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THE ENFORCEABILITY OF PRIVATE MONEY CONTRACTS, MARKET EFFICIENCY, AND TECHNOLOGICAL CHANGE

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ABSTRACT

The period prior to the U.S. Civil War saw the introduction and rapid diffusion of the railroad. It was also the Free Banking Era (1838-1863) during which some states allowed relatively free entry into banking. Banks in all states issued distinct private monies, called bank notes, which circulated at discounts from face value in secondary markets at locations away from the issuing bank. This paper proposes a pricing model for bank notes, and then, using a newly discovered data set of monthly bank note prices for all banks in North America, studies the secondary market for privately issued bank notes during the American Free Banking Era, 1838-1859. To test the model, the durations and costs of trips from Philadelphia to other locations are constructed from pre-Civil War travellers' guides in order to measure improvements resulting from the diffusion of the railroad during this period. The results suggest that the note market accurately priced risk. Systematic wildcat banking was not possible. The transportation costs of note redemption explain only part of bank note discount variation. Bank default risk was differentially priced and such risk premia varied cyclically.

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> At this time ... any person who could raise a small amount of money was permitted to establish a bank, and allowed to issue notes for four times the sum raised. This being the case, many persons borrowed money merely long enough to exhibit to the bank inspectors, and the borrowed money was returned, and the bank left without a dollar in its vaults, if, indeed, it had a vault about its premises. The result was, that banks were started all over the Western States, and the country was flooded with worthless paper. These were known as the 'Wild Cat Banks.' ... I began to think seriously of becoming a banker. I accordingly went a few days after to a printer, and he, wishing to get the job of printing, urged me to put out my notes. ... My head being filled with the idea of the bank, I needed little persuasion to set the thing finally afloat. Before I left the printer the notes were partly in type, and I studying how I should keep the public from counterfeiting them. The next day, my Shinplasters were handed to me, the whole amount being twenty dollars; and, after being duly signed, were ready for circulation. ... At first my notes did not take well; they were too new, and viewed with a suspicious eye. But through ... a good deal of exertion on my part, my bills were soon in circulation.
>
> William Wells Brown (1853)

I. Introduction

A "free banking" system allows private individuals to issue their own money, without any government regulation other than the common law of personal liability. Government intervention into the private production of money has often been justified on the grounds that such private contracts are not enforceable. Indeed, the "specialness" of banks, necessitating regulation, is usually linked to their role in the production of a circulating medium.

The United States tried relatively unregulated banking following the demise of the Second Bank of the United States which President Andrew Jackson refused to recharter in 1832.[1] Thereafter, many states followed the lead of New York State which passed the Free Banking Act in 1838. The Act allowed anyone to open a bank, with the sole restriction that the private money issued by the bank be backed by designated securities deposited with state regulatory authorities.[2] Banks in chartered banking systems also were allowed to issue private money, but entry was more restricted.[3] Soon hundreds of distinct private monies, called bank notes, were

circulating as media of exchange. Table 1 lists the states which adopted free banking systems and the year of adoption. Also listed are the states which did not adopt free banking, but continued as chartered banking systems.

The experience of the American Free Banking Era, lasting from 1838 until the Civil War, has profoundly influenced subsequent attitudes towards banks, banking, and private money production, as well as the subsequent evolution of government regulation of banking and the structure of the banking industry.[4] The basic critique of private money issuance has been articulated by Milton Friedman (1959):[5]

> ...the contracts in question are peculiarly difficult to enforce and fraud peculiarly difficult to prevent...individuals may be led to enter into contracts with persons far removed in space and acquaintance, and a long period may elapse between the issue of a promise and the demand for its fulfillment...A fiduciary currency ostensibly convertible into the monetary commodity is therefore likely to be overissued from time to time and convertibility impossible. Historically, this is what happened under so-called "free banking" in the United States and under similar circumstances in other countries. (p. 6)

Friedman's claim appears to be that the production of private money constitutes an instance of market failure. Markets have a technological basis: contracts cannot be enforceable, nor a market exist, without the requisite information production and transmission technologies. For a bank note to have been priced correctly, information about the note's backing, including information about the issuance of additional money by the issuer, must flow across space and time. A note holder "far removed in space and acquaintance" from the issuing bank may have been unable to accurately price the bank note. In fact, as we shall see, bank notes were priced differentially: at locations some distance from the issuing bank, notes traded at discounts from their face values. But these prices may not have accurately reflected the value of the notes' backing.

Critics of the period have, in fact, argued that the U.S. was so technologically underdeveloped that it was difficult to price the notes. Information could not travel fast enough. Taylor (1951, p. 312) writes: "As long as transportation and communication were relatively slow and no effective clearing system had developed, mere distance from the centers of commerce was a valuable asset to a bank." In addition, Cagan (1963) argues that the large number of heterogeneous monies in circulation made it difficult to value individual monies, and rendered counterfeiting relatively easy.

Friedman's observation that "...a long period may elapse between the issue of a promise and the demand for its fulfillment..." is relevant because the bank note contract contained an option feature allowing the holder the right to redeem the note at par on demand. When might it be optimal to exercise this option? If the price of the note dropped, indicating, for example, the issuance of more money by the issuer, then redemption might be more desirable than holding the note. But, then to redeem the note it had to be physically carried back to the issuing bank's location. Even if the information about the issuer's behavior reached a distant location, physically returning to the bank of issue to redeem the note may have been costly. Perhaps redemption was so costly that the issuing banks were unconcerned about having to honor their notes.

The basic critique of free banking is rooted in technological considerations. Indeed, in pre-Civil War America communication and transportation were difficult. But, dramatic change did occur. The introduction of the railroad drastically lowered transportation costs as it spread across the country during this period. While the canal and steamboat continued to expand during the pre-Civil War period, it was the railroad which made the greatest advances. Introduced in

England in the 1820s, the railroad was quickly adopted in the U.S. Between 1838 and 1860 railroad mileage nationwide increased from about 3,000 miles to over 30,000 miles.[6] And, though not specifically analyzed in this paper, for the first time in American history it became possible to separate the message from the messenger because of the rapid diffusion of the magnetic telegraph, also first introduced during this period.[7]

The enforceability of private money contracts is intimately bound up with the ability of market participants to accurately price the risk of bank default and mismanagement. Information was required to price risk. Information was also needed to threaten delinquent banks with the redemption option. Market participants needed to know when to exercise this option, and they needed to be able to get to the issuing bank in order to demand redemption. Technological change should have improved the enforceability of the bank note contract. The railroad, in particular, should have eased the cost of note redemption and made information flow much faster. Indeed, the reductions in travel times were dramatic. Between 1836 and 1862 the travel time between Philadelphia and Boston was cut by 65 percent (to fourteen hours), for example. (See Gorton (1989D).) But it is not known what effects these technological changes had on free banking systems. Almost nothing is known, theoretically or empirically, about the workings of the bank note market.

Previous researchers have focused on the question of the alleged existence of "wildcat" banks. These were banks that opened and then inflated their currency to the point where it could not be continuously redeemed.[8] The banker then absconded with the proceeds, leaving the private money worth less than par. The result was, possibly large, losses to the note holders. Cagan (1963) estimated that note holders suffered losses on their note holdings of 25 percent per

year. According to Rockoff (1975) losses on notes ranged from seven cents on the dollar in Indiana to 63 cents per dollar in Minnesota.[9]

A necessary condition for wildcat banking is that such a bank's notes be traded at prices which systematically overvalue the bank's assets. The traditional argument is that because entry into banking was less restrictive in free banking states, wildcat banks may have operated in those states. The existence of wildcats was widely viewed as obvious by writers from the period. Dillistin (1949), summarizing such views, writes that "wildcat banking was prevalent during most of the State bank note era..."[10] Rockoff (1971, 1974A, 1974B, 1975, 1989) argued that wildcat banking did appear to characterize the experiences of some states, but found little evidence to confirm the traditional interpretation of a wildcat bank. Of the eighteen states that passed free banking laws, Rockoff found evidence of wildcat banking in Michigan, Indiana, Illinois, Wisconsin, Minnesota, and New Jersey. On the whole, Rockoff (1971) concluded that "...the empirical evidence suggests that the quantitative impact of wildcatting was probably negligible" (p. 454). Rolnick and Weber (1982, 1983, 1984) examined the timing of bank closings in four free bank states (Minnesota, Indiana, Wisconsin and New York). They argued that free bank failures and losses were not due to systematic wildcat banking, but to recessions.[11]

The possibility of wildcat banking bears directly on the question of the enforceability of bank note contracts. But, the above researchers have tended to focus on the relative numbers (and timing) of bank failures in different states, ignoring the fact that the risk of wildcatting may have been priced. Without ex ante price data it is not clear how to interpret the ex post evidence of relatively higher losses and failures in some free banking states. Also, importantly, the cross-section variation in state experiences reflects a large number of factors other than whether the

state system was a free banking system or chartered banking system. Some states allowed branch banking, and some states sponsored insurance funds. Banks in some states were members of formal or informal private bank associations which regulated members. Also, technological change did not affect all states simultaneously. Addressing root questions about the "specialness" of banking markets requires analyzing the functioning of the bank note market in the context of widely varying state banking systems and uneven technological change.

The simple note pricing model developed here provides a framework for addressing these issues. The goal of the model is to price a bank note. The main result of the model is the demonstration that, if the note market functioned well, then the bank note, a perpetual noninterest-bearing debt obligation of the issuing bank with an embedded redemption option, is equivalent to risky debt with maturity equal to the time it takes to return from the particular location of the note holder to the site of the issuing bank. In that case standard Black and Scholes (1973) option pricing theory can be used to price the bank notes. This model then provides the basis for empirical tests.

