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Bank Failures in Banking Panics: Risky Banks or Road Kill?

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Abstract: Are banks that fail in banking panics the riskiest ones prior to the panics? The free banking era in the United States provides useful data to examine this question because the assets held by the banks were traded at the New York Stock Exchange. The authors estimate the ex ante riskiness of a bank's portfolio by examining the portfolio relative to mean-variance frontiers and by examining the bank's leverage and notes relative to assets. The authors find that the ex ante riskiness of a bank's portfolio helps predict which banks fail and the extent of noteholders' losses in the event of failure.

JEL classification: G21, G28, E58, N21

Key words: banking panics, bank failure, banking regulation, portfolio risk

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Bank Failures in Banking Panics: Risky Banks or Road Kill?

I. Introduction

Are banks that fail in banking panics the riskiest ones or are they just in the wrong place at the wrong time, in short "road kill"? Many discussions of banking panics and banking crises suggest that the riskiest banks are the ones most likely to fail. There is no doubt that the banks that fail are those most susceptible to the problems in the panic or crisis. Are these banks the ones that are most susceptible to problems? This question acquires some importance because banks are using value at risk to measure their riskiness, and banking regulators are encouraging banks to do so (Altman and Saunders 2001). Correctly measured, it is hard to imagine a world in which reducing an individual bank's riskiness does not reduce its probability of failing (e.g. Wheelock and Wilson 1995; Kolari et al, 1999). Nonetheless, is reducing an individual bank's riskiness likely to reduce the probability of failing in a banking panic or in a financial crisis?

In this paper, we examine whether a bank's ex ante riskiness is a reliable guide to its fate in a banking panic. In general, it is extremely difficult to tell whether the riskiest banks failed in a banking panic such as the Great Depression in the United States in the 1930s. Banks' ex post exposures to the actual events invariably are clear after the fact, whether the events are the Depression in the 1930s, the Texas oil bust in the 1980s, or the Asian financial crisis in the 1990s. Nonetheless, banks generally hold nonmarketable assets and these assets' riskiness is far from apparent before the fact. In addition, it is hard to have much perspective on events that are so recent and clouded by political and other judgements.

Because of these problems with recent episodes, we use data from banking panics in

1860 to examine the importance of ex ante riskiness for banks' fates in a panic. There were runs on state banking systems in this period, which makes it possible to use these data to examine banks' fates in panics (Hasan and Dwyer 1994; Dwyer 1996; Dwyer and Hasan 1999). The single most important predictor of which banks failed in the panics are their losses on bond portfolios (Economopoulos 1990; Hasan and Dwyer 1994; Dwyer 1996; Dwyer and Hasan 1999). These bond portfolios were not an ancillary part of banks' business that happened to turn out badly. These state bonds were an integral part of the banks' business: issuing banknotes that were used as currency by the public. The bonds were held as required backing for the banknotes. The ex ante riskiness of these bonds can be estimated from market prices of the bonds in trades on the New York Stock Exchange (Dwyer, Hafer and Weber 1999). The availability of market prices before and after the panics makes it possible for us to estimate banks' ex ante riskiness in an important part of their business using standard financial tools.[1]

Before presenting the empirical analysis, we briefly describe free banking in the United States. These free banks were not laissez faire banks; there were substantial legal restrictions on how banks operated. The banks were called *free banks* because there was no discretionary restriction of entry into banking, a business that revolved around issuing notes used as currency. These free banking systems were an innovation that succeeded chartered banking in

[1] The notes issued by free banks were traded at less than par value at locations distant from the banks. There is virtually no useful information for our analysis because notes of continuing banks in a state generally were discounted at the same rate (Gorton 1996, 1999; Dwyer and Hasan 1999.)]

which a bank had to be granted an individual legislative charter to operate.[2] We also summarize the evidence on banking panics in the free banking period. While runs on banking systems occurred in various states in 1854, 1857 and 1860, the paucity of data for 1854 makes 1854 unlikely to be informative and the relatively few failures in 1857 make the 1857 panic useless for comparing failed banks with other banks. As a result, we focus on runs on selected state banking systems at the onset of the Civil War in 1860 in which many free banks failed.

In our empirical analysis, we estimate the riskiness of banks' bond portfolios relative to the mean-variance frontiers and find substantial support for the proposition that the ex ante riskiness of banks' portfolios is informative for predicting banks' fates. We also estimate banks' riskiness by their leverage and by their exposure to runs on notes. Banks are more likely to fail if they hold bond portfolios that are riskier ex ante or have a larger exposure to runs on notes.

II. Free Banking

Free banking in the United States began in 1837 when Michigan passed the first free banking law and ended in the 1860s when the federal government created the national banking system. This era in U.S. banking history has received a great deal of attention in recent years, partly to examine whether these relatively unregulated banks engaged in widespread fraud and partly to examine the implications of more recent banking regulation.

Because the federal government did not charter banks, all banks in the free banking period were state banks. Bank entry in states with free banking laws was not subject to

[2] Selgin and White (1994) summarize the literature on laissez faire banking and discuss its relationship to the literature on historical banking systems.

discretionary control and was easier than in states that did not have free banking laws (Economopoulos and O'Neill 1995). In a free banking state, a bank could be opened and issue banknotes after satisfying specific, legislative requirements. These requirements included meeting minimum bank capital requirements and providing collateral for banknotes issued.

The aggregate balance sheets in Table 1 for free banks in Illinois, Indiana and Wisconsin illustrate free banks' activities. Bonds and loans are over seventy percent of total assets, with the percentage of assets that are state bonds varying substantially, from 61 percent in Illinois to 36 percent in Indiana and 28 percent in Wisconsin. Notes and deposits are approximately sixty percent of total liabilities, with the percentage of assets that are notes also varying substantially, from 57 percent in Illinois to 28 percent in Indiana and 25 percent in Wisconsin. Equity capital is a substantial source of funding for the free banks: 35 percent of liabilities in Illinois; 42 percent in Indiana; and 40 percent in Wisconsin. In these as in other free banking states, liabilities primarily are banknotes and equity capital. Notes issued by banks were the predominant form of currency in the United States in this period because there was no government-provided currency.

The holdings of bonds and issuance of notes are related: state laws of the period required free banks to hold bonds as backing for their notes. Table 2 summarizes the free banking laws concerning banknotes and bonds, here illustrated by the laws in Illinois, Indiana and Wisconsin as of 1861. These free banking laws required that the banks hold bonds, with the banks having substantial latitude about exactly what bonds to hold. Hence, the attitude of a bank's owners toward risk could be reflected in the particular bonds held by a bank. The laws in all three states imposed substantial penalties on a bank for not redeeming its notes on

demand, up to forfeiture of the bank's charter. The laws in many states also required that a bank keep collateral related to the value of the notes after they were issued. Failure to maintain sufficient backing in the bond account in Illinois and Wisconsin resulted in forfeiture of the bank's charter, a provision which was enforced. There was no such provision in Indiana, but as noted above, Indiana did require that a bank redeem its notes on demand subject to forfeiture of the charter.

