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Insurance Pricing, Distortions, and Moral Hazard: Quasi-Experimental Evidence from Deposit Insurance

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Abstract

Pricing is integral to insurance design, directly influencing firm behavior and moral hazard, though its effects are insufficiently understood. I study a quasi-experiment in which deposit insurance premiums were changed for U.S. banks with unequal timing, generating differentials between banks in both levels and risk-based "steepness" of premiums. I find evidence that differentials in premiums resulted in distortions, including regulatory arbitrage, but also provided strong incentives to curb moral hazard. I find that firms that faced stronger pricing incentives to become (or remain) safer were more likely to subsequently do so than similar firms that faced weaker pricing incentives.

I. Introduction

Insurance can weaken the insured party's incentives to self-protect, resulting in increased risk-taking and, paradoxically, making losses more likely. This effect has been referred to in the literature as ex ante moral hazard, and it is present in various contexts. In deposit insurance, Grossman (1992) finds evidence from the early 1900s that thrifts that became insured took on more risk than their uninsured counterparts. Ioannidou and Penas (2010) find that introducing deposit insurance in Bolivia made banks more likely to originate subprime loans.[1] It has long been

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[1]Other studies that find a relationship between deposit insurance and moral hazard include Wheelock and Wilson (1995) and Hooks and Robinson (2002). Some studies, however, do not find evidence of moral hazard associated with deposit insurance, at least in specific contexts (see, e.g., Gueyie and Lai (2003) for Canadian banks in the 1960s, and Karels and McClatchey (1999) for credit unions). The focus of the present article, however, is not whether deposit insurance itself causes moral hazard; instead, the focus is on the effects of risk-based premiums, which are prevalent and, by design, are linked to each institution's level of risk.

known that penalizing risk-taking with higher premiums can mitigate ex ante moral hazard (Ehrlich and Becker (1972)). This was the reason that, in 1993, the U.S. deposit insurance system moved from flat-rate pricing to risk-based pricing, classifying institutions into several risk groups and charging institutions in higher-risk groups higher premiums (Bloecher, Seale, and Vilim (2003)).

In practice, however, the relationship between insurance pricing, firm behavior, and moral hazard is unclear, and very few studies address the issue. Risky banks facing higher premiums may respond in several ways without reducing their risk levels. They may reduce the assessment base on which premiums are charged and use nonassessable funding sources (if any are available).[2] If accessible risk-taking opportunities are not fully priced in the premiums, banks may ironically take on even more risk as a "search for yield" strategy. Banks may also engage in arbitrage to exploit the differentials in premiums. All these possibilities represent behavioral *distortions*: rational responses to risk-based pricing through avenues other than the risk-mitigation channel. Distortions can render risk-based pricing ineffective.[3] After all distortions are accounted for, it is an empirical question whether the residual negative impact of higher premiums on profitability is large enough to countervail any benefits to increased risk-taking that accrue to insured institutions. And even if that is the case, it is a priori unclear to what extent banks actually respond to such incentives by altering their business strategies and reducing their risk appetite; they may, for instance, be constrained from reducing their risk by other factors they deem more important (factors such as competition, location, management expertise, market conditions, and so forth). Very few studies explore the empirical relationship between insurance pricing and the behavior of insured firms in the context of ex ante moral hazard. Moreover, simply understanding the ways banks respond to changes in premiums is of importance in itself for lawmakers and regulators who price the insurance; for instance, the FDIC recently proposed to increase premiums as a result of the 2020 deposit influx shock driven by the COVID-19 pandemic (FDIC (2022)).

In the present article, I use a previously unexplored quasi-experiment to study the different effects of insurance pricing on firm behavior, particularly those relating to moral hazard. The results, in brief, point to the effectiveness of risk-based pricing at mitigating moral hazard, but also indicate a tendency for distortions to arise, highlighting the importance of robust laws and regulations surrounding risk-based pricing. Banks facing higher premiums switched funding away from deposits and into Federal Home Loan Bank (FHLB) advances, an alternate funding source that, at the time, was not assessed any premiums. They also reduced their cash and securities holdings and increased their lending, becoming less liquid in the process, as a "search for yield" strategy to offset higher premiums. In addition, a special class of banks engaged in an intricate form of regulatory arbitrage to make deposits assessable at lower premiums. Despite these distortions, however, I find that the residual impact of higher premiums on profitability is large and economically

[2]In the mid-1990s, the assessment base was domestic deposits (insured and uninsured). The Dodd–Frank Act of 2010 has since expanded the assessment base to include other funding sources.

[3]Furthermore, the regulatory and information environments in which risk-based pricing is implemented are central to its effectiveness. Prescott (2002), for instance, argues that environments in which regulators cannot observe bank risk severely hamper the proper functioning of risk-based pricing.

significant, even after accounting for the many ways banks attempted to offset the negative effects of higher premiums. I also find that this cost borne by banks facing higher premiums, in terms of reduced profitability, far outweighs any potential gains from increased risk-taking. Finally, I directly study whether banks respond to pricing incentives through the risk-reduction channel. I find that banks facing stronger pricing incentives to become (or remain) safer were more likely to subsequently do so than banks that faced weaker pricing incentives.

The quasi-experiment I use was spawned by rules governing the timing of reductions in deposit insurance premiums. In the mid-1990s, the FDIC oversaw two insurance funds, the Bank Insurance Fund (BIF) and the Savings Association Insurance Fund (SAIF). Emerging from the savings and loan crisis of the 1980s, both funds were undercapitalized, and by law, premiums were lowered for members of a fund once the fund reached its target capitalization level. For several reasons explained more fully in Section III, the BIF recapitalized faster than the SAIF, in the second quarter of 1995. The resulting disparity in premiums between the two funds was highly undesirable, so in 1996 Congress passed a law to recapitalize the SAIF through a one-time special assessment charged to all SAIF members in the third quarter of that year. Starting in 1997, premiums were lowered for SAIF members to virtually match those paid by BIF members. The disparity in premiums lasted 6 quarters, from the third quarter of 1995 through the fourth quarter of 1996. During the disparity, BIF and SAIF premiums differed not only in levels but also in steepness, that is, in the increments with which premiums increased for riskier institutions.

This 6-quarter disparity offers a unique window into the ways deposit insurance premiums influence bank behavior, and several aspects of the disparity uniquely aid in the identification of the results. The disparity generated both time and cross-sectional variation in levels of premiums as well as in their risk-based steepness. A cross-sectional comparison between high-premium payers and low-premium payers would typically be plagued with selection issues, but the disparity forced institutions with identical risk profiles to face different premium schedules, allowing for estimates that credibly isolate the effects of insurance pricing. To further ensure that the institutions from the two funds are comparable, I use a combination of propensity score trimming, sufficiently exhaustive fixed effects, and synthetic control methods. In addition, the timing of the disparity had a plausibly exogenous reason (precise date of recapitalization of the BIF), and so the change is not confounded with other contemporaneous shifts in policy or macroeconomic conditions, in contrast to changes that are born of crises or large-scale changes in regulations. Finally, the changes were economically meaningful. In Aug. 1995, in his telling congressional testimony on the disparity, Alan Greenspan, then-chairman of the Federal Reserve Board, notes:

> We are, in effect, attempting to use government to enforce two different prices for the same item – namely, government-mandated deposit insurance…The difference between paying, say, 24 basis points and paying 4.5 basis points for deposit insurance translates into about \$1.4 billion per year in additional premiums paid for SAIF deposits. For SAIF institutions, this equals roughly 18 percent of their 1994 pretax income. (Board of Governors of the Federal Reserve System, 1995)

Exploiting the disparity, this article proceeds in several steps (described in the paragraphs that follow) to build an integrated understanding of how institutions respond to insurance premiums.

The article's first set of results exploit differentials created by the disparity in levels of premiums between BIF members and otherwise-similar SAIF members. I find that institutions facing higher premiums reduced their reliance on deposits (as a ratio of liabilities) immediately before and during the disparity by a total of about 120 basis points and shifted their funding to FHLB advances, which were not assessed any deposit insurance premiums. This is only one of several distortions created by premium differentials (with others described in later results), and it is precisely distortions such as this one that erode the effectiveness of risk-based pricing by dampening the impact of premium differentials on profitability. If there is little difference in profitability between institutions that pay low premiums and institutions that pay high premiums, either because there are ways to evade the differentials or because the differentials are not large enough, then profit-maximizing firms have little incentive to change their risk-taking in response to changes in premiums.[4] Thus, I next study the effects of the disparity on profitability.

I find that the disparity introduced a large wedge between BIF and SAIF institutions in the return on assets (ROA), a wedge of about 16.5 basis points, or about 20.1% of the ROA of SAIF institutions in the quarter immediately preceding the disparity, with SAIF members having lower relative profitability. Importantly, this wedge implicitly accounts for any distortionary actions the institutions may have taken in response to the disparity, and thus shows the residual effect on profitability that could not be evaded by institutions. Moreover, I find that the magnitude of this wedge far outweighs any increase in profitability associated with increased risk-taking, suggesting that relatively minor differentials in premiums may be sufficient to mitigate moral hazard.

So far, however, the results do not necessarily imply that institutions actually do respond to pricing incentives by reducing their risk-taking.[5] Because it forced different levels of premiums on members of the two funds, and members of one fund could not simply switch to the other fund by altering their risk levels, the disparity in *levels* of premiums between the two funds cannot be used to identify the extent to which banks respond to premium differentials through the risk-mitigation channel. I address this issue by exploiting differences between BIF and SAIF institutions in the *steepness* of the risk-based premiums. When the FDIC lowered the premiums for BIF members, it lowered them more aggressively for banks already paying the lowest premiums on the risk-based pricing schedule. Thus, the modifications changed not only the levels of premiums but also the incremental penalties of becoming more risky, thereby altering the incentives for taking on more

[4]Note that the change in premiums during the six quarters of disparity occurred only for BIF institutions (apart from the one-time special assessment charged to SAIF members). Nevertheless, because of competition, it is not surprising if both types of institutions changed their behavior. Because the analysis of profitability is concerned with the residual relative effect of premium differentials on profits (accounting for any response to the differentials by either BIF or SAIF institutions), what is of interest is the ultimate *relative* effect on profitability (see Section II).

[5]As mentioned above, despite the existence of incentives, banks may be constrained not to change their risk appetite by other factors, including, for example, management expertise and location.

(or less) risk. Again, these changes occurred a year and a half earlier for BIF institutions than they did for SAIF institutions. I use these time and cross-sectional changes to study the resulting difference between BIF and SAIF institutions in the likelihood of becoming more or less risky before, during, and after the disparity. I find that when risky institutions had stronger incentives (through larger reductions in deposit insurance premiums) to become less risky, the institutions were in fact more likely to reduce their risk. Similarly, safer institutions that had stronger pricing incentives to remain safe were actually more likely to remain safe in subsequent quarters. During the disparity, the steepness of the risk-based pricing differed for BIF and SAIF members, but the differences were not unreasonably large. Thus, these results also suggest that relatively small changes in pricing incentives are sufficient to influence banks' risk-taking behavior, consistent with the conclusions reached above. Overall, these results again point to the effectiveness of risk-based pricing in mitigating moral hazard.

Finally, I use the disparity to study how deposit insurance premiums affect banks more generally and document other relevant distortions. I find evidence that SAIF institutions became relatively less liquid as a search for yield strategy. They reduced their cash holdings and had significantly higher rates of loan growth and lower rates of securities growth relative to similar BIF institutions. Consistent with the "search for yield" hypothesis, I find that the growth rate of SAIF institutions' interest income rose significantly during the disparity relative to that of BIF institutions. In contrast, I find no strong effects on the interest expense of SAIF institutions relative to BIF institutions (as a growth rate or as a percentage of interest-bearing deposits), suggesting that SAIF and BIF members continued to offer comparable interest rates on deposits. I find evidence that the so-called Oakar institutions (those that held deposits insured by both funds) engaged in regulatory arbitrage to reduce their total assessment burden. Despite rules and controls in place at the time to prevent the movement of deposits from the SAIF to the BIF, the evidence suggests that Oakar institutions, by exploiting an asymmetry in the rules governing deposit sales, migrated some of their deposits from the SAIF to the BIF.

The result on deposit migration highlights the importance of accompanying risk-based pricing with regulatory controls to prevent arbitrage. Arbitrage opportunities, and distortions more generally, weaken the effectiveness of risk-based pricing, for the riskier institutions facing higher premiums may find it feasible to evade the premiums without having to reduce their risk-taking. In addition, deposit migration is a serious concern for the insurer, for it reduces the assessment base of the fund from which deposits are fleeing, thus weakening the fund. The United States currently has only one deposit insurance fund for banks and savings institutions, but deposit migration may be relevant internationally.[6] Although an international study is beyond the scope of the present article, the article's findings concerning deposit migration within the United States highlight the importance of strong regulatory controls that not only discourage arbitrage but also eliminate any loopholes that could allow evasion of higher premiums.

[6]There is also a separate fund for insured credit unions. The National Credit Union Share Insurance Fund (NCUSIF), managed by the National Credit Union Administration (NCUA), insures accounts in credit unions.