In order to analyze these pricing issues, bank note prices are required. This paper uses a newly discovered complete set of bank note discounts or prices.[12] The source is a bank note reporter, as explained below. The data consist of monthly bank note prices of over 3,000 banks in the U.S. and Canada traded in the Philadelphia bank note market from February 1839 to December 1858. Also necessary for the analysis, given the technological change in transportation, are time series of measures of the durations and costs of trips from Philadelphia to the locations of these North American banks. Here, such measures are constructed from pre-Civil War travellers' guides.

The paper proceeds as follows. Section II discusses the workings of the bank note market, and introduces the data source. Section III presents an overview of the data. In Section IV the note pricing model is explained. The implications of the model are confronted by the data in Section V. Finally, Section VI concludes.

II. The Bank Note Market

The production and use of bank notes during the Free Banking Era involved three types of firms. First, banks issued and redeemed bank notes. Second, note brokers bought and sold bank notes, making a market in these risky securities. Finally, consumers using the notes consulted "bank note reporters," newspapers which reported the prices of various banks' notes. Hypotheses about the experience of the Free Banking Era are descriptions of the joint behavior and interaction of these three types of firms.[13] Each firm type is discussed in turn.

A) Banks and Banking Systems

A bank note was a small denomination noninterest-bearing perpetual debt obligation of the issuing bank. The note bearer had the right to present the note for redemption at par at the issuing bank at any time.[14] Notes were issued in convenient denominations to facilitate their use as a medium of exchange.[15] Despite government enforcement of various regulations there was always the possibility of a loss to the bearer of a bank note.

The risk of bank failure, and consequent loss to note holders, varied by state for a variety of reasons. Bank asset portfolios varied by region of the country because banks specialized in lending to borrowers with risks specific to their region. The result was that bank portfolios were not diversified.[16] Bank default probabilities also differed because state regulatory systems, and

the degree of enforcement, varied. As discussed above, there was a distinction between free and chartered systems. In addition, there was variation within each type of system. Bank failures occurred even in those systems which enforced stringent requirements on the acceptable assets for backing bank notes.

While the focus of previous research has been on the distinction between the type of banking system, free or chartered, banking systems differed in other, perhaps more important, ways.[17] First, some banking systems allowed branching, while others did not. State bank charters limited banks' operations to that state (for their deposit business if not their loan business). Most states also prohibited branch-banking within the state. This seems to have been unfortunate since the branch-banking states (Virginia, North Carolina, South Carolina, Georgia, and Tennessee) appear to have been less prone to panics and bank failure, possibly because of the effects of diversification admitted by branching. Also, branch systems allowed for easy interbank loans in times of emergency. (See Schweikart (1987), Calomiris (1989), and Calomiris and Schweikart (1988).)

A second important dimension of state heterogeneity concerns note insurance funds. Some states sponsored insurance funds, while others did not. In general, evidence suggests that banks in states with successful mutual-guarantee or co-insurance systems (Indiana, Iowa, and Ohio) fared better than their counterparts in states without insurance. Banks covered by insurance suffered fewer failures and losses and fared better during panics. For example, in Indiana no insured bank failed during the thirty years the fund was in operation. (New York, Vermont, and Michigan had less successful insurance systems.) (See Calomiris (1989).)

A third important way in which banking systems varied concerns the presence or absence

of bank coalitions. The default risk associated with bank debt, in the form of bank notes, appears to have been reduced by organizations of banks which enforced their own restrictions on member bank risk-taking activity. The Suffolk system of New England is the main example of such self-regulation. The Suffolk system was an arrangement organized around the Suffolk Bank of Boston which, together with other Boston banks, cooperated to curtail the note circulation of country banks. The basic arrangement worked as follows. The Suffolk Bank agreed to receive the notes at par of any country bank which was willing to make a permanent deposit of $5,000, together with additional sums as needed. The Suffolk benefitted in having more to loan out, while the country banks found that their note discounts fell to zero, or near zero.

The Suffolk Bank is often viewed as performing a central bank-like role in providing a clearing system for bank liabilities and concomitantly playing a regulatory role.[18] By the end of the Panic of 1839, for example, only four out of 277 banks in New England outside of Rhode Island suspended convertibility of notes into specie, and they remained solvent. In other areas of the country failure rates were much higher. For example, 13.4 percent of the banks in Ohio, Illinois and Michigan failed.[19]

The evidence strongly suggests that banks in branched systems, banks covered by well-run state insurance programs, and banks which were members of well-functioning bank coalitions were less prone to fail or suspend convertibility during panics. When failure did occur, banks in these systems had smaller losses. It is not known how these factors interacted with the factor which has received relatively more attention, namely, whether the system was a free or chartered banking system.

B) Note Brokers

Today bank liabilities, chiefly checks, clear through an internal bank process. In pre-Civil War America there was no such well-developed mechanism.[20] Instead, notes traded in informal secondary markets operated by note brokers. Note brokers were sometimes banks that quoted prices at which they were willing to buy and sell notes. Also, nonbank firms bought and sold notes, advertising their services in newspapers. Note brokers, often called "Exchange and Brokers' Offices," gathered information on banks, quoted bid and ask prices, often bought notes at discounts and, possibly, redeemed them at the issuing bank.

The role of note brokers in making a market, producing information about individual banks, and transporting notes, will be central to the pricing model to be proposed in Section IV. The basic link between enforceability of the note contract and market efficiency was expressed by one early such broker, who, in response to criticism by banks, defended the activities of the brokers thusly: "If their operations have had a tendency to demolish many institutions [banks] which had been established for the purpose of swindling an unwary public, they have fostered those which are entitled to their confidence and support."[21]

C) Bank Note Reporters

Finally, the third type of firm involved in the note business consisted of information producing firms called "bank note reporters." These firms reported the prices at which notes traded in the secondary markets to consumers using the notes in exchange. Agents offered unfamiliar notes consulted such publications to price the notes and determine their authenticity. Sumner (1896) explains how agents relied on bank note reporters to value notes of distant and unfamiliar banks:

> It is difficult for the modern student to realize that there were hundreds of banks whose notes circulated in any given community. The bank notes were bits of paper recognizable as a specie by shape, color, size and engraved work. Any piece of paper which had these came within the prestige of money; the only thing in the shape of money to which the people were accustomed. The person to whom one of them was offered, if unskilled in trade and banking, had little choice but to take it. A merchant turned to his "detector." He scrutinized the worn and dirty scrap for two or three minutes, regarding it as more probably "good" if it was worn and dirty than if it was clean, because those features were proof of long and successful circulation. He turned it up to the light and looked through it, because it was the custom of the banks to file the notes on slender pins which made holes through them. If there were many such holes the note had been often in the bank and its genuineness ratified.

Such bank note reporters were obtained like other newspapers, by subscription or from a newsstand. Typically, the reporters were printed monthly.[22] The next section presents the data from one such bank note reporter.

III. Bank Note Reporters and the Behavior of Bank Note Prices

The data used in this study are from Van Court's Counterfeit Detector and Bank Note List, a bank note reporter printed in Philadelphia which commenced publication on February 14, 1839. In this section the data source is briefly discussed and the data described. Further detail on the data is provided by Gorton (1989B).

The Van Court reporter was published monthly from February 1839 through December 1858. It is a small tabloid which lists discounts on the notes of the banks of twenty nine states and territories and three provinces of Canada. Table 2 lists the coverage dates and localities of the reporter. For each bank listed by Van Court an integer number was provided. As explained in Gorton (1989B), this number is interpreted as the percentage discount from face value to be applied to that bank's notes. The number "5," for example, is interpreted as a five percent

discount: a note of this bank which has a par value of, say, one dollar, trades in the Philadelphia secondary market at ninety-five cents worth of gold.[23]

The prices quoted by Van Court are not necessarily transactions prices. Van Court never explained exactly where the prices came from and never provided volume data. But, it is not likely that every note for which Van Court quoted a price actually traded that month. Since the purpose of the reporter was to provide a price quotation to consumers on very conceivable note which might appear in a transaction, the coverage is extensive, but trading volume is not implied.[24] Nevertheless there is evidence that the volume of notes circulating with origins outside the local area was sizeable. For example, Knox (1969, p. 368) notes that in 1857 the Suffolk Bank redeemed almost $400,000,000 worth of notes. He also points out that for many years "Connecticut bank notes had been eagerly sought after for circulation in Ohio, Indiana and other Western States..." (p. 384). These observations are consistent with the sizeable inter-regional trade flows in ante bellum America. Fishlow (1964) presents quantitative evidence on these flows. Lindstrom (1975) specifically discusses Philadelphia. A related point is that prices are quoted for notes of banks which, in fact, are insolvent. Their notes may continue to circulate, however.[25]

Not all banks issuing private money during the Free Banking Era are covered by Van Court. Comparing Table 1 to Table 2, note that Oregon, Texas, California, and Minnesota were not covered by Van Court. Bank notes from these locations, if listed by Van Court, were described as of "uncertain" value. Also, only partial coverage is provided for many locations, such as Canada, Wisconsin, and Montana.[26] It is noteworthy that the locations which are not covered, or for which coverage is partial, are typically locations long distances from Philadelphia. While

this is consistent with the notion that distance from Philadelphia back to the issuing bank is important in note pricing, it also suggests that the situation is more complicated. For example, Montana is further away than Minnesota. Yet, Minnesota is never covered.[27] Below these observations about distance will be made more precise.

A) Free Banking States, Chartered Banking States

Tables 3 and 4 provide summaries of the data from Van Court for two states. The two states, to some extent representative of the variety of state experiences, are Indiana and North Carolina. (Gorton (1989A) contains similar tables for all other locations.) Indiana adopted free banking in 1852. North Carolina was a chartered banking state for the entire period.

