An Examination of How the Proposed Bifurcated Implementation of Basel II in the U.S. May Affect Competition among Banking Organizations for Residential Mortgages

Paul S. Calem

and

James R. Follain

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Calem is Vice President for Product Research at Loan Performance and Follain is a private consultant. Helpful comments were provided on an earlier version of this paper by a number of former colleagues on the staff of the Federal Reserve Board, participants at seminars at both OTS and OFHEO, and, especially, all of those who contributed to the interviews we conducted in 2003-04 as background for the study. Opinions expressed are our own and do not necessarily represent the views of the Federal Reserve Board or its staff.

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I. Introduction

In June of 2004, the Basel Committee on Banking Supervision published the outcome of its work over the past several years to produce significantly more risk-sensitive regulatory minimum capital requirements[1] for internationally active banks.[2] The new agreement is an update of the 1988 Accord (Basel I) and is widely referred to as the Basel II Accord. The most advanced set of rules that define minimum capital requirements under Basel II, called the Advanced Internal Ratings Based (AIRB) approach, places substantial reliance upon the internal data and risk measurement and management processes of those banks that use it. Two alternative sets of rules – the Foundation approach and the Standardized approach – incorporate more risk sensitivity than Basel II but stop short of the variations in risk sensitivity of capital requirements associated with the AIRB approach. Currently, U.S. bank regulators have proposed that only the AIRB approach will be admissible in the U.S.

Now that the principles of Basel II have been agreed to by participating countries, regulators in each country are now focused more fully upon the plans for implementation in their countries. The Basel Committee expects the implementation rules to be fully in place by the end of 2007 and to become operative in 2008, but significant latitude is permitted in its application among banking organizations within a country. The optimal implementation system for a country such as the U.S. involves a tradeoff between the explicit and implicit cost of implementing all aspects of the proposal for all banking organizations and the benefits of a more risk-sensitive system of capital requirements. A

[1] Some other elements remain unchanged; in particular, the goal of having a total capital requirement equal to 8 percent of risk-adjusted assets remains.
[2] BIS (2004).

substantial component of the explicit costs includes the considerable fixed and variable considerable resource costs needed to implement the AIRB approach. Another potentially substantial and less explicit component of the costs of the U.S. implementation plan -- and the focus of our paper -- is the potential to alter the existing competitive landscape among U.S. banking organizations.

At one end of the range of implementation possibilities is a plan that requires full-implementation of the AIRB approach for all banking organizations. This would almost surely impose an unjustifiable burden for many smaller banking organizations and bank regulators. At the other end is a bifurcated plan in which only the largest internationally active banking organizations would be required to implement the AIRB approach (adopters). This would impose little or no explicit costs on nonadopters, but it has the potential to generate less explicit costs that may arise from the impact of a bifurcated implementation upon the competitive landscape between adopters and nonadopters. Of course, variants between these two limits are possible.

U.S. regulators have, in fact, proposed a system closer to the latter. The plan calls for ten or so of the largest banking organizations to be required to adopt the AIRB approach. Though a small number may choose to apply for AIRB status (opt-in candidates), all of the other 10,000 or so banking organizations and thrifts would continue to operate under Basel I rules. Hence, limiting the implementation to only the largest organizations attains some of the intended benefits of Basel II – greater risk sensitivity of capital requirements for some large banking organizations – while avoiding the imposition of any substantial costs (explicit or implicit) upon nonadopters. The plan

and its rationale are well-summarized in a June 2003 speech by Roger Ferguson, Vice-Chairman of the Federal Reserve Board.[3]

When this implementation plan was originally proposed, regulators expressed a belief that the competitive effects within the U.S. are unlikely to be significant due to changes in regulatory capital requirements. An excerpt from Vice Chairman Ferguson's speech highlights this original thinking:

> "The dispersion of capital requirements has also created an unexpected criticism from some observers: it will distort the competitive landscape, as if somehow lower capital requirements were a random gift and higher capital requirements a random penalty, rather than correctly reflecting underlying risk…..To be sure, some, but not all, of the concern in this country has reflected objections from banks that will not be required to apply Basel II--and thus will not see their capital requirements change at all. Some of these entities fear they will face a rival that will get a capital break because the rival is following Basel II and has lower risk exposures recognized by the new accord…..
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> The extent to which regulatory capital requirements drive pricing or profitability is an empirical question. My own view is that in a world in which banks hold capital buffers and can securitize and sell assets, and with bank management increasingly allocating resources and making decisions on the basis of internal economic capital measures, the answer must be: not very much, if at all."

That is, neither adopters nor nonadopters will have an advantage or disadvantage in the competition for a particular product since adopters already base their costs and prices upon economic capital, which is invariant between adopters and nonadopters.

More recently, though, regulators have expressed second thoughts on the validity of this view. In essence and in full recognition of the complexity of the issues involved, we will argue that the original thinking may be mistaken when it comes to the market for residential mortgages for two primary reasons. First, the adopters will be granted a potential cost advantage for particular residential mortgage products because regulatory capital for these products under Basel I generally exceeds the economic capital for such products. Second, since bank investments in residential mortgages are quite large and varied in terms of economic capital, especially among mortgage specialists, the disparate

[3] See Ferguson, 2003.

regulatory capital treatments will likely have substantial impacts on the profitability of nonadopters with large residential mortgage portfolios.

Producing a highly precise and econometrically based estimate of these potential competitive effects is not something we or the regulators can offer. One reason stems from the lack of detailed information available to either the public or the regulators (e.g. Call Report data) on the holdings of residential mortgages by banking organizations. Another is the complexity of the residential mortgage market and, especially the complex ways in which it is affected by securitization. Here, we offer an analysis designed to articulate and validate as best we can a view that the proposed bifurcated regulatory capital system may have significant competitive effects in the case of residential mortgages. Our arguments include a simple theoretical model that shows how regulatory capital requirements can have profound impacts on the holdings of banks and the observed relationship between total economic and regulatory capital as well as a case study based upon the GSE experience that we believe supports the simple model. We also offer reasonable estimates of the amount of business that may be lost to nonadopters for some key risk segments. Lastly, we present what we consider to be a plausible range of the aggregate losses to nonadopters that we label as significant and contrary to the view embedded in the current bifurcated implementation plan.

Our attention is focused primarily upon competition among banking and savings organizations subject to Basel II. The current role of the two large government-sponsored enterprises (GSEs) – Fannie Mae and Freddie Mac – and the potential impacts of heightened competition for residential mortgages between them and the adopters are discussed, but they are not deemed central to the decision facing the regulators about

Basel II unless bank regulators place a benefit on a reduced size of the GSEs as a benefit of Basel II.

Some requisite background information about the market for residential mortgages and Basel I and II regulations pertaining to mortgages is presented in the next section. The simple theoretical model and the case study that underlies much of our thinking are contained in the third section. The fourth and fifth sections offer our estimates of the likely competitive effect, which we measure in terms of the transfer of accounting income from nonadopters to adopters due to Basel II. The final section summarizes the results and their implications regarding ways in which Basel II may be modified to reduce the competitive effect. Two appendices are included. The first summarizes key points from interviews that we conducted for the Federal Reserve Board to ascertain the views of various financial sector institutions on the subject of this study. A second addresses a rather technical issue regarding the distribution of effective durations of the 30 year fixed-rate mortgages held by thrifts.

II. Background Information

The arguments presented in this paper rest upon a number of assumptions and perspectives about the workings of the current market for residential mortgage, the impact of Basel II on the computation of regulatory capital for adopters, and the relative importance of regulatory capital in bank investment decisions. We seek to explain some of the requisite background information in this section. The first part of the section defines what is meant by economic capital and its contribution to the cost of mortgage investment. The second describes what we know and expect to be the impact of Basel II on the cost of regulatory capital for residential mortgage investments by adopter banks.

A. *Capital as a component of the cost of mortgage investing*

The annualized cost of holding a residential mortgage consists of three major components.[4] The first and most substantial component is the cost of debt financing of the mortgage since mortgage investments by banks is a highly leveraged undertaking. In the case of banks, this component is typically approximated by the cost of deposits, although more sophisticated and expensive forms of debt are also used, e.g. subordinated debt, callable debt, etc. The second is the cost of originating and servicing the mortgages; these are largely the operating costs and the cost of infrastructure used in such operations. The third is the cost of credit and interest rate risk associated with mortgage investments.

Both credit and interest rate risk stem from the options available to borrowers. Credit risk arises from the put option available to borrowers and interest rate risk from the call option available to them.[5] Investors demand a premium for assuming these risks. These premiums can also be expressed as the sum of two components: expected costs and the cost of capital. In the case of credit risk, expected costs refer to expected or average credit losses due to default. In the case of interest rate risk, expected costs refer to the ongoing costs of hedging activities designed to meet basic duration and convexity targets.

Our focus is upon the capital cost components of credit and interest rate risk because it is only these costs that are directly impacted by Basel II. We define capital costs (CC) as the annualized cost of equity capital set aside to insure against unexpected or extreme losses; that is, $CC = i_e (K_c + K_i)$, where i_e is the price of equity capital, K_c is

[4] Posner (2002) presents a comprehensive look at variations in the cost components of mortgage investments.
[5] An enormous literature exists to explain and measure these option-based approaches.

the capital set aside to insure against unexpected credit losses and K_i is the amount set aside for unexpected losses due to interest rate risk. The amounts of capital that banks would allocate internally; that is, in the absence of regulatory intervention, to cover losses in an extreme or highly unlikely outcome are known as economic capital. Economic capital need not coincide with the capital allocated to meet regulatory requirements. Within the present context, our focus is upon the relationship between the regulatory environment and the two capital terms, since we do not expect Basel II to have a substantive impact upon i_e.

Considerable variation in the shares of the credit and interest rate risk components of *economic capital* exists across mortgage products or categories. For example, a portfolio of fixed-rate mortgages (FRMs) with coupon rates at or above the current market mortgage rate of interest is exposed to substantially greater risk – potential reductions in value due to, say, a large and unexpected shock of a 200 basis point rise in interest rates, than on one in which the coupon rate is well-below the market rate. [6] Adjustable-rate mortgages (ARMs) are, on the other hand, generally less risky than FRMs in terms of interest rate risk and require lesser amounts of K_i, all else equal. More examples of this variation are discussed below.