This article contributes most closely to a debate in the literature on the desirability and effectiveness of risk-based pricing of deposit insurance. Risk-based pricing can reduce moral hazard and can promote fairness by reducing cross-subsidization of risk, but it also requires a transparent information environment and strong institutions, and it may be difficult to properly design and implement (cf. Ehrlich and Becker (1972), Flannery (1991), Chan, Greenbaum and Thakor (1992), Laeven (2002), Prescott (2002), and Pennacchi (2006)). As of year-end 2018, less than half of the members of the International Association of Deposit Insurers (IADI) utilized some form of risk-based pricing (IADI (2020)). With few exceptions, much of the existing literature on risk-based pricing is either theoretical in nature or dependent on hypothetical counterfactual evidence that does not fully account for banks' optimal response to changing premiums.[7] To my knowledge, the current article is the first contribution to this strand of literature to present causal empirical evidence on the effects of risk-based pricing from otherwise-similar banks that face different pricing regimes.[8]

Another related strand of literature examines cross-country differences to understand the effects of deposit insurance in general and the factors that make it more effective (e.g., Demirgüç-Kunt and Kane (2002), Anginer, Demirguc-Kunt, and Zhu (2014)). This literature does not typically focus on the pricing of deposit insurance and the role of pricing in reducing moral hazard. However, some studies find that moral hazard effects are not as severe in countries in which deposit insurance is accompanied with risk-based pricing (e.g., Demirgüç-Kunt and Detragiache (2002), Hovakimian, Kane, and Laeven (2003)). The current article differs from existing cross-country comparisons by providing quasi-experimental evidence from similar banks facing similar institutions, laws, and regulations to isolate the effects of the pricing of deposit insurance from other potential confounders and directly study whether there is evidence that risk-based pricing can mitigate moral hazard concerns.

This article also relates to the literature studying the effects of funding costs on bank behavior and risk-taking. This literature does not typically study whether risk-based pricing can mitigate the moral hazard associated with deposit insurance, so it differs in focus from the current article. However, like the current article, this literature identifies some distortions that could result from differential pricing. Kim and Rezende (2020) use a kink in the pricing of deposit insurance and estimate that higher premiums incentivize banks to search for yield by reducing their reserves and increasing their lending in the interbank market instead. Their findings are consistent with the present article's results on increased risk-taking

[7]See, for instance, Gómez-Fernández-Aguado, Partal-Ureña, and Trujillo-Ponce (2014). Cornett, Mehran, and Tehranian (1998) analyze the period when banks paid flat-rate premiums, before the implementation of risk-based pricing, and concentrate on shocks to bank stock prices in response to events that made the implementation of risk-based pricing seem more likely or less likely. They find that healthy and well-capitalized banks benefited from events that made the implementation of risk-based pricing more likely, and that the opposite was true for risky banks.

[8]More generally, the present article also complements the normative literature on optimal design and pricing of deposit insurance (e.g., Boyd, Chang, and Smith (2002), Pennacchi (2005), Acharya, Santos, and Yorulmazer (2010), and Allen, Carletti, and Marquez (2015)).

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by SAIF institutions (though the risk-taking mechanism differs), but the BIF-SAIF quasi-experiment I use allows for a unique source of identification in which institutions with *identical* risk profiles are charged different premiums. Kreicher, McCauley, and McGuire (2013) estimate several effects of the change in deposit insurance assessment base instated by the Dodd–Frank Act of 2010. They find a shift in funding toward deposits after the widening of the assessment base. This result is consistent with the present article's finding on shifting funding sources in response to pricing, though their identification strategy and analysis time period differ from those of the current article. Other related papers include Keating and Macchiavelli (2017), Basten and Mariathasan (2018), Heider, Saidi, and Schepens (2019), Banegas and Tase (2020), Duquerroy, Matray, and Saidi (2020), and Kandrac and Schlusche (2021). Besides differences in the precise research questions and effects estimated, the present article is unique in using the disparity in deposit insurance premiums between BIF and SAIF members as a quasi-experiment to study the effects of the premiums on bank behavior.

In the literature on the economics of insurance more broadly, several studies find evidence of ex ante moral hazard in various contexts (e.g., Cohen and Dehejia (2004), Dave and Kaestner (2009), and Spenkuch (2012)). There is also literature, especially within the context of health insurance, on how the design of the insurance contract affects moral hazard (e.g., van Kleef, van de Ven, and van Vliet (2009), Brot-Goldberg, Chandra, Handel, and Kolstad (2017)). But this literature often differs from the current article in two important ways. First, unlike the current article, it focuses on ex post moral hazard, which is the propensity to increase spending on claims (e.g., medical care or unemployment insurance) *after* a loss has already occurred. Second, the focus is typically on other aspects of the insurance contract, such as deductibles. Again, despite the prevalence of risk-based premiums in different insurance contexts (auto, home, property, and so forth), very few studies deal directly with the relationship between risk-based premiums and ex ante moral hazard.

II. Theoretical Preliminaries

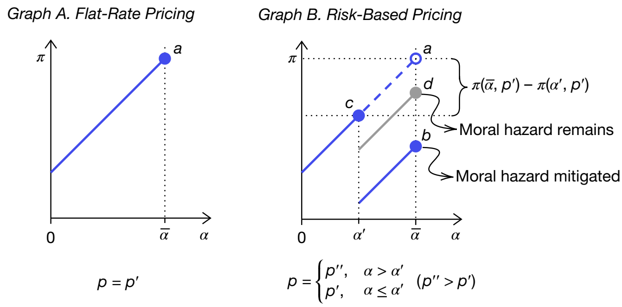
Suppose a bank's profits depend on, among other things, both the level of risk-taking, $\alpha \in [0, \overline{\alpha}]$, with higher values of α denoting higher risk, and deposit insurance premiums, p. To highlight the relationship between risk-based pricing and moral hazard, consider a scenario in which the bank's profit function, π, is strictly increasing in α when the bank is insured and when there is no risk-based pricing. Under the flat-rate regime, all banks pay the same deposit insurance premium $p = p'$. This illustrative setting is a worst-case scenario for moral hazard, for it implies that deposit insurance (with its associated lack of market discipline) incentivizes the bank to maximize its risk in order to maximize profits.[9] This case is illustrated in Graph A of Figure 1.

[9]In reality, the profit function need not be strictly increasing in bank risk-taking. All that is needed to justify risk-based pricing is that banks' risk levels in the absence of risk-based pricing are higher than the regulator would prefer. Moreover, other regulatory actions besides risk-based pricing can also curb profit-taking; examples of such actions are direct rules on capitalization and on levels of risk-taking.

FIGURE 1

Deposit Insurance Premiums and the Moral Hazard Problem

Graph A of Figure 1 illustrates a worst-case scenario for moral hazard, where profit (π) is strictly increasing in risk-taking (α) and insurance premiums are a flat-rate set at p'. In Graph A, an insured firm chooses the maximum risk level, $\overline{\alpha}$. Graph B shows the effect of setting a risk-based premium with two levels depending on whether the risk α is above or below some risk level α'. For $\alpha > \alpha'$ the premium is set at p'' and for $\alpha \leq \alpha'$ the premium is set at p', and $p'' > p'$. Whether the pricing structure in Graph B incentivizes an insured firm to reduce its risk or not depends on the profitability loss to the firm were it to remain at risk level $\overline{\alpha}$, and how that loss compares to any potential loss from moving to α'.



A regulator can attempt to alleviate moral hazard by making the premium dependent on the risk level α, with higher values of α resulting in higher premiums $p'' > p'$. Suppose a regulator wishes to incentivize the bank to move to a lower level of risk, $\alpha' < \overline{\alpha}$. Graph B of Figure 1 illustrates the effect of setting two different premiums with $p = p'' > p'$ if $\alpha > \alpha'$ and $p = p'$ otherwise. This new premium structure is successful (i.e., solves the moral hazard problem and incentivizes the bank to lower its risk level to α') if the following condition is satisfied:

$$(1) \qquad \pi(\overline{\alpha}, p') - \pi\left(\overline{\alpha}, p''\right) > \pi(\overline{\alpha}, p') - \pi(\alpha', p').$$

Simply, as I illustrate in Figure 1, the effectiveness of risk-based pricing hinges on the degree to which higher premiums reduce profitability for a firm that remains risky (the left-hand side of condition (1)), and how that reduction to profitability compares to any potential loss the firm may face by reducing its risk (the right-hand side of condition (1)). If higher premiums sufficiently reduce the firm's profitability (point *b* in Figure 1), the firm will find it optimal to reduce its risk to α'. However, if higher premiums do not sufficiently reduce firm profitability, either because the premium differentials are simply not large enough or because the firm can somehow dampen the effect of higher premiums on its profitability, the insurance pricing will not incentivize the firm to reduce its risk; this situation is illustrated by point *d* in the figure. Several (but not all) of the empirical results in this article revolve around understanding which of these two points in Figure 1, *b* or *d*, is more reflective of reality. The BIF-SAIF disparity uniquely aids in this endeavor.

Reliably estimating the effect of premiums on profitability (e.g., whether a firm at point *a* in Figure 1 would end up at point *d* or point *b* when faced with higher premiums) requires observing firms *at the same risk level* but that face *different* deposit insurance premiums; this is typically difficult or impossible to observe without exogenous variation in premiums. The BIF-SAIF disparity, however, forced firms that have identical levels of risk to face different levels of deposit insurance premiums. Because firms could not avoid the premiums disparity, the estimates I obtain are of the "residual" effect on profitability. That is, the estimates account for distortions, or all the ways firms may have attempted to dampen the effect of the premium differentials.

Distortions are rational responses to risk-based pricing through nonrisk-mitigation channels. Even the simplest models suggest that with differential premiums, high-risk banks compensate in ways that lower the left-hand side of condition (1) and dampen the effect of the high premiums on their profitability.[10] The extent to which distortions exist is purely an empirical question, because distortions are highly contextual and depend on the institutional environment and the laws and regulations surrounding risk-based pricing. If, for instance, the bank has access to an alternative low-cost nonassessable funding source, it is likely to shift its funding sources away from deposits. Alternatively, if competitors pay lower premiums and pass on the savings to depositors, the bank could be forced to raise its rates, making deposits more expensive for the bank and, again, incentivizing the bank to shift away from deposits. The bank may also exploit any inefficiencies in the design of the risk-based pricing and become even more risky to offset the effect of premiums on its profits (i.e., may increase some measure of risk not captured by the measurable α). Finally, the existence of differential premiums itself may completely alter the profit function of the bank if loopholes or opportunities for regulatory arbitrage allow the bank to expend some costly effort to reclassify some of its deposits at low premiums.

In my empirical results, I find evidence of distortions such as shifts in funding sources, arbitrage, and increases in some forms of risk-taking (see Sections V.A and V.D–V.F), but I also find evidence that risk-based pricing provides sufficient incentives to mitigate risk. That is, the evidence suggests that condition (1) holds. In Section V.B, I use unique variation from the disparity to estimate the residual effect of premiums on profitability (i.e., the left-hand side of condition (1)), and I compare it to estimates of the effect of risk on profitability (i.e., the right-hand side of condition (1)).[11] I find that the loss to profitability

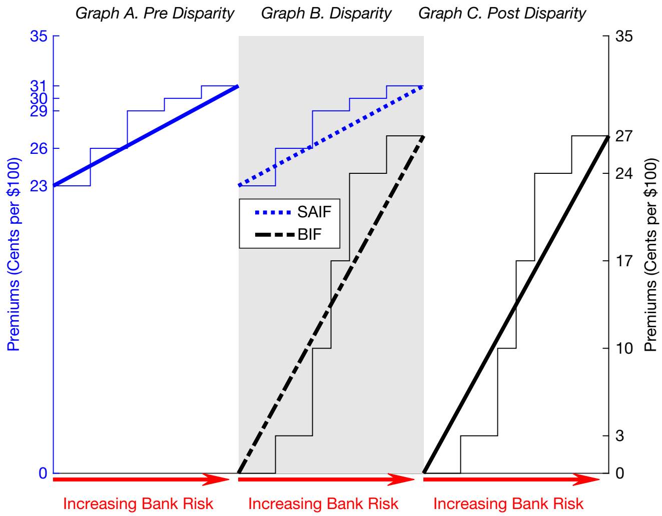
[10]To illustrate one form of this dampening in a highly simplified model, suppose the bank must also decide on $\beta \in [0,1]$ specifying its portion of funding that comes from deposits, with its funding level fixed at some $F>0$. Let its profit function be of the following form: $\pi(\alpha,p,\beta) = R(\alpha) - \beta F p - E(\beta)$, where R is an increasing function and E is the interest expense of the bank given that it funds a portion β of its total funding F from deposits and a portion $1-\beta$ from other sources. Under flat-rate premiums with $p=p'$ independent of α, the bank always chooses $\alpha=\overline{\alpha}$, the highest risk level, and chooses β to minimize the total cost of funding, $(\beta F p' + E(\beta))$. Consider now a move from flat-rate premiums to risk-based premiums as illustrated in Figure 1 with $p=p''>p'$ if $\alpha>\alpha'$ and $p=p'$ otherwise. Let β' be the choice of β that minimizes $(\beta F p' + E(\beta))$ and let β'' be the choice that minimizes $\left(\beta F p'' + E(\beta)\right)$. In the absence of any distortions (that is, if the bank does not alter its level of deposit funding as a result of the premiums), the analogous left-hand-side of condition (1) in this setting is $\left(\beta' F p'' + E(\beta')\right) - (\beta' F p' + E(\beta'))$. However, because the bank has the ability to change its funding mix, its choice of β at $p=p''$ is β'', as stated previously. Thus, in reality, its left-hand side of condition (1) is $\left(\beta'' F p'' + E\left(\beta''\right)\right) - (\beta' F p' + E(\beta'))$, which is lower than it would have been in the absence of distortions because, by definition, β'' is the choice of β that minimizes $\left(\beta F p'' + E(\beta)\right)$.

