly 1-year T-bill yield, 10-year T-note yield, dummies	SURE, Cross-section	° / ✓
Panel 6. Global Perspective					
Madura and Zarruk (1995)	1988–1993	P/ MCB: 6 Canadian, 4 U.K., 4 German, 7 U.S., 8 Japanese	Monthly changes on short- and long-term interest rates and international indices	SURE	°
Oertmann, Rendu, and Zimmermann (2000)	1982–1995	P/ Banks and Insurers: 6 French, 16 German, 12 Swiss, 23 U.K. *plus* 47 industrial firms	Monthly changes on long-term government bonds and global indices	OLS, GMM	✓

Panel 7. Structural Shifts					
Hancock 1985	1973–1978	18 New York banks from the 2nd Federal Reserve District	Quarterly balance sheet and capital data, dummies	Pooled cross-section time series, Proposition of production model	° / *AL*
Kane and Unal (1988)	1975–1985	P/ 9 MCB, 13 super-regional banks, 9 regional banks, 8 S&L	Monthly returns on long-term bond, dummies	OLS, Maximum likelihood, GQSRM	° / ✓
Mitchell (1989)	1976–1983	16 large banks, 17 medium banks, 30 small banks	Annualized 6-month T-bill rate, 1-year T-bill rate, 3- and 5-year T-bond rates	SURE	° / *AL*
Chen and Chan (1989)	1972–1986	P/ 32 banks, 22 S&L	Monthly 3-month T-bill rate, dummies	OLS	✓
Brewer and Lee (1990)	1978–1984	45 banks	Daily 3-year T-note rate	OLS	
Akella and Chen (1990)	1974–1984	P/ 23 large banks	Quarterly returns T-bill, long-term govt. bond, dummies	OLS	
Ehrhardt (1991)	1973–1985	PI/ 637 stocks from various industries	Monthly returns of bond portfolios with up to 5 months, 3-year, and 16-year maturity	OLS, Cross-section GLS	~ / ✓
Kohers and Nagy (1991)	1970–1988	PI/ 28 large banks	Monthly S&P's medium-term U.S. govt. security index, Index of leading economic indicators, T-bill yield, Fed funds rate	OLS	✓
Wetmore and Brick (1994)	1986–1991	P/ 11 MCB, 20 super-regional, 48 regional	Weekly returns 1-year T-bill, 7-year T-note, long-term bond, weighted USD index–10 currencies	OLS, Cross-section	Ø / ✓

(*Continued*)

APPENDIX: (*Continued*)

	Period	Sample	Key Variables[a]	Methodology[b]	Extra Factors[c]
Jensen and Johnson (1995)	1962–1991	CRSP value weighted index, CRSP equally weighted index, Financial firm index	Daily discount rate changes (78 changes announced), 3-month T-bill rate, 10-year T-bond rate	Stock returns following announcements	
Adjaoud and Rahman (1996)	1963–1989	P/ Canadian financial services index	Daily/monthly 90-day T-bill rate	OLS, Ferson (1989) test, Conditional beta	
Faff and Howard (1997)	1978–1992	P/ banks and finance firms	Monthly returns 90-day bank-accepted bill, 10-year Commonwealth govt. bond	OLS	
Kaen, Sherman, and Thranian (1997)	1985–1993	P/ 3 national universal banks, 2 regional universal banks	Daily Lombard and discount rates (6 changes in each rate *plus* 15 combined changes, i.e., 27 in total), dummies	MVRM, Event study CAR	° / ✓
Faff and Howard (1999)	1978–1992	P/ 5 large banks, 10 small banks, 18 finance firms	Monthly returns 90-day bank-accepted bill, 5- and 10-year Commonwealth govt. bonds, term premium (i.e., 10-year bond *minus* 90-day bill), dummies	OLS	Ø / ✓
Madura and Schnusenberg (2000)	1974–1996	P/ 98 banks	Daily Fed funds rate (148 changes announced), discount rate (60 changes), dummies	OLS, SURE	Ø / ✓

Panel 8. Non-Standard Approaches

Unal and Kane (1988)	1975–1985	P/ 5 large banks, 16 medium banks, 9 small banks, 9 S&L	Monthly/Quarterly returns T-bill and T-bond, recorded and unrecorded equity, dummies	OLS, SMVAM	° / ✓ / *AL*
Born and Moser (1990)	1962–1982	50 Fed-member banks	Daily discount rate changes (63 changes announced), dummies	OLS, Event study CAR	✓
Kane and Unal (1990)	1975–1985	P/ 25 large banks, 54 to 97 medium banks, 25 small banks	Quarterly returns long-term govt. bond, bookable, and unbookable equity	GQSRM, Cross section,SMVAM	° / *AL*
Choi, Elyasiani, and Kopecky (1992)	1975–1987	P/ 48 largest banks (assets > $10 billion)	Monthly 3-month T-bill rate, weighted USD index–10 currencies, dummies	OLS, Cross-section time series	✓
Allen and Jagtiani (1997)	1974–1994	P/ 351 depository, 193 security firms, 78 insurance, 246 mutual funds, 255 financial firms	Monthly 3-month T-bill rate, dummies	OLS, Cross-section 60-month rolling betas	✓
Wetmore and Brick (1998)	1986–1995	P/ 66 banks (MCB, super-regional banks, regional banks)	Weekly long-term bond rate, basis: prime rate *minus* (Fed funds rate+LIBOR)/2, weighted USD index–10 currencies	OLS, Cross-section	Ø / ✓
Benink and Wolff (2000)	1974–1993	P/ 20 largest U.S. bank holding companies	Weekly 3-month T-bill rate, 10-year T-bond rate, Survey data for the Fed funds rate	OLS	
Johnston and Madura (2002)	1987–2001	P/ 53 life insurance, 55 health insurance, 128 property insurance	Monthly 30-year T-bond yield, NAREIT All-REIT and Equity-REIT indices	OLS, SURE, Cross-section	✓