The amount of capital for mortgage credit risk also varies widely among loans. Calem and Follain (2003) demonstrate the wide variation that exists among mortgages that differ with the borrower's credit rating (FICO score) and the original loan-to-value

[6] Duration is a measure of the degree of interest rate risk inherent in an asset. For example, the duration on a fixed-rate, 30-year mortgage is commonly estimated to be about 4.5 or so, which means that the value of an MBS backed by fixed-rate mortgages can decline by 4.5 percent for every 1 percentage point increase (e.g., 6.0 to 7.0 percent) in the prevailing mortgage interest rate. The net duration of the mortgage portfolio is the difference between the average duration of the mortgage assets in the portfolio and that of the debt used to finance them. Portfolios with higher net durations require more capital for the implied interest rate risk of the portfolio, all else equal.

ratio (LTV) of the loan. For example, the economic capital needed for the credit risk of a "risky" loan (620 FICO, 95 percent LTV) is over 20 times that for a "safe" loan (740 FICO, 70 percent LTV). In addition, economic capital needed for credit risk is substantially higher for banking organizations with more geographically concentrated mortgage loan portfolios.[7]

The significance of these capital costs also depends upon the particular form of mortgage investment undertaken by an investor. Some may choose to invest in all aspects of the mortgages, but the practice of "unbundling" is the norm rather than the rule among mortgage investments. Unbundling refers to the ability of investors to focus their mortgage investments on one or more aspects of the income and risk associated with such mortgages. For example, some may focus upon the servicing income. Some may focus on the interest rate risk associated with mortgages and jettison both the risks and rewards associated with credit risk and servicing. Indeed, many banking organizations, those that function as origination specialists, retain relatively few, if any, of the income and risks generated by the loans they originate.[8] Some may focus just on the credit risk component. Because of unbundling, investors can even choose to take on portions of these largely separable risks.[9]

The cost of capital as a fraction of total costs varies widely depending upon which of the various pieces of the mortgage investment is selected by the investor. At one extreme is the investor who chooses to invest in all elements of a high quality mortgage;

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[7] Economic capital for a portfolio with whole loans from a wide variety of regions – nationally diversified – is lower than is economic capital for a portfolio of similar risk characteristics from a single region – regionally concentrated.

[8] Even fewer institutions are engaged in servicing mortgages. Unbundling of the servicing function has allowed economies of scale associated with servicing to be realized.

[9] Follain and Zorn (1990) discuss the history of these developments through 1990; Posner (2002), Paffenberg (2004), and Van Order (2000, and 2003) provide comprehensive and recent updates.

in such a case capital costs are typically dwarfed by the cost of debt because these investments are so highly leveraged. The other extreme is represented by those who choose to invest solely or primarily in the credit risk portion of a mortgage.

The prototypical example of this point and, more generally, the unbundling process is the standard GSE MBS. The GSE typically purchases loans from one or more originators and then packages them into an MBS. The originator receives the sale price of the loans and is largely out of the picture, although some may retain servicing or choose to purchase the MBS via a swap program. A portion of the cash flows from the mortgages goes to a servicing institution which is paid a servicing fee. The MBS is sold to an investor. The GSE retains the credit risk on the pool of mortgages (that is, it provides a credit guarantee, exclusive of the portion that is assigned to mortgage insurers, if applicable) and it receives a "guarantee fee" in return. The interest rate risk is transferred to the investor who purchases the MBS, who in turn receives coupon payments. In essence, this particular securitization process involves the sale of credit risk protection or a credit guarantee to the investors in the MBS in exchange for a guarantee fee.[10]

A simple example demonstrates the importance of capital costs to this particular investment type. The gross guarantee fee charged by the GSEs for MBS backed by prime or high quality loans is currently in the range of 15-20 basis points. Assume that operating costs for this program are 5 bps, a cost of equity capital of 15 percent, and a

[10] Entities other than the GSEs -- including large banking organizations, the Federal Home Loan Bank system, and nonbanks -- also issue securities that transfer unbundled credit risk for pools of nonconforming mortgages. The Federal Home Loan Bank (FHLB) MPF program is an example discussed by Frame (2003), Frame and White (2004), and Van Order (2000). Under this program, a participating bank or thrift sells its loans to an FHLB and retains a second, or mezzanine, loss position. The FHLB holds a first loss and a catastrophic loss position. All of the interest rate risk is owned by the FHLB.

ratio of tail loses to expected losses of four (K_c/EL = 4); then capital costs comprise 37.5 percent of total credit costs and 25 percent of total costs.[11]

B. *How Basel II will affect regulatory capital requirements for mortgages*

Here we simply want to highlight critical elements of the Basel II accord and, especially, the implementation plans proposed for the U.S. More can be found at: http://www.federalreserve.gov/generalinfo/basel2/default.htm. After a brief summary of the existing capital rules (Basel I), we focus upon what is called Pillar I of Basel II, which defines certain explicit rules for minimum capital requirements for assets held by banking organizations.[12]

The existing Basel I capital requirements set two basic sets of information. The first is the total amount of capital required by the banking organization and the second is a set of risk-weights that vary among assets and are used to define total risk-weighted assets of the bank. Tier 1 capital is set at 4 percent of risk-weighted assets; total capital is set at 8 percent of risk-weighted assets. Risk-weights are stated relative to a 100 percent risk-weight. Residential mortgages ("prudently underwritten") have a 50 percent risk-weight and hence require 200 basis points of Tier 1 capital (200 = 0.50*400) and 400 basis points of total capital. Other assets have higher or lower risk-weights.

Separately, U.S. banks are subject to a set of "leverage" requirements (not part of the Basel Accord) that define required capital in terms of non-risk-adjusted assets. These vary by the rating a bank requires in order to achieve one of several categories of adequate capitalization. For example, a well-capitalized banking organization has at least

[11] Define the guarantee fee as: $g = EL + G\&A + i_eK_c$. Assume $K_c = 4EL$, then $i_eK_c/g = .25$ if G&A = 5 and $i_e = .0.15$.

[12] Pillar II pertains to additional capital requirements that can be imposed by bank regulators during the supervisory process. Pillar III refers to the use of public disclosure.

total capital in excess of 10 percent and Tier 1 capital in excess of 5 percent. Although it is typical for Basel I capital requirements to exceed the leverage requirements for a bank involved in the full spectrum of credit risk, this is not always the case. Indeed, this situation is likely to be potentially important to mortgage lending specialists and it receives special attention below.

Basel II is designed to improve the alignment between economic capital and regulatory capital. It replaces the relatively small number of risk-weight buckets in Basel I with, in essence, a very large number of risk-weights with a much wider range than is the case with Basel I. By design, the extent of the alignment between the Basel II minimum capital rules and economic capital will vary among banks. Those with large portfolios and sophisticated risk management systems able to estimate economic capital will be candidates for the most sophisticated approach available under Basel II: the advanced-internal ratings approach (AIRB). Some large banking organizations will be required to adopt this approach and some may opt-in to the AIRB approach.[13]

The proposed implementation plan for the U.S. calls for mandatory adoption of the AIRB rules for 10 or so of the largest bank holding companies, the opportunity to "opt-in" to those who can and wish to meet the criteria associated with this approach. All other banking organizations will remain under Basel I rules. Implementation of the Foundation and Standardized approaches is not planned in the U.S.

As discussed by Calem and Follain (2003), the AIRB approach will generate substantial reductions in the minimum regulatory capital requirements for most residential mortgages. Examples of the Tier 1 minimum capital requirements are

[13] As noted above, Pillar I of Basel II also includes two other approaches that provide the opportunity for more variation in risk-weights among assets than under Basel I but not as many as allowed under the AIRB approach. These are called the Foundation and the Standardized Approaches.

contained in the Table II-1 above. The last row provides an estimate of the amount of Tier 1 capital that would be required for an adopter with an average portfolio of high quality mortgages that are well-diversified geographically. *The amount is 40 basis points, which is one fifth of the 200 bps that would be required by nonadopters, all else equal.* For some risk segments the difference is larger and for some others it is smaller.

III. Are Regulatory Capital Rules Binding?

We have now established how capital costs *can* influence the cost of mortgage investing and that Basel II *will* generate a substantial disparity in regulatory capital costs for typical mortgage investments between adopters and nonadopters. A remaining issue is whether capital assignments and investment decisions for particular products are much or at all influenced by regulatory capital for those products. Alternatively stated, we wish to know whether regulatory capital rules are *binding* upon the normal operations of banking organizations. If not, then a disparity in regulatory capital treatment would have no competitive impact. If so, then some competitive effects are possible.

A *binding* regulatory regime, by our definition, is one in which bank decisions pertaining to the total amount of capital, capital allocations for specific investment categories, or the risk composition of a bank's portfolio are different than they would be in the absence of these regulations. More specifically, regulatory capital rules are defined to be *nonbinding* if a bank allocates capital and makes investment and business decisions solely on the basis of internal economic capital targets or market-based requirements.[14]

[14] The capital required for a favorable interest rate or rating from bondholders, uninsured depositors, borrowers, and rating agencies may be independent of regulatory capital ratios.

Two types of evidence are offered in support of the position underlying our view. The first is a case study of the market for credit risk among conforming and conventional loans. We seek to link the dominance of this market by the two GSEs to existing regulatory capital differences that favor the two GSEs versus banks. The case study is especially helpful in explaining and motivating what we define as Case 2. The second part of the section offers a simple theoretical model of how the amounts of regulatory and economic capital interact to influence bank investments.

A. *A case study of the impact of regulatory capital rules*

The GSEs have become dominant in the market for *credit risk* on conventional, conforming mortgages through the credit guarantee associated with their securitization programs. A widely accepted stylized fact is that upwards of 75 percent of conventional conforming mortgages are held in the form of GSE MBS and the attached GSE credit guaranty.[15] The GSEs are much less dominant in the market for the interest rate risk associated with conforming, conventional mortgages. For example, the GSEs held about $1.25 trillion of the $3 trillion in outstanding MBS at the end of 2003 (Fannie Mae, 2004). The rest were held by banks, thrifts, insurance companies, and other investors.