[11]Estimating the elasticity of profits with respect to risk-taking, which relates to the right-hand side of condition (1), requires an estimate of the slope of the lines in Figure 1. Estimates of that slope can be obtained from observing firms that pay the same premium but have risk profiles that are different, at least

FIGURE 2

Illustrated History of Risk-Based Premiums in the Mid-1990s

Graphs A–C of Figure 2 show the primary phases in the evolution of risk-based premiums, highlighting the time period around the disparity of the mid-1990s. Solid step-increasing lines show the risk-dependent premiums paid by BIF and SAIF members in the three regimes: pre-disparity, disparity, and post-disparity. Lines connecting the minima and maxima in each of the premium structures show an illustrated approximation of the risk-dependent slope faced by institutions. Graph B excludes the one-time special assessment paid by all SAIF members in the third quarter of 1996; Graph B also excludes the illustration of BIF premiums paid in the last 2 quarters of 1995, which were 4 basis points higher than BIF premiums paid after 1995 and which were partially refunded to banks because the BIF had recapitalized (see Table 1 for details).



that a high-risk bank would face by paying higher premiums far exceeds any potential loss to profitability that it may experience by reducing its risk. That is, the evidence suggests that point *b* in the illustrative example in Figure 1 is more representative of reality than point *d*.

The results described above show that risk-based premiums create incentives for banks to lower their risk, but additional variation from the BIF-SAIF disparity allows me to go further and directly estimate whether banks respond to pricing incentives through the risk-mitigation channel. As previously mentioned, even if a bank faces incentives to reduce risk, it may be constrained by management expertise, location, or other factors to maintain its risk-taking levels. Thus, condition (1) is necessary but not sufficient to conclude that risk-based pricing mitigates moral hazard. In Section V.C, I use variation from the disparity in the steepness of risk-based premiums (see Figure 2), and find that banks do indeed respond to insurance pricing through the risk-mitigation channel; banks facing steeper penalties were observably more likely to curb risk-taking.

marginally. Premiums in a risk-based pricing system often move up in a step-wise fashion depending on risk, and thus for significant masses of firms, they remain constant. Firms that pay the same premiums within each "step" of the pricing can be used to estimate the elasticity; in Figure 1, for instance, firms with $\alpha \leq \alpha'$ can be used to estimate the slope.

III. A Brief History of the 1995–1996 BIF-SAIF Disparity

Before 1989 the FDIC's Permanent Insurance Fund insured commercial banks and some mutual savings banks. The Federal Savings and Loan Insurance Corporation (FSLIC) insured most Savings and Loan Associations (S&Ls). Savings banks and S&Ls can both be classified as thrifts.

The distinctions between thrifts and commercial banks go back to the 19th century, when thrifts were founded to serve working-class people who were not being adequately served by commercial banks, which focused on serving businesses. Initially, the charters of thrifts and commercial banks were significantly different: they had different powers, with thrifts being restricted to housing-related lending. In the early 1980s, however, Congress passed laws that expanded the powers of thrifts and virtually eliminated the historical distinctions between them and commercial banks (Lateef and Sczudio (1995)). The most important difference that remained was the *extent* to which thrifts could engage in activities unrelated to housing. Thrifts were allowed to hold up to 40% of their assets in commercial mortgage loans, up to 30% in consumer loans, up to 10% in commercial loans, and up to 10% in commercial leases. During the remainder of the 1980s, the practical distinctions between thrifts and commercial banks continued to fade, and by 1992 commercial banks held more mortgage loans than thrifts did (Lateef and Sczudio (1995)).

In the middle of the 1980s, however, the thrift industry was in the throes of what came to be called the S&L debacle, to which Congress responded with major pieces of legislation, two of which are particularly relevant to this brief history. The first was the Financial Institutions Reform, Recovery, and Enforcement Act of 1989 (FIRREA), and the second was the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA).

FIRREA abolished the FSLIC, the insurer of most S&Ls, and established a new insurance fund, the Savings Association Insurance Fund (SAIF), which would insure most thrifts and would be managed by the FDIC. In addition, FIRREA established the Bank Insurance Fund (BIF) – also managed by the FDIC – to assume all the assets and liabilities of the Permanent Insurance Fund (Segal (1991)) and insure most commercial banks.

FDICIA, passed a little over 2 years after FIRREA, contained several important provisions affecting deposit insurance premiums (see FDIC (1998)). Before FDICIA, all banks had paid a flat rate for deposit insurance. FDICIA introduced risk-based premiums: banks (henceforth this word will apply to both commercial banks and thrifts unless specified otherwise) were to be classified into 1 of 9 categories depending on their capital ratios and supervisory risk group. Starting in Jan. 1993, the risk-dependent assessment rate varied between 23 and 31 cents per $100 of assessable deposits. These rates applied equally to both BIF- and SAIF-insured banks and are displayed in Panel A of Table 1 and in Graph A of Figure 2.

At the time FDICIA was passed, both the BIF and the SAIF were undercapitalized. Under FDICIA, banks were to be charged assessments until the fund under which they were insured was fully capitalized to 1.25% of insured deposits. FDICIA required the FDIC to develop a plan to recapitalize the BIF within 15 years; that plan was adopted in 1992. FDICIA also required the FDIC to develop a plan to

TABLE 1

Premiums of BIF and SAIF Institutions (Basis Points)

Panels A–C of Table 1 show the differences in premiums between BIF and SAIF institutions before, during, and after the disparity. All values are in annual basis points, or cents per $100, of domestic deposits. Supervisory groups (columns) are classifications of banks by composite CAMELS ratings into three levels, with supervisory group A being the healthiest banks and supervisory group C being the least healthy; similarly, banks are assigned to rows on the basis of their capital ratios. Panel A shows the premiums charged to BIF and SAIF institutions before the start of the disparity (i.e., before the third quarter of 1995). SAIF institutions continued to pay the premiums in Panel A through the fourth quarter of 1996, the last quarter of the disparity. Panel B shows that premiums were reduced for BIF institutions in the third and fourth quarters of 1995; in addition, excess assessments paid to the BIF after it reached its target capitalization percentage were refunded (FDIC (1996)). Panel C shows the premiums charged to BIF institutions starting in Jan. 1996; these premiums are also the postdisparity premiums that both BIF and SAIF institutions paid, but SAIF institutions did not move to the lower premiums in Panel C until Jan. 1997.

	Supervisory Group		
	A	B	C
Panel A. BIF and SAIF Predisparity			
Well capitalized	23	26	29
Adequately capitalized	26	29	30
Under capitalized	29	30	31
Panel B. BIF July 1, 1995, Through Dec. 31, 1995 (before refunds)			
Well capitalized	4	7	21
Adequately capitalized	7	14	28
Under capitalized	14	28	31
Panel C. BIF Starting on Jan. 1, 1996, and SAIF Starting on Jan. 1, 1997			
Well capitalized	0	3	17
Adequately capitalized	3	10	24
Under capitalized	10	24	27

recapitalize the SAIF, but the plan was not required until 1998; at the time, nearly half of SAIF assessments were being diverted to other purposes stemming from the S&L crisis, so it was clear that the SAIF would take much longer than the BIF to recapitalize.

In 1993, however, the banking industry was much more profitable than it had been in the immediately preceding years. In the fall of 1992, more than 1,000 institutions had been on the FDIC's list of "problem institutions" (institutions requiring additional attention from regulators), but by year-end 1993, the number had dropped to 472 institutions, leading the FDIC to project substantial reductions in the number of bank failures in 1994 and 1995 (FDIC (1994)). As a result of the sharp rise in banks' profitability in 1993, the BIF recapitalized in May 1995, much faster than lawmakers had anticipated.

Because the BIF was recapitalized, the FDIC was required to reduce the deposit insurance premiums for its members. In the third and fourth quarters of 1995, therefore, the premiums of BIF-insured banks were reduced to between 4 and 31 cents per $100 of assessable deposits (with excess assessments refunded to BIF members (FDIC (1996))), and starting in Jan. 1996 the premiums were again reduced to range from 0 to 27 cents per $100 of assessable deposits. Panels A–C of Table 1 show the evolution of premiums for SAIF and BIF institutions throughout the 6 quarters of the disparity – the period when BIF premiums differed from SAIF premiums. Table 2 shows the percentage of BIF and SAIF institutions in each of the 9 categories that determined premiums. By far, most banks were in the "healthiest" category as defined by the FDIC throughout this period. Thus, most BIF-insured banks faced an assessment rate of 4 basis points in the third and fourth

TABLE 2
Distribution of BIF and SAIF Members Across Risk Categories

Table 2 shows the percentage of BIF (SAIF) members in each supervisory group and capitalization level as of Dec. 31, 1995, as reported in FDIC (1996). Supervisory groups (columns) are classifications of banks by composite CAMELS ratings into three levels, with supervisory group A being the healthiest banks and supervisory group C being the least healthy; similarly, banks are assigned to rows on the basis of their capital ratios.

	Percentage of BIF (SAIF) Institutions as of Dec. 31, 1995		
	Supervisory Group A	Supervisory Group B	Supervisory Group C
Well capitalized	93.5% (90.5%)	4.2% (5.5%)	0.9% (0.8%)
Adequately capitalized	0.7% (1.1%)	0.2% (0.8%)	0.3% (1.1%)
Under capitalized	0.0% (0.0%)	0.0% (0.0%)	0.2% (0.2%)

quarters of 1995 (before assessment refunds) and 0 basis points in all quarters of 1996. Most SAIF-insured banks, on the other hand, continued to be assessed 23 basis points, according to the earlier risk-based premium schedule. Graph B of Figure 2 illustrates the primary premiums structures for BIF and SAIF members during the disparity.

The disparity was undesirable, and was projected to cause several problems. Thus, Congress responded by passing the Deposit Insurance Funds Act of 1996, which mandated a one-time special assessment of 65.7 basis points that SAIF members would pay in the second half of 1996 to recapitalize the SAIF. Congress decided that the base for the special assessment would be the SAIF-assessable deposits held on Mar. 31, 1995 (FDIC (1997)). Starting in 1997 both SAIF- and BIF-insured banks faced the same deposit insurance premiums, illustrated in Graph C of Figure 2, except that an additional premium was charged to members of both funds to finance the Financing Corporation (FICO) bonds (which had been issued during the S&L crisis), and the FICO assessments differed slightly between the two funds.[12] In 2006, pursuant to the Federal Deposit Insurance Reform Act of 2005, the BIF and the SAIF merged to form the Deposit Insurance Fund.

The focus of this article is the 1995–1996 6-quarter period of disparity, when the premiums charged to one set of institutions were different from the premiums charged to the other set. The empirical analysis extends from the beginning of 1993, when risk-based premiums were first implemented, through the end of 1997.

IV. Data and Sample

The main sources of data are the quarterly Reports of Condition and Income (Call Reports) filed by commercial banks and the quarterly Thrift Financial Reports (TFRs) filed by thrifts. Both reports contain detailed balance sheet and income statement information for the reporting institutions. I also use confidential data on banks' supervisory CAMELS ratings.[13]

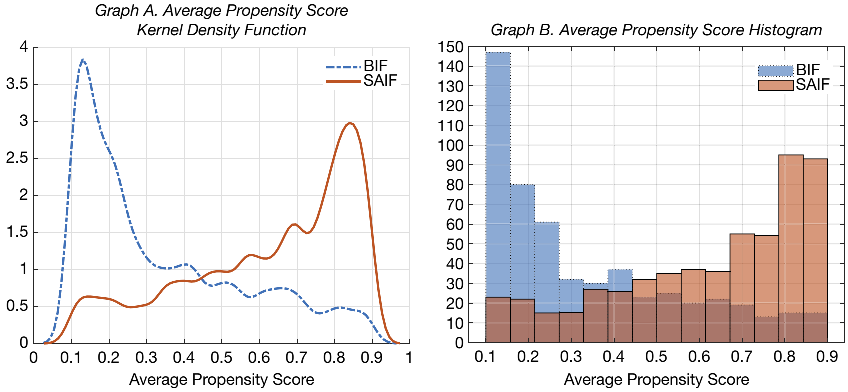
[12]SAIF-insured institutions paid FICO assessments of about 6 basis points, while BIF-insured institutions paid FICO assessments of 1 basis point (FDIC (2017)). In 2000 the FICO assessments equalized for both sets of institutions.

[13]CAMELS ratings are supervisory ratings between 1 and 5 (1 being the best) assigned to banks by supervisory regulators. A CAMELS rating has six components (*C*apital Adequacy, *A*sset Quality, *M*anagement Quality, *E*arnings, *L*iquidity, and *S*ensitivity to Market Risk), each of which receives a

FIGURE 3

Resulting Propensity Score Distribution After Sample Trimming

Figure 3 shows the distribution of the average propensity score for BIF and SAIF institutions after trimming based on the procedure described in Section IV to produce a sample with comparable BIF and SAIF institutions. Graph A shows the estimated kernel density functions, and Graph B shows the histograms of the average propensity scores for the two types of institutions.