(*Continued*)

APPENDIX: (*Continued*)

	Period	Sample	Key Variables[a]	Methodology[b]	Extra Factors[c]
Wetmore (2003)	1990–1997	P/ 7 MCB, 13 super-regional, 30 regional	Weekly long-term bond rate, prime rate *minus* (Fed funds rate+LIBOR)/2, log of the refinancing index (MBAA), weighted USD index–10 currencies	OLS	Ø / ✓
Staikouras (2005)	1989–2000	P/ 18 banks, 15 finance firms, 21 insurance, 61 invest. trusts, 30 REIT, 94 industrial	Weekly 1- and 3-month T-bill discount rates	SURE	∼
Viale, Kolari, Fraser, and Sorescu (2006)	1986–2003	P/ All CRSP banks, K. French's non-financial firms	Monthly 1-month T-bill rate, term spread (i.e., 25-year bond yield *minus* 90-day T-bill), default risk, book-to-market, size, human capital component of wealth, gap, loan loss provisions	OLS, Time series cross-section, SURE, GMM, Monte Carlo, Fixed-effects panel data model, Fama-MacBeth approach	Ø / ✓ / *AL*
Panel 9. Conditional Volatility					
Song (1994)	1976–1987	P/ 9 MCB, 8 S&L, 16 Regional banks	Monthly returns long-term govt. bond	ARCH, GMM	° / ✓

Flannery, Hameed, and Harjes (1997)	1973–1990	P/ All NYSE-AMEX stocks, 785 bank-thrift firms	Weekly excess returns 10-year T-bond	GARCH-M, SURE	∼ / ✓
Elyasiani and Mansur (1998)	1970–1992	P/ 10 MCB, 14 large banks, 32 regional banks	Monthly 10-year T-composite yield, dummies	GARCH-M	° / ✓
Tai (2000)	1987–1998	PI/ 7 MCB, 11 large banks, 13 regional banks	Weekly 10-year T-composite yield, weighted USD index–10 currencies	MGARCH-M, SURE via GMM, Pricing Kernel	° / ✓
Faff, Hodgson, and Kremmer (2005)	1978–1998	P/ 8 small banks, 5 large banks, 18 finance firms	Monthly returns 10-year Commonwealth govt. bond, dummies	GARCH-M	Ø / ✓

[a]The column presents the main factors employed in analyzing the determinants of equity returns and the interest rate sensitivity of financial institutions. Some studies have employed short- and/or long-term interest rates with their effect measured as simple yield changes, percentage changes and/or returns. A brief comment regarding the interest rate index is provided under Section II, footnote 17.

[b]Note that in many studies where cross-section analysis is employed a number of regressors are obtained from financial statements.

[c]The column presents four different symbols. Studies marked with a tick (✓) have exceeded and/or amended the classic two-factor specification (market and interest rate indices) in explaining the equity return generating process. Furthermore, there are cases where interest rate risk is taken into account, but the endogenous variable is obtained from financial statements—not stock market returns. Then, in these studies the following acronym (*AL*) is shown.

Wherever the circle symbol (°) is presented, the work has taken into account the size of the institution. The latter does not necessarily come as an exogenous variable, but it is also employed as a benchmark to form portfolios/groups which are estimated independently. Nevertheless, a few studies have not used assets as their portfolio benchmarks, but instead they have employed market capitalization, common competitors, common practices, management orientation or gap size, NIM, mortgage activity—where relevant etc. In these cases the following symbol (Ø) is displayed. Finally, research marked with a tilde (∼) indicates that portfolios have been constructed on the basis of their sensitivity to a certain factor such as market index, FOREX, interest rate etc.

P/ = These studies employ portfolios instead of individual stock estimations.

PI/ = These studies employ both portfolios and individual stock estimations.

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XI. NOTES ON CONTRIBUTORS

Sotiris K. Staikouras currently serves as associate professor of finance at Cass Business School, City University, London. His major research interests are risk analysis and management of financial institutions, asset pricing, and financial modeling. Dr Staikouras has worked as a research advisor at London Clearing House and as financial analyst/consultant for other institutions. He holds a Ph.D. degree in finance from Cass Business School, and his research has been published in U.S. and European journals.

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