The tables list a variety of information about the note discounts, including the "average modal discount" which is the annual average of the monthly modes. At each date the bank notes of most banks at each particular distant location are trading at the same discount in Philadelphia. This number is the modal discount. The column entitled the "average modal percent" gives the average of the monthly percentages of the total number of banks in that location which had the modal discount. The mean discount is higher than the modal discount because many of the banks with discounts listed by Van Court are (presumably) insolvent. The tables also provide the number of banks in existence each year. Also listed are some measures of bank leverage. The leverage measures, constructed from the 1876 Comptroller of the currency Annual Report, are measures of the annual aggregate leverage of banks in the particular location.

Indiana is often viewed as one of the worst examples of free banking, though its insurance system is considered to have been a success. Between 1834 and 1853 the State Bank of Indiana was the only bank in the state. It had branches throughout the state, but the "branches" were

separately owned and operated. The bank easily weathered the storm of the Panic of 1837. In 1853, however, the state constitution was changed to allow free banking. (Free banks were not covered by insurance.) As can be seen in Table 3, the number of banks quickly increased. The modal discount also increased dramatically. The modal percentage falls by one half implying that the newly entering banks' notes were more heavily discounted.

During the Panic of 1857 two thirds of the Indiana banks went bankrupt. In Table 3 there is no entry for this year because Van Court listed Indiana banks as all uncertain (even before the panic). Rockoff (1974B) cites evidence suggesting that the problem in Indiana was that the state auditor may have valued Indiana bonds, used to back bank note issues, at par when their market value was less than par.[28]

North Carolina is an example of a chartered banking system (without an insurance system). North Carolina authorized an official state bank in 1854. This bank had branches in four cities and agencies in six others, but did not have a monopoly because the legislature also authorized two other banks. The state government appears to have overseen these banks carefully. Between 1847 and 1860 the state authorized the incorporation of fourteen new private banks with twenty-six branches. These new banks were allowed to receive deposits but could not "issue any bill, note or other device in the nature of a bank note." (See Knox (1969).) Notably, as shown in Table 5, both the modal discount and the standard deviation of the modal discount are low compared to the free banking states.[29]

In Tables 3 and 4 the modal discount is most relevant. The modal discount is the focus of the subsequent empirical work because it represents the price at which the notes of solvent banks traded. In Philadelphia the notes of most banks at any specific distant location traded at the

same price, the modal discount. All other discounts of banks at the particular location are higher, suggesting that those banks may have been insolvent. Since there is no way of knowing for sure whether they were insolvent, this study will focus on the banks trading at the modal discount.

The variety of state experiences are illustrated by the tables. Several other important observations can be made about Tables 3 and 4. For any given location, the modal discount varies substantially over time and does not decline smoothly as might be predicted from a simple notion of how the discount relates to the diffusion of the railroad and the telegraph. Not only does the discount not decline smoothly, but the effects of the introduction of the railroad and the telegraph are not obvious. It seems clear that the modal discount is not solely a function of distance from Philadelphia to the issuing bank, though more will be said about this below. Finally, note the variation in the modal percentage over time for a given location. This presumably reflects the number of insolvent banks with notes still in circulation.

B) Note Discounts, Railroads, and Panic

Table 5 provides a summary of the data from Van Court for the year 1839, the beginning of the sample period. The table shows the monthly modal discounts for each location on which Van Court reported in each of that year. During this period there was a banking panic, visible in Table 5 as negative discounts.[30] As expected, the modal discount for Pennsylvania is always zero. Also, the modal discounts for New England states tend to be lower than other states. This is probably the effect of the Suffolk system in which the Suffolk Bank of Boston monitored member bank risk-taking activity. But another possibility is simply that New England was a long-settled, possibly less risky, region. Moreover, there was almost no free banking in New

England. But, it has been argued that state legislatures in this region were quick to grant bank charters so that entry into banking was similar to a free banking state.[31]

Table 5 also makes clear that distance is not related to note discounts in any simple way. The table provides several examples where the discounts are higher on the notes of banks at locations which are closer to Philadelphia. For example, the discounts on the notes of Tennessee are zero in Table 5. Yet, Tennessee is clearly farther from Philadelphia than many of the other locations. Also, note that the discounts of Vermont's banks' notes are the same as those of New Jersey bank notes. There are many examples of this sort in the data.

C) Travelling From Philadelphia to the Bank of Issuance

In order to exercise the redemption option feature of the note contract, the note bearer had to travel to the location of the issuing bank. Also, for much of the period and many locations, information would have to have travelled by the same mode of transportation that people used. Consequently, the cost of such a trip in terms of time or money would naturally seem to be related to the note discounts or prices. Banks which are more distant from Philadelphia should have notes which are more heavily discounted, ceteris paribus. In fact, a traditional hypothesis explaining the cross-section variation in note discounts is that the cost of returning from the note holder's location to the bank of issuance is the dominant factor. Since banks were risky institutions it is not clear to what extent the discounts reflect travel costs and to what extent they reflect other factors.

In order to analyze the relations between travel costs and note discounts, and to evaluate the note pricing model to be described in Section IV, measures of the distance from Philadelphia back to the location of the banks covered by Van Court are needed. In particular, measures of

the costs and the durations of such trips are needed. Such measures would capture the dramatic diffusion of the railroad across the eastern part of the U.S., as well as the improvements in canals and steamships.

Gorton (1989D) constructs transportation costs and trip duration indices using pre-Civil War travellers' guides and historical information on the costs and speeds of various modes of travel. The travellers' guides provided the pre-Civil War traveller with the most commonly used routes from Philadelphia to various other locations in North America. The guides detail the route to be taken, and indicate whether each leg of the journey was to be by stagecoach, canal, steamboat, or railroad. Combining this information with estimates of the speeds and costs of each mode of transportation, indices were constructed for three years: 1836, 1849, and 1862 (the only years for which such guides could be located). See Gorton (1989D) for details.

Improvements in transportation technology were dramatic. The time and costs of a trip from Philadelphia to other locations in North America were greatly reduced. Figure 1 graphically portrays the reductions in the durations of trips from Philadelphia to the capitals of selected other locations.

To what extent does the distance to the issuing bank explain cross-section variation in the discounts? Table 6 reports the (Spearman rank) correlations of discounts with the measures of the cost of the return trip and the duration of the return trip.[32] Cross-section regressions of the (annual average) modal discount on both transportation indices jointly yield:

For 1839:

$$\text{Modal Discount} = -1.07 - 0.44^{*}\text{Trip Cost} + 0.122^{*}\text{Trip Time}$$

$$(4.3) \quad (4.2) \qquad\qquad (5.3)$$

$R^2 = .31$

For 1849:

Modal Discount = 0.326 + 0.011*Trip Cost + 0.04*Trip Time

(1.19) (0.27) (3.05)

$R^2 = .12$

For 1858:

Modal Discount = 0.333 - 0.059*Trip Cost + 0.067*Trip Time

(3.3) (4.08) (7.3)

$R^2 = .11$

T-statistics are given in parentheses. The results in Table 6 and the above regressions confirms the popular notion that the return trip to the issuing bank is a prime determinant of the discount in cross-section. The traditional hypothesis does fairly well.

A number of questions remain. First, we have previously noted examples where discounts were higher on the notes of banks which were relatively closer to Philadelphia. Either there are other important determinants of the discounts or the note market was inefficient. Are these other determinants the risk attributes of the banking system of that state? Were these risks priced? In order to analyze this question the next section presents a model of bank note pricing.

IV. Pricing Bank Notes

In this section a very simple, stylized, model of bank note pricing is presented. The model is based on Svensson (1985). The goal of the model is to relate the note price to the duration of a trip back to the bank of issuance. Then the above transportation indices can be used to

study the effects of technological change.

A) A Model of Bank Note Pricing

Assume that agents are spatially separated. Let 'd' be a measure of the distance from an agent's home to the market which is the location of the agent's trade at time t. Thus, d indexes location. (A time subscript on d will be omitted, except as necessary.) Each agent owns a firm at the home location. Firms at each location produce a stochastic output of a single nonstorable good, $y(d)_t$. Output is assumed to be independently, identically, lognormally distributed at each date t and location d. The standard deviation of output at location d is given by $\sigma(d)$.

Each household-firm begins period t with equity, Q_{t-1}, and debt, D_{t-1}, outstanding. The debt of a firm consists of small denomination noninterest-bearing perpetuities with embedded American put options allowing conversion of the debt into consumption goods. The debt is called "bank notes." The stock does not pay dividends. Each household is a money-issuing firm so the terms "bank," "household," and "firm" all refer to the same economic unit.

The representative agent (at a representative location) is assumed to prefer goods procured from locations further from home rather than procured nearer home:

$$E_t\{\sum_{j=t}^{\infty} \beta^{j-t} U(c(d))\} \qquad (1)$$

where $0 < \beta < 1$, where $U'_c > 0$, $U''_{cc} < 0$, $U'_d > 0$, $U''_{dd} < 0$. The assumption that utility depends on distance is intended to capture the notion of a division of labor. The idea is that goods produced at other locations are desirable because they are not produced at the home location. The introduction of distance as an argument of the utility function is a device to model

this desire for goods from other locations.[33]

Each household is to be thought of as consisting of a buyer and a seller, as in Lucas (1980). The seller stays at home and sells the output of the firm receiving bank notes in exchange. The buyer chooses to travel a distance, d, to buy consumption goods, paying for them with bank notes. Only one market can be visited at each date t. Buyers face a cash-in-advance constraint which can only be satisfied by bank notes.[34] Let $P_t(d)$ be the price (in terms of consumption units) of bank notes issued by the representative agent and traded at location, d, at time t. Thus, the buyer is constrained by:

$$C_t \leq \Sigma_d P_t dD_{t-1}(d) \qquad (2)$$

which is the cash-in-advance constraint. In (2), the buyer may carry a portfolio of bank notes from banks at different distances, d, from the market that is chosen for transactions at date t.