GSE dominance in the market for credit risk of conforming mortgages has in part been driven by the disparity between the regulatory minimum capital requirements for the GSEs (which are generally believed to be binding on the GSEs) and the Basel I

[15] A precise estimate of the GSE share of this market is difficult to obtain from publicly available data because of the difficulty of defining a conforming loan. Loan limits are helpful, but these are not sufficient to identify the potential size of GSE purchases because some loans meet the loan size limit but not the underwriting criteria associated with a conforming conventional mortgage.

regulatory requirements for banking organizations.[16] GSE capital rules require 45 basis points of equity capital for bearing the credit risk associated with their outstanding MBS (whether the MBS are held in their own portfolios or held by others). Thus, the GSEs have a marginal capital charge of only 45 basis points for bearing the credit risk of MBS held either by themselves or by others. In contrast, a bank that chose to hold only the credit risk on a whole prime mortgage or pool of such mortgages by, for example, completely hedging away the interest rate risk would still need to hold, under Basel I, at least 200 basis points of equity (regulatory tier 1) capital. Finally, note that while the GSEs currently enjoy a regulatory capital advantage over banking organizations with respect to bearing unbundled credit risk, they have no such regulatory advantage (indeed, are disadvantaged) with respect to regulatory minimum capital requirements for their portfolio holdings of MBS.[17]

Do factors other than regulatory capital rules regarding credit risk also influence the important role that the GSEs play in the market for credit risk on conforming mortgages? This is certainly the case. For instance, much attention has been given to potential funding advantages for the GSEs.[18] Similarly, the expertise of the GSEs in the

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[16] The GSEs face both minimum and risk-based capital requirements, but the minimum regulatory requirements have always been the binding constraint. See, for example, the most recent report by the Office of Federal Housing Enterprise Oversight (OFHEO) in which it presents the capital requirements for the GSEs as of the end of 2003, Q3: http://www.ofheo.gov/media/pdf/capclass3q03.pdf

[17] A GSE must also hold 205 basis points of equity capital for bearing interest rate risk, so that the total minimum equity capital requirement is 250 basis points for a prime MBS held in a GSE portfolio. In contrast, for a banking organization, 80 basis points of tier 1 capital (corresponding to a 20 percent risk weight) would be required for holding a GSE MBS (assuming other regulatory capital requirements, including the leverage requirement, are met). Thus, under Basel I, banking organizations face a *lower* marginal regulatory minimum capital charge for holding either an MBS (80 basis points per dollar of outstanding balance of the MBS) or a whole, prime loan (200 basis points) than the GSEs' regulatory capital charge for holding an MBS (250 basis points).

[18] Passmore (2003) argues that this funding advantage is particularly important in explaining their holdings of GSE issued MBS. We mention this paper since it is widely cited and raises a plausible concern, although one that is not directly related to our main issue – the dominance in the market for the credit risk on their MBS. The paper does not link a funding advantage to substantially higher guarantee fees on their

management of mortgage credit risk may play a role in their dominance. The degree to which such factors may contribute to GSE dominance is of tangential interest to this study, however, since our focus is on the competitive landscape within the banking industry and not on competition between banking organizations and the GSEs.

In sum, the competitive landscape for mortgages is greatly influenced by the presence of the GSEs. In particular, the GSEs are especially dominant in the market for credit risk protection on conventional, conforming mortgages owing, at least in part, to their regulatory capital advantage in the holding of credit risk. This fact provides a strong inference about how Basel II and its bifurcated implementation may affect the competitive landscape for mortgages. Specifically, adopting banks may obtain a similar advantage over nonadopting banks in the market for credit risk protection on nonconforming mortgages, and be better able to compete with the GSEs in the market for credit risk on conforming mortgages.

B. *A simple model of binding capital rules*

A sufficient condition for a regulatory capital rule to be nonbinding is that economic capital per unit of investment exceeds required regulatory capital in every relevant asset or investment category. In this case, the regulatory standard clearly is irrelevant to cost-of-capital calculations affecting investment decisions.[19] Although this is a sufficient condition for a regulatory rule to be nonbinding, it is not a necessary

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MBS. The degree to which the GSEs exert the kind of dominance described in Passmore (2003) in the market for MBS is a matter of some debate. For example, Van Order (2000) stresses that both the GSEs and banking organizations have favorable charters relative to purely private entities, so the issue of dominance depends upon a detailed comparison of their complex charters. Blinder, Flannery, and Kamihachi (2004) provide a more recent and specific rebuttal to Passmore. Steve Abraham, in his December 16, 2003 weekly article and in others, consistently notes the variability in the GSE's share of the market for their own MBS and, in particular, the intense competition for these MBS with banks.

[19] This statement presumes that the bank does not seek to hold a capital "cushion" above the regulatory standard that is larger than the amount accorded by its internal capital allocation.

condition. A regulatory rule can be nonbinding even if marginal regulatory capital exceeds marginal economic capital in some, but not all, investment categories. We elaborate on this point below.

When a regulatory capital rule is binding, then theory suggests that it tends to influence decisions regarding the composition and amounts of assets held in the direction of increasing portfolio credit risk.[20] For instance, Jones (2000) argues that banks will increase their credit risk exposure in various ways to arbitrage the excess of regulatory over economic capital, a response commonly referred to as "regulatory capital arbitrage." Calem and Rob (1999) develop a model where a binding regulatory capital floor implies a shift in the composition of the loan portfolio toward riskier assets. The intuition behind this result is that profitability is driven by maximizing leverage. The maximum amounts of leverage for each product are determined by the inverse of the economic capital ratios. A situation in which regulatory capital exceeds economic capital for a particular asset reduces the leverage achievable for that asset and the portfolio given some fixed amount of capital. In such a situation, investors will move their asset allocation away from the asset in which regulatory capital exceeds its economic capital. This may be accomplished either through directly increasing the share of risky assets held in the portfolio (for example, the share of subprime relative to prime mortgages), or through more complex forms of regulatory arbitrage involving securitization and off-balance sheet exposures (Jones 2000). The extent of the shift and the impact upon portfolio profitability and capital ratios depends upon a variety of factors, which we discuss below.

[20] There is a substantial theoretical literature on the relationship between capital regulation and bank risk taking. The literature generally suggests that banks will increase portfolio risk in response to a binding regulatory capital requirement. Under special conditions, this relationship need not hold; for instance, if relative risk weights under the regulatory standard align with relative economic capital as in Rochet (1992). See Allen (2004) for a review of this literature.

Our notion of regulatory capital arbitrage is similar in fundamental ways to that described by Jones; the key difference is that we use the concept to include transfers within the banking industry as well as transfers between banks and nonbanks.

Analysis of a Specific Model. This section offers a formal model intended to clarify the meaning of a "binding" regulatory capital rule and explain how regulatory capital rules may influence investment decisions and observed capital ratios of banking organizations. Toward this end, we construct a model of bank portfolio choice for a bank that is not constrained by regulatory capital, and then add a binding regulatory capital constraint into the model.

No regulatory capital restrictions. We model the bank as investing in two asset types, broadly labeled "risky" and "safe." The bank chooses amounts A_r and A_s of each type of asset, respectively, financing the investment using a mix of debt and equity capital. Economic capital per unit of each asset, denoted k_r and k_s, respectively, is determined ex ante by the shareholders of the bank.[21] Debt financing per unit of each asset, denoted d_i, then equals $1 - k_i$, for $i = r, s$. The cost of debt is assumed to be exogenously given at i_d.[22]

The bank is presumed to have an initial endowment of equity capital, *K* which is presumed to be consistent with the ex ante preferences of the shareholders. Without loss of generality, we set K=1. Investment (absent a regulatory constraint) is constrained by the requirement that the economic capital allocations for each asset sum to total capital:

[21] They are assumed to choose capital to allow the firm to survive a stressful event such as the 95th or 99th percentile scenario.

[22] Although this is a simplifying assumption, it does reflect a belief that the cost of debt to banking institutions is likely to be a below market rate due to the nature of the financial safety net available to them – payment systems, deposit insurance, and, for some, the implicit guarantee associated with the "too big to fail" option. This assumption leads to the emphasis upon the maximization of leverage.

(1) $k_r A_r + k_s A_s = 1.$

In essence, this relationship follows from the bank's decisions regarding the amount of economic capital assigned to each asset class, which imply an incentive to maximize leverage subject to the ex ante determined economic capital constraint. Note that total debt, D, then satisfies the adding up constraint:

(2) $D = A_r + A_s - 1 = (1- k_r) A_r + (1- k_s) A_s = d_r A_r + d_s A_s$

The goal of a bank in this model is to maximize its return on equity (ROE) subject to (1). The bank's ROE is a weighted average of the expected ROEs for each asset type, where the weights are the economic capital allocations for each asset type:

(3) $ROE = k_r A_r*ROE_r + k_s A_s* ROE_s$

In turn, expected ROE for each asset type, denoted ROE_i for i=r, s, is the ratio of its expected net income to the economic capital for the asset, or:

(4) $ROE_i = [R_i - EL_i - (1-k_i) i_d]/k_i$ for i = r, s

where R_i and EL_i, respectively, denote promised return (net of operating costs) and expected loss per unit of the asset. Note that the bank's optimization problem can be reduced to a choice of either A_r or A_s, with the other amount then determined by (1); in particular, (3) may be rewritten:

(5) $k_r A_r*ROE_r + (1 - k_r A_r)* ROE_s.$

Clearly, a uniquely determined solution exists only if (5) is a concave function of A_r.

Concavity can be introduced via any of a number of plausible assumptions; for convenience, we opt for a very simple approach that assumes that the bank (or the banking sector) has some amount of market power.[23] In particular, we assume that the

[23] For instance, concavity could be introduced by specifying economies of scope on the operating cost side, or diversification benefits that affect economic capital. We do not believe that introducing concavity in

bank faces a downward sloping demand curve with constant price elasticity for each asset. As such, ex ante returns on the two assets can be written as:

(6) $R_i = \{A_i / [\delta_i * (EL_i + i_k k_i + i_d (1- k_i)]\}^{-1/\varepsilon_i}$ $i = s, r.$

That is, R_i is the ex ante return or price inclusive of a mark-up over the *competitive* return, and ε_i determines the slope of the demand relationship. Given these assumptions, it is readily verified that the objective function, specified in (5), is concave, where the particular solution will depend on the values of the parameters contained in (6). Each δ_i is a parameter in the constant elasticity demand equation; that is, $A_i = \delta_i * (EL_i + i_k k_i + i_d (1- k_i) R_i^{-\varepsilon_i}$. They are based upon a calibration in which each R_i is set equal to the competitive return at what amounts to a very high level of demand within our model. In other words, each δ_i guarantees that each R_i equals the competitive return from at a very high level of demand.

An illustration is provided in Figure III-1. The example is based upon the following parameters: $k_r/EL_r = k_s/EL_s = 4$; $EL_r = 0.025$; $EL_s = .005$; $i_k = 0.15$; $i_d = 0.05$; $k_r = 0.1$; $k_s = 0.02$; $\varepsilon_r = 3.0$; and, $\varepsilon_s = 100$. The curve labeled ROE without Regulatory Requirements depicts the expected ROE in relation to the percent of the portfolio allocated to the safe asset when the regulatory requirements are not binding (see equation (5)).