Unless otherwise noted, I use a "trimmed sample" of institutions, which I construct by first imposing several basic restrictions and then by applying a propensity score trimming procedure to keep BIF and SAIF members comparable. This sample includes commercial banks and thrifts that i) were in business in all quarters between the first quarter of 1993 and the fourth quarter of 1997; ii) for each of those quarters, were classified as a national bank, state member or nonmember bank, savings bank, or savings and loan institution; iii) were headquartered in the contiguous, continental United States; iv) had a positive value for total loans and leases, total deposits, and domestic deposits; and v) did not experience a change in charter type, ownership structure, primary insurance fund, or membership status in a holding company. Also excluded were young (de novo) institutions established in 1992 or after.

I then trim this sample of institutions using propensity scores to ensure that the two subsamples in the estimates, one of BIF members and one of SAIF members, are comparable. The trimming procedure proceeds by first constructing a propensity score for each institution, estimating the likelihood that an institution is SAIF-insured based on observable characteristics and using only pre-disparity data (see Section I of the Supplementary Material for details on the construction of the propensity scores). Following Crump, Hotz, Imbens, and Mitnik (2009), I trim institutions whose predisparity average propensity score is less than 0.1 or greater than 0.9. Figure 3 shows the density functions and histograms of propensity scores for both BIF and SAIF institutions after the trimming. The resulting sample contains comparable institutions, with significant overlap in their propensity score distributions. The trimmed sample contains 565 SAIF-member institutions

rating between 1 and 5. In addition, supervisory regulators assign the bank a composite CAMELS rating (also between 1 and 5) to summarize the bank's overall health; the composite ratings may differ from the average of the component ratings.

TABLE 3

Summary Statistics: Trimmed Sample, Quarter 1, 1995

Table 3 shows descriptive statistics for BIF and SAIF members in the first quarter of 1995 for several variables of relevance. The columns for each sample show the mean and standard deviation for each variable. The sample in Panel A contains all institutions without any restrictions. The sample in Panel B is trimmed based on propensity scores, as described in Section IV. For each sample, the column labeled Δ shows the difference in means between BIF and SAIF members as well as its statistical significance from an independent samples *t*-test allowing for unequal variances (*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively). The column labeled Δ_w is constructed analogously to the column labeled Δ after the samples are winsorized at the 1% and 99% levels within each quarter.

	BIF Members		SAIF Members		Difference in Means	
	Mean	Std. Dev.	Mean	Std. Dev.		
Panel A. All Institutions						
					Δ	Δ_w
Asset size ($millions)	412.7	4,087.7	428.2	1,760.0	−15.5	−106.1***
Deposits/liabilities (%)	95.2	10.3	91.3	11.2	3.9***	4.0***
Loans and leases/assets (%)	56.4	15.5	66.1	18.2	−9.7***	−9.7***
1–4 family residential loans/assets (%)	17.3	12.5	50.1	18.1	−32.8***	−32.6***
Commercial and industrial loans/assets (%)	9.1	7.3	1.2	2.5	7.8***	7.7***
Cash/assets (%)	5.0	4.4	5.2	5.4	−0.2	−0.2*
Securities/assets (%)	31.4	15.3	24.2	18.0	7.2***	7.3***
Nonperforming assets/assets (%)	0.9	1.6	1.0	1.8	−0.1**	−0.1***
Leverage ratio (%)	10.8	29.6	9.6	5.0	1.2***	0.5***
Efficiency ratio (%)	65.5	41.4	67.1	75.8	−1.7	−1.5***
Return on assets (%)	1.1	1.4	0.7	1.2	0.4***	0.4***
Return on equity (%)	9.9	218.6	7.5	14.8	2.4	3.9***
No. of obs.	10,589		1,807			
Panel B. Trimmed Sample						
					Δ	Δ_w
Asset size ($millions)	432.5	2,635.4	345.5	1,320.5	86.9	8.7
Deposits/liabilities (%)	94.1	12.0	92.8	10.3	1.3*	1.5**
Loans and leases/assets (%)	59.4	18.8	64.0	18.4	−4.6***	−4.5***
1–4 family residential loans/assets (%)	39.5	17.7	46.5	15.9	−7.0***	−7.0***
Commercial and industrial loans/assets (%)	2.0	2.3	1.1	2.1	0.9***	0.9***
Cash/assets (%)	5.3	6.8	5.0	4.6	0.3	0
Securities/assets (%)	28.6	16.7	26.5	18.3	2.1*	2.0*
Nonperforming assets/assets (%)	1.2	2.1	1.2	1.9	0	0
Leverage ratio (%)	10.2	5.7	9.7	4.2	0.5*	0.3
Efficiency ratio (%)	66.9	17.2	67.3	26.6	−0.4	0.6
Return on assets (%)	1.0	1.9	0.8	1.0	0.2**	0.1***
Return on equity (%)	10.5	11.9	8.4	10.8	2.1***	1.4***
No. of obs.	539		565			

and 539 BIF-member institutions. Table 3 shows descriptive statistics for members of the two funds in the trimmed sample as well as the entire sample with no restrictions or trimming. Depending on the question of interest, some sections (most notably Sections V.C and V.D) restrict the sample further or use a much larger sample of banks. Section VI shows that the article's findings are robust to alternative sample construction criteria and alternative propensity score trimming thresholds.

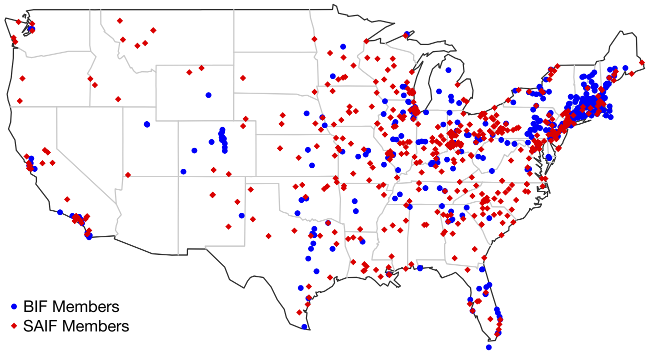
Figure 4 shows the geographic distribution in a public version of the trimmed sample.[14] Members of both funds have wide geographic dispersion, and it is unlikely for any specific location to have an outsized impact on the results. For additional robustness, I include the state-quarter level as one dimension for cluster-

[14]The public version of the trimmed sample follows the same construction of the trimmed sample except for excluding CAMELS ratings from the covariates of the logit regression generating the propensity scores.

FIGURE 4

Public Trimmed Sample BIF and SAIF Members Headquarters Locations (1995:Q1)

Figure 4 shows the geographic distribution of the main office of BIF and SAIF members in a public version of the trimmed sample. The trimmed sample is used in much of the article's analysis. (See Section IV for details on the construction of the samples.)



adjusted standard errors (the other being the institution), and Section VI shows that the article's findings are robust to a wide variety of alternative samples.

V. Main Findings

A. Shifts in Funding Sources as a Response to Higher Premiums

As mentioned previously, whenever premiums are charged on deposits, institutions can mitigate the effect of higher premiums by shifting funding away from deposits.[15] This strategy is one example of a distortion, and it erodes the effectiveness of risk-based insurance pricing by neutralizing (to whatever degree, depending on the case) its ability to mitigate moral hazard. This subsection provides estimates of the extent to which institutions sidestep higher premiums by shifting funding sources. I do this by studying the response of differentially affected institutions to the BIF-SAIF disparity, using the following two specifications:

(2) $$y_{it} = \alpha + \beta\left(\mathbf{1}_{i\in \mathrm{SAIF}} \times \mathbf{1}_{t\geq 1995\mathrm{Q3}}\right) + \gamma \mathbf{x}_{it} + c_i + d_t + \varepsilon_{it},$$

(3) $$y_{it} = \alpha + \sum_{k=1993\mathrm{Q2}}^{k=T_f} \beta_k\left(\mathbf{1}_{i\in \mathrm{SAIF}} \times \mathbf{1}_{t=k}\right) + \gamma \mathbf{x}_{it} + c_i + d_t + \varepsilon_{it},$$

where y_{it} is the dependent variable of interest for institution i in quarter t, $\mathbf{x}_{it}$ includes controls at the institution-quarter level, c_i is an institution-fixed effect, and d_t is a quarter-fixed effect. The coefficient of interest in specification (2) is β. The sample for these specifications is from the first quarter of 1993 through T_f, which may vary depending on the question under consideration. Specification (3) is a dynamic

[15]The Dodd–Frank Act of 2010 redefined the assessment base for U.S. institutions to be average consolidated total assets minus average tangible equity.

version of specification (2); the coefficient of interest is β_k, which shows the effect of being insured by the SAIF in each quarter within the sample (with the first quarter excluded). Controls for both specifications include the log of the institution's assets and age as well as the following terms entered as a ratio to assets: 1–4 family residential loans, commercial and industrial loans, credit card loans, securities, cash, and nonperforming assets; to control for the institution's risk levels, the covariates also include all the capital ratios used in determining premiums (total risk-based capital ratio, Tier 1 risk-based capital ratio, and the leverage ratio) as well as the institution's composite CAMELS rating. This set of controls is the standard set used throughout the article, unless stated otherwise. All variables except composite CAMELS ratings and the log of age are winsorized at the 1% and 99% levels within each quarter. Standard errors are clustered at both the institution and state-quarter levels.

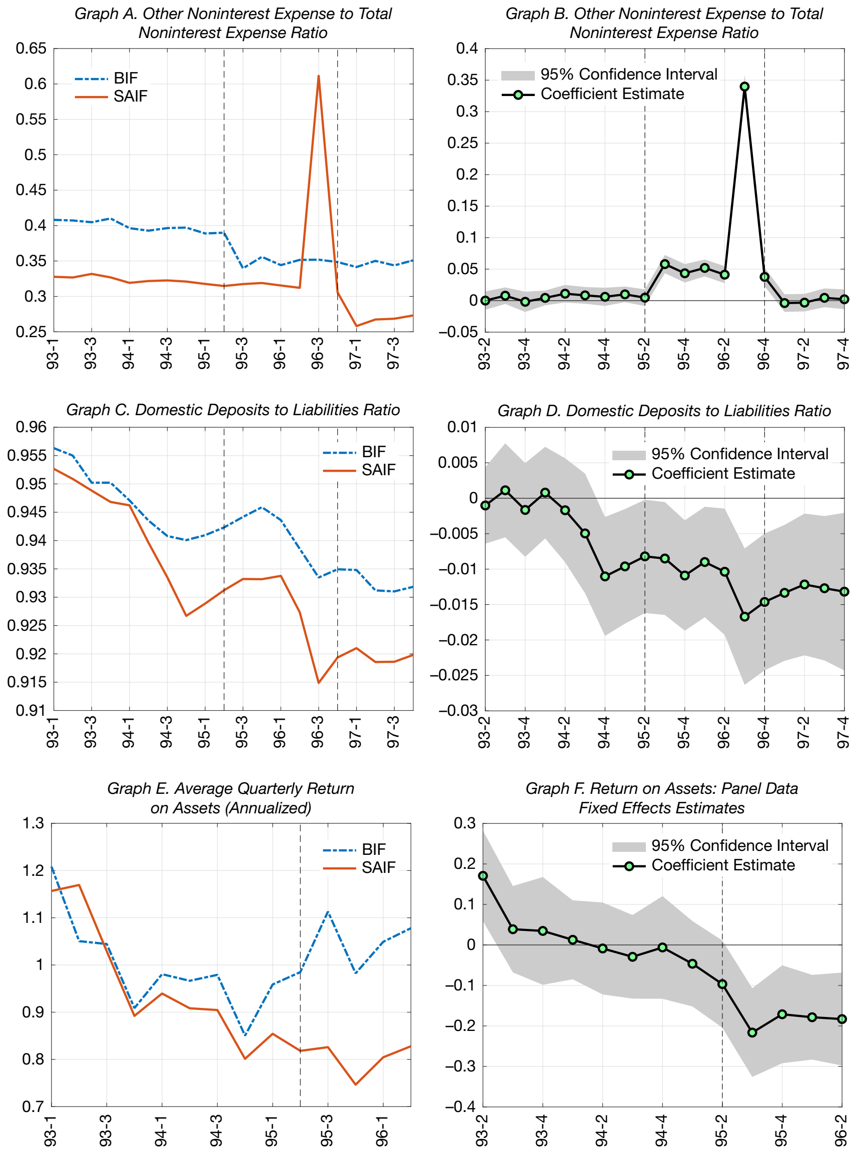
As a "first stage," I compare the cost structures of BIF and SAIF members. Evidence of the disparity in measures of cost would suggest that the disparity did in fact differentially affect institutions and that SAIF members were not able (or not willing) to shift business strategies beforehand in ways that would offset the disparity's direct effects. The dependent variable for this analysis is the ratio of an institution's "other noninterest expense" to "total noninterest expense." Noninterest expense includes items like employee's salaries, benefits, and expenses on premises and fixed assets. "Other noninterest expense" includes deposit insurance assessments as well as other items that do not have their own reportable category.[16] Figure 5 (Graph B) shows the β_k estimates from specification (3). It shows three abrupt changes exactly coinciding with the events of the disparity. In the third quarter of 1995, the dependent variable suddenly becomes relatively higher for SAIF members. It then has a large 1-quarter increase for SAIF members (relative to BIF) in the third quarter of 1996. Finally, after the end of the disparity, there is no statistically discernible difference between SAIF and BIF members in the dependent variable. Graph A confirms that all three events are driven by the directional shifts in the dependent variable that would be expected to happen as a result of the disparity in premiums. In the third quarter of 1995, there is a sharp decline in the dependent variable for BIF institutions, with the dependent variable for SAIF institutions remaining fairly constant, coinciding with the reduction in BIF members' deposit insurance premiums. In the third quarter of 1996, there is a one-time large increase in the dependent variable for SAIF institutions, coinciding with the one-time special assessment levied on SAIF members to recapitalize the SAIF. Finally, in the first quarter of 1997 there is a sharp decline of the dependent variable for SAIF institutions, with the dependent variable for BIF institutions remaining fairly constant, coinciding with the reduction in SAIF members' premiums to match BIF members' premiums and the end of the disparity.