The sequence of events in a period, t, is as follows. At the start of period t, the current state, $y(d)_t$, is learned for each location, d.[35] Then the goods market opens. The household buyer travels the distance d carrying the predetermined portfolio of bank notes. (The portfolio was held over from date t - 1.) The buyer purchases C_t consumption units from sellers at location d, using bank notes, and then returns home. Meanwhile, the seller sells goods in the home market, receiving bank notes in exchange for consumptions goods. After the goods market closes, and buyers have returned home, the securities market in which notes and shares are traded opens at each location. At this time a household chooses a portfolio of notes and shares and, in particular, may decide to redeem some notes. When the securities market opens, prices for the notes will already have been established in the goods market. At those prices households decide to hold notes or redeem notes, depending on whether they expect to travel a

greater or lesser distance next period.

In order to model the idea that note redemption requires a time consuming trip the following assumption is made. The receipt of a note issued by a firm at distance d from the issuer's location is assumed to imply that it takes d periods to return for redemption, if the holder wants to redeem it. In other words, there is assumed to be an asymmetry between household buyers and sellers. Buyers can carry a note a distance d during a single period. But, a seller who receives the note requires d periods to return it if the redemption option is exercised. Thus, it is costly to redeem notes in the sense that it is time consuming. Since it is time consuming to redeem notes, the amount of debt which will actually be redeemed in period t was, in fact, determined at past dates, and so is predetermined at the start of period t.

The amount of debt that will be redeemed in the current period depends upon the profile of locations, and hence, dates in the past, from which debt was sent for redemption. Notes sent for redemption at date t will be <u>in transit</u> for d_t periods.[36] Suppose that a note of a bank located at a distance d from the home location was sent for redemption k periods ago. This note will be in transit for d periods before it is redeemed. At any time t, if $d > k$, then the note will be redeemed in $d - k$ periods. If, at time t, $d = k$, then the note is presented for redemption in the current period. Let D_t^R be the amount of notes sent for redemption d periods ago. Then this is the amount which the bank must currently redeem.

The situation of the firm, at time t, is as follows. When selling output at time t, the firm will receive bank notes which are the obligations of banks various distances away. Thus, the representative firm has received $\Sigma_d P_t(d)D_t(d) = y_t$ from sales in period t. At the firm's own location the price of a dollar of its own notes is $P_t(0)$. This is the price at which its notes will

be redeemed in period t. The amount of debt which the firm will redeem is: $P_t(0)D_t^R(0)$. ($P_t(0)$ = 1 if the firm is solvent.)

The firm may also issue new debt and new equity. For simplicity assume that no new equity is issued and that the face value of new debt issued always equals the face value of the amount redeemed, so long as the firm is solvent. Thus, the firm's leverage is always the same in book value terms. This assumption means that the amount of resources available for the household from the operation of the firm in a period is always y_t.

Let $q_t(d)$ be the price of shares of banks at location d in period t. Then, the resources available to the household consist of shares, the value of the debt of other firms redeemed, any monies not spent satisfying the cash-in-advance constraint, and the returns from the operation of the firm. In the securities market these resources will be used to finance a portfolio of shares and debt. The household purchases bank shares of various types, bank notes of various types to be held until the next period to finance consumption, and decides how much of each bank's notes should be sent for redemption. So the budget constraint is:

$$\Sigma_d\{q_t(d)Q_t(d)+P_t(d)[D_t(d)+D_t^R(d)]\} \leq$$

$$\Sigma_d P_t(d)D_{t-1}(d)-C_t+P_t(0)D_t^R(0)+\Sigma_d q_t(d)Q_{t-1}(d)y_t \qquad (3)$$

B) Equilibrium

The representative agent chooses a distance to travel in period t, d_t, an amount of notes of each type, d, to be sent for redemption $D_t^R(d)$, an amount of notes of each type, $D_t(d)$, to be carried to next period, and an amount of equity shares of each type, $Q_t(d)$, to:

$$MAX: E_t\{\sum_{j=t}^{\infty} \beta^{j-t} U(C, d)\}$$

subject to: (i) $C_t \leq \Sigma_d P_t(d) D_{t-1}(d)$

and (ii): $C_t \leq \Sigma_d \{P_t(d)D_{t-1}(d) - P_t(d)[D_t(d) + D_t^R(d)]\} + P_t(0)D_t^R(0) + \Sigma_d q_t[Q_{t-1}(d) - Q_t(d)] + y_t$

(The time subscript on d is omitted.) Let μ be the Lagrange multiplier associated with the cash-in-advance constraint, (i). The first order conditions with respect to choice of $D_t(d)$, $D_t^R(d)$, d_t, and Q_t, respectively, can be written as:

$$U'_C = \beta E_t\{U'_{C+1}[P_{t+1}(d)/P_t(d)]\} + \beta E_t\{\mu_{t+1}[P_{t+1}(d)/P_t(d)]\} \quad (4)$$

$$U'_C P_t(d) = \beta^d E_t\{U'_{C+d} P_{t+d}(0)\} \quad (5)$$

$$U'_C = -U_C P'_{dt}\{D_{t-1}(d) - [D_t(d) + D_t^R(d)]\} + \mu_t P'_{dt} D_t(d) \quad (6)$$

$$U'_C q_t(d) = \beta E_t\{U'_{C+1} q_{t+1}(d)\} \quad (7)$$

where "E_t" indicates the expectation conditional on information available at time t.

Equilibrium requires that: (i) the goods market at each location clear, i.e., $C_t(d) = y_t(d)$ for all d; (ii) the market for each bank's equity clear, $Q_t(d) = Q_{t+1}(d) = 1$, for all d; (iii) the market for each bank's debt clear, $D_{t-1}(d) = D_t^R(d) + D_t(d))$, for all d.[37]

The first order condition (4) determines the optimal choice of $D_t(d)$, the face value amount of bank notes from location d to be carried over to next period to provide the household buyer with bank notes to satisfy the cash-in-advance constraint. A bank note dollar held to next period has a direct return, as part of wealth, the first term on the right-hand side of (4), and a future

benefit in the form of future liquidity services when the note dollar is used to satisfy next period's cash-in-advance constraint, the second term. See Svensson (1985) for a discussion.

Conditions (5) and (7) price the firm-bank's debt and equity, respectively. Write (5) as:

$$P_t(d) = \beta^d E_t\{P_{t+d}(0)[U'_{Ct+d}/U'_{Ct}]\} \tag{8}$$

where $P_{t+d}(0)$ is the redemption value of a note d periods from now. This price assumes a first-come-first-served rule since at date t + d, $D^R_{t+d}(0)$ notes have been presented for redemption, and only this debt must be honored at that time. Bankruptcy is defined by whether or not the bank can honor the amount of debt being presented for redemption, $D^R_t(0)$, and not by the outstanding amount of debt.

In considering redemption a complication arises because notes may have been sent for redemption in the past which have not yet reached the issuing bank. These notes are in transit to the bank. Notes in transit will be honored upon arrival only if the bank has not gone bankrupt in the interim. Suppose, for the moment, that there are no notes in transit. (This would be known at time t.) If there are no notes in transit, then there is no question of the bank defaulting prior to presentation of the notes currently being sent for redemption. The value of the bank at time t and location d is: $V_t(d) = P_t(d)D_t + q_tQ_t$.

We now turn to pricing the bank notes. To begin note that:

> **Proposition 1:** The bank notes of a bank a distance d away are valued as risky debt claims with a maturity of d periods.

To see this note that from equation (5), which can be solved for the price of the bank note at location d, $P_t(d)$, the representative agent must, in equilibrium, be indifferent between holding a one dollar note and sending the note for redemption (assuming an interior solution). The value

of a note sent for redemption is given by equation (8). Equation (8) values the note as a risky debt claim maturing d periods later. Even though the debt is perpetual, from the point of view of the representative agent, since it takes d periods to redeem, it can be priced as debt of maturity d. Thus, we can state:

> Proposition 2: Assume that preferences display constant relative risk aversion. Then, if $D_t^R(d)$ is the face value of the amount of debt sent for redemption at date t, from location d, its value at date t is given by:
>
> $$P_t(d) = [D_t^R(d)]^{-1}\{V_t(d)[1-N(h_D+\sigma)]+(1-r_f)^{-1}D_t^R(d)N(h_D)\} \quad (9)$$
>
> where: $h_D \equiv \{\ln[V_t(d)/D_t^R(d)] + \ln(1+r_f)\}/\sigma - \sigma/2.$

σ is the variance of one plus the rate of change of the value of the bank, and r_f is the risk free rate of interest (assumed constant). $N(\bullet)$ indicates the cumulative Normal distribution function.[38] The proposition says that bank notes can be priced using Black and Scholes (1973) option pricing formula. The proof of this proposition is standard and due to Rubinstein (1976).

Propositions 1 and 2 were derived under the assumption that there were no notes in transit. What if there are notes in transit? Then, between the current date, t, and date t + d, these notes will, successively, be presented for redemption. These notes are more senior claimants in a sense. The bank may default on one of these payments. From the point of view of the household-stockholder of the bank these successive redemptions are akin to coupon payments. The stock is a compound option because until the current amount, $D_t^R(d)$ has been redeemed at date t + d, the stockholders have the option of buying the option to redeem the next amount which will be presented. Under these conditions a proposition analogous to Proposition 2 can be proven. That is, assuming that preferences display constant relative risk aversion, the bank

notes can be priced according to Geske's (1977) extension of Black-Scholes.