Many free banks failed. Research on free banking has focused on whether free banks that failed were primarily due to owners operating unsound banks – sometimes called "wildcat banks" – or to exogenous events. The general conclusion from the research is that banks generally were operated in a way that was consistent with the banks continuing operations absent some negative exogenous event (Rolnick and Weber 1984; Economopoulos 1988; Dwyer 1996.) A related argument about free banking is a claim that banks would locate in remote areas "where the wildcats roam", thereby raising the cost of redeeming banknotes and of acquiring information about the banks. Dwyer (1996) examines this colorful view of banks' locations and finds evidence inconsistent with it after some experience with free banking.

The importance of exogenous events for explaining free banks' failures has received a great deal of attention. For example, Rolnick and Weber (1983, 1984), Economopoulos (1988, 1990), Hasan and Dwyer (1994) and Dwyer and Hasan (1999) examine the effects on free banks of the decline in southern bond prices at the onset of the Civil War. All of these authors find that holdings of southern bonds and losses on those bonds are important determinants of whether free banks remained open or ceased operations.

Hasan and Dwyer (1994) and Dwyer and Hasan (1999) examine whether there were

runs on the banking systems and conclude that such runs did occur, contrary to some prior suggestions. Dwyer and Hasan find that the much higher failure rate in Illinois than in Wisconsin in 1861 is partly explained by a suspension of payments in Wisconsin but not Illinois. This suspension also reduced noteholders' losses in Wisconsin. Dwyer and Hasan's evidence also indicates that decreases in the value of bond portfolios and banks' leverage are important for explaining both banks' closing and noteholders' losses in those banks.

III. The Riskiness of Banks' Portfolios

Were the banks that failed riskier or were they just in the wrong place at the wrong time? There were runs on free banking systems in 1854 in Indiana, 1857 in New York and 1861 in Illinois and Wisconsin. For 1854, there is little of the weekly data on bond prices that we use to construct efficient portfolios of bonds (Dwyer, Hafer and Weber 1999). In 1857, relatively few banks failed (Dwyer 1996). As a result, we concentrate on the runs in 1861 in Illinois and Wisconsin, in which many banks failed. We also include data from Indiana in 1861, which had fewer bank failures, as a contrast.

A. Bond Prices

Figure 1 shows weekly data on bond prices from 1859 through 1862 for northern, border state and southern bonds from Dwyer, Hafer and Weber (1999). The figure includes the prices of United States bonds and state government bonds that account for at least 10 percent of banks' portfolios in Illinois, Indiana or Wisconsin in October 1860. Bonds issued by Illinois and Indiana are more than ten percent of banks' bond holdings in those states respectively, but these bonds are relatively unimportant in other states. United States bonds are included in the figure for comparison with the state bonds; these bonds were not held by any banks in Indiana

and Wisconsin and they are less than ten percent of Illinois banks' aggregate portfolio.

The onset of the Civil War is evident in Figure 1. There are large decreases in the prices of southern bonds after Lincoln's nomination in May 1860 and precipitous decreases with the beginning of open warfare in April 1861. While the prices of southern and border state bonds fall at the start of the Civil War, the prices of U.S. and northern bonds do not fall nearly as much.

The decrease in southern bond prices is an important contributor to the closure of 44 percent of the banks in Wisconsin and over 87 percent of the banks in Illinois during a period when two of the 20 banks in Indiana closed.[3] Almost two-thirds of the bonds held by Illinois and Wisconsin banks are the southern and border state bonds that so clearly reflect the onset of the Civil War. Only 35 percent of the bonds held by Indiana banks are southern bonds, but this does not reflect greater diversification: over 60 percent of the bonds held by Indiana banks are Indiana bonds. The price of Indiana bonds has a substantial fall, from about 90 percent of par in early 1861 to 70 percent of par later in the year, but this is small relative to the price decreases of southern and border state bonds.

Ex post, a portfolio of southern bonds was risky in the sense that there were large losses on those bonds. The criticism that free banks were risky because they held risky portfolios is long-standing (Dowrie 1913; Krueger 1933; Hammond 1957).

Ex ante, a portfolio of southern bonds may or may not have been particularly risky. Figure 1 does indicate greater riskiness of southern and border state bonds before Lincoln was

[3] One of these two banks – the Boone County Bank – was a new bank whose owners issued fraudulent currency.

nominated in May 1860, even though the volatility of those bonds is not obviously greater than for other bonds. Even before May 1860, southern bonds have lower prices, but these prices generally are near or below par.[4] Southern bonds generally have the same 6 percent coupon as other bonds and, absent knowledge of any other differences, greater perceived riskiness of these bonds presumably accounts for the lower prices. Other than the generally lower prices, though, there is no apparent evidence of greater risk.

Efficient portfolios of the bonds held by the banks and the riskiness of the actual portfolios can provide more systematic evidence on southern bonds' riskiness. The underlying bond data are weekly returns. The banks' actual portfolios included small amounts of many securities, and data are not available for all of these securities. For example, six banks in Wisconsin have relatively small holdings of Michigan bonds, for which we have no prices. We estimate the riskiness of actual portfolios and the efficient portfolios using prices for securities that are widely held by the banks. These are prices of bonds issued by the United States government and the states of California, Indiana, Ohio, Pennsylvania, Georgia, Indiana, Louisiana, Kentucky, Missouri, North Carolina, Tennessee and Virginia. We have no reason to think that the omission of other bonds biases our results one way or the other. The omitted bonds tend to be northern bonds, but they are likely to be less liquid precisely because they are not trading often enough to create a useful record. Overall, we think that it is better to omit the bonds on which we have no data than to make unfounded assumptions about the first and second moments of returns.

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[4] These prices made southern bonds more attractive given the laws that limited banks to issuing notes up to the minimum of the bonds' par or market value.

Figure 2 shows efficient frontiers estimated for dates chosen to highlight contemporary events. These frontiers show the minimum variance given the rate of return, with the returns ranging from the lowest to the highest. We estimate efficient frontiers for: April 1860, just prior to Lincoln's nomination; October 1860, just prior to Lincoln's election; April 1861 at the start of hostilities; and October 1861 when the war is in progress. Each of these frontiers uses the most recent 26 weeks of data through the end of the month to estimate the means and standard deviations of the portfolios.[5]

The frontiers in Figure 2 have rough parabolic shapes. The implication that an efficient frontier must be parabolic relies on unrestricted weights of various securities, and the frontiers in Figure 2 are estimated subject to the restriction that bond holdings be nonnegative. We impose this restriction because banks being short bonds is not consistent with the laws of this period or with the bonds being held as backing for notes. We also do not include a risk-free asset because very few banks held the risk-free asset – gold or silver that paid zero interest – as backing for their notes.[6]

The frontiers show the dramatically worsening situation in terms of both the portfolios' returns and standard deviations. By April 1861, none of the bonds has a positive return for the prior 26 weeks.[7] The returns for the next half year, from April 1861 to October 1861, range up

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[5] These frontiers are more informative than alternatives which we examined based on only 13 weeks of returns or as many as 52 weeks of returns.

[6] The only United States government securities for which prices are available are long-term bonds. These long-term bonds are included in the portfolios.