In this example, the solution has 75 percent of capital allocated to the safe asset and 25 percent to the risky asset; the corresponding values of A_s and A_r are $37.50 and

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other ways would affect the basic points we wish to emphasize. In particular, introducing the benefits of diversification raises another thorny problem regarding the distribution of the capital surplus. Myers and Read (2001) summarize and add to the literature on the issue of how insurance companies and, more generally, financial institutions can allocate a capital surplus among divisions or asset classes. Although they do propose a rule for such intra-firm allocations, they acknowledge the complexity of the issue, especially for infra-marginal changes in investment decisions.

$2.50, respectively. Initially, expected ROE rises as risky assets are added to the portfolio (proceeding along the curve from right to left), reflecting the benefits of the price premium earned on investment in the risky assets when the quantity invested is not too large. The marginal return from additional investment in risky assets declines as the premium falls along the demand curve for this asset type. Expected ROE peaks at 25 percent. Alternative calibrations with higher premiums and higher (absolute) values of the demand slope parameter would move the peak to the left.

Binding regulatory restrictions. An additional rule is added to the model to analyze the effects of a binding regulatory capital requirement. A simple minimum capital rule is posited, namely

8) $K_{reg} = \lambda (A_r + A_s)$

The concept of a binding regulatory requirement now can be formally defined within the model. The rule (8) is binding on the bank, if and only if $\lambda (A_r^* + A_s^*) > K = 1$, where A_r^* and A_s^* denote the solution to the unconstrained optimization problem (i.e., if required regulatory capital for the optimal portfolio exceeds the initial endowment of one unit of equity capital). We can also refer to the rule as being binding for a particular portfolio composition A_r and A_s if $\lambda (A_r + A_s) > 1$.

The bank now has two options if K_{reg} exceeds available capital or, alternatively, λ exceeds k_s. These are demonstrated by a continuation of the preceding example with $\lambda = 0.50(k_r + k_s) = 0.06$, i.e. simple average of the amounts of economic capital for each of the two assets. Also, the cost of additional capital equals i_k. *Option 1 is to simply purchase the additional capital needed to be compliant with the capital rule.* This can be thought of as an additional cost of business and would reduce the ex ante ROE of the

portfolio. The curve labeled Adjusted ROE in Figure III-1 is the ROE without capital regulations less this additional cost of business. *Option 2 is to choose an investment allocation in which the regulatory capital rule is satisfied.* In this example and with capital held fixed at one unit (i.e., no additional capital raised), option 2 calls for the bank to allocate only 15 percent of its capital to the less risky asset. Expected ROE declines to 14.2 percent, and a slight regulatory capital surplus arises relative to the optimal allocation in the absence of a capital regulation. The bank's optimal response to the binding rule in this particular example is actually a combination of these two. The bank will purchase 8 percent additional capital and reduce its share of capital devoted to the safer asset from 70 to 20 percent. As Figure III-1 shows, this strategy generates the highest possible ROE (14.6 percent) subject to the capital rule and well below the 25 percent earned when the regulation was not binding.

This example highlights what we believe is central to our analysis of a binding capital constraint; that is, the allocation of the portfolio to the safer asset declines dramatically from 70 percent to 20 percent of available capital. The ex ante ROE is lower at this new solution than in the unrestricted case, but much higher than if no portfolio change had been made (14.6 percent versus 5.9 percent). Reducing regulatory capital for this portfolio will have the opposite effect. It is this reversal that adopting banks will be able to pursue but nonadopting banks will not.

A second aspect of the solution is the impact of the constraint upon the capital ratio. In this particular example, the optimal solution equates regulatory and economic capital. Note, however, that a solution with an excess of economic capital can easily be obtained in this model by, for example, increasing the demand elasticity of the riskier

asset.[24] In such a case, capital to asset ratio and the ex ante ROE decline, which highlights the intuition underlying this model. That is, leverage is the key to profitability and regulatory rules that inhibit leverage reduce ex ante ROE and move the portfolio away from the safer asset.[25]

A third aspect of the solution is the impact of regulation on the prices of the two assets. Although the specific relationship between the gross price and the competitive price for each asset is hypothetical and dependent upon the specified shapes of the demand curves and the size of k_s relative to λ, the qualitative impact of regulation is clear. That is, the price charged for the safe asset increases and the price for the risky asset decreases. In our particular example, the numbers are chosen to accentuate the outcomes in two extreme cases. The price of the risky asset, which exhibits the less elastic demand, changes by 300 bps whereas the change proves to be small (10 bps) in the case of the safe asset because it was posited to have a larger price elasticity of demand. More generally, the larger the elasticities, the lower are the impacts of regulatory rules on prices.[26]

Some implications of the model regarding the impact of Basel I and II

The analytical model is helpful for evaluating three arguments that are sometimes used to downplay the importance of binding regulatory capital constraints. One of these focuses upon the total amount of capital held by banking organizations relative to

[24] The opposite is not possible – economic capital in excess of regulatory capital given our requirement that the regulatory capital requirement be met.
[25] In a more general model with multiple assets, a binding regulatory regime would be represented by a misalignment of regulatory and economic capital. Portfolio allocations to those assets with the more punitive regulatory capital rules, e.g. regulatory capital in excess of economic capital, will be adversely affected.
[26] In fact, one could introduce rules regarding pricing for imperfectly competitive models, as some colleagues have suggested. We do not pursue this avenue in this paper since the market upon which we focus – the residential mortgage market – is highly competitive.

regulatory capital requirements. Large "surpluses" -- i.e., total capital in excess of minimum regulatory required capital -- are quite common in today's environment owing in part to the highly profitable business of banking in the past few years. Some view the existence of such large surpluses or buffers as *prima facie* evidence that regulatory requirements are not binding. Indeed, given the very large capital surpluses that exist for most banking organizations today, it is tempting to conclude that regulatory rules are not binding and their realignment under Basel II would have little or no impact. This conclusion, in our view and based upon the model presented above, need not hold. Surpluses of regulatory capital can easily be generated in a model in which regulatory rules are binding, especially in markets with highly elastic demands. More specifically, the existence of a surplus does not imply that the regulatory rules are not binding.

Another argument sometimes made to show that regulatory rules are not binding focuses on the capital required by rating agencies for banks. This issue arose in 2003 in a paper by the FDIC (2003) and is particularly relevant to portfolios with large amounts of single-family mortgages. For example, S&P (2003) stated that it would not expect to lower its capital requirements for banks with substantial amounts of mortgages just because Basel II regulatory rules were reduced. Of course, this makes complete sense in the case of mortgages since the rating agencies' requirements are presumably based on economic capital for both interest rate and credit risk. In addition and more generally, the amount of capital for a bank portfolio depends upon the riskiness of the assets in the portfolio. If the bank shifts into riskier assets to avoid binding regulatory rules, the amount of capital required by rating agencies will increase and vice versa. A more accurate policy statement from a ratings agency is probably something like this. Absent

changes in the composition of bank portfolios, banks should not expect changes in the amount of capital needed to attain a certain rating. However, if banks adjust their portfolios by taking on safer assets formerly penalized by Basel I, then the rating agencies would reduce capital requirements for the banking organizations that do so.

A third argument of this type focuses on whether banks have pricing rules that include specific references to the regulatory capital associated with a particular product. Ferguson (2003) and White (2004) argue that pricing is driven by economic capital, not regulatory capital. Although we and our model are in general agreement with them on this point, we view their point as a "red herring" because this point does not imply that regulatory capital has no impact on the kinds of business in which a bank pursues. Nonadopters will price their investments using economic capital as will adopters, but nonadopters will not be participants in those products in which their regulatory capital exceeds the economic capital. In this sense, regulatory rules produce what might be called quantity effects rather than price effects.

IV. Potential Impact of a Bifurcated Approach

The purpose of this section is to show how a bifurcated implementation of Basel II is, in our view, likely to impact the competitive landscape for mortgages among banking organizations. A change in the competitive landscape is possible because the regulatory capital requirements for residential mortgages will be significantly lower for those who adopt the AIRB capital rules (adopters) versus those who do not (nonadopters) The differences may set in motion a process in which the adopters will increase their share of investments in residential mortgages relative to nonadopters.

The process we have in mind can be considered an example of regulatory capital arbitrage.[27] Regulatory capital arbitrage is a shift in a particular line of banking business from the participant with a higher and binding regulatory capital requirement for this line of business to a participant with a lower capital requirement. Jones (2000) applies this concept to argue that Basel I resulted in a shift in certain types of investments from banking organizations to nonbanking organizations not bound by Basel I rules. Securitization and, specifically, the emergence of the market for CDO securities (collateralized debt obligations) shifted certain business loans from banking organizations to a wider variety of investors. Van Order (2000) discusses the concept of regulatory capital arbitrage specifically in relation to mortgage portfolios and competition between banks and nonbanks. Frame and White (2004) also discuss how Basel II bank regulatory capital may affect the competition between the GSEs and adopting banks. Our analysis is more specific than Frame and White and highlights the potential transfers within the banking industry.

We propose two cases (scenarios or channels) in which adopters may gain at the expense of nonadopters in the mortgage market by virtue of the bifurcated approach. Both are premised on the prediction that Basel II will reduce the cost to adopter banking organizations of bearing the credit risk of high-quality residential mortgages. This cost advantage for bearing credit risk will result from lower regulatory capital requirements for adopters compared to nonadopters for such exposures. The cost advantage would make nonadopters less competitive in the market for residential mortgage investments.

[27] Indeed, the process can be viewed as an example of the concept of the "regulatory dialectic", which was coined by Kane (1981) and is regularly cited in the banking literature as a concept to describe the "cat and mouse" game between banking organizations and their regulators. Recent examples with numerous references to his work are Kovakimian and Kane (2000) and Cabral dos Santos (1996).

Although the change will also make adopters more competitive with the GSEs for conforming mortgages and with securitization options, this is not a critical part of our analysis since it is not highly germane to the policy issue we address – will Basel II alter the competitive landscape within the banking industry.[28]

In the first case, *whole loan transfer (case 1)*, adopters would be able to acquire for their own portfolios a larger fraction of mortgage originations relative to nonadopters. Alternatively stated, case 1 predicts that adopters will end up holding more of both the interest rate and credit risk associated with residential mortgages relative to nonadopters. The second case, *transfer of only credit risk (case 2)*, posits that a significant share of investment in *only* the credit risk of mortgages would shift to adopting banking organizations from nonadopters. The unbundling of interest rate and credit risk implied in this case can be done in any number of ways that include GSE like securitization or simply the purchase of credit guarantees or protection by nonadopters from adopters. Although this case will likely involve some effect on competition between banking organizations and the GSEs, our emphasis is upon competition among banking organizations for types of mortgages that currently are commonly held in bank portfolios. That is, we focus is on competition among banking organizations for adjustable rate mortgages and *nonconforming* mortgages..