Equilibrium in the goods market requires that the note price, $P^t(d)$, adjust to clear the market given choice of location d. Then, in the securities market, notes will be demanded for satisfying future liquidity constraints. See equation (8). We can now inquire as to when the redemption option is worth exercising. A note dollar held must satisfy (4); a note dollar sent for redemption must satisfy (5). Thus, the option is "in the money" when a note dollar is more valuable being sent for redemption, i.e., when the value of a note given by the right-hand side of (5) is greater than the left-hand side and vice versa for (8).

C) Equilibrium Note Price Characteristics

Since bank notes can be priced using Proposition 2, Black and Scholes' option formula, some useful comparative statics are immediate.[39] In particular, note that the value of the notes, $P_t(d)$, varies inversely with d, σ, and leverage of the bank. (See Merton (1974).) These results, will provide the basis for confronting the data, starting in the next section.

An important feature of the data is that Van Court quoted "all uncertain" for banks a long distance from Philadelphia, suggesting that the notes of these banks were very highly discounted, perhaps to zero. Locations even further away were not listed. The above valuation model implies that, at the same distance from the issuing bank, not all notes will circulate. Condition (6) determines the optimal choice of distance from home, d^*_t, the buyer should travel to buy consumption goods. To understand (6), recall that in equilibrium $D_{t-1}(d) = D_t(d) + D^R_t(0)$, i.e., the stock of bank notes outstanding for each bank and carried over into period t, must be divided into an amount held until next period and an amount sent for redemption.[40] Thus, in equilibrium, (6) becomes:

$$U'_t = -\mu_t P'_{dt} D_t(d) \qquad (10)$$

Recall that, by Proposition 2, $P'_{dt} < 0$, i.e., the value of notes issued at the home location falls as distance increases because the maturity of the debt increases. Condition (10) says that d_t^* is chosen to equate the marginal benefit of increased distance to the marginal cost of the capital loss associated with carrying the notes further away from home. The notes decline in value with distance leaving the buyer with less on hand to satisfy the cash-in-advance constraint. To summarize:

> **Proposition 3:** At each date, t, there exists a critical distance, d_t^*, beyond which bank notes of banks at location d will not circulate.

The critical distance depends on σ^2 and leverage. Note prices which at various times are quoted in Philadelphia as "uncertain" (or which are note listed at all) may, at other times, be quoted because σ^2 or bank leverage have changed. For example, in Table 5, Arkansas and Nebraska are initially quoted, but subsequently are not quoted, even though the notes of more distant banks are quoted.

Now consider what happens if the household buyer goes to the home market and purchases goods from the household seller using bank notes from the home location, i.e. $d_t = 0$. Then, since the debt has no maturity, the option could be exercised instantly. If a bank note issued by a bank at the home location traded at discount at the home location, it could be costlessly converted into consumption goods at par as long as the bank is solvent. If the note were not priced at par, then this would occur until the bank was closed. Hence, the notes of banks at the home location must have no discount at the home location. By Proposition 2 if $d = 0$, then the discount is zero if the bank is solvent. Thus, $d = 0$ implies that those notes are risk free.

Consequently, the notes of Philadelphia banks should always have a zero discount; they are riskless.

During the Free Banking Era transportation costs and the duration of trips declined greatly with the spread of the railroad across the continent. Since the model does not explicitly detail the transportation technology, this improvement must be thought of in terms of a shift in the utility function, allowing agents to get greater utility from goods at any given location d, and hence, a willingness to travel further for the procurement of consumption goods. This corresponds to an exogenous reduction in the time it takes to get back to a given location, i.e., to a reduction in d. Empirically, technical change in transportation is captured by reductions in d, the time it takes to return to the issuing bank. Technical change reduces d, and hence increases notes prices (reduces discounts), ceteris paribus. If these other factors change, while technical progress is occurring, then note discounts will not necessarily decline smoothly.

Note discounts are not monotonically increasing in time to return, d^*, because of the effects of σ^2 and leverage. The factors which a priori evidence suggests affect bank risk are captured by σ^2. Coalitions of banks which may have effectively been self-regulating, in particular the Suffolk Bank system, encompassing the banks of New England, correspond, in the context of the above model, to a reduction of σ^2. Similarly, σ^2 can be interpreted as capturing the effects of branching restrictions and insurance. σ^2 also captures the default risk associated with bank issuance of additional money by wildcat banks. Whether or not the type of banking system, free or chartered matters, would also be captured by σ^2.

V. The Behavior of Bank Note Prices

By relating the time to return to the issuing bank to the note price, the effects of technological change in transportation are linked to contract enforceability, and market efficiency. If secondary note markets accurately priced risk, that is, accurately priced the redemption option, then the private money contract was enforceable in the sense that note holders would not suffer an unanticipated (i.e., unpriced) transfer to the note issuer (via, say, issuance of additional currency as in wildcat banking or via increases in bank asset risk). The question to be addressed now is: Do bank note prices reflect bank risk?

The strategy for empirically testing the model is to relate Van Court's note prices, or measures of bank riskiness extracted from note prices, to a priori measures of bank riskiness. These measures focus on the dimensions across which banks in different states varied, that is, by market structure (branched or unit banking), by the presence or absence of state-sponsored insurance programs, and by the presence or absence of formal bank coalition (the Suffolk system). Finally, there is the question of whether the type of banking system, free or chartered, matters.

Two empirical strategies will be pursued in this section. The first approach follows the banking literature on "market discipline." This literature is concerned with the modern question of whether market prices of bank uninsured liabilities reflect the default risk of the bank. The empirical strategy used in this literature is to regress bank liability prices on measures of bank risk and normalization variables (such as leverage and maturity) to detect the presence of market pricing of bank risk. While motivated generally by models of corporate liability pricing, the linear specification is ad hoc. Testing various uninsured bank liabilities, in the post-World War

II period, in this way has led to mixed results. It is often not clear whether failures of the model should be interpreted as evidence of market inefficiency or implicit government deposit insurance. Alternatively, the empirical procedure may be flawed and the results nonsensical. A tangential question, of interest in its own right, is whether linear regression is a sensible empirical procedure.[41]

The second strategy (not used in the market discipline literature) is based more closely on contingent claims pricing. Based on the result of Section IV, that bank notes can be priced with the Black-Scholes model as applied to corporate debt by Merton (1974), the volatilities of bank assets, i.e., σ^2's, implied by the note prices can be extracted be inverting the Black-Scholes formula. The implied volatilities are then regressed on the ex ante measures of risk. Using the closed-form Black-Scholes solution depends upon some strong assumptions. Consequently, each empirical strategy has advantages and disadvantages. These are discussed in the final subsection.

A) Linear Note Pricing

According to the note pricing model, note discounts are increasing functions of bank risk, time to maturity, and a decreasing function of bank leverage. The approach typically used in the market discipline literature would regress the monthly modal discount for each date and state on time to maturity, leverage, proxies for bank risk, and some other (normalization) variables. The discount is a censored variable since its range in the data is restricted to minus one and plus one.[42] Therefore, the appropriate estimation procedure is a two-limit Tobit procedure. The question is whether the market prices of bank notes impounds the risks associated with different banking system attributes.

If secondary note markets functioned efficiently then the risk attributes of state banking

systems, discussed above, should be priced. Prior information about state banking system attributes suggests that the notes of well-branched banks, well-insured banks, and banks which were members of the Suffolk System should have lower discounts once leverage and maturity are accounted for. Explanatory variables, thus, include a dummy variable indicating whether the state is a member of the Suffolk System (SUFFOLK), a dummy variable indicating whether the state is a branch banking system (BRANCH), and a dummy variable indicating whether there is a state sponsored insurance arrangement (INSURANCE). Previous research has focused on the distinction between free and chartered banking systems, but it has never been clear how this distinction interacted with other characteristics of state banking systems. Free banking states may have higher discounts since banks in chartered banking states are argued to have been typically less risky than banks in free banking states. A dummy variable indicating whether the state is a free banking state (FREE).[43] (There are only a handful of risk variables available due to the data limitations associated with this period.)

Statements about risk are conditional on a number of other variables. In the linear specification the other right-hand side variables are the measure of the duration of the trip from Philadelphia back to the issuing bank (TRIPTIME), bank leverage, a monthly index of stock prices (SDEX), and a dummy variable for the periods of suspension (SUS). Inclusion of leverage and the time to return to the bank of issuance, are motivated by the pricing model. In including the index of trip times the estimated equations split the sample period into three approximately equivalent parts and assigns the duration of the return trip index, calculated for only three years, to each of the three parts of the sample. (Results are robust to small perturbations of this split.) Leverage is alternatively measured as notes to total assets and as

notes plus deposits to total assets. Inclusion of the stock index implies that there is a "market" effect moving the different states' volatilities in the same direction (as there is for modern stock prices).

The results of the Tobit analysis are contained in Table 7. The table reports the results for a number of different constellations of independent variables and is representative of other results. First, consider the risk attributes of different state banking systems. As expected, membership in the Suffolk System is negative and significant, that is, the note discount is reduced (note price increases) if this bank coalition in present. The branching and insurance attributes, however, are significant, but of the wrong sign. Discounts do not fall when the bank is in a branching system or a state with an insurance fund.

The free banking dummy variable is significant and positive, suggesting that free banking systems are more heavily discounted. In regressions (5) and (6) of Table 7 the free banking systems are split into two groups: good and bad. On the basis of independent evidence Rockoff (1974B) suggests that the free banking states can be usefully divided into two groups: "good" free banking states and "bad" free banking states. Many of the states which adopted free banking laws did not have many banks which operated under these new laws. These states are classified as "good." Also, some states which passed free banking laws, and which had nontrivial numbers of free banks, did not have high failure or loss rates because the free banks were closely regulated. A small number of states, however, adopted free banking and did not carefully regulate.[44] As seen in Table 7, this division does not effect the results.