[7] While it might be desirable to examine the weights of individual securities, standard estimation procedures estimated the weights imprecisely relative to the frontier (Best and Grauer 1991; Britten-Jones n.d.).

to 1.05 percent per week, but these high returns are accompanied by high standard deviations. The standard deviation of the minimum-standard-deviation portfolio is a good summary measure of the volatility of returns. The minimum standard deviations in April and October 1861 are 0.37 and 0.36 percent per week. The minimum standard deviation in April 1861 increases almost 40 percent to 0.50 percent per week. The minimum standard deviation in the six months from April 1861 to October 1861 is higher yet: 0.83 percent per week. While this still is substantial turmoil after the fall in bond prices, at least the prices of most bonds are increasing.

B. The Riskiness of Banks' Portfolios

Figure 3 shows the fates of banks with different portfolios combined with the efficient frontier for April 1860. The left-hand panel shows banks that remained open or closed, and the right-hand panel shows banks that failed.[8] We combine data on banks that close with those which remain open because noteholders suffer no losses in closed banks.[9] The data plotted are the weekly mean returns and standard deviations in April 1860 for banks in Illinois, Indiana and Wisconsin that existed in October 1860. The portfolio mean returns and standard

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[8] In Illinois, a bank is counted as closed or failing if there is no balance sheet information in the October 1861 report or it is reported to be ceasing operations in that report. In Indiana, a bank is counted as closed or failing if it is reported to be ceasing operations in the January 1862 report. In Wisconsin, a bank is counted as closed or failing if there is no balance sheet information in the January 1862 report or it is reported to be ceasing operations in that report.

[9] Fourteen of the ninety banks in the left panel of Figure 3 closed, and the bank with the highest return in that figure is one that closed.

The analysis in this figure reflects only information on what noteholders were paid by the state banking regulator. Noteholders may have received more payments, because banks had other assets and stockholders were liable for up to twice the book value of capital in the bank. Information on such payments is relatively difficult to acquire though because it is likely to be available only in the courthouses of the counties in which banks were located if the information exists at all.

deviations are computed using banks' bond holdings in October 1860 because the earliest prior data available is from late 1859, which is likely to be too early to be representative of banks' actual experience. The estimates do not substantially reflect banks' relative ability at estimating the risk and implications of war because October 1860 precedes Lincoln's election and the dramatic drop in bond prices. The symbols in Figure 3 are letters indicating the state in which a bank is located. The letter *i* indicates a bank in Illinois, the letter *n* indicates a bank in Indiana and the letter *w* indicates a bank in Wisconsin.

The striking contrast visible in Figure 3 is the higher returns for banks that closed or remained open compared to banks that failed. For a given standard deviation, the banks that fail have noticeably lower returns. This is especially striking because these average returns are for November 1859 through April 1860, well before the election leading to the Civil War. It is not apparent that the banks which failed were the riskiest ex ante in terms of the raw standard deviation. On the other hand, it is clear that the banks with lower returns for a given standard deviation were more likely to fail. That said, banks in both sides of the figure are clustered around low returns, presumably at least partly due to deviations of ex post returns from expected returns. The banks in Indiana appear to have higher returns than the other banks, with many of them in the upper half of the area enclosed by the frontier.

Figure 4 compares the riskiness of banks that failed with other banks. The ex ante riskiness of a bank's portfolios is one possible way to examine the bank's likelihood of failure. Leverage is another measure of risk, which can be measured in a variety of ways. We measure leverage by the ratio of bonds to capital in Figure 4 because this measure of leverage reflects the risk borne by stockholders for a given standard deviation of returns. Figure 4 is similar to

Figure 3, with the open and closed banks in the left panel and the failed banks in the right panel and the same symbols for the observations. Figure 4 shows that banks that stayed open or closed have a low ratio of bonds to capital, a low standard deviation, or both. Many banks that failed have similar ratios of bonds to capital and standard deviations as banks that did not fail, but a fair number of banks that failed in Illinois have relatively high ratios of bonds to capital and high standard deviations. Figure 4 also shows that banks in Illinois have far higher ratios of bonds to capital than banks in Indiana and Wisconsin. The average ratio of bonds to capital is 2.22 in Illinois, 1.12 in Indiana and 0.92 in Wisconsin. The lower ratio of bonds to capital in Wisconsin than in the other two states is explained by the legal restriction in Wisconsin limiting notes issued by banks to no more than their equity capital. There is no similar explanation for the contrast between Indiana and Illinois though. Combinations of high leverage and high portfolio risk may be associated with failure, although the importance of the two is not discernable from the figure alone.

IV. The Predictability of Bank Failures Conditional on Ex Ante Riskiness

In this section, we report our statistical analysis of the relationship between banks' fates and the ex ante riskiness of their bond portfolios and their leverage. The information on the balance sheets of the banks in Illinois and Indiana are for October 1860 and in Wisconsin are for January 1861.

We use a maximum likelihood estimator developed by Dwyer and Hasan (1999) to estimate the relationship between a bank's riskiness and its fates. The statistical framework is a two-equation maximum likelihood estimator of the probability of banks closing and the losses borne by noteholders. We do not repeat the statistical discussion in that paper, but the basic

elements can be summarized simply. The equation for whether or not a bank remains open is a standard probit with an underlying normal distribution of the unobservable variable, the present value of the bank's earnings. Losses borne by noteholders are represented by an inverse measure: the redemption rate, which is one minus the loss rate. The redemption rate is the average value of notes received by noteholders. The distribution of the redemption rate is truncated from below at zero because notes becoming worthless was the worst that could happen to noteholders.[10] The value of the notes is censored from above at one because noteholders never received more than the par value of the notes. An additional complication for the estimation is that no bank could redeem its notes at less than par value and remain open; hence, any open bank necessarily has an observed redemption rate of one. This means that the two-equation system is related to Poirier's (1980) model of partial observability because a bank that remains open and has a redemption rate less than one is impossible. This restriction on observable states implies that maximum-likelihood estimation of the note-value equation without the present-value equation is inconsistent (Poirier 1980; Maddala 1983; Meng and Schmidt 1985)

The measures of ex ante risk that we use are related to a bank's bond portfolio and leverage. The leverage that matters to owners of a bank is the ratio of bonds to equity capital. The lower this ratio, the more the losses that will be absorbed by stockholders before a bank has a negative book value of capital. Noteholders care about a different measure of leverage: the amount of bonds backing their notes. The maximum amount of notes that banks could issue

[10] Noteholders had no liability in the event of a bank's insolvency.

was limited by the amount of bonds, but there was no minimum amount of notes that could be issued. All else the same, the more bonds held by a bank given its note issue, the higher the redemption rate on a bank's notes. As an additional measure of risk, our statistical analysis includes the exposure of a bank to a run on its notes, measured by the ratio of notes to assets. Because we know that there was a run on banknotes in 1861, this measure of risk of exposure to a run on notes may be an ex post measure of risk and not an ex ante measure, which means that caution is required in interpreting it as a measure of ex ante risk.