A. *Case 1: whole loan transfer*

This case predicts that adopting banks will hold relatively more residential mortgage debt (more whole loans) than nonadopting banks under the bifurcated

[28] Banking regulators, to our knowledge, have not expressed a sense that this particular landscape is critical to their evaluation of Basel II.

approach. That is, some whole loans will be transferred from nonadopters to adopters over some period of time.

The simple theoretical model offers a motivation for this prediction. Adopters can be viewed as banks in which the regulatory capital rules are not binding; that is, the AIRB rules reflect economic capital. Nonadopting banks, on the other hand, operate in an environment in which the regulatory rule is binding for some loans and not for others. Hence, and as the model predicts, the adopters would hold relatively more safe loans than the nonadopting banks, all else equal

A more precise statement of case one requires a definition of the cost of financing an investment in mortgages. For the unconstrained case, the cost of financing per dollar of mortgage debt can be written as:

$C = i_d (1-K_e) + i_e K_e + EL + GA;$

where C is the marginal cost of investing in a new residential mortgage; i_d is the cost of debt financing; K_e is the amount of economic capital for this mortgage; i_e is the cost of equity financing; EL represents expected credit losses; and GA represents administrative expenses. K_e is chosen to meet a certain risk tolerance or probability of bankruptcy set by shareholders and it includes the capital for both interest rate (K_i) and credit risk (K_c). The mortgage coupon rate earned on the mortgage less this cost of financing represents the spread income earned by the bank. Higher amounts of capital reduce the riskiness of the investment to the bank and reduce the spread income earned on the investment.[29]

The capital requirement (K_{na}) for a particular nonadopter and mortgage type is assumed to be the maximum of economic and regulatory capital; that is, $K_{na} = \max (K_e,$

[29] Other ways of reducing the risk of this investment such as options could be included as capital substitutes; we simply assume that the bank chooses the least costly way of hitting its risk tolerance targets with capital or capital substitutes.

K_r). So, for example, K_{na} equals 400 basis points of total capital to nonadopters for a prudently underwritten mortgage if the sum of economic capital for interest rate and credit risk for the mortgage falls below 400 bps.[30] Thus the regulatory requirement under Basel I is the appropriate marginal capital required by nonadopters for some mortgage products and economic capital is appropriate for others.

The advantage to the adopter versus the nonadopters is the difference in their cost of financing the same mortgage. Holding everything else the same except for the amount of capital held by adopters under Basel II produces the following expression of the difference in the cost of financing for the case in which the regulatory capital amount is binding:

$$dC = C_{na} - C_a -= \text{Max}[0, (i_e - i_d)(K_{na} - K_e)] = \text{Max}[0,(i_e - i_d)(K_r - K_c - K_i)].$$

The last term reveals an important point; that is, the size of the regulatory advantage depends upon the amount of both interest rate and credit risk in the mortgage.

The difference varies significantly among products because of variations in the economic capital for both interest rate and credit risk. Several examples are provided to highlight these variations (see Table IV-1). The first three pertain to the same 30 year fixed-rate mortgage (FRM) but with three different assumptions regarding its interest rate risk. In all three cases, the duration of the mortgage is 3.5, which is consistent with the change in the value of this type of mortgage for a 200 bps increase in the level of interest rates.[31] The first of these three cases assumes the mortgage is financed with a liability with duration of 1 while the second is financed with liability duration equal to 3. The third of these examples simply assumes that interest rate risk capital equals 160 bps (total

[30] Similarly, the amount of Tier 1 capital required by nonadopters would be 200 bps in this case.
[31] See OTS web site for these two tables: http://www.ots.treas.gov/pagehtml.cfm?catNumber=10

capital requirement), which is the amount of regulatory capital for a GSE issued MBS.[32] The other examples pertain to adjustable-rate mortgages with various types of indexes. For these, interest rate risk capital is set equal to the maximum of a duration based calculation or 160 bps. Other assumptions include: i_e = 1250 bps; i_d = 250 bps; K_c = 100 bps; regulatory capital = 400 bps; EL + GA = 20 bps.[33]

Two main conclusions emerge from these examples. First, adopters have an advantage under certain plausible assumptions in the cost of financing a mortgage investment relative to nonadopters. The advantage ranges from 0 to about 15 bps or 5 percent of the cost of financing to nonadopters under Basel I for the product categories and our assumptions underlying Table IV-1. Second, the advantages highlight the critical role of capital for interest rate risk in determining the size of the advantage to the adopters. The adopters have no advantage in the first two examples –because Basel I is not a binding constraint for nonadopters; however, the lower the amount of interest rate risk, the larger the potential gain to adopters, all else equal.

B. *Case 2: credit risk transfer*

As noted in Section II, unbundling of credit risk from interest rate risk is commonplace in today's mortgage markets. The classic example is the GSE MBS, which allows banks to retain all of the interest rate risk on a pool of mortgages and transfer (for a price) all of the credit risk to the GSEs. Because the credit risk of residential mortgages can be unbundled, each banking organization is viewed as having a derived demand for

[32] We also point out that this amount of capital is below but near the regulatory capital required of the GSEs for their MBS investments (205 bps).

[33] We do not include an explicit cost of transferring the mortgage at this point, although we do in our discussion of Case 2. We could include such costs at this point as well even though they are not essential to Case 1. They are also likely to be quite small given the extensive network of mortgage brokers who may simply end up selling more loans to the adopters and bypassing nonadopters more frequently.

credit risk protection. The amount a nonadopter chooses to retain versus transfer to adopters depends, in part, upon which group has the lowest cost of capital for such an investment

The provider of credit risk protection and thus the bearer of credit risk, like the on-balance sheet investor, must charge a price, or premium, covering administrative expenses, expected losses, and the cost of holding a certain amount of capital (economic or regulatory) for this risk. The gross cost per unit of mortgage debt, *G*, a supplier would require for providing credit risk protection and bearing some or all of the credit risk of a particular mortgage asset may be expressed as the sum of three cost components:

$G = EL + GA + i_e K.$

As with the cost of financing in case 1, the critical ingredient in our analysis of case 2 is the *marginal* amount of capital associated with such an investment (K_{na}). For the nonadopters, this depends upon the regulatory amount (K_r) and the amounts of economic capital for interest rate risk (K_i) and credit risk (K_c). Specifically, the amount of additional capital held by a nonadopters for an additional mortgage is the maximum of two terms. The first of these terms is the additional amount of economic capital associated with the credit risk. The second term is additional amount of regulatory capital to the nonadopters, which is the difference between the Basel I regulatory rule for a mortgage and the amount of economic capital the bank would hold for interest rate risk. Thus, the marginal amount of capital to the nonadopters is: $K_{na} = \max (K_{c,} K_r - K_i)$.

If the Basel I rule is not binding for nonadopters, then the adopters (whose additional capital for credit risk capital equals K_c) have no cost advantage due to Basel I. If it is binding, then the difference in costs can be written as:

$dG = G_{na} - G_a = i_e\,(K_r - K_c - K_i) - C_{ub}$. The last term ($C_{ub}$) is the cost of unbundling and is assumed to be borne by the adopters.[34]

The *absolute* size of the cost differential is similar to that in case 1 with two distinguishing features. First, only the cost of equity matters in this calculation since the transfer is an off-balance sheet activity that involves no debt finance. Second, the calculation includes a cost of unbundling the credit risk. The relative sizes of the cost differentials, dC/C and dG/G, respectively, are quite different since the denominators are quite different.

As with Case 1, several examples are presented to provide a sense of the size of the advantage to the adopters for the same set of products and assumptions (see Table IV-2). No advantage exists in the fixed-rate mortgage examples with substantial interest rate risk; in fact, the advantage is negative because we include a cost for the unbundling itself (we assume 2 bps). Otherwise, the pattern is the same as in Case 1. The smaller the amount of capital for interest rate risk, the larger the advantage to the adopters. The percentage differences are, of course, much more pronounced than in Case 1 because the numerator is about the same size as in Case 1 but the typical guarantee fee is only 10 percent or so of the cost of financing the entire mortgage.

What kinds of mechanisms are available to bring about the transfers in case 2? There are many. The simplest would involve an unsecuritized and straight forward credit guarantee in which the adopters would receive payments from the nonadopters in exchange for a guarantee of losses. Securitized options are possible as well. Something like the GSE credit guarantee is an obvious one. For example, one of the adopters would

[34] In neither case 1 nor 2 do we include the cost of losing the markup over costs that a lender is able to enjoy. These markups may be considerable in some cases, especially where competition among lenders is limited.

buy loans from nonadopters and issue an MBS with their credit guarantee. Many more elaborate securitization approaches are possible.[35]

Does the particular type of mechanism or process for the credit transfer affect the essence of our story? We think not. Straightforward comparison of the expressions for dC and dG shows that, absent an unbundling cost, the credit risk transfer mechanism (case 2) would dominate. Thus, the degree to which case 1 would prevail over case 2 would relate to the cost of unbundling.

Another possibility is that the optimal mechanism will be affected by another portion of the Basle II agreement we do not explicitly consider; these are the Basel II rules that pertain to capital requirements for securitization. Our reading of Basel II suggests this is a second order issue because of the guiding principle underlying the development of Basel II capital rules that affect securitization. In particular, the principle is to make banking organizations neutral with respect to either holding loans or holding securities based upon the loans.[36] To the extent this principle is achieved by the Basel II securitization rules, they will not affect our basic argument – adopters will have a cost advantage in case 2. The biggest impact of the securitization rules is likely to be their influence upon the broader choice between securitization and direct credit guarantees. This issue, though important in itself and worthy of more study, is one we view as beyond the scope of our study.

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[35] The MODERNS security issued by Freddie Mac is one example; see Glenn (1999). A more general approach is labeled as a synthetic security and includes some done by Bank of America for the specific purpose of transferring credit risk on mortgages between two or more parties.

[36] See paragraph BIS(2004), paragraph 610, which states that: "For a bank using the IRB approach to securitisation, the maximum capital requirement for the securitisation exposures it holds is equal to the IRB capital requirement that would have been assessed against the underlying exposures had they not been securitised …."

V. Estimates of the aggregate size of the transfer

Now we address a more difficult but important question: is the potential aggregate impact likely to be materially significant? We address this question in hopes of providing insight about the quantitative significance of the story we are putting forth. A full cost-benefit analysis of the implementation proposal would consider a much wider variety of costs and benefits to the proposal. Of course, this is beyond the scope of this paper. Our goal is more limited. As noted above, it appears that the regulators originally may have underestimated the competitive costs of the proposed plan within the mortgage market. If so, then a finding of a sizeable or substantial aggregate impact in the market for mortgages may lead the regulators to revise the implementation plan to address these concerns.