The pricing model relates discounts positively to the time it took to return to the issuing bank. The results in Table 7 confirm that the duration of the return trip to the issuing bank is

positively related to the discount.

The leverage measures should have positive coefficients since the note discount should increase (note price fall) when the debt to total assets ratio rises. In Table 7 the leverage measures are significant, but of the wrong sign.

The best that can be said is that the results shown in Table 7 are mixed. It would be tempting to conclude that the relevant risk attribute, namely, type of banking system (free or chartered) was priced, and the other risk attributes were not important. Clearly, too much has gone wrong to draw such a conclusion. Results like those in Table 7 are reminiscent of the literature on market discipline in modern banking. (See Gorton and Santomero (1990) for a review.) Here, however, the results cannot be attributed to the existence of implicit insurance. The problem may well be that the method of determining whether bank note prices accurately reflect bank risk does not take into consideration the fact that the pricing relation derived above, in Section IV, was nonlinear. Instead it relies on an ad hoc specification.

B) Contingent Claims Pricing of Bank Notes

An alternative empirical strategy explicitly relies on the option pricing formula to extract measures of bank risk implied by the note prices. This approach is also not without problems. In general, it has not been widely attempted because (among other reasons) firm capital structures make application difficult. Capital structures and corporate bonds are more complicated than those captured by contingent claims models. Attempts to accurately price corporate debt have been mixed at best.[45] There may be more hope in the case at hand, however, since banks during this period did not have a large number of different liabilities and the only embedded option, the redemption option, has been priced by the above model.

In the note pricing model, bank risk is completely captured by the variance or volatility of bank asset values. The basic approach is to first obtain this volatility from the note prices by inverting equation (10).[46] (Note that leverage and trip time (i.e., maturity) are used in the formula to obtain the implied volatilities and do not enter the subsequent regressions.) In this way a measure of the volatility of bank asset values is recovered from market prices for each location and each date. These implied risk measures are regressed on the measures of bank riskiness used above, namely, dummy variables for free bank or chartered banking system, branch banking, insurance program, and membership in the Suffolk System.

The method outlined above uses the exact closed form pricing solution for bank notes obtained in Proposition 2 under the assumption that there are no notes in transit or that agents behaved as if there were no notes in transit.[47] Application of the Black-Scholes formula also requires assuming that the volatility and risk-free interest rate are constant through time. The first of these assumptions may be violated. Evidence suggests, however, that this violation is not likely to be important.[48] The second of these assumptions may also be violated. But, the implied returns on the bank notes are so high that the results are robust to a number of interest rate assumptions.[49]

Table 8 reports the results of regressing the implied volatilities on the ex ante risk measures. Consider first whether the risk attributes are correctly correlated with the measure of risk implied by the note prices. Remarkably, the results in Table 8 are largely as expected. The estimated coefficients on Suffolk system membership, branch banking, and insurance are all of the correct sign and significant. The presence of any of these factors is associated with lower volatility of bank assets (and hence lower discounts ceteris paribus). (This is true whether year

dummies are included or not.)

Is the existence of free banking priced? Column (1) is consistent with the traditional assertions about free banking, that is, free banking systems are perceived by the market as riskier. The result in column (1) suggests that the market recognized and priced this risk. The results appear stronger in columns (3) and (4) where the distinction between "good" and 'bad" free banking systems is imposed. Notes of the bad free banking systems are heavily discounted because, ceteris paribus, they are associated with higher implied volatilities.

But, when the other risk attributes of branch banking and insurance are included there is a slightly different story. The free banking system risk attribute is either insignificant, as in column (5), or significantly negative, as in column (6). Dividing free banking systems into good and bad systems does not change this result.

Finally, notice that volatility rises when the stock market declines. The suspension variable is difficult to interpret since its sign depends on whether the year dummies are present or not. Though not reported, it is worth noting that seasonal dummies were always insignificant.

C) Summary of Results

There are three conclusions. First, the results in Table 8, based on the contingent claims model, are quite suggestive that the bank note market accurately priced bank risk. Pre-Civil War bank note markets were efficient given the available technology. In this sense private money contracts were enforceable.

Secondly, the results suggest that the type of banking system, free or chartered, was not the primary factor determining the relative risk of different banking systems. Despite the widespread attention to wildcat banks both then and now, the other risk attributes appear to have

been more important. This conclusion is, however, subject to an important caveat. The dummy variable for free or chartered banking system is not bank specific. That is, when a state adopts free banking the dummy variable is set to one even though many of the banks in that state may still be chartered. While this procedure is the best than can currently be done, it may be too crude to accurately capture the desired attribute.

Finally, there is a methodological implication for the market discipline literature. The results in Table 7 are not consistent with the prior evidence about the riskiness of different banks. However, the empirical procedure is also not consistent with the note pricing model. The linear model is an ad hoc specification. While the contingent claims model relies on some fairly strong assumptions, given the prior evidence about the riskiness of different banking system attributes, one should perhaps conclude that the contingent claims model is closer to the truth.

VI. Concluding Remarks

Explanations of the significant economic growth in the period before the Civil War have long been controversial. (See Weiss (1989).) When Robert Fogel studied the impact of the railroad on the U.S. economy in his celebrated book Railroads in American Economic Growth (1964) he did not consider the impact of the railroad on the production and transmission of information. Perhaps his conclusions about the inaccuracy of Rostow's take-off hypothesis would not have been altered. Nevertheless, pre-Civil War consumers made use of the improvements in transportation technologies to accurately price the myriad currencies they faced in daily life. In this sense bank note contracts were enforceable. Broadly speaking, secondary

bank note markets were efficient, subject to the available technologies. How these improvements in efficiency resulted in allocative gains is, of course, not known.

Technological change did substantially alter the U.S. banking industry. By the Civil War the U.S. had developed an adequate currency for both large and small transactions. There were ample supplies of both standardized gold and (subsidiary) silver coin, as well as minor coins for small change. (See Carothers (1930).) These improvements were the outcomes of improved minting technologies, mining discoveries, and accumulated experience. Improvements in specie made bank notes less competitive. Declines in trip times back to the bank of issuance may also have made bank notes less desirable to consumers (because the expected return declines as maturity declines ceteris paribus). During the Free Banking Era, notes declined in importance relative to demand deposits. For example, in New York State the ratio of notes to deposits was 1.25 in 1837 and fell, almost monotonically, to 0.27 by 1860.

The decline and ultimate disappearance of the bank note market appears to have been largely due to technological change. (Bank notes were eventually effectively outlawed by a prohibitive tax passed as part of the National Banking Act (1863).) The dominant form of bank liability became the bank check, a liability which is not traded in secondary markets. That technological change would result in the closing of a market raises tantalizing issues about the interaction between technological change and the availability of trading or risk-sharing opportunities. Also, the closing of the bank note market seems to correspond to the information asymmetry assumed by many models of banking panics. Rather than being an exogenous feature of banking, this asymmetry appears to be related to the underlying technology.

The issues of how technology and markets are related strongly caution against drawing any

normative conclusions about current banking issues based on the free banking experience. Moreover, while this study has suggested that the bank note system worked in the sense that agents accurately priced risk given the available technology, it has not addressed a variety of other issues, such as counterfeiting. Nor does it suggest that wildcat banking did not occur in particular isolated instances. If there are public policy implications from this study they are broad, suggesting only that economic systems are constantly in the process of metamorphosis.

Footnotes

[1]The Second Bank's charter then expired in 1836. However, a new, state, charter was obtained in Pennsylvania. The bank suspended specie payments in 1837, resumed in 1838, suspended again in 1839, and finally failed in 1841. The Second Bank of the United States was of particular importance because it acted as a quasi-central bank which disciplined the note issuance of state banks. (See Myers (1931)). On President Andrew Jackson's veto of the Second Bank of the United States see Hammond (1957) and Temin (1969).

[2]In general, "free banking" refers to the passage of a general incorporation law for commercial banks. Free banking laws varied by state, but contained some common features. Typically, under free banking laws, banks had to back their note issuance with designated state bonds deposited with state banking authorities. Bank notes were printed and registered, under the direction of state authority, and issued to the bank in an amount equal to the securities deposited. Free banks had to redeem their notes at par on demand in specie otherwise they would be closed by state regulators. Sometimes the stock holders of free banks faced double liability. Entry into the banking business was fairly easy under a free banking law, especially so when compared to States with chartered banking systems. Chartered banking, the alternative to free banking, was a system under which special charters for banks were granted, usually by the state legislature. Entry into the banking industry in chartered banking systems was tougher, leading to the presumption that chartered systems would be less subject to abuse. According to Knox (1903), "..banks specially chartered were favorite organizations. The amount of currency issued was frequently twice, and in many instances three times, the amount of the nominal capital of such banks. These charters were thus very valuable,and the State Legislatures were besieged by applicants for such special privileges" (p. 316). Further background can be found in Dewey (1910), Hammond (1957), Grant (1857), and Cleaveland (1857).

[3]Chartered banking systems were sometimes subject to abuse so that entry into banking was not always difficult. For example, Chaddock (1910),speaking of New York just prior to passage of the Free Banking Act, writes: "Since the granting of a bank charter by the legislature had become a matter of party politics, charges of corruption were frequently made and in some cases proven. It was to the interest of existing banks to keep rivals out of the field, and those who sought charters used various means to win over legislators. Stock was distributed to members with the promise of an immediate market at a premium. Granting of a bank charter was linked with various forms of special legislation, and log-rolling was encouraged" (p. 242). Also, see Hammond (1957, p. 332-37) and Knox (1903, p. 413). Ng (1987) argues that it is not obvious that entry was really harder on chartered banking systems than under free banking systems. Sylla (1985) argues that in New England chartered banking systems entry was essentially free.