In our statistical analysis, we use the returns on banks' portfolios for the 26 weeks ending in May 1860. These data from late 1859 and early 1860 are prior to Lincoln's nomination and are unlikely to reflect the full effects of Lincoln's nomination, his election, the secession of southern states and the subsequent outbreak of war. We measure the banks' portfolios using both the mean weekly return and the weekly return's standard deviation. Figure 3 also suggests that deviations from the efficient frontier may be important, possibly due to managerial inefficiency, an argument related to that in Wheelock and Wilson (1995). We measure a bank's deviation from the frontier alternatively by the horizontal, vertical and Euclidian distances from the frontier.

These measures of ex ante risk are not the only variables that are likely to be important for determining a bank's present value or the value of its notes. Additional variables included in the statistical analysis are: the ex post losses on the bond portfolio; a dummy variable equal to one for a bank in Indiana and Wisconsin and zero for a bank in Illinois; a bank's age; the population density of the county in which a bank is located; and the bank's assets. We present estimates with and without a bank's ex post losses from July 1860 to July 1861. Ex post losses

relative to capital are included in the present-value equation because losses and the subsequent cost of reorganizing a bank affect the bank's present value. Ex post losses on the bonds relative to the par value of notes affect the value of the notes to their holders. We also include a dummy variable equal to one for banks in Indiana and Wisconsin and zero for Illinois, a grouping consistent with the characteristics of the banks and the regulatory environment.[11] The balance sheets of banks in Illinois have smaller deposits and loans compared to banks in Indiana and Wisconsin. In addition, Illinois closed banks when a bank's bond account was deficient or someone protested the bank's notes, but Wisconsin had an effective suspension of payments (Dwyer and Hasan 1999) and Indiana never closed banks solely because of deficient bond accounts. We include the bank's age in the equations as a dummy variable equal to zero unless a bank is one year old or less in October 1861 in Illinois and Indiana or in January 1862 in Wisconsin. This measure of age is consistent with Gorton's (1996) evidence on the riskiness of new banks. Population density is included in both equations because low population density may be associated with remote locations and wildcat banking. Finally, we include the asset size of each bank in both equations, which may be associated with the bank's reputation, stability or other factors. It is plausible that larger banks are more likely to stay open and have higher redemption rates than smaller banks when they do close, although there is no strong theoretical reason to expect any particular relationship.

Portfolio Riskiness

[11] A statistical analysis with a separate dummy variable for Indiana is not particularly informative because no banks closed in Indiana. A statistical analysis similar to that in the paper for Illinois and Wisconsin without Indiana generates similar results and conclusions.

Table 3 presents the results of estimating these equations including all variables other than deviations from the banks' efficient portfolio frontiers. The table reports the estimated coefficients and their standard errors, the latter calculated from the square root of the diagonal elements of the inverted Hessian. The table also presents the p-values of likelihood ratio tests of the hypothesis that each coefficient is zero and the marginal effects of a change in each variable. The marginal probabilities in the present-value equation and the marginal effects in the note-value equation are the partial derivatives of the estimated equations evaluated at the means of the right-hand-side variables.[12] Some variables are transformed by logarithms because the equations' fit is better when logarithmic transformations of the variables are used. The table also includes estimates of the correlation of the errors across equations and the standard deviation of the error term in the note equation, both of which are estimated parameters because the errors are unobservable. Finally, the table includes the likelihood ratio statistic to test whether all coefficients other than the intercepts are zero.

The control variables' estimated coefficients in Table 3 that are statistically significant generally have the anticipated signs. The surprising result is the positive sign of the ratio of bonds to capital in the equation for whether a bank remains open.[13] This estimate may reflect the endogeneity of this particular variable, with higher present-value banks holding more bonds relative to capital. This positive coefficient also can be interpreted as indicating that Wisconsin's restriction on note issuance relative to capital reduced banks' present values, and

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[12] The value of notes, losses relative to notes and losses relative to capital are all measured in dollars per dollar. The population density is measured as persons per acre.

[13] Dwyer and Hasan (1999) report a similar finding.

more notes relative to capital increased banks' present values in Illinois and Indiana. Not surprisingly, ex post losses relative to capital and notes are important determinants of banks' present values and redemption rates on their notes respectively.

Ex ante risk is important in these estimates. The standard deviation of the rate of return on a bank's bond portfolio is statistically significant. The Chi-square test statistic for the standard deviation in both equations is 8.01 with two degrees of freedom, which has a p-value of 1.8 percent. The Chi-square for the mean return in both equations is smaller, 4.63, with a p-value of 9.9 percent. Because the equations in Table 3 include the ex post losses in addition to the ex ante return and standard deviation, the statistical insignificance of the mean return may reflect nothing more than the superiority of hindsight over foresight.

Table 4 presents estimates with the ex post losses on the bond portfolios deleted from the equations. To overcome a problem of nonconvergence of the estimation algorithm, the estimates in Table 4 are conditional on a correlation of the errors of 0.95, which is roughly the same as the estimate in Table 3.[14]

The estimates without ex post losses provide substantial support for the informativeness of a bank's ex ante riskiness. A bank's ex ante riskiness is measured by the standard deviation of the portfolio's return, the mean return, the bank's leverage and its exposure to a run on notes. Both the standard deviation and the mean return are statistically significant in each equation and also are jointly significant in both equations. There is also support in Table 4 for leverage's importance, even though neither the coefficient of bonds relative to capital nor the

[14] Estimates conditional on an estimated correlation of 0.00 are similar, which suggests that the estimates are insensitive to the value of the correlation of the errors.

coefficient of bonds relative to notes is statistically significant. The Chi-square test statistic for both coefficients being zero simultaneously is 10.293 which has a p-value of 0.5 percent. In addition, the concentration of a bank on the note business clearly lowers the bank's present value and the noteholders' redemption rate in the event of a run on notes.

The estimated coefficients in Table 4 do, however, suggest a problem with the mean return. Both estimated coefficients of the mean return are positive, the opposite of what would be expected if a higher mean return suggests more risk and is associated with a lower probability of continuing in business. Positive coefficients are more consistent with the mean return being a measure of a bank's losses. This interpretation is bolstered by the fact that the return is statistically significant at the five percent significance level in Table 4 without the ex post loss but not in Table 3. The correlation between the mean return on the bond portfolio for the 26 weeks ending in April 1860 and the loss per dollar of notes, included in Table 3, is -0.526.[15] This negative correlation is consistent with the mean return being an imperfect proxy for the later loss but hardly sufficient to be sure.

A big difference between banks that failed and banks that did not fail is the lower return even in April 1860 for banks that failed, a point evident in Figure 3. This appears as vertical deviations from the efficient frontier in that figure. These deviations from the efficient frontier may be due to unexpected decreases in the prices of bonds, decreases that continued into 1861 and resulted in the demise of many banks; they also may simply reflect inefficiency on the part of many insufficiently diversified banks.

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[15] The correlation of the loss per dollar of notes and the standard deviation of the portfolio's return is 0.19, smaller in magnitude.