Our estimates of the aggregate impact require two additional types of information. The first we refer to as the elasticity of market share (ε) with respect to an advantage in either the cost of financing (Case 1) or the cost of a credit guarantee (Case 2). The second is the amount of business at stake in the current environment; that is, how much potential business is being done by nonadopters that could shift to adopters? The first parameter allows us to estimate the impact for a particular risk segment (step 1), while the latter allows us to aggregate among risk segments (step 2).

Step One: Size of transfer per risk segment. Consider first the case of a whole loan transfer (our case 1). The share of adopters after Basel II (S_a) in this case is defined as follows:

$$S_a = IS_a + (1 + \varepsilon)\, dC/C_{na}\, IS_{na}$$

where IS_a is the initial share of this risk segment held by adopters; dC is the size of the cost advantage to adopters in this risk segment after Basel II; C_{na} is the cost of financing to nonadopters before Basel II is implemented (or under Basel I rules); and IS_{na} is the share of nonadopters before Basel II is implemented. In words, the new share for adopters is its initial share plus some fraction of the share held by nonadopters. The elasticity reflects the responsiveness of household demand for mortgage debt across various mortgage lenders to differences in the cost of debt. Our basic view is that this demand is likely to be highly elastic and much more elastic than the demand for mortgage debt by households. Indeed, the elasticity we have in mind is likely to increase as the cost of searching among lenders declines.[37]

We could find little evidence in the literature on this elasticity. Some insights were obtained from a recent study by Ambrose and Saunders (2003), who evaluate the probability that a lender will either hold or sell a particular mortgage loan. Presumably, the loan is sold from one who has higher costs to one with lower costs of holding the mortgage, all else equal. The estimated coefficients of their empirical model of the decision to hold or sell a loan can be used to infer the sensitivity of this choice to price. We performed such calculations and concluded that the model suggests an elasticity of loan sale three or higher. Although this exercise is not identical to the demand we have in

[37] We distinguish this elasticity from the price elasticity of the aggregate household demand for mortgage debt. Follain and Dunsky (1998) and Dunsky and Follain (2000) find evidence of an elasticity of the demand for the tax price of mortgage debt to be quite elastic and as high as 2 to 3. The price elasticity of the demand among different suppliers would be expected to be much higher. This is driven by the market price of debt versus equity and other factors. The elasticity we have in mind in the paper has to do with household demand among many suppliers at one point in time. We would expect this to be much more elastic than aggregate household demand for debt. The only reasons it would not be "infinitely elastic" would be due to issues such as customer loyalty, the cost of searching among lenders, potential cross-selling benefits, etc. A quote from one lender with whom we spoke captures the spirit of what we have in mind: "the heightened focus of customers on the price of credit has reduced the value of customer loyalty to about 25 basis points."

mind, it is consistent with our hypothesis that the demand by households among lenders is substantially higher than it is for the underlying debt.[38]

Consider another simple example to explain how we use the elasticity measures to estimate the potential impact for a particular risk segment. Calculations of the shift in the amount of business to adopters for this example are presented in Table IV-3. Variation in these estimates is driven by assumptions regarding the initial market shares and the elasticities. The particular risk segment used in this example is the ARM with a market index of less than six months. This risk segment provides information about the initial cost of financing to nonadopters (310 bps) and the cost advantage to adopters under Basel II (14 bps).

The largest impacts pertain to a case with a relatively small initial market share for adopters (30 percent) and a relatively high elasticity (-5). In this case, $332 million in annual net income associated with investing in this risk segment is transferred to adopters from nonadopters per $100 billion in this risk segment. Their market share increases from 30 to 42 percent of this risk segment, but they earn less per dollar of investment in this risk segment because they are assumed to price based upon their lower cost of capital. Nonadopters lose more than the adopters gain. Their market share declines to 58 percent and the price they earn on this smaller share also declines. The net impact is a loss $472 million per $100 billion in this risk segment. Lowering the elasticity and the initial market share assumptions reduces these estimates to $10 million gained by adopters and $150 million lost by nonadopters per $100 billion investment in this risk segment.

[38] A description of the results of this analysis is available upon request from the authors.

We apply similar logic to assess the size of the transfer that would occur in Case 2 – credit risk transfer – for a particular risk segment, although the analysis for this case involves three distinguishing features. The first difference is the definition of the base price. Here we use the guarantee fee (G) charged for credit protection as the basis of the share calculation; that is,

$S_a = IS_a + (1 + \varepsilon)\, dG/G_{na}\, IS_{na}$;

otherwise, all other terms are the same as in case 1. The switch to G from C highlights the logic associated with the unbundling of credit and interest rate risk in the mortgage market; that is, once unbundled, the party with the lowest cost in this particular component of mortgage investment tends to dominate the investment or, in this particular case, the provision of credit protection. The second difference is that we limit the maximum potential market share of adopters to 80 percent, which is what many believe to be the share of the GSEs in the market for credit risk protection for conforming mortgages.[39]

As with Case 1, we present an example to illustrate the potential impacts for particular risk segments (Table IV-4). The specific risk segment evaluated is the fixed-rate 30 year mortgage with the capital for interest rate risk set to 160 bps. Estimates of the impact for this risk segment are presented in Table IV-4. Also as in Case 1, the largest impacts pertain to the case with a relatively small initial market share for adopters (30 percent) and a relatively high elasticity (-5). In this case, adopters earn an additional $126 million in annual net income associated with the provision of credit risk protection for this risk segment per $100 billion in this risk segment. Their market share increases

[39] Implicitly, we are assuming in this example and throughout our analysis that the elasticity of market share approaches zero as the adopters' share approaches 80 percent; whatever dominance the adopters may gain will not exceed that currently enjoyed by the GSEs.

from 30 to 80 percent of this risk segment; the 80 percent is the maximum we impose. Nonadopters lose $281 million per $100 billion in this risk segment. Lowering the elasticity and the initial market share assumptions produces a loss to both adopters and nonadopters. Adopters lose -$11 million per $100 billion of debt in this risk segment because the gain in market share is offset by a much lower price per dollar of credit protection offered.[40] Nonadopters lose $144 million per $100 billion investment in this risk segment.

Step 2: Aggregating among risk segments. The ideal set of information needed to classify residential mortgage debt held by banking organizations for our purposes -- the distribution of the debt across risk segments classified by degrees of interest rate and credit risk--is simply not available to regulators or to the public. Hence, we pursue a less ambitious approach and focus upon what we believe is the critical variable – the distribution of mortgage debt across segments defined by amount of interest rate risk. Risk segments in our analysis are distinguished by the repricing dates or remaining maturities of closed, first lien mortgages on 1-4 mortgage loans. This information is available from Call Report data for commercial banks. Six categories are available: less than 3 months; 3 to 12 months; 1 to 3 years; 3-5 years; 5-15 years; and more than 15 years. We choose the midpoints of each category as a measure of the effective duration of the assets in the segment and use to motivate an estimate of the amount of economic capital for interest rate risk in each segment, i.e. K_i. These data are presented in Table IV-5. Total debt of this type equaled just over $1 trillion as of 2004:Q1. About two-thirds

[40] The ex ante ROE remains 15 percent for the entire amount of the investment by nonadopters because we used this assumption in the calculation of the credit guarantee fee.

had repricing or maturity dates in excess of five years and the rest were scheduled for repricing or maturity within three years.

We assume throughout that the shares for adopters equal those for nonadopters per risk segment even though our analysis suggests, if anything, that nonadopters hold a disproportionate share of ARMs. In this sense, our assumption adds a conservative element to our predictions. We further assume that adopters hold 37.5 percent of the debt in question. Both assumptions are sensitive to the specific definition of the adopters, but our assumptions reflect what we consider to be both plausible and conservative in our estimates of the aggregate impact. If anything, a narrow definition of adopting banks would show them to have a smaller share of total debt and disproportionate shares of FRMs. As such, we label our approach as conservative because it probably underestimates the potential amount of business "at risk" to nonadopters or "in play" for adopters.

Further assumptions underlying our estimates of the aggregate impact of Basel II are as follows:

1. *Economic capital for credit risk equals 100 bps*. We view this as a reasonable estimate of the amount of total capital (Tier 1 plus Tier 2) for a geographically-diversified portfolio of residential mortgages. The tier 1 equivalent would be 50 basis points.
2. *The point estimates of the amounts gained by adopters and lost by nonadopters is the average among the several assumptions employed above regarding elasticity and initial market shares*. The average amount of income transferred per risk segment is the simple average of the amounts using various elasticity assumptions (-2 to -5) and the two share assumptions for adopters (30 and 45 percent). For example, the average gain to adopters is about 16 bps for the ARM product among all assumptions in Table IV-3; the average loss to nonadopters is about 30 bps for the same assumptions.
3. *We include 20 percent of the loans in the risk segments with the three highest stated maturities as mortgage debt at risk to nonadopters.* This simply reflects the fact that many loans with stated maturities in excess of three years have much

smaller effective durations. Appendix A-2 explains how we derived the 20 percent estimate.

The entire set of assumptions employed for our aggregation exercise is summarized in Table IV-5 along with the results.

Consider, first, the aggregate gains to adopters under Case 1 and Case 2, which we estimate to be about $279 million and $116 million, respectively. We view these two estimates as offering a range of what may be gained by adopters not as separate components that should be added. Case 1 is more beneficial to adopters because they end of capturing the both the interest risk and credit risk income. If only Case 2 comes about, the number and amount of mortgage debt affected by Basel II would be the same as in Case 1. However, the amount of income transferred under Case 2 would be less because only the credit portion would be transferred. Since it is likely that some income will be transferred via Case 1 and some via Case 2, we view the two separate estimates as ends of a range of possible outcomes.

The most important results from a policy perspective pertain to the losses to nonadopters. Recall that their losses stem from two forces: their shares of the market declines and the income earned per dollar of debt owned declines. Nonadopters lose $880 million per year under Case 1 and $655 under Case 2. Hence, the likely outcome is somewhere between $655 and $880. These results are what we consider to be sizeable, significant, and worth consideration by policymakers.

Of course, these results are sensitive to our assumptions. One particularly important one is the amount of 1-4 family mortgage debt. We use the amount owned by commercial banks; including the roughly $500 billion of such debt owned by thrifts increases the impacts by 50 percent so that the estimated losses to nonadopters straddle

$1 billion in lost income per year. As such, the estimates presented in Table IV-5 along with some of the other assumptions employed in their calculation lead us to conclude that they are both significant and somewhat conservative.

