ADVERSE SELECTION AND COMPETING DEPOSIT INSURANCE SYSTEMS IN PRE-DEPRESSION TEXAS

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Abstract: In 1910, Texas instituted a highly unique deposit insurance program for its state chartered banks consisting of two separate plans: the depositors guaranty fund, similar in operation to the deposit insurance schemes adopted in several other states; and the depositors bond security system, which required the procurement of a privately issued insurance policy. We hypothesize that the provision of a choice in funds led to risk-sorting among the banks, with the relatively conservative institutions opting for the comparatively rigorous bond security system. Employing a probit model with heteroskedasticity, the evidence we obtain from balance sheet data recorded at the time the banks were required to enlist in an insurance plan indicates that such was the case, as the alternative plan relying on privately issued insurance was widely unpopular except among relatively conservative and well-managed institutions.

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> ...for in nothing have we been at greater pains than to spare the field of our tillage from the sowing of unwholesome seed, the evil fruitage of which, if not deleteriously affecting the health of the system itself, would destroy or undermine the vigor of some of its component parts.
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> Texas Commissioner of Insurance and Banking, 1919[1]

I. Introduction

Prior to the establishment of federal deposit insurance in the early 1930s, a number of states experimented with various systems offering deposit guarantees in the early part of the century. These insurance programs were largely in response to the financial distress resulting from the panic of 1907. Texas was one of eight states to establish a formal system of deposit guarantees for state chartered banks during this time period. These insurance plans differed in their implementation and operations, but they all attempted to establish a safety fund through assessments on banks that would be available to meet their insurance obligations in the event of bank failures.[2] And these plans all suffered the same fate, in that they ultimately collapsed when bank failures began to escalate in the 1920s.

The Texas system, however, contained some features that set it apart from the other seven. Texas was the only state where insured depositors were ultimately paid in full. In addition, while participation in the deposit insurance system was mandatory for Texas state chartered banks, they were given a choice in the manner in which they could obtain a guaranty of

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[1] Commissioner of Insurance and Banking (1919, p. 6).

[2] The other states were Oklahoma, Kansas, Nebraska, Mississippi, South Dakota, North Dakota, and Washington. See American Bankers Association (1933). Also, see Calomiris (1989) for a description of these deposit insurance plans, plus an overview of even earlier attempts to provide for deposit insurance. In a related issue, White (1981) finds that unit banking states were more likely to implement deposit insurance.

deposits. One method of coverage available was similar to the plans implemented in the other states—banks contributed to a fund from which payments to insured depositors were made. In the other plan, banks were required to obtain a private insurance policy or indemnity to cover their depositors. Once banks decided on their choice of plan, they were forbidden to switch until very late in the operations of the Texas deposit insurance system.

This choice in method of coverage offers a unique opportunity to investigate the extent of adverse selection in deposit insurance systems. Relatively risky banks probably found the option of obtaining a private insurance policy much less attractive than joining a fund with a fixed-rate premium structure. In fact, only a small percentage of Texas banks insured their deposits by obtaining a private indemnity policy. We hypothesize that those banks that chose to obtain their own insurance policy were less risk-prone, more conservatively managed, and generally in a stronger financial position than the banks that joined the more common guaranty fund plan, giving rise to an adverse selection problem. Calomiris (1989) highlights the potential for adverse selection problems in voluntary deposit insurance systems, and Grossman (1992) and Wheelock and Kumbhakar (1995) find evidence of adverse selection in two distinct voluntary deposit insurance systems. While membership in the Texas deposit insurance program was compulsory for state chartered banks, the provision of a choice in funds may nevertheless have led to risk-sorting among the banks.

To investigate this hypothesis, we collect call report data from Texas state chartered banks at the time they were required to choose the type of insurance coverage they desired. Using a probit regression to model the choice of deposit insurance coverage, we obtain evidence consistent with the assertion that those banks that chose to insure their deposits by obtaining a

private insurance policy generally exhibited less risky balance sheets than the banks that chose participation in the more conventional type of insurance plan. Our results provide evidence consistent with the proposition that the provision of a choice in plan tended to sort risk-prone banks from more conservative institutions. We proceed as follows. Section II offers some background on the deposit insurance program in Texas. In Section III, the data are presented. Section IV describes the econometric methodology used, including the calculation of marginal effects in the presence of heteroskedasticity. Section V presents our results, followed by our conclusions in Section VI.

II. Deposit Insurance in Pre-Depression Texas

The Texas deposit insurance law passed the state legislature in May 1909 in the form of Senate Bill Number 4 and became effective January 1, 1910. All state-chartered banks were required to join the program. National banks were permitted to join, but the Comptroller of the Currency had previously forbidden nationally chartered banks from participating in state sponsored insurance schemes. While Texas state banks were required to have deposit insurance coverage, they were offered a choice of two plans.[3] Once a bank had decided on which type of coverage it preferred, it was not allowed to alter its decision.

[3] The choice of plans was the result of a compromise reached by the state legislature. One group of legislators favored a deposit guaranty plan similar to those in operation in Oklahoma and Kansas. Another faction wanted a plan whereby banks would furnish a bond or some other sort of security to protect its depositors. See Warburton (1959).