[16]Examples of other items reportable as "other noninterest expense" are income or loss associated with minority interest ownership of subsidiaries; some fees levied by brokers who supply brokered deposits; payments to nonsalaried employees such as attorneys and accountants; expenses related to employee training; gifts or bonuses given to depositors for opening new accounts; fees and travel expenses paid to directors for attendance at board of directors meetings; legal fees and other costs incurred in connection with foreclosures; and amortization expense of intangible assets. This list is not exhaustive and is based on Call Report preparation instructions from Sept. 1997.

FIGURE 5

Effect of the Disparity on Cost, Funding, and Profitability

The vertical dashed lines in all graphs in Figure 5 denote the quarter immediately preceding the disparity and the final quarter of the disparity in deposit insurance premiums between the BIF and SAIF funds. Graphs B, D, and F plot the time-dependent coefficient from specification (3). The dependent variable is listed in the title of each graph. Institution and quarter-fixed effects are included, as well as the standard set of controls (see Section V.A). All variables except the composite CAMELS ratings and the log of age are winsorized at the 1% and 99% levels within each quarter. Standard errors are clustered at the institution and state-quarter levels. Graphs A, C, and E plot the mean of the corresponding dependent variable for BIF and SAIF institutions.



I consider next the domestic deposits to liabilities ratio. Using specification (2), the first two columns of Table 4 show that the average domestic deposits to liabilities ratio for SAIF institutions was about 0.7% to 0.8% lower relative to BIF institutions starting in the third quarter of 1995, compared with the same

TABLE 4

Effect of the Disparity on Deposits to Liabilities Ratio

Estimates in Table 4 are from specification (2). The dependent variable is the ratio of domestic deposits to total liabilities. Columns 1 and 2 include the full sample from the start of 1993 through the end of 1997. Columns 3 and 4 include only the years 1993 and 1997 to provide more accurate estimates of the effect of the disparity by excluding anticipation effects and by using only 1993 propensity scores to trim the sample. All variables except the composite CAMELS ratings and the log of age are winsorized at the 1% and 99% levels within each quarter. Robust standard errors clustered at the institution and state-quarter levels in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4
SAIF × post-1995:Q3	−0.007**	−0.008***	−0.010**	−0.012***
	(0.003)	(0.003)	(0.004)	(0.004)
log(Assets)		−0.037***		−0.030***
		(0.009)		(0.011)
1–4 family residential loans/assets		−0.058*		−0.082**
		(0.029)		(0.038)
Commercial and industrial loans/assets		0.058		0.050
		(0.074)		(0.085)
Credit card loans/assets		0.065		−0.416
		(0.378)		(0.376)
Securities/assets		−0.083***		−0.094**
		(0.028)		(0.038)
Cash/assets		0.047		−0.018
		(0.033)		(0.049)
Nonperforming assets/assets		0.074		0.157
		(0.103)		(0.138)
Total risk-based capital ratio		0.002		0.006
		(0.004)		(0.005)
Tier 1 risk-based capital ratio		−0.001		−0.006
		(0.004)		(0.005)
Leverage ratio		0.003*		0.002
		(0.002)		(0.002)
Composite CAMELS rating		0.002		0.001
		(0.002)		(0.003)
log(Age)		0.016		0.024
		(0.018)		(0.017)
No. of obs.	22,080	22,080	8,216	8,216
R^2	0.860	0.868	0.839	0.847
Bank FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
R^2 (adj., within)	0.00206	0.0556	0.00420	0.0497

difference between the two types of institutions before the disparity. For three reasons, however, these estimates are likely to be a lower bound on the effect of the disparity. First, the time period before the disparity can include anticipation effects, which are likely to influence the estimates of the effect of the disparity in the direction of zero. Second, the time period from the third quarter of 1995 until the end of 1997 includes periods after the disparity ended, which would also typically influence estimates of the effects of the disparity in the direction of zero if institutions reverted to "normal" behavior after the disparity. Finally, propensity score trimming may lead to the inclusion of BIF institutions whose predisparity trend in the deposits to liabilities ratio is similar (declining) to that of SAIF institutions, even if such trend in SAIF institutions was in anticipation of the disparity. If the declining trend continues postdisparity, the estimates in specification (2) may be further attenuated. To circumvent most of these issues, columns 3 and 4 of Table 4 restrict the sample to include only years 1993 and 1997, and with the propensity-score trimming redone based on only 1993 propensity

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scores. These estimates suggest that the effect of the disparity on the reduction in SAIF institutions' deposits to liabilities ratio relative to BIF institutions is closer to 1.2%.[17] Further confirming these estimates with specification (3), Figure 5 shows the variation over time in the effect of the disparity on institutions' choices of funding sources. Graph D of Figure 5 displays the β_k coefficient estimates from specification (3), and shows a clear reduction in thrifts' relative dependence on deposits before and during the disparity. This trend is reversed immediately following the end of the disparity, where β_k remains stable or slightly increasing until the end of 1997. Graph C confirms that the estimates are indeed driven by a reduction in thrifts' reliance on deposits.

The shift away from deposits was made up almost entirely by increased reliance on Federal Home Loan Bank (FHLB) advances for funding (see Figure A1 in the Supplementary Material). This is despite no change in thrifts' absolute cost of funding from either deposits or FHLB advances. However, it was unclear how the disparity would be resolved or how long the disparity would last. Thus, one can assume it likely that thrifts viewed FHLB advances as a more advantageous source of funding that did not put them at a long-term competitive disadvantage with BIF institutions.

B. The Disparity and Profitability: Implications for Risk Taking

As described in Section II, the effectiveness of risk-based pricing ultimately hinges on the residual effect of premiums on profitability, after accounting for all the ways institutions may attempt to dampen the effect of higher premiums. The BIF-SAIF disparity forced institutions with identical risk levels to face different premiums, allowing for credible estimates of how premiums affect the profitability of institutions that are optimizing their behavior in response. Besides using panel data specifications (2) and (3), in this subsection, I also use synthetic control methods based on an Interactive Fixed Effects (IFE) model (see Bai (2009), Gobillon and Magnac (2016), Xu (2017), and Athey, Bayati, Doudchenko, Imbens, and Khosravi (2018)).[18] The model is as follows:

$$(4) \qquad y_{it} = \beta_{it}\left(\mathbf{1}_{i \in \text{SAIF}} \times \mathbf{1}_{t \geq 1995\text{Q3}}\right) + \gamma \mathbf{x}_{it} + \lambda_i' \mathbf{f}_t + c_i + d_t + \varepsilon_{it},$$

where y_{it} is the outcome of interest for institution i in quarter t; β_{it} is a heterogeneous treatment effect for institution i in quarter t showing the effect on the outcome

[17]Table A1 in the Supplementary Material shows that the effect on total domestic deposits is driven primarily by insured deposits.

[18]The IFE synthetic control model as formulated by Xu (2017), which I follow in this subsection, has several advantages over both panel data fixed effects models and the early formulations of synthetic control models. Unlike traditional panel data fixed effects models, the IFE synthetic control model relaxes the parallel trends assumption by modeling time dynamics in a data-driven way; in addition, it addresses treatment heterogeneity by providing an estimated treatment effect for each treated unit. Also, this approach moves beyond the initial applications of synthetic control methods popularized by Abadie and Gardeazabal (2003) and Abadie, Diamond, and Hainmueller (2010). It nests traditional fixed effects models and therefore allows each treated unit to have a unit-specific intercept and includes a time-fixed effect; such fixed effects are not typically included in the more traditional synthetic control models (Doudchenko and Imbens (2016)). Moreover, it naturally allows for multiple treated units and for intuitive inference based on a valid bootstrap procedure for standard errors.

variable of being a SAIF member during the disparity; $\mathbf{x}_{it}$ is a vector of covariates containing the same controls used in Section V.A; $\mathbf{f}_t = [f_{1t}, \ldots, f_{rt}]'$ is an $(r \times 1)$ vector of unobserved common time factors, and r is the number of factors; $\lambda_i = [\lambda_{i1}, \ldots, \lambda_{ir}]'$ is an $(r \times 1)$ vector of unknown factor loadings; c_i and d_t are unit- and time-fixed effects; and ε_{it} is an idiosyncratic error term.[19]

To estimate the relationship between insurance premiums and profitability, specifications (2)–(4) are used with ROA as the dependent variable. The sample for these estimates is truncated to include quarters from the first quarter of 1993 through the second quarter of 1996; this isolates the effect of the premiums from distortions of profitability caused by the special assessment that SAIF institutions had to pay in the third quarter of 1996.

Table 5 reports results from specifications (2) and (4). The results show that over the course of its first 4 quarters, the disparity introduced a wedge in ROA between SAIF and BIF institutions of between about 16.5 basis points (preferred specification) to 20.9 basis points, with SAIF institutions' ROA being relatively lower. This wedge is economically significant: it is about 20.1% of ROA of SAIF institutions in the quarter immediately preceding the start of the disparity. Figure 5 shows the dynamic estimates over time of the effect on ROA (specification (3)) of being a SAIF member (Figure A2 in the Supplementary Material shows the analogous plot for specification (4)). There is a clear relative decline in SAIF members' ROA in every quarter starting with the first quarter of the disparity. The synthetic control method generates an estimate for each SAIF member, allowing for analysis of the heterogeneity in the estimated effects. Section II of the Supplementary Material discusses the implications of the heterogeneity and shows that most of the negative effect of the disparity on profitability was concentrated among the small and medium-sized banks.

The results thus far establish that differentials in premiums cannot be easily evaded by the majority of banks, but the question still remains whether the incentives are sufficiently large to induce banks to change their behavior (see inequality (1) in Section II). Answering this question requires estimates of the relationship between risk-taking and profitability. Such estimates cannot be obtained simply from a cross-section of all banks, because premiums are set to be higher for riskier banks, potentially resulting in endogenous selection. I use variation in risk-taking for banks that face the same premium; specifically, I use all banks in the trimmed sample that pay a premium of 23 basis points from 1993:Q1 to 1995:Q2 (i.e., I drop bank-quarter observations in which the bank faces any premium higher than 23 basis points).[20] I use the following specification:

[19]Note that the term $\lambda_i' \mathbf{f}_t$ is very general and allows the model in specification (4) to nest more-standard models like those with additive unit- and time-fixed effects (even if the terms c_i and d_t were excluded). As noted by Xu (2017), this model also nests specifications with unit-specific linear or quadratic time trends (e.g., with $f_{1t} = t$ or $f_{1t} = t^2$), autoregressive components, and other possibilities. The number of factors is determined by cross-validation.

[20]The group of banks kept contains the vast majority of banks in the sample, but it excludes banks that pay higher premiums. Using higher-premium banks in the estimation has the drawbacks that for virtually all groups facing a fixed premium level above 23 bp (i.e., 26, 29, or 30 bp), there is a direct relationship between CAMELS ratings and capital ratios (see Panel A of Table 1), making the identification of the effects of these two factors on profitability difficult to separate; in addition, in some of these groups there are very few banks, resulting in minimal usable variation (see Table 2).

TABLE 5

Impact of the Disparity on Profitability

Estimates in columns 1 and 2 of Table 5 are from the panel data fixed-effects specification (2); estimates in columns 3 and 4 are from the synthetic control specification (4). The dependent variable is the quarterly annualized return on assets. The sample includes all quarters starting in the first quarter of 1993 through the second quarter of 1996. All variables except the composite CAMELS rating and the log of age are winsorized at the 1% and 99% levels within each quarter. Standard errors (in parentheses) in columns 1 and 2 are clustered at the institution and state-quarter levels; standard errors in columns 3 and 4 are bootstrap standard errors. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4
SAIF × post-1995:Q3	−0.209***	−0.194***	−0.169***	−0.165***
	(0.026)	(0.026)	(0.031)	(0.027)
log(Assets)		0.257**		0.120*
		(0.109)		(0.101)
1–4 family residential loans/assets		0.669**		0.609**
		(0.311)		(0.296)
Commercial and industrial loans/assets		0.640		0.91
		(0.652)		(0.864)
Credit card loans/assets		−2.472		−4.703*
		(3.103)		(3.105)
Securities/assets		−0.170		−0.286
		(0.259)		(0.367)
Cash/assets		−0.129		−0.062
		(0.355)		(0.423)
Nonperforming assets/assets		−11.261***		−8.292***
		(1.656)		(2.287)
Total risk-based capital ratio		0.005		−0.037
		(0.027)		(0.052)
Tier 1 risk-based capital ratio		−0.001		0.055
		(0.027)		(0.050)
Leverage ratio		0.077***		0.068***
		(0.017)		(0.016)
Composite CAMELS rating		−0.031		−0.043
		(0.021)		(0.028)
log(Age)		0.548***		0.956***
		(0.202)		(0.264)
No. of obs.	15,456	15,456	15,456	15,456
R^2	0.483	0.502	0.559	0.57
Bank FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
R^2 (adj., within)	0.00780	0.0427		

$$\text{ROA}_{it} = \alpha + \beta \text{RISK}_{it} + \gamma \mathbf{x}_{it} + c_i + d_t + \varepsilon_{it}, \quad (5)$$

where ROA_{it} is the return on assets for institution i in quarter t; RISK_{it} is the set of risk-taking covariates from the set of controls in Section V.A, where each covariate is introduced in the regression separately to avoid colinearity; $\mathbf{x}_{it}$ contains other controls as listed in Section V.A; and c_i and d_t are bank and quarter fixed effects.