[4]Free banking was effectively ended with passage of the National Banking Acts, passed during the Civil War. The National Bank Act passed in February 1863, and revised in June, 1864, provided for a uniform national currency. The new laws made the issuance of private

bank notes unprofitable by levying a tax of ten percent per centum on the amount of notes issued.

[5]Friedman has apparently changed his views. See Friedman (1986, 1987) and Friedman and Schwartz (1986). Also, there is a long literature articulating the view that uncontrolled banking is not problematic. See Hayek (1976), Klein (1974), and Black (1970).

[6]On the diffusion of the railroad see Fogel (1964) and Fishlow (1965).

[7]Prior to the telegraph the only way that a message could travel independently of the messenger was by use of carrier pigeon or semaphore. In 1846 a continuous telegraph line was first strung from Boston to Washington and then from Philadelphia to New York, though the Hudson River could not be crossed. By 1860 there were 50,000 miles of telegraph lines, and in 1861 the continent was spanned. Five million messages per year were sent by telegraph in 1860. See Duboff (1980, 1983, 1984) and Thompson (1947). The present paper does not specifically take the development of the telegraph into account because of difficulties establishing the exact dates of the diffusion of the telegraph. This is the subject of current research.

[8]A number of definitions of wildcat banking have been proposed in the literature. Rockoff (1974B, 1975), however, provided the definition which seems to have become the standard. According to Rockoff, a necessary condition for wildcat banking was the possibility that free banks could value the bonds backing their note issuance at par when, in fact, the market value was much lower than par. Then a wildcat bank, according to Rockoff (1975), was a bank which deposited backing securities which were valued at par by the state banking authorities, but, in fact, were worth less than par. Backing its note issue with overvalued securities then (allegedly) allowed this bank to issue notes which were insufficiently backed. The difference was earned as seigniorage and the bank left to fail. See Dillistin (1949) for a discussion of the origin of the term.

[9]Knox (1903, p. 315) estimates the losses to note holders to have been "about five percent per annum." These are losses from face value, but it is worth keeping in mind that the notes quite likely did not enter circulation at face value. See Gorton (1989C).

[10]Also, Knox (1903) writes: "In other States the best features of the New York [free banking] law were omitted...Many of organizations were not banks, in any true sense of the word, but were associations without capital, located at places not easily accessible, and owned by non-residents who availed themselves of ill-considered legislation to convert bonds into currency at rates higher than the market value...When the bonds depreciated in value...the banks failed" (p. 318). For references to the popular press of the period see Dillistin (1949), Chapter IV.

[11]In particular, in recessions asset prices fall and so the value of bank portfolios could fall below the par value of their outstanding debt. See Rolnick and Weber (1984), and the response by Rockoff (1989).

[12]Gorton (1989B) provides background detail on the Van Court bank note reporter. Previously, no complete set of bank note reporters had been discovered. Macesich (1961) examines a few issues of a bank note reporter and discusses the numbers of banks in existence. Rockoff (1975) also presents some evidence from several issues of a reporter. Calomiris and Schweikart (1988) make use of some data from Thompson's bank note reporter published in New York City.

[13]There were also the state bank regulators. State bank regulators exhibited a vast heterogeneity in the enforcement of regulations. The usual view is that chartered banking systems were better policed.

[14]Note holders were the senior claimants on the value of the bank. R. M. Breckenridge (1899): "The note holder's priority has long been an established principle of American banking legislation, introduced by Connecticut in 1831, adopted by Ohio in 1845, by New York in 1846, and by Massachusetts in 1849 and is still to be found in the statutes of Georgia, New Jersey, Massachusetts and of the Federal Government itself" (p. 257-8).

[15]Bank notes entered circulation in a variety of ways. Banks issued notes to borrowers taking down loans. Sometimes bank loans were made by paying out notes under an agreement whereby they would not be redeemed before a specified date. Another common device for getting notes into circulation was to purchase goods or notes of other banks at some distance from the issuing bank. See Dewey (1910), p. 102-3. Gorton (1989C) studies the primary bank note market.

[16]It was during the National Banking Era that regional interest rates converged. The convergence of regional interest rates has been interpreted as the development of a national capital market. See Binder and Brown (1988) for a review of the literature on the convergence of regional interest rates. However, also see Rockoff (1990).

[17]The heterogeneous experiences of state banking systems is quite remarkable. For example, Knox (1903) writes: "The laws and regulations governing the institutions did not seem to have much to do with their success or failure... Thus, a banking system succeeded well in Louisiana under almost identical laws with those of banking systems in Alabama, Mississippi, and Florida, which were most ridiculous failures" (p. 314).

[18]The Suffolk Bank system was a mechanism for clearing bank notes. But, its effectiveness depended on the ability of the Suffolk Bank, the large bank at the center of the system, to control the risk-taking activities of the member banks. See Mullineaux (1987), Dewey (1910), and Whitney (1878). Gorton (1989A) presents a theoretical rationale for such bank coalitions.

[19]There is a variety of evidence suggesting the existence of informal bank coalitions. For example, Hammond (1957) argues that banks in branching states were able to coordinate because there were so few banks. In New Orleans an insolvent bank was bailed out by the other banks during the Panic of 1857. See Green (1972). Also, see Calomiris and Schweikart (1988).

These informal coalitions are not accounted for in subsequent empirical work because there is currently no way of identifying membership.

[20]Actually, the first private bank clearinghouse, the New York City Clearinghouse Association, began operation in 1853. See Myers (1931), Gorton (1985), and Gorton and Mullineaux (1987). This coalition of banks had only a small number of members and is not accounted for in subsequent empirical tests.

[21]The quotation is cited in Cole (1959)

[22]See Dillistin (1949) for a discussion of bank note reporters.

[23]Van Court used notation which was difficult to interpret since he gave no explanation. It is important to note that the data used may be subject to interpretation in some instances. See Gorton (1989B) for details. Note discounts were the same regardless of denomination and no distinction was made for the volume of notes being discounted. For each bank Van Court also gives a description of what the counterfeit notes of that particular bank looked like. Each issue of the reporter also contains some general news, stock and commodity prices, and advertisements.

[24]One might expect that the volume of notes from distant locations traded in Philadelphia would be rather low since the discounts on notes rose with distance from the issuing bank. (This is demonstrated with the model in Section IV.) The countervailing forces, however, were the costs of transacting with specie, discussed below in footnote 35, and the volume of intra- and inter-regional trade due to a division of labor. There is a sizeable literature on ante bellum interregional trade. See Mercer (1982) for a review.

[25]The notes of insolvent banks had positive prices because insolvent banks were liquidated over a period of time. During the liquidation period some notes were redeemed and the value of the remaining assets fluctuated. Rockoff (1974) also makes this point. Van Court does not indicate whether a bank is insolvent or not.

[26]It appears that a kind of learning occurred with Van Court. Initially, the reporter lists discounts for several very distant locations, but then they are omitted or listed as "all uncertain." Later, sometimes many years later, discounts for these locations are again listed. Apparently, Van Court was initially optimistic about supplying quotes on the notes of distant banks. But, these banks' notes were extremely risky and Van Court began listing them as "all uncertain" until the effective distance was reduced with the introduction of the railroad.

[27]Minnesota is generally considered an example of a failed free banking system. See Rockoff (1989) and Rolnick and Weber (1988).

[28]For further information about Indiana see Harding (1895) and Dewey (1910). See Calomiris (1989) on Indiana's insurance system.

[29]For more information on North Carolina see Schweikart (1987).

[30]In Table 7 the reader will notice that there are some negative entries for modal discounts. These occur during the Panic of 1839 (and during a few months of the Panic of 1857). During periods of suspension of convertibility following banking panics Van Court apparently switched from quoting prices in terms of gold to quoting prices in terms of Philadelphia bank notes. During a period of suspension it was not possible to convert bank notes into specie on demand. Apparently, for this reason Van Court switched to quoting prices in terms of Philadelphia bank notes during suspensions. Thus, in terms of Philadelphia bank notes, the notes of some banks would be worth a "premium" though still at a discount in terms of gold. See Gorton (1989B) for details. On the Panic of 1857 see Van Vleck (1943).

[31]Sylla (1985) makes this argument.

[32]Note that only the year 1849 is the correct match of the distance data with the discount data. Unfortunately, the distance data for 1836 had to be matched with 1839. Similarly, 1858 and 1862 were matched. Also, note that the indices of the cost of the return trip and the duration of the return trip are very highly correlated.

[33]In ante bellum America, there was a spatial division of labor. The traditional thesis concerning this division of labor was articulated by Schmidt (1939) and Callender (1909). Also, see Mercer (1982) and Pred (1980). Fishlow (1964) presents quantitative evidence on the size of interregional trade flows and Lindstrom (1975) specifically discusses Philadelphia. The main point is that interregional trade flows between different locations were sizeable. It is not known to what extent these flows imply a large volume of bank notes moving around the country.

[34]For simplicity the model omits specie as an alternative medium for satisfying the cash-in-advance constraint. Since a capital loss is associated with carrying notes to distant markets, gold or silver would appear to be preferable as a means of exchange. Thus, unless there is some cost to using gold or silver, bank notes would not circulate much beyond the location of the bank of issuance. During the ante bellum period the costs of using specie were sizeable. First, specie is heavy and difficult to transport. Second, insofar as there were coins available, there was a confusing array of denominations because many (possibly most) of the coins in circulation were foreign. The U.S. Mint was incapable of reminting the foreign coins because of poor mechanical minting equipment and because of the transportation costs of moving specie. See Carothers (1930). Third, there was a shortage of small change. According to Carothers (1930):

> From 1810 to the Civil War the notes of state banks were the major element in the currency, the outstanding circulation being two to four times the estimated quantity of coin. There was no domestic coin between the 50 cent piece and the $2.50 gold coin, and there was in general circulation no coin of any sort larger than the Spanish dollar. The banks filled the vacancy with notes, the majority in denominations of $1 and $5. (p. 79).