A. Depositors Guaranty Plan

The most popular of the two plans was known as the depositors guaranty fund and was similar in operation to deposit insurance programs adopted in other states. When banks joined the guaranty fund, they were required to pay a premium of one percent of their average daily deposits over the previous year. Thereafter, each bank was assessed annually one-fourth of one percent of its daily average deposits until the fund reached $2 million, after which additional regular assessments were not required. However, if the guaranty fund fell below $2 million, or in the event of an emergency, banks would be subject to a special assessment that was not to exceed more than two percent of average daily deposits for any one year.[4] Banks were required to pay only 25 percent of their assessments in cash, with the remainder to be held in a deposit to the credit of the State Banking Board. And, banks under the guaranty plan could count their contributions to the fund as among their assets. The guaranty fund covered only noninterest bearing deposits payable on demand, although there was no limit on the amount of these deposits that was covered by insurance.

B. Depositors Bond Security System

The second deposit insurance plan offered to Texas banks was known as the depositors bond security system. Section 15 of Senate Bill Number 4 contains the requirements for membership in this plan.

> Each and every State bank or trust company now or hereafter incorporated under the laws of this State, which shall elect to come under the provisions of

[4] In response to mounting banking difficulties, the minimum amount required in the guaranty fund was increased to $5 million in 1921. See Warburton (1959, p. 8).

> the bond security system of this Act, shall, on January 1, 1910, and annually thereafter, file with the Commissioner of Insurance and Banking and his successors in office for and on behalf of the lawful depositors of such bank a bond, policy of insurance, or other guaranty of indemnity in an amount equal to the amount of its capital stock, which said bond, policy of insurance or other guaranty of indemnity shall be for and inure to the benefits of all depositors. Such instrument and the security thereby provided shall be approved by the county judge of the county in which such business is domiciled, and shall take effect and be in force from and after it is approved and filed in the office of the Commission of Insurance and Banking.[5]

The effect of the protection offered under this type of deposit insurance was essentially the same as a doubling of the minimum capital requirement (Warburton, 1959, p. 4). Besides the requirement of an annual filing of a surety bond with the Commissioner of Insurance and Banking, the bond security system contained other safeguards as well. Whenever the deposits of a bank insured under the bond plan exceeded six times its capital and surplus, additional security was to be furnished equal to the amount of the excess. Further, Section 24 of Senate Bill Number 4 included the following provision.

> If at any time it shall appear to the State Banking Board that any bond, or policy of insurance or other guaranty of indemnity filed as provided for herein by any corporation organized under the laws of Texas is insufficient, they shall have the authority, and it shall be their duty, to require such corporation to file new or additional security in an amount sufficient to protect its depositors in accordance with this Act.[6]

C. Resolving Bank Failures

It was the responsibility of the Commissioner of Insurance and Banking to liquidate insolvent banks. For banks operating under the depositors guaranty fund, most of the failures (80 percent) were liquidated by the Commissioner, with only 20 percent of failures resolved through

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[5] See *General Laws of Texas* (1909), Chapter 15, Section 15, p. 416.

[6] See *General Laws of Texas* (1909), Chapter 15, Section 24, p. 421.

other means (Warburton, 1959, p. 48). Depositors were paid first from the cash immediately available from the insolvent bank, with the remainder paid out of the depositors guaranty fund. Over the life of the fund, 31.9 percent of insured deposits were paid directly from the liquidation of failed banks' assets, with the remainder coming from the guaranty fund.[7]

In the event of the failure of a bond plan bank, liquidation was undertaken by the Commissioner of Insurance and Banking, who then notified the persons obligated in the bond, and, 60 days after such notification, the bond became payable. If a Texas corporation was obligated in the bond and refused payment, its charter was forfeited. If an out-of-state corporation was obligated under the bond and refused payment, it was then prohibited from transacting business in Texas. If, after 90 days, payment was still refused, the attorney general was required to bring suit.

Except for the requirement of a special examination before admission into the guaranty fund, banks belonging to either plan were subject to the same set of rules and regulations. These included limits on the indebtedness to a bank of its officers and directors, additional penalties for fraud, and a specification that no state bank could own more than 10 percent of the capital stock of another bank. Perhaps most importantly, Texas was one of the first states to impose capital requirements on insured banks.[8] Ostensibly, these regulations were put in place to limit the potential moral hazard problems associated with deposit insurance. As Robb (1921, p. 151)

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[7] Over the life of the depositors guaranty fund, recoveries from the sale of assets of failed banks totaled 24 percent of insured deposits, leaving a loss to the fund equal to 44.1 percent of insured deposits, or slightly more than $11 million. See Warburton (1959).

[8] These capital requirements were based on the level of deposits. See Robb (1921, Chapter VI) and Section 27 of Senate Bill Number 4.

points out, “By these additional regulations the law attempts to counteract any tendencies toward reckless banking that the guaranty system may engender.”

D. The Troubled Twenties

The first ten years of the deposit insurance system in Texas operated smoothly. By 1920, the guaranty fund had reached its required minimum of $2 million and only 24 state banks had failed, compared with the more than 1,000 operating at the end of that year. According to Weaver (1926, p. 29), no bond plan banks were among these failures.[9] Only small disbursements were required from the guaranty fund, and those were easily covered by special assessments that returned the fund to its legislated minimum. After allowing for recoveries on the assets of the failed banks, the special assessments on guaranty fund banks averaged about 3/100 of one percent of the deposits of participating banks (Warburton, 1959).