Table 6 shows that, in the aggregate, there is no evidence that increased risk-taking is associated with higher profitability, keeping constant all else, including deposit insurance premiums. In fact, there is some evidence that higher capital ratios, particularly the leverage ratio, are associated with higher returns. These estimates, however, do not necessarily rule out that some banks may find it profitable to take on excessive risk; the estimates in Table 6 are overall averages, and there may be significant heterogeneity among banks. Nevertheless, Table 6 shows that, on average, the incentives for banks to take on excessive risk (in terms of lower

TABLE 6

Risk-Taking and Profitability

Table 6 shows estimates from specification (5), in which the dependent variable is quarterly annualized return on assets. The sample of this regression excludes all quarters after the second quarter of 1995, and excludes bank-quarter observations where the bank's deposit insurance premium was higher than 23 basis points. All variables except the composite CAMELS rating and the log of age are winsorized at the 1% and 99% levels within each quarter. Robust standard errors clustered at the institution and state-quarter levels in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4
log(Assets)	0.296**	0.293**	0.430***	0.200*
	(0.124)	(0.124)	(0.144)	(0.119)
1–4 family residential loans/assets	0.838**	0.835**	0.804**	0.833**
	(0.340)	(0.341)	(0.356)	(0.339)
Commercial and industrial loans/assets	0.605	0.588	0.483	0.226
	(0.854)	(0.851)	(0.777)	(0.844)
Credit card loans/assets	0.733	0.791	−0.052	0.599
	(3.310)	(3.318)	(2.991)	(3.522)
Securities/assets	0.248	0.249	0.486*	0.475*
	(0.330)	(0.332)	(0.290)	(0.285)
Cash/assets	−0.312	−0.313	0.059	−0.124
	(0.434)	(0.436)	(0.392)	(0.417)
Nonperforming assets/assets	−6.664***	−6.621***	−7.034***	−6.641***
	(2.063)	(2.070)	(2.088)	(2.085)
log(Age)	0.410	0.405	0.445	0.397
	(0.370)	(0.370)	(0.374)	(0.380)
Total risk-based capital ratio	0.016*			
	(0.009)			
Tier 1 risk-based capital ratio		0.016*		
		(0.009)		
Leverage ratio			0.089***	
			(0.024)	
Composite CAMELS rating = 2				0.017
				(0.024)
No. of obs.	9,004	9,004	9,004	9,004
R^2	0.541	0.541	0.546	0.539
Bank FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
R^2 (adj., within)	0.0125	0.0123	0.0229	0.00855

capital ratios or worse supervisory ratings) in an attempt to chase higher returns are weak.[21]

Combining the results from Tables 5 and 6, the evidence suggests that it is not worthwhile for banks to pay higher deposit insurance premiums in order to chase extra returns through excessive risk-taking. Relatively minor differentials in risk-based premiums may be sufficient to incentivize banks to avoid excessive risk-taking. This is consistent with the fact that virtually all banks chose to remain in the group paying the lowest deposit insurance premiums (see Table 2).[22] The next

[21]Tables A2 and A3 in the Supplementary Material repeat the analysis in Table 6 for BIF and SAIF members separately. The results are generally consistent with those in Table 6, but show a weakly-significant association between being a 2-rated institution (as opposed to 1-rated) and profitability for SAIF members. However, the magnitude of the association is small, it is an order of magnitude lower than the negative effect of increased premiums on profitability (see Table 5).

[22]There were, however, other benefits to being in the group paying the lowest deposit insurance premiums – benefits accruing from rules such as Prompt Corrective Action (Aggarwal and Jacques (2001)).

subsection presents direct evidence that pricing incentives affect banks' risk-taking behavior.

C. Direct Evidence of Moral Hazard Mitigation Through Pricing

During the disparity, BIF members faced a steeper risk-based pricing schedule (Figure 2); that is, they had stronger pricing incentives to become (and remain) safer. This variation in steepness allows for direct estimates of whether institutions respond to insurance pricing incentives through the risk-mitigation channel or if they merely respond through other means.

I first consider the sample of all "risky" institutions – those paying higher-than-minimum premiums. In every pair of quarters $(t-1, t)$, the sample contains all banks that in quarter $t-1$ were *not* in the lowest-premium category and that satisfy other basic criteria.[23] These banks had room for improvement (reduction) in their premiums by improving either their capital ratios or their CAMELS ratings or both. The sample contains both BIF and SAIF institutions, and some of the institutions in this sample were not in the trimmed sample described in Section IV. I use the following logistic regression:

$$(6) \qquad P(\text{IMPROVE}_{i,t-1\to t}=1) = G\left(\alpha_t + \beta_t \mathbf{1}_{i\in \text{BIF}}^{t-1} + \gamma_t \mathbf{x}_{i,t-1}\right),$$

where $\text{IMPROVE}_{i,t-1\to t}$ is a binary variable that takes a value of 1 if institution i improved its premium category between quarters $t-1$ and t.[24] The function $G(z) \equiv (e^z)/(1+e^z)$ is the logistic function, $\mathbf{1}_{i\in \text{BIF}}^{t-1}$ is an indicator for whether the institution was a BIF member in quarter $t-1$, and $\mathbf{x}_{i,t-1}$ is a vector of controls containing the same controls as in Section V.A as well as the number of quarters since the institution has been examined. The coefficient of interest in specification (6) is β_t; it reflects the effect of being a BIF member on the likelihood of improving premium categories between quarters $t-1$ and t. Again, because the disparity introduced stronger pricing incentives for BIF institutions to become safer, if institutions actually responded to those incentives then β_t should be positive and significant around the time of the disparity, and β_t should be statistically indistinguishable from 0 otherwise.

Graph A of Figure 6 shows evidence that institutions were indeed responding to pricing incentives in their risk-taking decisions. Institutions that faced stronger incentives to become safer (BIF members) were more likely to do so, and the same institutions were not any more likely to become safer in most periods when the pricing incentives were identical for both BIF and SAIF members. There appears to

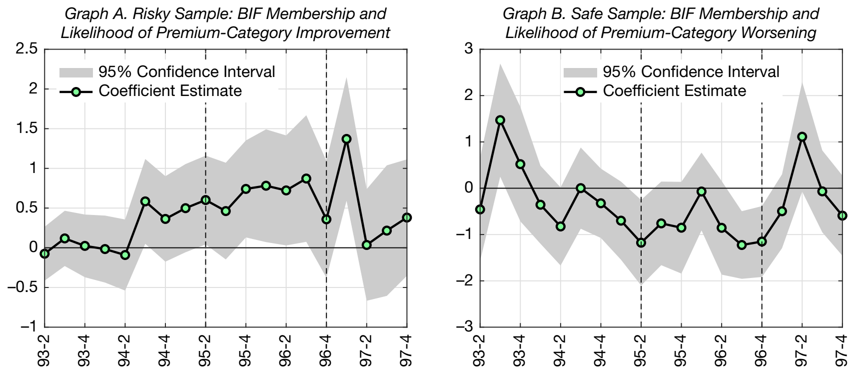
[23] To be included in the sample, institutions must have satisfied the same basic restrictions applied in Section IV for quarters $t-1$ and t (excluding the propensity score trimming). For instance, a change in an institution's ownership structure between the first and second quarters of 1997 would cause that institution to be excluded in the regression between those two quarters, but would not cause it to be excluded from the quarter-on-quarter regression between the first and second quarters of 1994.

[24] Because CAMELS ratings can change only when an exam happens, a bank may not get a chance to improve its CAMELS ratings from one quarter to the next (but it can still change its capital ratios). The infrequency of exams reduces the overall likelihood of improvement for all banks, which is not problematic for this analysis because the main focus is on the difference between BIF and SAIF institutions in likelihood of improvement.

FIGURE 6

Pricing Incentives and Risk-Taking

Graph A of Figure 6 shows the effect of being a BIF member on the likelihood that a risky institution moves to a better premium category. Graph B shows the effect of being a BIF member on the likelihood that a safe institution moves to a worse premium category. The estimates are for the coefficient on a BIF membership indicator from specification (6) for Graph A and (7) for Graph B. The dependent variable in Graph A (Graph B) is an indicator with value 1 if an institution improves (worsens) its premium category between periods $t-1$ to t, and 0 otherwise. Control variables include the standard set of controls (see Section V.A), as well as the number of quarters since the institution has been examined.



be some anticipation effect, which is natural considering that banks may get only one chance per year (on being examined), or even less often, to improve their CAMELS ratings; thus, anticipating the change in pricing, institutions would have an incentive to move to the lower-premium category before the actual change in pricing. Apart from the quarters of (and immediately preceding) the disparity, there is not much evidence for a statistically significant difference between BIF and SAIF banks in the likelihood of improving premium categories.

The new premium schedules also introduced stronger pricing incentives for the sample of all safe banks to avoid becoming classified in a higher-risk category, and I test this next. In every pair of quarters $(t-1, t)$, the sample for this analysis contains all banks that in quarter $t-1$ were in the lowest-premium category and satisfied other basic criteria as mentioned above. Again, the sample in each quarter-pair includes both BIF and SAIF institutions. I use the following logit regression:

$$(7) \qquad \mathrm{P}\left(\mathrm{WORSEN}_{i,t-1\to t}=1\right)=G\left(\alpha_t+\beta_t \mathbf{1}_{i\in\mathrm{BIF}}^{t-1}+\gamma_t \mathbf{x}_{i,t-1}\right),$$

where $\mathrm{WORSEN}_{i,t-1\to t}$ is an indicator variable that takes a value of 1 if institution i worsened its premium category between quarters $t-1$ and t by having worse capital ratios or CAMELS ratings or both; the rest of the components of the regression are as in specification (6). If the pricing incentives provided by the new premium schedule actually incentivized safe banks to remain in the lowest-premium category, the β_t coefficient on BIF membership status should be negative and significantly different from zero around the time of the disparity.

Graph B of Figure 6 shows that the *only* quarters in which the β_t coefficient from specification (7) becomes negative and significantly different from zero are either during the disparity or immediately before. BIF institutions in the lowest-premium category were less likely to migrate to a higher-premium bucket when

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their incentives to remain in the lowest premium category were stronger than those for SAIF institutions. Again, there is some evidence for an anticipation effect.

Overall, the results in this subsection provide direct evidence that risk-dependent deposit insurance pricing influences banks' risk-taking. Risky banks that could save more in premiums by becoming safer were more likely to become safer, and safe banks that would suffer larger increases in premiums from becoming riskier were more likely to remain safe. These results hold even with quarter-to-quarter changes that are more prone to temporary idiosyncratic movements in capital ratios and supervisory ratings. Again, the fact that the vast majority of institutions are concentrated in the category with the lowest premium is consistent with the evidence in this subsection that risk-dependent deposit insurance pricing is effective at reducing risk-taking.

D. Regulatory Arbitrage Through Migrating Deposits

This subsection documents an intricate regulatory arbitrage strategy using deposit sales by which some institutions moved deposits from the SAIF to the BIF, despite several regulations in place to prevent deposit migration through deposit sales or other means. A moratorium on conversion transactions between the two funds was imposed by FIRREA in 1989; thus, SAIF institutions could not simply change their fund membership from the SAIF to the BIF or move their deposits from the SAIF to the BIF. In addition, even in cases of mergers or acquisitions or deposit sales, SAIF-assessable deposits were intended to continue being classified as such and the acquiring bank would pay their assessments to the SAIF, even if the bank was a member of the BIF. These banks were called "Oakar" banks. Finally, even if a thrift in the SAIF changed its charter from a savings association to a bank, they remained SAIF members with SAIF-assessable deposits; such banks were called "Sasser" banks (Helfer (1995)). Nevertheless, the disparity created strong incentives to engage in regulatory arbitrage through deposit migration.[25]

The form of arbitrage I document exploited an asymmetry in the calculation of the amount of SAIF-assessable deposits between the buyer and the seller of deposits. A bank's sum of deposits that counted as "SAIF deposits" was called the Adjusted Attributable Deposit Amount (AADA). The AADA of both the buyer and seller in a deposit sale transaction changed as a result of the sale, but the calculation to adjust (down) the Oakar seller's AADA was different from the calculation to adjust (up) the buyer's AADA (see Section III of the Supplementary Material for details). This asymmetry allowed deposit sale transactions to migrate deposits from

[25]The following news article quotation illustrates the arbitrage incentives created by the disparity: "TCF and Great Western are two of seven companies that have applied for bank charters to avoid the costly deposit insurance premiums levied by the Savings Association Insurance Fund. The companies plan to open bank branches at their thrift locations and then use higher rates to tempt depositors to shift their funds… William A. Cooper, chairman and chief executive of $7.5 billion TCF, said that the 23 cent premium disparity between the Bank Insurance Fund and the thrift fund forced his institution to act. 'We pay $10 million to $12 million a year in premiums on $5 billion of deposits, while Bank of America, which has around $200 billion in deposits, only pays $2,000,' Mr. Cooper said. 'In the absence of congressional action, we need to take the necessary steps to protect our competitive position'" (Senerpont Domis (1996)).