No matter what the verdict is about the usefulness of the mean return, the equations in Table 3 with the ex post return deleted suggest that ex ante risk is important. The standard deviation of returns still helps to predict whether a bank remains open and the redemption rate if the mean return is deleted from the equations. The Chi-square test statistic for the standard deviation's coefficients in both equations being zero is 11.54 with two degrees of freedom and a p-value of 0.3 percent. A bank's leverage appears to be informative, although the economic significance of the results is not obvious. The coefficient of leverage in the present value equation is positive and the coefficient in the note equation is negative; the anomalous positive coefficient is quite statistically significant and the expected negative coefficient has a p-value of 75.6 percent. Notes relative to assets, on the other hand, are informative: the p-value for both negative coefficients of notes relative to assets being zero is 0.08 percent.

The association between a bank's standard deviation and its fate as well as noteholders' losses is clear evidence that the ex ante riskiness of a bank's bond portfolio helps to predict whether a bank fails. The importance of exposure to a run on notes bolsters the result for the standard deviation. Even so, it is worthwhile to explore the association between the mean return and a bank's fate, in part because it may be associated with ex ante inefficiency of banks' portfolios.

Portfolio Inefficiency

Figure 3 suggests that deviations from the efficient frontier may be important for predicting which banks fail. The two panels of Table 3 present test statistics for examining the importance of those deviations. The first panel shows test statistics for horizontal and vertical deviations from the efficient frontier. We interpret these statistics as providing little support for

the importance of inefficient frontiers, suggesting instead that the mean return is important at least partly because it is a proxy for ex post losses. Vertical deviations associated with lower holding period returns are statistically significant but horizontal deviations are not. The vertical deviations are more directly affected by unexpected decreases in bond prices than are the insignificant horizontal deviations. In addition, the p-value for the mean return falls from 0.003 percent to 0.2 percent when the vertical deviation is included, which is consistent with the vertical deviation and the mean return both being proxies for the ex post loss to some extent.

The bottom panel of Table 3 shows tests based on using Euclidian distance to measure deviations from the frontier. The Euclidian distance is the minimum distance to the frontier from the bank's mean return and the standard deviation of its return. This measure of distance is statistically significant with a p-value of 1.4 percent. This provides some support for the importance of deviation from the frontier, although this measure of distance reflects the vertical deviation in addition to the horizontal deviation. Overall, we conclude that deviation from the frontier may be important, but the unimportance of horizontal deviations of a bank's standard deviation from the efficient standard deviation leaves a large measure of doubt.

V. Conclusion

Greater ex ante riskiness helps to predict a bank's fate, at least in this banking panic. Not surprisingly, a bank's ex post loss on its bond portfolio helps to predict its fate. The ex ante variability of a bank's portfolio also consistently helps predict its fate and the redemption rate. While the importance of the standard deviation is the strongest evidence for the importance of ex ante risk, this is not the only evidence. We find that a bank's exposure to runs on notes is associated with the likelihood of failure and noteholders' losses. There is a

clear association between a bank's mean return on its portfolio well before the panics and the final outcomes, but this is clouded by the correlation of the mean return and the later ex post loss. The relationship between the Euclidian distance from the frontier and the outcomes is the strongest evidence that an inefficient portfolio of bonds contributed to the likelihood of failure and noteholders' losses.

The evidence in this paper is based on one episode, but it is a fairly typical banking panic with atypical data available. An exogenous event occurred that raised questions about the ability of the banks to honor their obligations and a run on the banks ensued. We find that riskier banks were more likely to fail and holders of notes in such banks were more likely to suffer losses. In this panic, measures of risk based on typical, everyday events are informative about outcomes associated with an atypical event – a banking panic.

We conclude that predicting the fate of a bank in a banking panic may be like predicting the fate of a person crossing the road. Generally it's a car that you don't see that hits you, but a person who crosses more prudently is less likely to get hit.

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Table 1

BALANCE SHEETS OF FREE BANKS IN ILLINOIS, INDIANA, AND WISCONSIN (THOUSANDS OF DOLLARS)

AGGREGATES WITH SUMMARY COMMON CATEGORIES	ILLINOIS OCTOBER 1, 1860		INDIANA JANUARY 7, 1861		WISCONSIN JANUARY 7, 1861	
	DOLLARS	FRACTION	DOLLARS	FRACTION	DOLLARS	FRACTION
Assets						
Bonds	11,921	0.613	1,298	0.355	4,656	0.279
Loans	2,485	0.128	1,480	0.405	8,051	0.483
Notes of other banks	287	0.015	134	0.037	1,163	0.070
Cash and other cash items, due from banks and brokers	3,576	0.184	292	0.080	871	0.052
Specie	506	0.026	195	0.053	371	0.022
Real estate	518	0.027	70	0.019	364	0.022
Other accounts	145	0.007	189	0.052	1,199	0.072
Total assets	19,438		3,658		16,676	
Liabilities						
Notes in circulation	11,011	0.566	1,036	0.283	4,233	0.254
Deposits	808	0.042	782	0.214	4,081	0.245
Due to others	486	0.025	77	0.021	1,634	0.098
Other accounts	381	0.020	213	0.058	0	0.000
Capital	6,751	0.347	1,550	0.424	6,732	0.404
Total liabilities	19,437		3,658		16,681	

Notes: Data are from individual banks' balance sheets. We have used common titles for categories with slightly different titles in the originals and have combined related items to make the states' balance sheets comparable. Assets and liabilities do not add to exact equality in the originals. Sources: The data are from U.S. Congress (1861). The states and the respective pages are: Illinois, pp. 222-27; Indiana, pp. 231-32; Wisconsin, pp. 256-77.

Table 2

MAJOR PROVISIONS OF THE FREE BANKING LAWS ILLINOIS, INDIANA AND WISCONSIN AT START OF 1861

RESTRICTION	ILLINOIS	INDIANA	WISCONSIN
Backing for Banknotes			
Eligible bonds	U.S. and states paying full interest	U.S., Indiana and states paying interest semi-annually or more frequently.	U.S. and states paying full interest. Also secured Wisconsin railroad bonds with 7 percent coupon, but not more than half of a bank's total bond deposit.
Value of bonds used to determine notes issues	Ninety percent of the last 6 months average price. Fifty percent if coupon less than 6 percent. Not more than par value or market value at time of deposit.	Ten elevenths of value. Shall be, or made equal to, 6 percent coupon bonds. Not more than par value or market value at time of deposit.	The average of the last 6 months price. Shall be, or be made equal to, 6 percent coupon bonds. Not more than par value or market value at time of deposit.
Other limits on notes issued	None	Total note issue for all free banks not more than $6 million.	Total note issue not to exceed subscribed capital.
Bond account deficient when	Bonds lessened in value or insufficient as security.	Bonds have depreciated in value by 5 percent or issuer fails to pay interest.	Market value of bonds for 60 days less than value at which deposited.
Grace period to make up deficiency	Reasonable time (in practice before 1861, 40 days).	None specified	30 days
At end of grace period	Bank closed	Nothing	Bank closed
Bank Size			
Minimum size	Minimum subscribed and paid-in capital of $50,000	At least $50,000 in bonds deposited	Minimum subscribed capital of $25,000
Maximum size	None	Total note issue not to exceed $200,000	$500,000
Stockholders' liability	Double subscribed capital	Double subscribed capital	Double subscribed capital plus bond for value of one-quarter of notes issued.
Liability after sale or transfer of stock	6 months	1 year	6 months
Protested Notes			
Grace period to redeem	10 days	None	10 days
At end of grace period	Bank closed	Bank closed	Bank closed
Penalty paid to holder of protested notes	12 percent per year	10 percent per year	5 percent damages

Sources: Illinois (1851-1861); Indiana (1851-1861); and Wisconsin (1852-61).