Beginning with a severe recession in 1920, however, the Texas economy suffered a series of setbacks that led to banking difficulties throughout the decade. The liquidation rate of Texas state chartered banks rose sharply in the 1920s, peaking at 17 percent in 1925 (Grant and Crum, 1978).[10] As failures mounted, special assessments on state banks were necessary to maintain the guaranty fund’s designated minimum balance. In the early 1920s, the assessment burden

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[9] Failure data obtained from the Texas Department of Banking, however, indicate that two bond plan banks surrendered their charters involuntarily over this time period.

[10] The liquidation rate includes both voluntary and involuntary liquidations. A portion of the voluntary liquidations involved banks switching to a national charter to avoid the increasing costs associated with membership in the depositors guaranty fund. Also, Grant and Crum (1978, p. 155) point out that the voluntary category included liquidations undertaken in response to considerable pressure from bank regulators for financially impaired banks to surrender their charters. “...(M)ost of the banks that entered ‘voluntary’ liquidation, except for those that were nationalized, did so because of financial difficulty.”

amounted to almost 2 percent of total deposits.[11] As the assessment burden continued to rise, state bankers began to question the wisdom of membership in the guaranty fund. But, short of switching to a national charter, they could not exit the plan. In response to increasing pressure from bankers, the state legislature revised the original legislation and, effective February 1925, banks were allowed to switch from the depositors guaranty plan to the depositors bond security system.[12]

A mass exodus from the guaranty fund occurred. Within the first three months of this change in the law, approximately 300 of the more than 800 state banks in existence switched to the bond plan. The percentage of eligible banks participating in the guaranty fund fell from 96 percent in January 1925 to 8.5 percent by December 1926.[13] What no doubt contributed to this flight to the bond plan was a significant dilution of its requirements for an acceptable surety bond. Banks were now allowed to count certain bonds already on their books as sufficient to meet the requirements of the bond security system. As Weaver (1926, p. 33) points out, under this revision "...the only special security afforded to the depositor is the fact that an amount of assets equal to the capital stock must be in liquid bonds. This is of some advantage to the depositor, in case of liquidation, but he is not so well protected as he would be if...security outside the bank's assets were provided." Thus, as a result of this revision to the deposit guaranty law in Texas, "The

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[11] In 1921, special assessments amounted to 1.5 percent of total deposits, while in 1922, special assessments totaled 1.8 percent of total deposits. See Warburton, (1959, Table 4 and Table 13). For comparison, the maximum effective assessment rate charged by the FDIC during the banking difficulties of the past decade was one-fourth of one percent of total deposits (FDIC, 1995, p. 109).

[12] Warburton (1959, p. 37) reports one failure of a bond plan bank up until 1925. Data from the Texas Department of Banking show four bond plan banks with "involuntary" charter surrenders from 1910 through 1924.

[13] See Grant and Crum (1978, pp. 181-185).

liability of the bondsmen will be avoided while the banks will not suffer the expense of the Guaranty Fund."[14]

This change in the insurance regime ultimately proved unsuccessful in rescuing the depositors guaranty system. The failure of the Commercial State Bank of Longview in September 1926, coupled with the accumulated liability for refunding assessments due to the banks that had withdrawn from the fund, resulted in the guaranty fund being unable to meet its obligations. By the end of the year, six more banks failed, while only 34 banks remained in the guaranty fund (Warburton, 1959, p. 29). State banks, the Texas Bankers Association, and the state Department of Banking all favored repeal of the insurance system. On February 11, 1927, legislation was signed that repealed both the depositors guaranty fund and the depositors bond security system. Liquidation of the guaranty fund required another four years (Grant and Crum, 1978, p. 186, 189).

E. An Assessment

In some respects, despite its ultimate demise, the experiment with deposit insurance in Texas could be labeled a success. Of the eight insurance schemes in place in the different states, it was only in Texas where the obligations of the fund were paid in full with no taxpayer assistance.[15] However, as failures mounted and assessment burdens increased, the cost of

[14] Weaver (1926, p. 34).

[15] Section 31 of the guaranty legislation in Texas limited the extent to which banks could advertise their deposit insurance. Guaranty fund banks were only allowed to state that "The non-interest bearing and unsecured deposits of this bank are protected by the depositors guaranty fund of the State of Texas." Bond plan banks were permitted to state that "The deposits of this bank are protected by guaranty bond under the laws of this State." The banks were expressly forbidden to state that their deposits were guaranteed by the state of Texas. (*General Laws of Texas*, 1909, Chapter 15, p. 424). Obligations of the various insurance funds in operation at the time that were not

membership in the guaranty fund proved too great, which ultimately led to its demise. The weakening of the requirements of the bond security system helped hasten its end as well.

The severe agricultural depression that afflicted Texas and other states in the 1920s was a prime factor behind the wave of bank failures. Another factor contributing to these failures, and the associated difficulties with the guaranty fund, might reflect the structure of the deposit insurance program in pre-Depression Texas. The availability of two distinct methods of coverage with different requirements could have resulted in an adverse selection problem. Riskier banks may have been tempted to choose the depositors guaranty fund, given its flat-rate premium structure, rather than try to obtain an insurance policy from a private indemnity company. On the other hand, more conservative banks might have opted for the depositors bond security system, rather than subsidize the potential for increased risk inherent in the depositors guaranty plan.