Mortgage specialists would be particularly hard hit. We use the definition offered by the FDIC – lenders with at least fifty percent of their assets in the form of residential mortgages and mortgage-backed securities. A total of 243 commercial banks (among 7,600) fit this description and these banks earn about $1.4 billion per year. We do not attempt to offer a precise estimate of their share of the losses, but it seems clear to us that the impact upon them would be substantial. Similarly, those with relatively large amounts of ARMs in what may be called highly concentrated portfolios from a geographical perspective would be among those likely to be at most risk from heightened competition from the adopters.

Another potential and offsetting case

We conclude our empirical analysis with some comments about another potential and offsetting impact of the proposed implementation plan. This involves an additional case or channel in which both adopters and nonadopters would actually reap some additional income. This one stems from the potential benefits of increased competition between adopters and the GSEs for conforming loans. As noted above, differences in the regulatory capital requirements faced by both the GSEs and the adopting banks for credit risk on residential mortgages will be reduce and probably eliminated under Basel II. The GSEs currently dominate the market for credit risk protection in this market. Greater competition from the adopting banks may lead to lower guarantee fees associated with conforming loans. If so and if the originators of nonconforming loans are able to capture

the benefits of the higher competition, then they will, in essence, receive higher prices for the loans they sell to the GSEs or their new competitors, adopting banks.

Though plausible, we believe the size of this benefit is likely to be small for several reasons. First, the guarantee fees charged by the GSEs for prime loans have been on the decline in recent years due, in part, to the so-called alliance wars among the GSEs and several large banks. In an effort to obtain a larger and a more stable share of mortgage originations, alliances were built between the GSEs and selected mortgage originators. One outcome widely noted in the press and in the time-series data on guarantee fees is a sharp reduction in average guarantee fees during the past five or so years. The average rates declined from the mid-twenties to the high teens for typical bundles of originations. So, perhaps there may have once been room for substantial reductions, recent developments suggest that the current gains may be minimal.

Second, we specifically raised this question during our interviews. Only one of those interviewed thought it was likely. The argument did not resonate with any of the others.

Lastly, even if the additional competition between adopters and nonadopters leads to reduced guarantee fees, what would lead to an outcome in which the nonadopting mortgage originators would be able to capture the benefits of lower guarantee fees? Presumably, most or all of the gain would be passed along to consumers in the form of lower rates on mortgages.

VI. Key Conclusions, Other Impacts, and Policy Suggestions

We argue that the proposed bifurcated implementation plan for Basel II in the U.S. is likely to have a significant impact on the competitive landscape within the

banking industry in its competition for residential mortgage investments. Nonadopting banking organizations may lose in the neighborhood of $1 billion per year in net income due to a reduction in their share of the market and the reduced price they earn in such investments. The impetus is the sizeable decline in the Basel II capital requirements for residential mortgages that will be available to adopting banking organizations relative to the requirements (existing Basel I rules) that will continue to apply to nonadopting banking organizations. Although we readily acknowledge the difficulty of producing precise estimates of this impact with information available to the public and regulators, we believe the evidence is more supportive of this position than the view that there will be little or no effect.

One implication of our analysis is that the capital rules pertaining to residential mortgages for nonadopters be adjusted downward for the credit risk embedded in them. Something like the risk-weights associated with the Standardized approach (35 percent versus the current 50 percent) would move a long way toward reducing the potential for competitive inequities. These reduced weights would be assigned to banking and savings organizations with geographically dispersed investment portfolio and interest rate risk management processes designed to keep such risk to levels acceptable to regulators. The existing Basel I weights would apply to those organizations that do not meet these two criteria.

Mortgage specialists would seem to be among those especially at risk of competition from adopters under the proposed implementation plan. Although some may be obvious candidates for a reduction in the risk-weight for residential mortgages, such a reduction may be of little benefit to the mortgage specialists because they are likely be

bound by the more stringent leverage requirements. Otherwise, the mortgage specialists become candidates for expansion into riskier asset categories or candidates for acquisition by more diversified institutions. Given the long history and legislative support for such institutions, regulators may want to acknowledge this potential affect and seek broader "buy-in" to it by policy-makers.

We conclude with a brief discussion of another potential and related impact of the bifurcated approach. It stems from the omission in the Pillar I minimum capital requirements for mortgages under both Basel I and Basel II of a particularly critical component of the cost of investing in mortgages – capital for interest rate risk. This omission – along with the vague and opaque manner in which such capital is determined for both adopters and nonadopters in Pillar II, have the potential to generate highly undesirable competitive responses by nonadopters to their competitive disadvantage with respect to capital for credit risk. What we have in mind is the type of response noted by the Ferguson (2003) regarding international competition. That is, "perhaps one of the largest risks to the safety of the world banking system is the competitor--either local or cross-border--that erroneously evaluates risk, acts on that evaluation, and induces a competitive response that increases risk exposures broadly."[41] In our view, the omission of interest rate risk in the minimum capital rules and the bifurcated system pose such a potential problem within the U.S. not unlike the problems faced during the S&L crisis of the 1980s.[42] As a result, regulators may want to commit to increase their monitoring of the interest rate risk of nonadopting organizations with substantial mortgage investments.

[41] The error to which we refer is the differential between economic capital and regulatory capital for nonadopters.

[42] Herb Sandler (2003) of Golden West has been particularly outspoken on this point in a number of forums, including our interview with him in 2003.

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Appendix 1: Duration calculations

Time to stated maturity provides an imprecise picture of the effective duration of fixed-rate mortgages owing to the propensity to refinance these mortgages prior to stated maturity when the market rate of interest falls below the mortgage coupon rate. Instead, we prefer a measure that takes into account the expected maturity of the loans (or expected prepayment behavior). We conducted additional analysis of the three categories with the longest dates to repricing or maturity in order to obtain the preferred estimates. Unfortunately, Call report data do not provide such information for commercial banks; however, two reports produced by the OTS for thrifts do provide insights about the FRM portfolios held by thrifts. These include estimates of the effective duration of fixed-rate mortgages that differ by coupon rate. Our calculations focus only on FR 30 mortgages, which lead to an overstatement of the effective duration of all FR mortgages and another element of conservatism in our analysis. The results offer specific estimates of a well-known fact about mortgages; those with below average coupons have higher durations and a lower propensity to prepay and vice versa.[43] A second report provides information about the distribution of the existing thrift portfolio of 15 and 30 year FRMs and balloon loans by coupon rate.

Our analysis of these two reports provides an estimate of the distribution of the effective duration of a large (about $240 billion) portfolio of FR 30 loans as of 2004:Q1 (see Figure A-1).[44] The analysis demonstrates the wide variation in effective durations as

[43] The Asset and Liability Price tables provide this information; see http://www.ots.treas.gov/docs/1/18410.pdf .

[44] The effective durations of balloons and 15 year FRMs would be considerably less than 30 year FRMs, all else equal; hence our focus use of estimated durations using 30 year FRMs is another source of conservatism in our estimates.

of the end 2004:Q1. Over 20 percent of the 30 year FRM loans have durations below 3. We use this result to include 20 percent of the loans in the risk segments with schedule maturity in excess of five years as "in play." That is, 20 percent of the FRM loans have expected durations and, hence, economic capital for interest rate risk comparable to those for ARMs.

Appendix 2: Summary of Interviews Conducted

During the initial stages of this research underlying this paper, the public comments submitted in response to the Basel II ANPR were carefully reviewed for insights about competitive issues. Numerous comments voiced concerns that the adopters would gain a substantial advantage because of the reduced capital they would be required to hold relative to nonadopters. This concern was frequently raised about residential mortgages, but typically in quite general terms. Some others discounted these concerns by citing the role of economic capital versus regulatory capital as the driver of most investment decisions.

Very seldom was strong and convincing empirical evidence put forth to bolster arguments on one side or the other. Hence, a decision was made as part of this study to conduct a number of interviews with a wide variety of industry experts to seek a clearer understanding of the various channels by which adverse competitive effects might come about, and to identify data to help quantify the likely outcomes. A summary of each meeting is posted on the Federal Reserve Board's public web site at: http://www.federalreserve.gov/generalinfo/foia/index.cfm?doc_id=R%2D1154.

Several quite general conclusions emerged from the interviews, all of which are referenced to varying degrees in the main text. Issues on which rather broad agreement exists include:

- *Wide variations among banking organizations*. There are wide variations among both adopter and nonadopters. Hence, some adopters may be more apt to benefit than others. In particular, only adopters with a strong commitment to understanding the mortgage business will be able to benefit. Regulatory capital advantages are small relative to the importance of more general skills related to underwriting, servicing, risk management, and marketing. On the other hand, among adopters and nonadopters with comparable amounts of expertise in mortgage operations, capital advantages may be significant at some time during the long real estate cycle.
- *Other regulatory capital rules and market perceptions may matter more.* Basel II will determine minimum capital rules; however, adopters will still be subject to other regulations such as prompt corrective action and leverage. Several interviewees commented that these other regulations may actually dominate those associated with the minimum capital rules of Basel II. The ratings assigned by the major rating agencies were also identified as major determinants of capital decisions.
- *Broad qualitative agreement on the direction of the effects included in the two cases.* The interviews were helpful in defining the two cases, identifying their importance relative to some others that were raised, and confirming our views regarding the likely direction of their effects. However, there was wide variation in the predictions of the size of the effects.

Table II-1: Proposed Basel II Capital for 1-4 Family Residential Mortgages

Selected examples of simulated PD, LGD, and Basel II capital by risk segments

LTV / FICO Score	Annualized 10-year Default Rate (PD) (percent) (1)	Loss Generated by Default (Recession LGD) (percent) (2)	Risk Weight (percent) (3)	Marginal Tier 1 Capital Requirement (Basis points) (4)
70 / 620	0.27	16	9	34
70 / 660	0.16	16	6	23
70 / 700	0.10	16	4	16
70 / 740	0.07	16	3	12
80 / 620	0.51	20	17	67
80 / 660	0.31	20	12	48
80 / 700	0.20	20	9	35
80 / 740	0.15	21	7	29
90 / 620	1.00	25	34	136
90 / 660	0.62	26	25	100
90 / 700	0.42	26	19	76
90 / 740	0.30	26	15	61
95 / 620	1.38	26	45	181
95 / 660	0.87	27	34	135
95 / 700	0.58	28	26	104
95 / 740	0.43	28	21	84
Jumbo Prime Pool	0.27	25	13	53
Alt-A Pool	0.28	35	19	77
Seasoned & Diversified Portfolio of Prime Loans	0.19	25	10	40

Source: Calem and Follain (2003).