Table 3

BANKS CLOSING AND REDEMPTION RATE
LOSS RATE IN EQUATION
ILLINOIS, INDIANA AND WISCONSIN 1861

	PRESENT VALUE		NOTE VALUE	
RIGHT-HAND-SIDE VARIABLES	COEFFICIENT STD. DEV.	MARGINAL EFFECT P-VALUE	COEFFICIENT STD. DEV.	MARGINAL EFFECT P-VALUE
Intercept	-4.071 3.302	-1.331 0.512	0.469 0.456	0.728 0.662
Dummy variable for Indiana and Wisconsin	1.121 0.385	0.525 .001	0.143 0.041	0.222 $<10^{-3}$
Standard Deviation of Bonds' Return	-145.190 51.107	-47.471 0.005	-9.610 6.680	-14.894 0.157
Holding period return on bonds	344.095 181.378	112.504 0.065	49.109 27.818	76.113 0.085
Logarithm of loss/capital	-3.859 1.092	-1.262 $<10^{-3}$		
Loss/Notes			-0.933 0.145	-1.446 $<10^{-3}$
Dummy variable for age not more than 1 year	0.208 0.335	0.068 0.535	0.005 0.035	0.007 0.894
Population density	0.382 1.348	0.125 0.833	0.349 0.236	0.541 0.204
Logarithm of bonds/capital	1.978 0.548	0.647 $<10^{-3}$		
Logarithm of bonds/notes			0.268 0.231	0.416 0.219
Logarithm of assets	0.279 0.268	0.091 0.742	0.045 0.036	0.069 0.168
Logarithm of notes/assets	-2.015 0.498	-0.659 $<10^{-3}$	-0.281 0.049	-0.281 $<10^{-3}$
Standard deviation of error	1		0.17	
Correlation of errors Likelihood ratio p-value	0.955 $<10^{-3}$			
Maximized value of log likelihood	-33.312			
Number of observations	199			
Chi-square likelihood ratio test statistic	256.620			
Degrees of freedom	20			
p-value	$<10^{-3}$			

Table 4

BANKS CLOSING AND REDEMPTION RATE
LOSS RATE EXCLUDED FROM EQUATION
ILLINOIS, INDIANA AND WISCONSIN 1861

	PRESENT VALUE		NOTE VALUE	
RIGHT-HAND-SIDE VARIABLES	COEFFICIENT STD. DEV.	MARGINAL EFFECT P-VALUE	COEFFICIENT STD. DEV.	MARGINAL EFFECT P-VALUE
Intercept	-3.446 2.882	-1.113 0.077	0.425 0.491	0.668 0.208
Dummy variable for Indiana and Wisconsin	1.301 0.333	0.420 $<10^{-3}$	0.161 0.047	0.253 $<10^{-3}$
Standard deviation of bonds' return	-167.463 47.115	-54.089 0.019	-28.447 7.678	-44.727 0.003
Return on bonds	572.509 159.379	184.914 $<10^{-3}$	129.496 28.655	203.605 $<10^{-3}$
Dummy variable for age not more than 1 year	0.063 0.290	0.020 0.699	-0.032 0.043	-0.050 .061
Population density	-0.440 1.820	-0.142 0.282	0.075 0.366	0.117 0.129
Logarithm of bonds/capital	1.035 0.358	0.334 0.538		
Logarithm of bonds/notes			-0.054 0.170	-0.085 0.738
Logarithm of assets	0.153 0.235	0.049 0.094	0.039 0.038	0.061 0.369
Logarithm of notes/assets	-1.888 0.420	-0.610 $<10^{-3}$	-0.255 0.055	-0.401 $<10^{-3}$
Standard deviation of error	1		0.202	
Correlation of errors	0.95[a]			
Maximized value of log likelihood	-61.699			
Number of observations	199			
Chi-square likelihood ratio test statistic	199.846			
Degrees of freedom	18			
p-value	$<10^{-3}$			

a. No likelihood ratio is included for the correlation of the errors because the parameter is fixed at 0.95 in the estimation.

Table 5

TEST STATISTICS FOR ALTERNATIVE HYPOTHESES

HYPOTHESIS	CHI-SQUARE TEST STATISTIC	DEGREES OF FREEDOM	P-VALUE
Equations with Horizontal and Vertical Deviations from Frontier Added			
No vertical deviation	13.773	2	0.001
No horizontal deviation	0.386	2	0.825
No horizontal deviation and no vertical deviation	14.915	4	0.005
No vertical deviation conditional on no horizontal deviation	13.978	2	$0.92 \cdot 10^{-3}$
No horizontal deviation conditional on no vertical deviation	1.142	2	0.565
No mean return	8.090	2	0.018
No standard deviation	8.572	2	0.014
No mean return and no standard deviation	13.019	4	0.011
Equations with Euclidian Distance from Frontier Added			
No Euclidian deviation	8.491	2	0.014
No mean return	21.548	2	$0.21 \cdot 10^{-4}$
No standard deviation	14.115	2	$0.86 \cdot 10^{-3}$
No mean return and no standard deviation	39.089	4	$0.67 \cdot 10^{-7}$