When the guaranty law was passed in May 1909, state banks currently in existence were required to choose which plan they wished to join by October 1 and to then insure their deposits by one of the two plans by January 1, 1910. They were then not allowed to change plans (until 1925, as noted above). This requirement of no switching between the plans was demanded by the larger banks who expressed their concerns that they would bear a disproportionate share of any losses that might result from banks switching plans (Weaver, 1926, p. 29).

From its beginnings, the depositors bond security plan was not popular with the banks. By August 31, 1910, 541 banks had chosen the depositors guaranty fund, while only 43 banks insured their deposits through the bond security system. Before banks were allowed to switch

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met ranged from zero percent of insured deposits for Texas to as high as 75.3 percent of insured deposits in the North Dakota plan. Mississippi's plan also resulted in no losses to insured depositors, but this was paid for by the proceeds of a state bond issue. See FDIC (1956).

insurance plans in 1925, membership in the bond plan never exceeded 10 percent of state-chartered banks in Texas. The reasons why obtaining a private bond or insurance policy was not popular among most banks are summarized by Weaver (1926, p. 29).

> The preference for the Guaranty Fund plan before 1920 is, of course, easy to explain. As has already been shown, it was very inexpensive. In some years no failures at all occurred, while in others the members were not subject to a special assessment. The average cost per member per year until November 1, 1920 was less than fifty dollars. This is a very low cost for the advantages of being able to satisfy every depositor that beyond a doubt he would always be able to get his money back.
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> Under the Bond Plan, although a bank whose depositors were insured under this method has never failed, the liability of the directors and stockholders was too great for the plan to become popular. Under the Guaranty Fund, this liability was taken away with very little expense.

The bond plan was also not popular with at least one Commissioner. The 44th *Annual Report* of the Commissioner of Insurance and Banking contains a somewhat ironic comment concerning the functioning of the guaranty fund. The Commissioner urged the repeal of the bond security system so that these banks might "...join the great band of guaranty fund banks whose resources are behind the credit of its *weaker members*." Further, the Commissioner pointed out that the only reason that the bond plan system was successful was that "...the banks that have elected to work under it achieve their success, not with it as a helpful influence, but rather because of *their own individual character and resourcefulness...*" (Commissioner of Insurance and Banking, 1919, p. 11, italics added).

The distinct features of the two deposit insurance plans offer a unique opportunity to test for the role of adverse selection in insurance coverage. Because the depositors bond security system functioned to a substantial degree as a private insurance scheme, we might expect that those (relatively few) banks that chose this type of coverage would be more conservative, well-

managed, and risk-averse institutions. On the other hand, the depositors guaranty fund operated much the way federal deposit insurance did until a few years ago. Premiums were independent of the risk profile of individual institutions, so that risk-prone banks may have tended to favor the protection offered by the guaranty fund.

III. Bank Data at Time of Insurance Choice

To test whether this type of risk sorting took place, we collect data from 940 Texas banks at the time they were required to choose which type of deposit coverage they preferred. These data are mostly from the *Third Biennial Report* of The Commissioner of Insurance and Banking, 1909-1910, which contains balance sheet data for the individual state banks then in existence. This particular report includes data as of September 1909 and thus represents the call report date closest to the time (October 1) when existing banks were required to choose their type of insurance coverage.

To capture subsequent chartering activity and insurance choice, we also collect data on newly chartered banks from the *Annual Reports* of the Commissioner of Insurance and Banking for the years 1910-1911, 1911-1912, and 1913-1914. These data are from the September call report closest to the time each bank was chartered and required to choose insurance type. Use of the September call date for these subsequently chartered banks ensures comparability with the September 1909 data.[16]

[16] We are unable to obtain *Annual Reports* for the 1915-18 period. *Annual Reports* after 1918 through 1922 are available, but they do not contain data on individual banks. No *Annual Reports* were published after 1922, when a separate Department of Banking was established.

Using all the available call reports, we have balance sheet data at the time of deposit insurance plan choice for 877 banks that elected to join the guaranty fund, and 63 banks that selected the bond security plan.[17] Unfortunately, the available balance sheets are relatively simple and do not include a great amount of financial detail. Nevertheless, we are able to obtain for inclusion in our model bank-specific measures of capital, liquidity, lending activity, size, and age. In selecting the risk proxies to be included in our model of adverse selection, we depend heavily on the previous work of White (1984) in modeling bank failures during the banking crisis of 1930 and subsequent refinements by Wheelock (1992) in the context of Kansas bank failures during the 1920s.

Because capital serves as a buffer protecting bank solvency against financial loss, a high ratio of capital to assets signals financial strength. For the state chartered banks in our sample, we are able to obtain only a book-value measure of capital adequacy, which may overstate the banks' true capital positions. However, book-value capital may nevertheless provide a useful comparison of capital strength across banks. White (1984) finds that banks entering the banking crisis of 1930 with relatively low capital ratios were more likely to fail than banks with high capital. In an analysis of Kansas banks during the 1920s, Wheelock (1992) also finds a negative relationship between book-value capital and bank failures.[18] Given the maintained hypothesis of adverse selection, we would expect those banks joining the bond plan to have had relatively strong capital positions. In accordance with the data available to us in the reported bank balance sheets, we

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[17] Based on the lists of bond fund banks contained in the available *Annual Reports*, a total of 68 existed prior to 1922. Hence, our sample of 63 is fairly complete.