Ex Ante ROE Outcomes with Binding Capital Rules and Pricing Power
Figure III-1

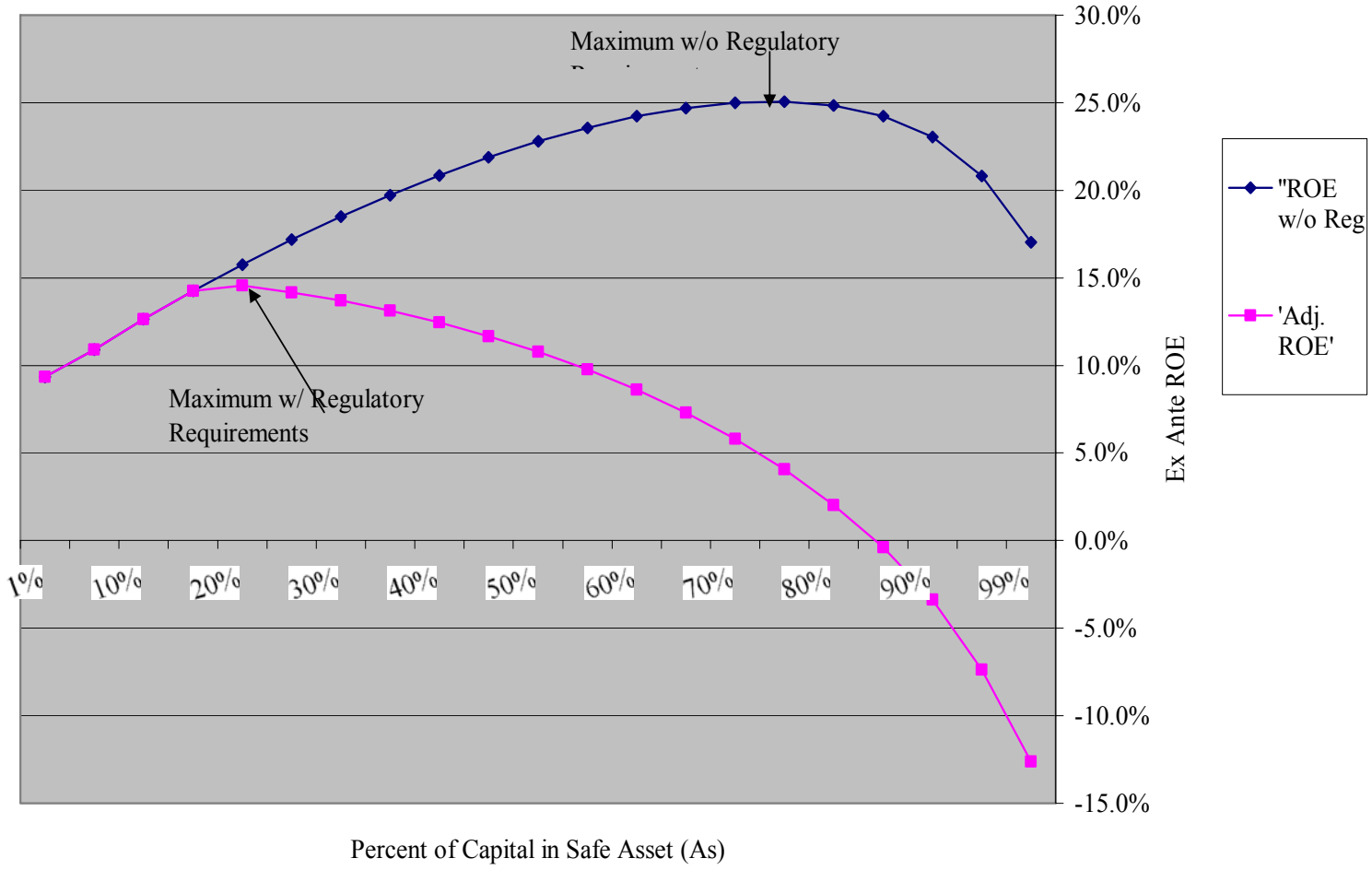

Table IV-1: Examples to Demonstrate the Cost Advantage to Adopters

	Duration	Duration of Liabilities	Capital for IRR for 200 bps up and Typical Financing Kirr	Capital for Credit Risk (bps) Kcr_RC	Kcr_ND	Total Econ K to Adopter	Total Capital for NonAdopter : Max of Econ or Reg	Capital Advantage to Adopter	Cost of Financing to Adopter (bps)	Cost of Financing Advantage of Adopter (bps)
30 FRM Loans	3.5	1	500	100	100	600	600	0	330	0
30 FRM Loans	3.5	2	300	100	100	400	400	0	310	0
30 FRM Loans	3.5	NA	160	100	100	260	400	140	296	14
Market Index< 6 months	0.29		160	100	100	260	400	140	296	14
Duration of Liabilities	1									

Assumptions	
Avg Debt/Assets	**1**
RC vs. ND	1
Cost of Equity	1250
Cost of Debt	250
Total Capital	400
EL + GA	20
Less IRR	1
Min IRR	160
Source for duation:	http://www.ots.treas.gov/docs/2/211410.pdf

Table IV-2: Example of Case 2 and Credit Risk Transfer

	Effective Duration	Duration of Liabilities	Econ K for additional CR for Adopters	Reduced K due to CR Layoff for Nonadopters	Capital Advantage to Adopter	Cost of Credit Guarantee to Adopter (bps)	Cost of Credit Guarantee to NonAdopter	Cost of Credit Guarantee Advantage of Adopter (bps)	Cost of Credit Guarantee Advantage to Adopter (percent)
30 FRM Loans	560	1	100	200	100	35	45	10.50	23.3%
30 FRM Loans	3.5	2	100	200	100	35	45	10.50	23.3%
30 FRM Loans	3.5	NA	100	240	140	35	50	15.50	31.0%
Market Index< 6 months	0.29		100	240	140	35	50	15.50	31.0%
Liabilities	1								

Assumptions	
Avg Debt	**1**
RC vs. ND	2
Cost of Equity	1250
Cost of Debt	250
Total Capital	400
EL + GA	20
Cost of Unbund	2
Max Kirr	160

Source: http://www.ots.treas.gov/docs/2/211410.pdf

Table IV-3: Calculating size of income transfer via Case 1 for ARM with index adjustment less than six months

	Initial Share for Adopters	Cost of Financing Advantage to Adopters (bps)	Original Cost of Financing to Nonadopters (bps)	dCF/CF	Elasticity ε	New Share for Adopters (1+ ε)dc/c + S)	Additional Income for Adopters (bps)	Income Loss to Nonadopters (bps)	Net Income Gains to Adopters per $100 billion of UPB	Net Income Loss to Nonadopters per $100 billion of UPB
	30%	14	310	-4.5%	-5	42.6%	33	(47)	$ 332,296,774	$ (472,296,774)
	30%	14	310	-4.5%	-4	39.5%	24	(38)	$ 238,722,581	$ (378,722,581)
	30%	14	310	-4.5%	-3	36.3%	15	(29)	$ 145,148,387	$ (285,148,387)
	30%	14	310	-4.5%	-2	33.2%	5	(19)	$ 51,574,194	$ (191,574,194)
	45%	14	310	-4.5%	-5	54.9%	23	(37)	$ 231,090,323	$ (371,090,323)
	45%	14	310	-4.5%	-4	52.5%	16	(30)	$ 157,567,742	$ (297,567,742)
	45%	14	310	-4.5%	-3	50.0%	8	(22)	$ 84,045,161	$ (224,045,161)
	45%	14	310	-4.5%	-2	47.5%	1	(15)	$ 10,522,581	$ (150,522,581)
Average	37.5%	14	310	-4.5%	(3.50)	44.6%	15.6	(29.6)	**$ 156,370,968**	**$ (296,370,968)**

Source: Author Calculations

Table IV-4: Calculating size of income transfer via Case 2 for FRM with index adjustment less than six months

	Initial Share for Adopters	Cost of Financing Advantage to Adopters	Original Cost of Financing to Nonadopters	dCF/CF	Elasticity ε	New Share for Adopters (1+ ε)dc/c + S)	Additional Income for Adopters	Income Loss to Nonadopters	Gain to adopters for Each $100 Billion in FR 30 loans	Loss to Nonadopters for Each $100 Billion in FR 30 loans
	30%	16	50	-31%	-5	80.00%	13	(28)	$ 126,000,000	$ (281,000,000)
	30%	16	50	-31%	-4	80.00%	13	(28)	$ 126,000,000	$ (281,000,000)
	30%	16	50	-31%	-3	73.40%	10	(26)	$ 103,230,000	$ (258,230,000)
	30%	16	50	-31%	-2	51.70%	3	(18)	$ 28,365,000	$ (183,365,000)
	45%	16	50	-31%	-5	80.00%	5	(21)	$ 51,000,000	$ (206,000,000)
	45%	16	50	-31%	-4	80.00%	5	(21)	$ 51,000,000	$ (206,000,000)
	45%	16	50	-31%	-3	79.10%	5	(20)	$ 47,895,000	$ (202,895,000)
	45%	16	50	-31%	-2	62.05%	(1)	(14)	$ (10,927,500)	$ (144,072,500)
Average	37.5%	16	50	-31%	(3.50)	73.3%	7	(22)	**$ 65,320,313**	**$ (220,320,313)**

Note: Kirr = 160 bps

Source: Author Calculations

Table V-1: Aggregate Impacts of Case 1 and Case 2

Time to Repricing	Amount Held by Adopters	Shift to Adopters in Case 1	Shift to Adopters in Case 2	Loss to Nonadopters in Case 1	Loss to Nonadopters in Case 2
Lt 3 months	13%	$ 81,672,171	$ 34,116,638	$ (257,989,710)	$ (191,787,927)
3-12 months	7%	$ 42,609,884	$ 17,799,282	$ (134,598,007)	$ (100,059,312)
1- 3 years	11%	$ 68,958,873	$ 28,805,956	$ (217,830,375)	$ (161,933,730)
3- 5 years	16%	$ 20,272,519	$ 8,468,371	$ (64,037,741)	$ (47,605,254)
5-15 years	24%	$ 29,418,656	$ 12,288,955	$ (92,928,966)	$ (69,082,809)
GT 15 years	29%	$ 35,910,481	$ 15,000,763	$ (113,435,633)	$ (84,327,336)
Total	100%	**$ 278,842,583**	**$ 116,479,964**	**$ (880,820,434)**	**$ (654,796,368)**

Base Case Assumptions

Kc	100	
Fraction of 30 yr FRM in play		
Case 1	0.2	
Case 2	0.2	
Total Closed 1-4 Mortgage Debt (millions)	$ 1,059,445	$ 10.6
Average Market Share of Adopters	37.5%	

Durations of Thrift Portolio of 30 Year Fixed Rate Mortgages
Figure A-1