Figure 1

Prices of Bonds

January 7, 1859 to December 20, 1862

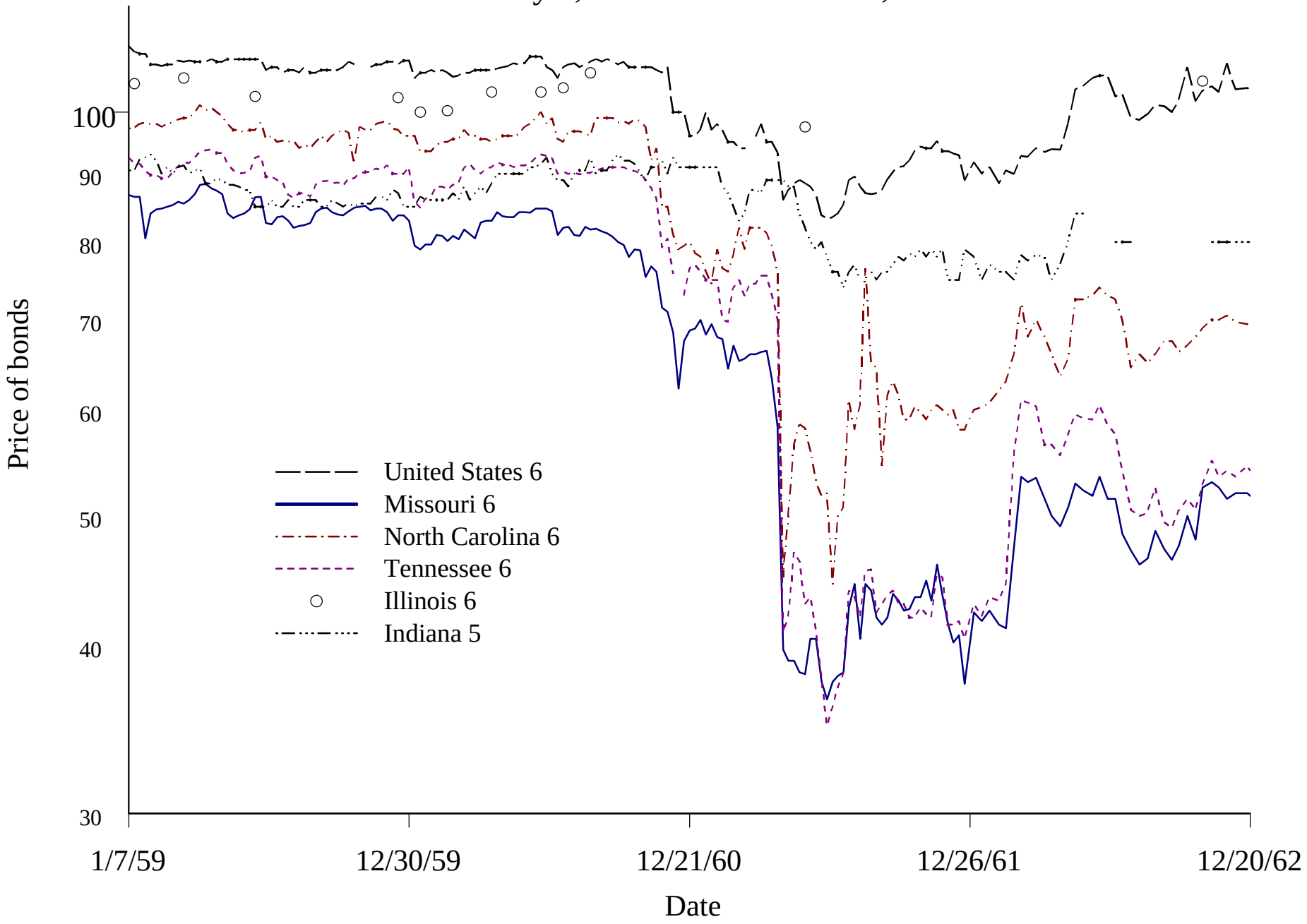


Figure 2
Efficient Frontiers

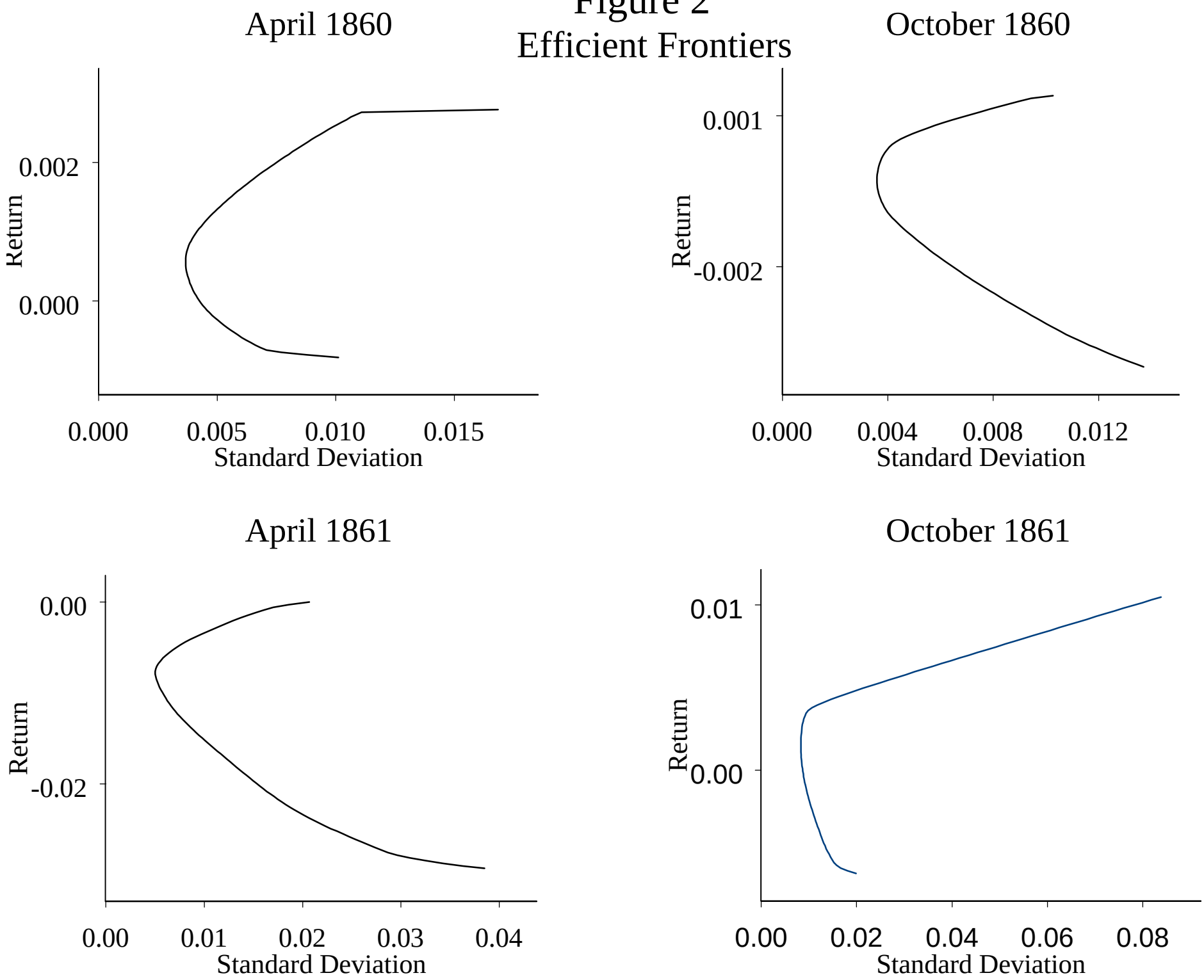
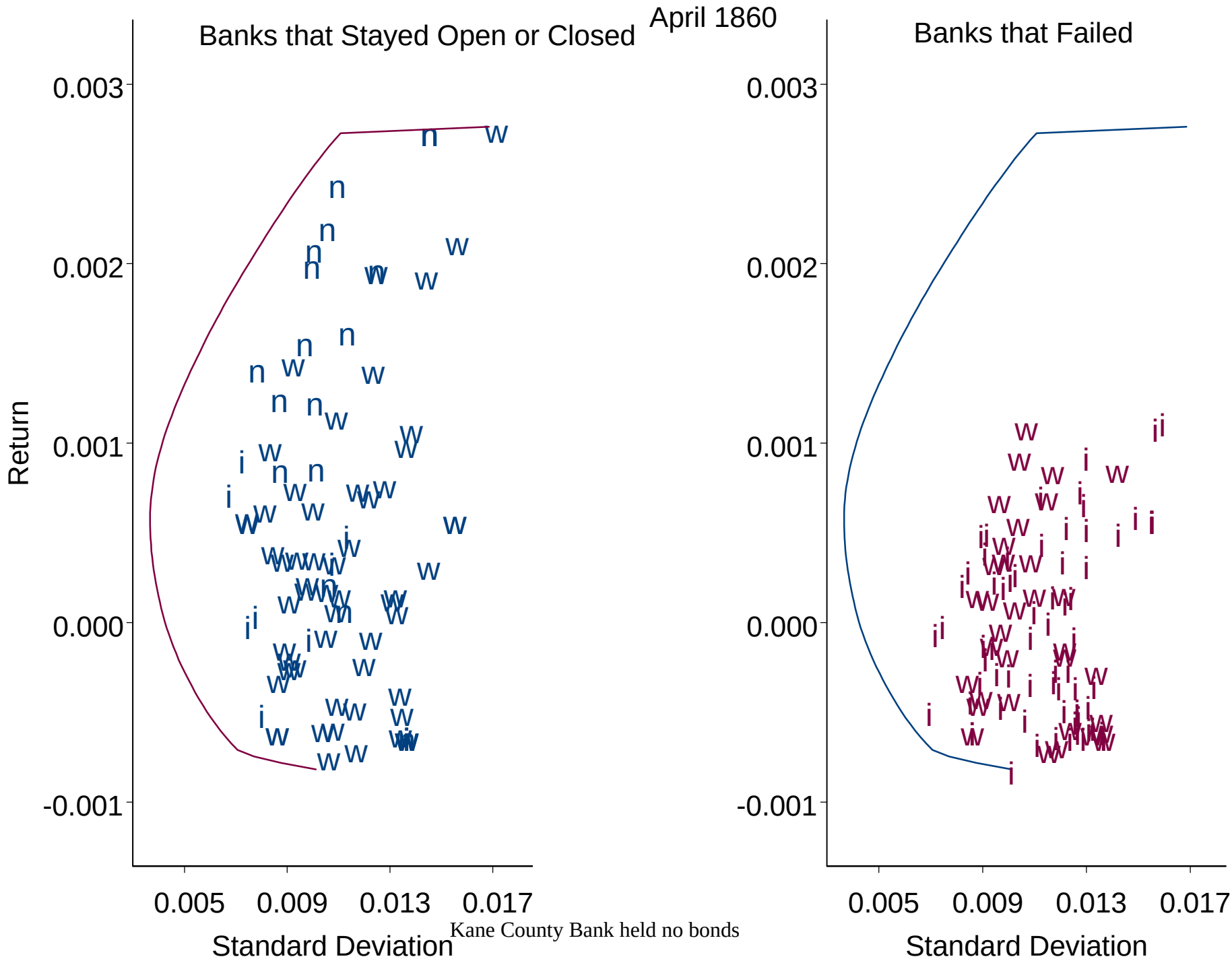