[18] A negative relationship between book-value capital and bank failures has been documented in relatively recent failure episodes also [e.g., Cole and Gunther (1995)].

measure capital adequacy (*CAP*) as the sum of the following capital accounts relative to total assets: 1) the paid-in capital stock, which represents the amount of capital originally contributed by bank owners; 2) the surplus fund, or the amount of additional capital paid in over time; and 3) net undivided profits, or what is commonly known today as retained earnings.

The size and direction of lending activities also can provide a reasonable indication of risk profiles for the state chartered banks in our sample. In his examination of the banking crisis of 1930, White (1984) documents a positive relationship between the loan-to-asset ratio and the likelihood of bank failure. Insofar as a relatively high proportion of total assets directed to lending activity reflected an aggressive financial posture, together with an associated greater exposure to economic downturns, we would expect that banks selecting the bond security plan may have exhibited lower loan concentrations. White's findings on the riskiness of lending activities suggest a negative effect on bond plan membership for the ratio of loans to total assets (*LOANS*).

Following Wheelock (1992), we include the log of total assets (*SIZE*) in the model to account for the possible financial benefits accruing to relatively large banks. It may have been relatively easy for large banks to obtain a private bond or insurance policy, to the extent that they were better known institutions than their smaller counterparts and, by virtue of greater loan diversification, also less risky.

Established banks may have enjoyed a relatively strong financial position compared to their newly established competitors and also may have been successful in building a positive reputation. Under the adverse selection hypothesis, these considerations suggest that established banks may have been more likely to join the bond plan than newly chartered ones. Wheelock

(1992) includes an age measure in his study of Kansas bank failures. Because Texas began chartering banks only in August 1905, and existing banks were required to choose a deposit insurance plan by October 1909, none of the banks in our sample were very old.[19] Nevertheless, newly chartered banks may have faced tougher circumstances than banks that had been in operation for several years. We set the variable *AGE* equal to the number of quarters for which a bank had been in operation prior to choosing a deposit insurance plan. For banks commencing business in July, 1909, or later, *AGE*=1. For the oldest bank in our sample, established in the third quarter of 1905, *AGE*=17. In our empirical work, we specify potential age effects using the log of *AGE*, denoted as *LAGE*, and hypothesize a positive relationship with membership in the bond plan.

With respect to bank liquidity, both White (1984) and Wheelock (1992) find a negative relationship between bank failures and the ratio of cash and exchange to assets. Under the hypothesis of adverse selection, we expect the ratio to assets of currency, specie, and cash items (*CASH*) to enhance the likelihood of membership in the bond plan. The balance sheet data available to us also include the net amount due from other banks and bankers, subject to check. Under the hypothesis of adverse selection, the ratio of these relatively liquid holdings to assets (*NETFR*) should enhance the likelihood of membership in the bond plan. Also, as argued by White (1984), holdings of U.S. government securities may have enhanced bank liquidity. Unfortunately, the balance sheet data available to us do not include a separate item for these

[19] The Texas state constitution forbade the chartering of state banks until August 1905 when the constitution was amended. Thus, many of the banks in our sample were relatively young. In the first five years of the Texas state banking system, 636 banks were granted charters. From August 1905 through August 1910, 52 of these banks surrendered their charters: 12 never opened; 4 converted to a national charter; 4 were merged with other institutions; 29 were liquidated; and only 3 banks were classified as failures. (Grant and Crum, 1978, pp. 48-52).

securities, but rather lump together all bonds and stocks held into one account. We include the ratio of this account to total assets (*BONDS*) in our model. However, because the quality of the assets included in this variable is unknown, its sign is difficult to predict. Also, following White (1984) and Wheelock (1992), we include in the model a measure of each bank's deposit base. Core deposits, defined here as individual deposits subject to check, most likely were the least expensive funding source widely available to our sample of banks. The proportion of assets funded by core deposits (*DEP*) is included to account for any beneficial effect of a large deposit base in reducing a bank's average cost of funds. As a final liquidity measure, we also include the ratio to total assets of bills payable and rediscounts (*BILLS*). The existence of adverse selection would suggest a negative effect on bond plan membership for *BILLS* and positive effect for *DEP*. The econometric model and results are discussed in the following sections.

IV. The Econometric Model

We employ a probit model to estimate the determinants of deposit insurance choice among Texas state-chartered banks. The specification is embellished by the incorporation of heteroskedasticity. While departure from a unit variance is rare in empirical applications using the probit model, the incorporation of heteroskedasticity enriches the model considerably, as demonstrated below.[20] Because the full implications for the probit model of heteroskedasticity have not been previously drawn out, a brief treatment is provided here.

[20] Published work using the probit model almost invariably ignores the potential for heteroskedasticity. Exceptions are O'Higgins (1994), Greene (1993), and Knapp and Seaks (1992).