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the SAIF to the BIF and save a buyer–seller pair millions of dollars *annually* in the form of reduced assessments.

The migration of deposits can be empirically observed (though imperfectly so) in instances where Oakar institutions sold deposits.[26] For instance, Home Savings of America (HSA), an Oakar BIF member, sold more than $8 billion in deposits to Greenpoint Financial (GF) in the middle of 1995 (Hansell (1995)). Before the sale, HSA had $43.5B in deposits (as of June 30, 1995). After the sale, its total deposits as of year-end 1995 were $34.9B. According to its parent's 10-K filings, HSA had SAIF-insured deposits of about $38B at the start of 1995, and its year-end SAIF-insured deposits were about $31B, a decline of about $7B; GF, however, had its SAIF-insured deposits increase by only about $3B following the transaction.[27]

One-time sales of deposits reduced Oakar institutions' AADA permanently and thus resulted in annual savings on assessments paid. A one-time reduction in the seller's AADA by $7B, for instance, resulted in annual savings of approximately $16M if the seller paid the lowest possible risk-based premiums; savings would be even higher if the seller paid higher premiums. On its 1996 10-K filing, H. F. Ahmanson, the parent of Home Savings of America, reported a reduction in its SAIF assessments to $55.1 million in 1996 from $79.9 million in 1995. This is a reduction of 31%, or $24.8 million, evidently driven in large part by its mid-1995 sale of deposits.

To analyze the selling of deposits by Oakar BIF members, I use the following logit model specification estimated separately for each quarter t on the sample of BIF members:

$$\text{(8)} \qquad \mathrm{P}(\mathrm{SALE}_{it} = 1) = G\left(\alpha_t + \beta_t \mathbf{1}^t_{i \in \mathrm{OAKAR}} + \gamma \mathbf{x}_{it}\right),$$

where SALE_{it} is a proxy for deposit sales by institution i in quarter t; it is equal to 1 if institution i's deposits and number of offices decreased from quarter-end $t-1$ to quarter-end t. The indicator $\mathbf{1}^t_{i \in \mathrm{OAKAR}}$ is the Oakar status of institution i as of start of quarter t. Controls in $\mathbf{x}_{it}$ are start-of-quarter t values and contain the same set of controls as in Section V.A; $G(z) \equiv e^z/(1+e^z)$ is the logistic function. The sample includes BIF Oakar members that satisfy the same basic restrictions applied in Section IV for quarters $t-1$ and t (excluding the propensity score trimming).

If Oakar banks sold deposits to exploit the disparity, the coefficient β_t should rise around the time of, and during, the disparity. (Oakar banks may have also disproportionately sold deposits beforehand in anticipation of the disparity.) Figure 7 shows the estimates of β_t from specification (8) for two different definitions of the SALE_{it} dependent variable. In Graph A, the dependent variable is

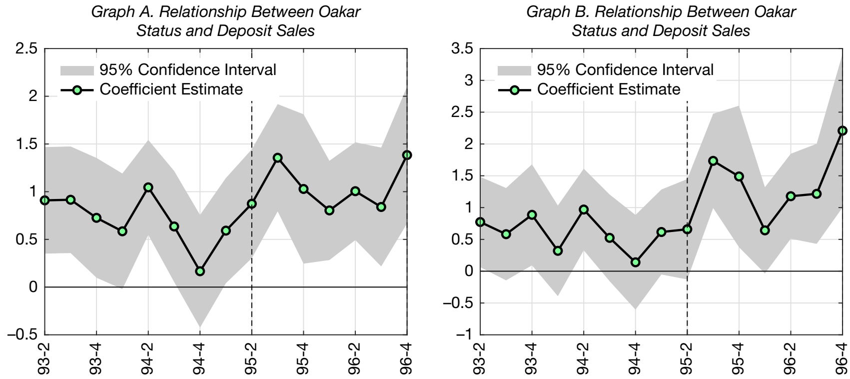
[26]Empirical observations can be made from "snapshots" of total deposits reported on banks' quarterly Call Reports, but those do not perfectly isolate the effects of deposit sales because banks could engage in other operations between reporting periods. In addition, the AADA was adjusted only semiannually.

[27]Figures for Home Savings SAIF-insured deposits are obtained from the 1994 and 1995 10-K filings by its parent, H. F. Ahmanson & Company: the 1994 value is an estimate based on its year-end 1994 total deposits and its percentage of deposits that are SAIF-insured (91%) reported on the 1994 10-K, and the 1995 value is reported directly in its 1995 10-K filing. Greenpoint's SAIF-insured deposits figure is obtained from publicly available Call Report data.

FIGURE 7

Effect of Being Oakar on Deposit Sales: Logit Estimates

Figure 7 shows the β_t estimates on the Oakar status indicator from logit specification (8). The dependent variable is a deposit sale binary indicator that takes a value of 1 if a bank had a reduction in both domestic deposits and total number of offices during quarter t. In Graph A, all reductions of domestic deposits are counted, and in Graph B only reductions by more than $10 million are counted. Graph B excludes banks with less than $100 million in assets as of quarter-end $t-1$. The vertical dashed line indicates the quarter immediately preceding the disparity. The standard set of controls is included (see Section V.A).



defined as above, and in Graph B, only reductions in deposits of $10 million or more are counted so as to exclude noise from normal quarterly fluctuations in institutions' deposits. Graph B also excludes institutions that had less than $100 million in assets as of quarter-end $t-1$. Graph A shows a strong relationship between Oakar status and deposit sales during the disparity. Graph B shows that this relationship is even stronger when the deposit sales variable is refined to exclude some of the more-minor quarterly fluctuations in deposits. These results suggest that Oakar banks were likely incentivized by the disparity to sell deposits to exploit the asymmetry in deposit sale calculations.

The results in this subsection highlight the importance of accompanying risk-based pricing with regulatory controls. The subsection shows that institutions will attempt to exploit available arbitrage opportunities to have their deposit insurance assessments lowered. In addition, the results show that if institutions have access to another insurer (e.g., internationally, or domestically if the country has more than one insurance fund), deposit migration may occur from the insurer or fund with the higher premiums to one with lower premiums, a migration that may erode the assessment base of the higher-premium fund and weaken its deposit insurer.

E. Effects of the Disparity on Risk-Taking and Liquidity

There is evidence that SAIF members took on more risk relative to BIF members, potentially as a "search for yield" strategy, in response to facing relatively higher premiums during the disparity. Their increased risk-taking was not through a decline in asset quality or a change in loan mix.[28] Instead, it was through a strategy

[28]In results not shown, I find no strong evidence that the disparity caused a shift in SAIF members' loan mix toward high-risk loans (sum of commercial and industrial loans, nonfarm nonresidential loans secured by real estate, multi-family 5 or more loans, and construction and land development loans), or

TABLE 7

Effect of the Disparity on Loans-to-Deposits Ratio and Balance Sheet Growth Variables

Estimates in Table 7 are from specification (2). The dependent variable is listed above each column number; dependent variables in columns 2–5 are 1-year growth rates in percentage terms. The asset growth control variable is the 1-year asset growth rate in percentage. All variables except the composite CAMELS rating and the log of age are winsorized at the 1% and 99% levels within each quarter. Robust standard errors clustered at the institution and state-quarter levels in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

		1-Year Growth Rate			
	Loans and Leases to Deposits Ratio	Assets	Loans and Leases	Securities	Deposits
	1	2	3	4	5
SAIF × post-1995:Q3	1.107**	1.568***	1.539**	−8.909***	1.045***
	(0.437)	(0.485)	(0.685)	(2.259)	(0.294)
log(Assets)	1.629	15.063***	−2.982	−7.853	1.413
	(1.615)	(1.827)	(2.068)	(5.084)	(0.939)
1–4 family residential loans/assets	52.813***	−9.999*	34.894***	40.375**	−5.010*
	(5.909)	(5.337)	(5.386)	(17.162)	(2.881)
Commercial and industrial loans/assets	61.945***	−5.072	67.056***	−8.118	−2.753
	(12.851)	(15.049)	(15.569)	(56.355)	(8.410)
Credit card loans/assets	116.083**	−101.586	112.654	−65.613	8.938
	(45.484)	(62.607)	(99.974)	(265.056)	(65.373)
Securities/assets	−56.188***	7.143	−19.052***	235.773***	−5.326*
	(5.597)	(4.579)	(5.499)	(16.302)	(2.847)
Cash/assets	−68.609***	5.284	−64.012***	8.430	10.777***
	(6.278)	(5.420)	(8.470)	(22.355)	(3.517)
Nonperforming assets/assets	−29.959	−185.439***	−145.518***	406.598***	−4.519
	(19.609)	(25.787)	(23.136)	(85.498)	(12.201)
Total risk-based capital ratio	0.079	−1.805***	−0.332	5.890***	−0.200
	(0.515)	(0.684)	(0.720)	(1.980)	(0.299)
Tier 1 risk-based capital ratio	−0.326	1.485**	−0.017	−6.080***	0.140
	(0.549)	(0.698)	(0.733)	(1.974)	(0.303)
Leverage ratio	0.950***	−0.199	0.486	−0.191	−0.078
	(0.289)	(0.269)	(0.316)	(0.980)	(0.160)
Composite CAMELS rating	−0.427	−2.333***	0.061	3.446**	−0.152
	(0.268)	(0.306)	(0.417)	(1.443)	(0.207)
log(Age)	0.583	−15.255***	−13.489***	−1.080	1.477
	(2.822)	(3.550)	(3.935)	(11.905)	(2.079)
Assets, 1-year growth rate			0.719***	1.367***	0.834***
			(0.033)	(0.101)	(0.022)
No. of obs.	22,080	22,077	22,074	21,721	22,077
R^2	0.947	0.493	0.589	0.334	0.771
Bank FE	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes
R^2 (adj., within)	0.510	0.153	0.345	0.155	0.625

of becoming less liquid: shifting their asset mix toward longer-maturity (and higher-yielding) assets like loans and leases and away from cash and shorter-maturity, lower-yielding assets like securities.

Table 7 shows results from specification (2) for the ratio of loans and leases to deposits (as a measure of liquidity), and several growth variables. Column 1 shows that the ratio of loans and leases to deposits of SAIF members relatively increased as a result of the disparity, suggesting that they became less liquid. Although column 2 suggests that SAIF members' overall assets grew faster than BIF members because of the disparity, this result is primarily driven by a reduction

that the disparity caused large increases in SAIF members' 30 days past due loans, 90 days past due loans, nonaccrual loans, Other Real Estate (ORE) owned loans, or reserves for loan losses.

in asset growth rates of BIF members immediately preceding the disparity (see Figure A4 in the Supplementary Material). Controlling for asset growth, columns 3 and 4 show a significant relative increase in loan growth for SAIF members and a significant relative decrease in securities growth. Column 5 shows a relative increase in SAIF members' deposit growth rates, controlling for asset growth, but the effect is smaller in magnitude than the effect on loan growth shown in column 3. The results in columns 3–5 are similar if asset growth is omitted from the set of controls.

Figure 8 shows the dynamic effects of the disparity on liquidity-related variables. The figure shows that SAIF members became less liquid: relative to BIF members, SAIF members increased their loan growth, reduced their securities growth, and reduced their cash holdings. The figure also shows that most of these effects happened immediately preceding the disparity showing, again, evidence of anticipation effects.[29]

F. The Disparity and Interest Income, Interest Expense, and Net Interest Margin

Figure 9 shows that the search for yield behavior of SAIF institutions resulted in a relative increase in their interest income. Interest income of SAIF members grew faster than that of BIF members and the timing of the change coincides with the timing of the disparity. Figure 9 also shows that as a ratio to earning assets, interest income of SAIF members remained stable or slightly increasing during the disparity, reversing a declining trend before the disparity that was likely driven by the sharp pre-disparity increase in loan growth of SAIF members (Figure 8).

Figure A5 in the Supplementary Material shows that the disparity did not have a strong effect on the interest expense paid on deposits by SAIF institutions when compared with BIF institutions. This suggests that, to the extent the disparity resulted in competition on deposit rates between SAIF and BIF institutions, SAIF institutions continued to offer competitive rates to depositors.