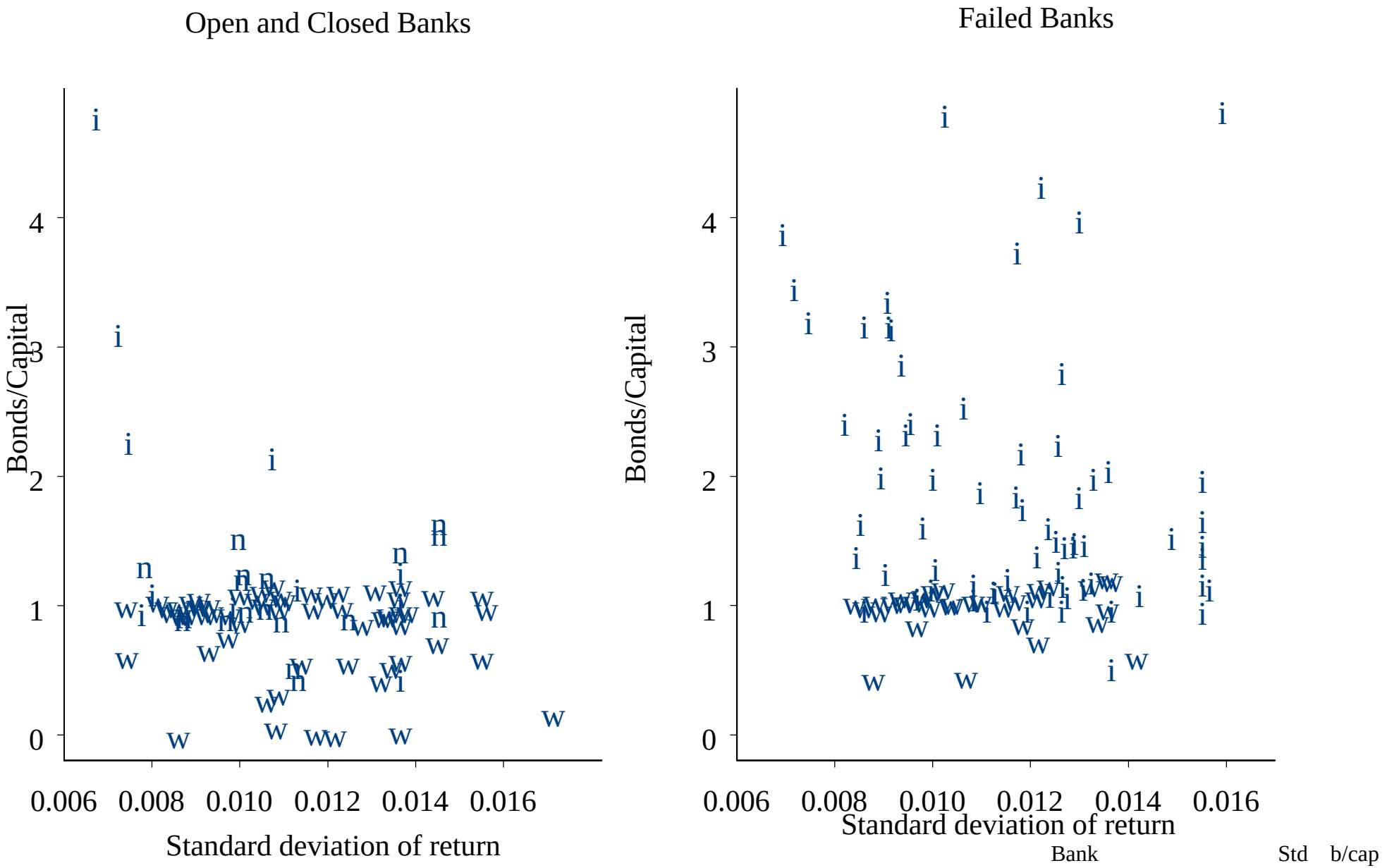
Figure 3
Banks' Fates and Their Portfolios



Kane County Bank held no bonds

Figure 4

Leverage and Variability of Bond Prices



Bank	Std	b/cap
Kane County Bank	0.000	0.68

Bank	Std	b/cap
Frontier Bank	0.012	9.68
Grayville Bank	0.014	9.24
Bank of Southern Illinois	0.012	6.4