It is well known that, in the presence of heteroskedasticity, the standard probit model produces inconsistent estimates of both standard errors and slope estimates [see Godfrey (1988)]. Yatchew and Griliches (1985) examine several conditions influencing the impact of heteroskedasticity on parameter estimates in the probit model, while Davidson and MacKinnon (1984) develop a Lagrange multiplier test for heteroskedasticity based on an artificial linear regression. However, little attention has been given to the effect of heteroskedasticity on the marginal effects calculated using the probit model.

We consider the model

$$P(B = 1) = \Phi\left[\frac{X'\beta}{e^{Z'\Gamma}}\right], \tag{1}$$

where the probability of choosing the bond security fund, *P(B=1)*, is specified using the cumulative standard normal distribution, $\Phi(\,.\,)$. The underlying stimulus for bond plan membership is assumed to depend on $X'\beta$ and a scale factor, $e^{Z'\Gamma}$. In general, *X* and *Z* may or may not have common elements, but a constant term in *Z* is not identified. The restriction $\Gamma=0$ in $\sigma=e^{Z'\Gamma}$ gives the standard probit model.

The inclusion of heteroskedasticity in the probit model has far reaching implications, and is more properly thought of as a change to functional form, rather than a matter of error variance alone. The meaning of this statement is clarified by an examination of the model's marginal effects. Assuming a variable *y* is present in both in *X* and *Z*, the associated marginal effect on the probability of bond plan membership is

$$ME_y = \frac{\partial P(B = 1)}{\partial y} = \phi\left[\frac{X'\beta}{e^{Z'\Gamma}}\right]\left[\frac{\beta_y - X'\beta\Gamma_y}{e^{Z'\Gamma}}\right], \tag{2}$$

where the restriction $\Gamma=0$ results in $\phi(X'\beta)\beta_y$, the usual marginal effect calculation associated with the standard probit model, and ϕ (.) denotes the standard normal density function. The first term in the second bracketed expression of equation (2) represents the effect of y on $X'\mathrm{B}$, while the second reflects the influence of y on the scale factor, $e^{Z'\Gamma}$.

The parameterization used for the variance term has a potentially large influence on the model's marginal effects. So much so that, as evident in equation (2), the sign of a variable's marginal effect no longer depends only on its weight in β, but also on the variable's influence on the scale factor. The critical point at which the marginal effect becomes equal to zero is

$$\frac{\partial\sigma/\partial y}{\sigma} = \frac{\partial X'\beta/\partial y}{X'\beta}, \tag{3}$$

which depends on the proportional effects of y on σ and β. The conditions under which a marginal effect's sign is reversed are as follows:

$$\begin{gathered} \textit{for sign } (\beta_y) = \textit{sign } (X'\beta), \\ \textit{sign } (ME_y) \neq \textit{sign } (PME_y) \quad \textit{iff} \quad \frac{\partial\sigma/\partial y}{\sigma} > \frac{\partial X'\beta/\partial y}{X'\beta}; \end{gathered} \tag{4}$$

$$\begin{gathered} \textit{for sign } (\beta_y) \neq \textit{sign } (X'\beta), \\ \textit{sign } (ME_y) \neq \textit{sign } (PME_y) \quad \textit{iff} \quad \frac{\partial\sigma/\partial y}{\sigma} < \frac{\partial X'\beta/\partial y}{X'\beta}; \end{gathered} \tag{5}$$

where PME_y denotes the marginal effect calculated using only the variable's weight in β.

V. Econometric Results

Table 1 contains a comparison of the mean values of the proxy variables chosen for use in the model. The comparison of means indicates that the bond plan banks tended to be both larger and older than banks in the guaranty fund, as the Wilcoxon test statistics for differences across the two groups of banks in the locations of the distributions corresponding to these variables is significant. These findings support the adverse selection hypothesis. However, among the liquidity variables, the results indicate that the bond plan banks held a lower proportion of their assets in currency, specie, and cash items than the guaranty fund banks, contrary to our expectations. The remaining variables exhibit no significance difference across the two groups of banks.

Turning to a more formal assessment of the relationship between these different risk proxies and membership in the bond plan, Table 2 provides the probit regression results. The first column corresponds to the standard model based on the assumption of $\sigma=1$, with all the proxy variables included. *CAP*, *SIZE*, *LAGE*, and *NETFR* are each statistically significant, and the positive direction of their effects corresponds with the operation of adverse selection. None of the other variables are individually significant.

For the probit model with heteroskedasticity, the list of variables to be included in $\sigma=e^{Z'\Gamma}$ is determined using likelihood ratio tests. As a first step, all the explanatory variables are included in *Z*. The associated likelihood ratio test statistic for the null of $\Gamma=0$ is significant at the 1-percent level, with a value of 36.7, compared to the associated χ^2 critical value of 21.7. However, in this

full model, only *LAGE* is significant in Γ, and it is significant at the 1-percent level. We therefore compare this model to an alternative using only *LAGE* in the heteroskedasticity term. The resulting likelihood ratio test statistic is 15.1, which falls short of the associated 5-percent critical value of 15.5. As a result, we adopt the specification of $\sigma=AGE^{\lambda}$.