Figure A6 in the Supplementary Material shows the effect on net interest margin (NIM). Relative to BIF members, SAIF members' NIM suffered as a result of the disparity, despite SAIF members' search for yield behavior. The timing of the decline in SAIF members' NIM coincides with the shift from liquid assets into illiquid ones (Figure 8). This suggests that the decline was caused by an increase in the denominator of the NIM metric (interest-earning assets), a fact confirmed by Figure 9 and Figure A5 in the Supplementary Material. Nevertheless, the search for yield behavior appears to have achieved its intended goals for SAIF members by increasing interest income at almost exactly the beginning of the disparity (Figure 9). Though the new, illiquid assets may not have been as profitable for SAIF institutions as their existing loan portfolio (as evidenced by the decline in NIM), the assets were profitable nonetheless, and improved SAIF members' ROA by increasing their interest income at precisely the time when the disparity caused their noninterest expense to suffer as compared to BIF members.

[29]Figure A4 in the Supplementary Material shows the dynamic effects from other dependent variables in Table 7.

FIGURE 8

Effect of the Disparity on Loan Growth, Securities Growth, and Cash-to-Assets Ratio

The vertical dashed lines in all graphs of Figure 8 denote the quarter immediately preceding the disparity and the final quarter of the disparity in deposit insurance premiums between the BIF and SAIF funds. Graphs B, D, and F plot the time-dependent coefficient from specification (3). The dependent variable is listed in the title of each graph. Institution and quarter-fixed effects are included, as well as the standard set of controls (see Section V.A; covariates for the cash-to-assets ratio regression exclude the cash-to-assets ratio from the standard set of controls). All variables except the composite CAMELS ratings and the log of age are winsorized at the 1% and 99% levels within each quarter. Standard errors are clustered at the institution and state-quarter levels. Graphs A, C, and E plot the mean of the corresponding dependent variable for BIF and SAIF institutions.

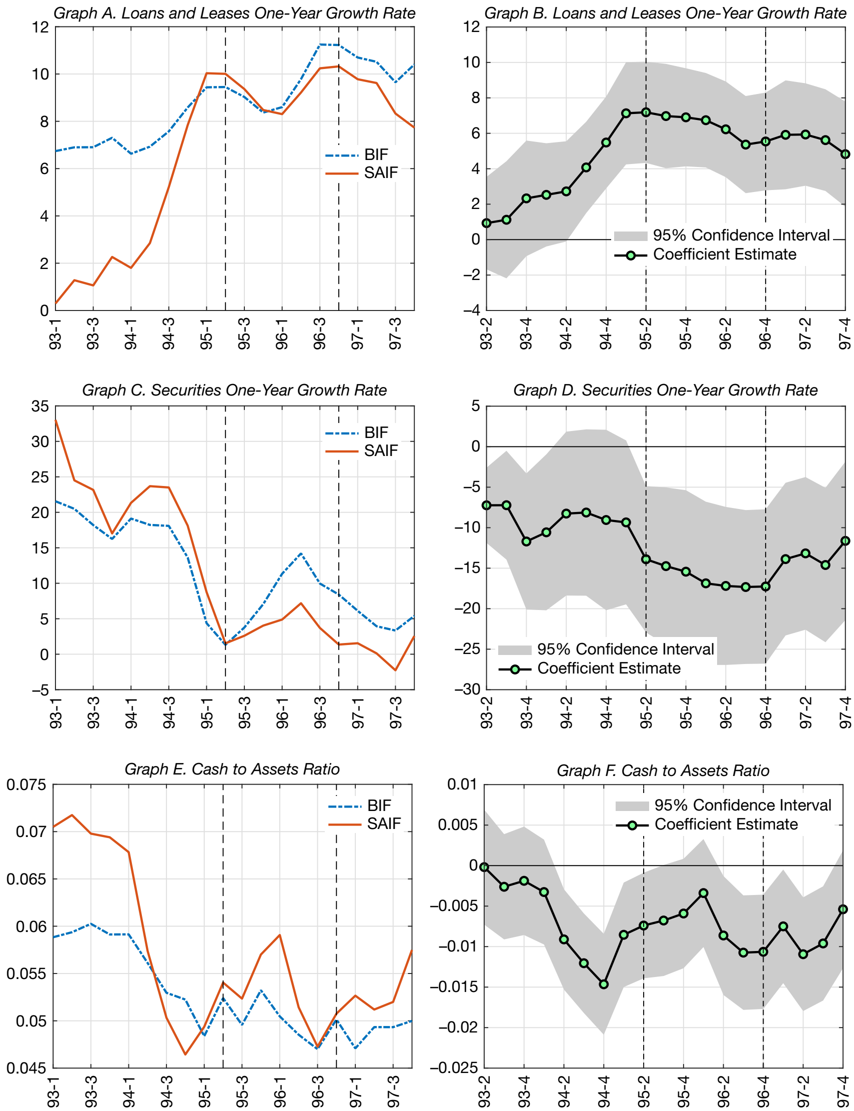
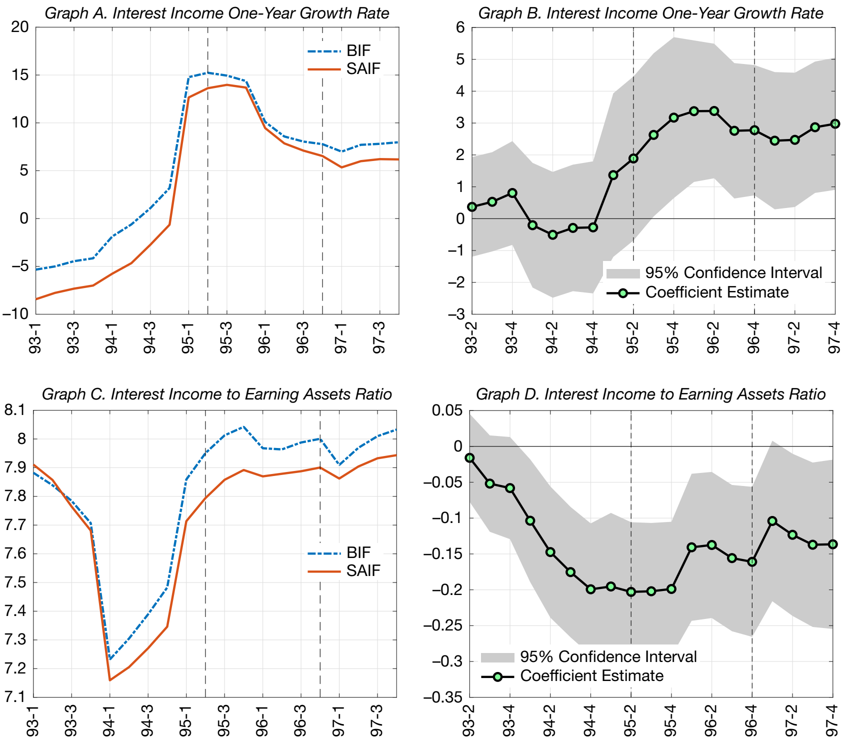


FIGURE 9

Effect of the Disparity on Interest Income

The vertical dashed lines in all graphs of Figure 9 denote the quarter immediately preceding the disparity and the final quarter of the disparity in deposit insurance premiums between the BIF and SAIF funds. Graphs B and D plot the time-dependent coefficient from specification (3). The dependent variable is listed in the title of each graph. Institution and quarter fixed effects are included, as well as the standard set of controls (see Section V.A). All variables except the composite CAMELS ratings and the log of age are winsorized at the 1% and 99% levels within each quarter. Standard errors are clustered at the institution and state-quarter levels. Graphs A and C plot the mean of the corresponding dependent variable for BIF and SAIF institutions.



VI. Robustness Tests

A. Expanded Sample

Some results in this article used a trimmed sample constructed from the universe of institutions through roughly two steps: i) Basic cleaning to remove institutions that may have experienced changes in behavior for unrelated reasons (e.g., young banks, banks undergoing a change in ownership structure), and ii) Propensity score trimming to ensure the institutions being compared are similar. To test the robustness of the article's findings, I eliminate the first step and repeat several of the article's main regressions both with and without the second step.

Table A4 in the Supplementary Material shows that the article's main findings are robust to eliminating the filtering criteria and preserving the propensity score trimming. Columns 1 and 2 show that the effect of the disparity on shifting funding sources away from deposits is roughly twice as strong with the expanded sample as the effects estimated in Table 4 in the article. Columns 3, 4, and 5 establish the robustness of the article's findings regarding the effects of the disparity on profitability and on the reduction in liquidity. Table A5 in the Supplementary Material shows that there is no evidence that increased risk-taking increases profitability (in fact, the results suggest the opposite), showing that the article's findings regarding the incentives created by the disparity are robust to changing the sample.

Tables A6 and A7 in the Supplementary Material repeat the above analysis on a sample that is expanded even further by eliminating both the basic filtering criteria and the propensity score trimming. Compared to Tables A4 and A5 in the Supplementary Material, the conclusions from Tables A6 and A7 in the Supplementary Material are uniformly stronger, showing, again, the robustness of this article's findings to changing the sample in the regressions.

B. Propensity Score Trimming Thresholds

Following Crump et al. (2009), the trimmed sample excludes institutions with propensity scores outside the range of [0.1,0.9]. In this subsection, I test the robustness of the article's main findings by considering three alternative samples: the first eliminates the propensity score trimming step, and the other two samples are constructed with different trimming thresholds.

First, eliminating propensity score trimming, Table A8 in the Supplementary Material repeats several of the article's main results and shows that the effects of the disparity on funding sources, profitability, and liquidity are all stronger with this alternative sample. In addition, Table A9 in the Supplementary Material shows that increased risk-taking is not associated with increased profitability; in fact, the evidence suggests the opposite, further strengthening the article's findings on the effectiveness of risk-based premiums.

The second alternative sample relaxes the trimming threshold and excludes institutions with propensity scores outside the range of [0.05,0.95]. Table A10 in the Supplementary Material shows that the estimates for the effects of the disparity on funding sources, profitability, and liquidity are similar or slightly stronger than those estimated in the article with the original trimmed sample. Table A11 in the Supplementary Material shows that the relationships between risk-taking and profitability for the alternative sample are consistent with those estimated in the main analysis in the article.

The third alternative sample uses stricter thresholds, of [0.15,0.85]. Analogously to the analysis with the samples above, Tables A12 and A13 in the Supplementary Material show that the article's findings are robust to the stricter propensity score trimming procedure.

VII. Conclusions and Further Research

This article provides novel evidence that risk-based pricing is effective at mitigating ex ante moral hazard, but also that it needs to be governed with robust laws and regulatory controls. Using quasi-experimental variation in premiums generated by the disparity between the BIF and SAIF in the mid-1990s, I show that differentials in premiums provide strong incentives for banks to curb ex ante moral hazard. In addition, I find that banks that faced stronger pricing incentives to avoid risk-taking did indeed respond to those incentives by taking on less risk. However, I also find that charging banks different premiums resulted in some distortions, such as the shifting of funding sources, reduced liquidity, and deposit migration through regulatory arbitrage.

To the extent that recent changes in laws and regulations reduced or eliminated some distortionary channels identified in this article, this article's results on the effectiveness and importance of insurance pricing become even more relevant. The Dodd–Frank Act of 2010, for instance, expanded the assessment base on which premiums are charged, eliminating the ability of banks to partially offset the impact of higher premiums by shifting their sources of funding. Accordingly, a bank facing higher deposit insurance premiums today has even stronger incentives to mitigate its risk-taking than a similar bank in the mid-1990s. Thus, this article's results on the effectiveness of insurance pricing at mitigating moral hazard may be seen as a lower bound, given the enhancements in laws and regulations since the mid-1990s.

Of interest for future research are event-type studies around the introduction of risk-based insurance pricing estimating its effect on risk-taking. For the U.S. banking system, such studies would be complicated by the fact that FDICIA required risk-based pricing at the same time that it made other changes (one of which was instituting Prompt Corrective Action), and the same thresholds that were used to determine deposit insurance premiums were also used to determine regulatory treatment for other, contemporaneous regulations, so that it would be hard to isolate the effects of risk-based pricing. International contexts may be a fruitful avenue to pursue in undertaking such studies, especially if risk-based pricing were introduced in a country that already had deposit insurance with flat-rate pricing.

This article presents evidence that minor differentials in premiums may be sufficient to mitigate moral hazard, but at what point are differentials in premiums too small to incentivize banks to draw away from excessive risk-taking? Which measures of health are least likely to be manipulated by banks, and what are the advantages and disadvantages of using particular measures of bank health in determining premiums? What are the implications of using different measures of bank size (or risk to the deposit insurance fund) as a base on which assessments are charged? Though beyond the scope of the current article, these issues are important and their study can inform the design of effective deposit insurance systems.

Finally, a subtle issue that this article's results point to as important is bank competition. SAIF-insured institutions clearly responded to the disparity (e.g., by shifting funding sources) despite the fact that the absolute level of their premiums was unchanged (perhaps there was, however, an expectation of future increases in premiums to recapitalize the SAIF). More generally, what role does bank competition play in mitigating moral hazard through risk-based pricing? Banks that are exposed to fiercer competition may be more responsive to risk-based pricing, but they may also generally be more likely to seek risky lending opportunities to improve their competitive position, or they may be more likely to attempt to evade higher premiums by other means (e.g., by taking on even more risk to compensate for having to pay higher premiums, engaging in arbitrage, and so forth). The relationship between bank competition and moral hazard, especially as it relates to risk-based pricing, is an important area for future research.

Supplementary Material

To view supplementary material for this article, please visit http://doi.org/10.1017/S0022109022001491.

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