The second column in Table 2 gives the results for the probit model with heteroskedasticity when all the risk proxies are included. *LAGE* is significant in β, although its sign has changed from positive to negative. And bank age also plays an important role in the heteroskedasticity term, as reflected in the significance of λ. Other than *LAGE*, the only variables found to be statistically significant are *SIZE* and *CASH*, and the direction of their effects on bond plan membership correspond to the results of our earlier comparison of means. *SIZE* possess the expected positive sign, while the coefficient on *CASH* is negative. Given that the list of variables included in the model is fairly exhaustive, the lack of significance for many of the variables may reflect redundancies associated with the adding up constraint that characterizes balance sheet information.

To assess the effect on our results of including potentially extraneous variables, we estimate an alternative model from which some of the less significant variables are dropped. In the third column of Table 2, we show the standard model based on the assumption of $\sigma=1$, with *BONDS*, *DEP*, and *BILLS* excluded. The likelihood ratio test statistic for this exclusion is only 0.9, compared to a 5-percent critical value of 7.8, indicating that these three variables can be safely dropped from consideration. In this relatively parsimonious model, each of the variables is significant, with the exception of *LOANS* and *CASH*. The probability of membership in the bond

plan is enhanced by high values of *CAP*, *SIZE*, *LAGE*, and *NETFR*. Each of these significant results is consistent with the operation of adverse selection.

For this parsimonious specification, we again determine the list of variables to be included in $\sigma=e^{Z'\Gamma}$ using likelihood ratio tests. When all the included variables are used in *Z*, the associated likelihood ratio test statistic for the null of $\Gamma=0$ is significant at the 1-percent level, with a value of 26.1, compared to the associated χ^2 critical value of 16.8. We now compare this model to the alternative using only *LAGE* in the heteroskedasticity term. The resulting likelihood ratio test statistic is 4.7, far short of the associated 5-percent critical value of 11.1. As a result, we again adopt the specification of $\sigma=AGE^{\lambda}$. The likelihood ratio statistic for the exclusion of *BOND*, *DEP*, and *BILL* from the model with heteroskedasticity is only 1.2, well below the associated 5-percent critical value of 7.8.

The results for the parsimonious model with heteroskedasticity are shown in the fourth column of Table 2. As in the standard model, *CAP*, *SIZE*, *LAGE*, and *NETFR* are each significant, while the variable *LOANS* remains insignificant. And λ is significant, indicating the importance of heteroskedasticity in the estimated model. Finally, *CASH* is significant, in contrast to the results for the standard model, and its sign is negative.

Unlike the other variables included in the model, the direction of the marginal effect of *LAGE* on the probability of membership in the bond plan does not necessarily correspond to the sign of its coefficient in β. Using eq. (2), we calculate the marginal effects of the various variables both for the parsimonious model including heteroskedasticity and for the standard model estimated under the restriction of $\Gamma=0$.

The results, shown in Table 3, provide an interesting comparison between the two models. In the first and second rows, we show the marginal effects calculated at the sample means for those banks that entered the deposit insurance program within one quarter after commencing operations (*AGE*=1). We then do the same for banks in each of four additional age groups, resulting in five groups defined as *AGE*=1, $2 \leq AGE \leq 4$, $5 \leq AGE \leq 8$, $9 \leq AGE \leq 12$, and $13 \leq AGE \leq 17$.[21]

For the first age group (*AGE*=1), the marginal effects for the two models are highly similar, with the exception of the effect associated with *LAGE*, which is negative for the model incorporating heteroskedasticity. While the meaning of this result for *LAGE* is somewhat unclear, it is consistent with a U-shaped rate of bond plan membership evident in the data. The proportion of banks in each of the five age groups that chose the bond plan is .059, .034, .034, .086, and .139, respectively, so that the tendency for bond plan membership does fall from the first age group to the second.

Interestingly, while the membership rate is constant between the second and third groups, it rises in groups four and five, consistent with the notion that relatively mature banks were more likely to choose the bond plan. Correspondingly, the marginal effect of *LAGE* on the probability of bond plan membership, as calculated using the probit model with heteroskedasticity, becomes positive for the second age group and continues to rise with bank age.[22] In contrast, the span across the five age groups of the marginal effect associated with *LAGE*, as calculated from the

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[21] The five age groups contain 511, 118, 59, 151, and 101 banks, respectively.

[22] Such a change in a marginal effect's sign is not possible in the standard probit model, where the marginal effect is given as $ME_y = \phi(X'\beta)\beta_y$.

standard probit model, is relatively narrow. In the model incorporating heteroskedasticity, the positive marginal effect of *LAGE* for the higher age groups, despite the negative sign of β_{LAGE}, results from the condition given in eq. (4).

Another striking aspect of our comparison between the two models involves the marginal effects of the other variables included in the models. While the marginal effects of these variables are comparable across the two models when *AGE*=1, for the higher age groups the marginal effects associated with the model incorporating heteroskedasticity tend to fall relative to the effects calculated on the basis of the standard probit model. The findings based on the model incorporating heteroskedasticity indicate that the effects of the other variables were most important for banks choosing a deposit insurance plan at a young age. For more mature banks, these other measures appeared to play a less important role. Overall, our empirical findings for these financial variables, together with the generally positive effect of bank age on bond plan membership, are consistent with risk-sorting behavior, whereby more conservative, less risk-prone banks chose to secure their deposits by obtaining a private insurance bond, while more aggressive banks preferred membership in the depositors guaranty fund.

As a check on the adequacy of our specification, we examine the stability of the model's slope coefficients across particular groups of banks. Because the banks for which *AGE*=1 were all established after or just prior to the implementation of the deposit insurance program, the possibility arises that our estimated age effects actually might reflect fundamental differences between the banks established before and after deposit insurance was put in place. Many of the banks established after June, 1909, may have been established with the express purpose of taking advantage of the deposit insurance system, whereas, unless the deposit insurance program was

effectively anticipated, such would not have been the case for the banks established earlier. For the model shown in the fourth column of Table 2, we test the restriction that the coefficients on *CAP*, *LOANS*, *SIZE*, *CASH*, and *NETFR* are the same for the group of banks for which *AGE*=1 and all other banks. The likelihood ratio test statistic is 10.91, below the associated 5-percent critical value of 11.07, and *AGE* retains its significance. These results support our specification and estimated age effects.

VI. Conclusions

Cooke (1911, p. 327), as cited by the National Monetary Commission soon after the Texas deposit insurance program was in place, stated that "As the largest Commonwealth in the United States, it is a wonderfully interesting field for a financial experiment and the result will be important." These words proved prophetic. The Texas deposit insurance program was unique in its success in covering all of its obligations. The program's failure, however, was due, to some extent, to its peculiar structure. Making deposit insurance coverage mandatory, but providing for a choice of coverage, led to risk-sorting between the two insurance plans. The one plan that functioned much like recent federal deposit insurance tended to attract more risky, aggressive banks. The other alternative offered to Texas banks was widely unpopular except for those more conservative, well-managed institutions. Allowing banks this choice of coverage was the outcome of a political compromise. The end result for the Texas deposit insurance system, however, despite some of its unique features, was similar to those of other states in the time period before the Great Depression.

Table 1

Comparison of Bond Plan Banks and Guaranty Fund Banks
At the Time of Plan Choice

	Bond Plan Banks	Guaranty Fund Banks	Wilcoxon Test Statistic
CAP	.434	.368	.01
LOANS	.624	.623	.19
SIZE	11.64	11.05	4.20**
LAGE	1.21	.891	2.24*
CASH	.056	.073	-3.07**
NETFR	.202	.166	.27
BONDS	.016	.005	1.48
DEP	.439	.493	-.76
BILLS	.059	.081	-1.83

Notes: The Wilcoxon test statistic is calculated with a continuity correction of 0.5 and is approximately normally distributed. * significant at the 5-percent level. ** significant at the 1-percent level.

Table 2

Probit Regression Results for Membership in the Bond Security System

	$\sigma = 1$	$\sigma = AGE^{\lambda}$	$\sigma = 1$	$\sigma = AGE^{\lambda}$
Constant	-7.585** (1.620)	-7.004** (2.693)	-6.889** (1.213)	-8.222** (1.699)
CAP	1.999* (.9644)	1.362 (1.684)	1.442** (.4472)	2.020** (.5649)
LOANS	1.119 (.9062)	1.183 (1.865)	1.055 (.7569)	1.416 (1.189)
SIZE	.3575** (.0839)	.4021** (.1102)	.3453** (.0729)	.4272** (.0919)
LAGE	.1958** (.0661)	-2.391* (.9710)	.2051** (.0647)	-2.267* (.9490)
CASH	-5.383 (2.875)	-8.822* (4.382)	-4.862 (2.621)	-7.936* (3.696)
NETFR	2.058* (.9223)	2.468 (1.790)	2.135** (.7593)	2.826* (1.226)
BONDS	.4337 (1.493)	-.6148 (2.444)		
DEP	.7125 (.9272)	-.5772 (1.749)		
BILLS	.1919 (1.080)	-1.545 (1.686)		
λ		.7394** (.1309)		.7242** (.1335)
$2 \ln(L_{UR}/L_R)$	61.1**	82.7**	60.1**	81.5**

Notes: Standard errors are in parentheses. * significant at the 5-percent level. ** significant at the 1-percent level.

Table 3

Marginal Effects for Membership in the Bond Security System

	CAP	*LOANS*	*SIZE*	*LAGE*	*CASH*	*NETFR*
AGE=1						
σ = 1	.1079	.0790	.0259	.0154	-.3639	.1598
σ = AGE^{λ}	.1323	.0927	.0280	-.0583	-.5198	.1850
2≤AGE≤4						
σ = 1	.1175	.0860	.0281	.0167	-.3962	.1740
σ = AGE^{λ}	.0403	.0283	.0085	.0190	-.1582	.0563
5≤*AGE*≤8						
σ = 1	.1621	.1187	.0388	.0231	-.5467	.2401
σ = AGE^{λ}	.0543	.0381	.0115	.0640	-.2132	.0759
9≤*AGE*≤12						
σ = 1	.2282	.1671	.0547	.0325	-.7697	.3380
σ = AGE^{λ}	.0612	.0429	.0129	.0900	-.2403	.0856
13≤*AGE*≤17						
σ = 1	.2640	.1932	.0632	.0376	-.8901	.3909
σ = AGE^{λ}	.0598	.0420	.0127	.1051	-.2351	.0837

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