Also see Dewey (1910).

[35]This assumption is consistent with the existence of the telegraph.

[36]Once notes have been sent for redemption, it is assumed that they cannot be called back.

[37]Since the model is simplified by omitting specie and, hence, lacks a specie-goods price, the note-goods price must clear the goods market. At the price which clears the goods market agents must subsequently decide, in the securities market, whether or not to redeem the notes. Strictly speaking the securities market does not determine note prices since agents simply decide whether to redeem or not given the prices that cleared the goods market. The first order conditions have nevertheless been set to equality.

[38]For simplicity the model has no riskless security. However, the shadow price of a riskless bond can always be calculated. A riskless security could easily be incorporated.

[39]If notes in transit were known, so that Geske's (1977) formula was appropriate, the same comparative statics would hold. See Geske (1977).

[40]Note that if there are notes in transit then, in equilibrium, the outstanding amount of notes would be divided between notes in transit, notes sent for redemption, and notes held to next period.

[42]For a survey of the "market discipline" literature in banking see Gorton and Santomero (1989).

[42]Recall that during periods of suspension of convertibility the notes of banks in some locations were priced at premiums relative to Philadelphia bank notes. These premia were entered as negative numbers (in percentage terms) so the highest premium would be minus one. See Gorton (1989B).

[43]The dummy variable is set to one when a state adopts free banking. In fact, such a state would have both free and chartered banks, but there was no feasible way to incorporate this information since it usually was not available.

[44]Following Rockoff the "bad" free banking states were identified as Michigan, Indiana, Illinois, and New Jersey. The remaining free banking states were classified as "good."

[45]Capital structures typically have multiple layers of corporate debt of different maturities. Each strata of debt may have different covenants, sinking funds, and embedded options. Applications of contingent claims pricing to corporate liabilities include Jones, Mason, and Rosenfeld (1984), Ramaswamy and Sundaresan (1986), Gorton and Santomero (1990), and Titman and Torous (1989).

[46]Let the modal discount (as a percentage of face value) be D so the note price is: P = 1-D. Then the return, R, is calculated by inverting P = EXP[-Rd], where d is the time it took to return from Philadelphia to the issuing bank (i.e., the maturity of the note). The spread between the expected return on the bank note and the risk free interest rate (of the same maturity) can be written:
$R-R_f = G(\sigma, L, d)$, where L is leverage, σ is the volatility of the bank's asset values, R_f is the risk free interest rate, and $G(\bullet)$ is a known function (see Merton (1974)). The volatility is calculated by inverting this formula using an iterative procedure.

[47]While the spatial distribution of any particular bank's notes would have been unknown to agents of the period, and is not known by modern researchers, it is, nevertheless, clear that this distribution may matter. The assumption that there are no notes in transit, i.e., notes that may be presented for redemption earlier than agents at a particular location (because the other agents are closer to the issuing bank), is made only because there is insufficient data to make any other assumption.

[48]The results of Schmalensee and Trippe (1978) and Latane and Rendleman (1976) demonstrate the value of using the Black-Scholes model to predict volatilities despite the inconsistency of using a model which assumes a constant variance to recover a possibly nonstationary variance. See Galai (1983) for further discussion.

[49]A variety of interest rate assumptions were attempted. A series of annual commercial paper rates from Macaulay (1938) was used. Also, the risk free rate was, alternatively, exogenously set to zero and three percent for the period. No interest rate assumption effects the results because the implied returns on the bank notes are so high.

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TABLE 1

States with and without Free Banking Laws by 1860

States with Free Banking Laws	Year Law Passed	States without Free Banking Laws
Alabama	1849**	Arkansas
Connecticut	1852	California
Florida	1853**	Delaware
Georgia	1838**	Kentucky
Illinois	1851	Maine
Indiana	1852	Maryland
Iowa	1858**	Mississippi
Louisiana	1853	Missouri
Massachusetts	1851**	New Hampshire
Michigan	1837*	North Carolina
Minnesota‡	1858	Oregon
New Jersey	1850	Rhode Island
New York	1838	South Carolina
Ohio	1851†	Texas
Pennsylvania	1860**	Virginia
Tennessee	1852**	
Vermont	1851**	
Wisconsin	1852	

Source: Rockoff (1975, p. 3, 125–30) as compiled by Rolnick and Weber (1983, p. 1082).

*Michigan prohibited free banking after 1839 and then passed a new free banking law in 1857.

**According to Rockoff, very little free banking was done under the laws in these states.

†In 1845, Ohio passed a law that provided for the establishment of "Independent Banks" with a bond-secured note issue.

‡Montana became a state in 1889. The Free Banking law was passed by a territorial legislature.

TABLE 2

Coverage of Van Court's Bank Note Reporter: States and Dates

States with Complete Coverage, February 1839–December 1858		States with Incomplete Coverage†		States Listed as "Uncertain" or not Listed
United States	Canada	United States	Canada	
Alabama	Canada**	Arkansas	New	Iowa Territory
Connecticut	Nova Scotia	(1840–58)	Brunswick	Minnesota
Delaware			(1840–48)	Missouri
District of		Florida		Texas
Columbia		(1842–58)		
Georgia				
Kentucky		Illinois		
Louisiana		(July 1856–58)		
Maine				
Maryland		Indiana		
Massachusetts		(1857)		
Montana*				
Pennsylvania		Michigan		
New Jersey		(1853)		
New York				
North Carolina		Mississippi		
Ohio		(1839, 1841–43,		
Rhode Island		1852–58		
South Carolina				
Tennessee		Nebraska		
Vermont		(1840–47)		
		New Hampshire		
		(1857–58)		
		Virginia		
		(1846–47,		
		1853–54)		
		Wisconsin		
		(1839–55)		

*Montana becamse the 41st state in 1889.

**Canada includes banks located in provinces other than Nova Scotia or New Brunswick.

†Incomplete coverage means that the Van Court Bank Note Reporter did not quote a price for banks in that state that month. The state may have been listed, though, and the notes of banks in that state described as "all uncertain." Dates in parentheses indicate periods for which the data was missing.

TABLE 3

Summary of Indiana Bank Note Discount Data*

Year	(1) Mean Discount	(2) Standard Deviation	(3) Minimum Discount	(4) Maximum Discount	(5) Average Mode**	(6) Annual Standard Deviation of Mode***	(7) Average Modal %†	(8) Number of Banks‡	(9) Notes / Total Assets	(10) Notes + Deposit / Total Assets	(11) Specie / Total Assets
1839	4.36	0.861	3.250	5.500	4.364	0.861	100.00	1	0.024	0.101	0.210
1840	4.83	0.389	4.000	5.000	4.833	0.389	100.00	1	0.026	0.083	0.156
1841	7.41	1.062	5.000	9.000	7.417	1.062	100.00	1	0.026	0.099	0.166
1842	21.67	23.800	5.000	70.000	10.417	4.940	87.50	2	0.027	0.076	0.187
1843	19.61	19.680	2.000	60.000	2.773	0.984	50.00	2	0.007	0.048	0.166
1844	10.01	8.640	1.500	22.500	1.688	0.155	50.00	2	0.012	0.055	0.209
1845	9.75	7.953	1.750	17.500	2.000	0.204	50.00	2	0.025	0.080	0.209
1846	7.31	6.422	1.500	17.500	2.125	0.506	50.00	2	0.014	0.082	0.183
1847	4.42	3.151	1.250	7.500	1.333	0.123	50.00	2	0.019	0.088	0.156
1848	4.81	2.762	1.750	7.500	2.125	0.433	50.00	2	0.043	0.137	0.156
1849	4.55	3.016	1.250	7.500	1.604	0.249	50.00	2	0.022	0.106	0.192
1850	4.48	3.089	1.000	7.500	1.458	0.209	50.00	2	0.015	0.111	0.187
1851	4.91	4.478	1.000	20.000	1.271	0.250	50.00	2	0.028	0.028	0.031
1852	9.05	9.363	0.750	20.000	1.313	0.188	48.10	5	0.043	0.129	0.161
1853	1.58	2.065	0.500	20.000	1.230	0.072	80.92	22	0.067	0.173	0.160
1854	6.60	6.251	1.130	15.000	5.105	6.012	99.72	91	0.046	0.159	0.125
1855	19.24	11.130	1.000	50.000	20.667	12.280	51.02	110	0.042	0.147	0.095
1856	26.73	27.980	1.000	80.000	5.000	0.000	33.24	97	0.046	0.198	0.153
1857	–	–	–	–	–	–	–	–	0.044	0.189	0.117
1858	9.70	17.04	5.000	75.000	5.000	–	90.91	33	0.043	0.197	0.163

*The missing values do not mean that the bank note reporter did not report the data. Rather, the reporter would list all the bank notes of the state as "uncertain."

**The average mode is the annual average of the twelve monthly modal discounts.

***The annual standard deviation of the mode measures the variation of the monthly modal discounts during the year.

†The model percentage is the percentage of total banks with modal discounts. The average modal percentage is the annual average of the twelve monthly modal percentages.

‡The number of banks in existence during the year.

TABLE 4

Summary of North Carolina Bank Note Discount Data*

Year	(1) Mean Discount	(2) Standard Deviation	(3) Minimum Discount	(4) Maximum Discount	(5) Average Mode**	(6) Annual Standard Deviation of Mode***	(7) Average Modal %†	(8) Number of Banks‡	(9) Notes / Total Assets	(10) Notes + Deposit / Total Assets	(11) Specie / Total Assets
1839	3.24	0.95	2.000	5.000	3.188	0.98	100.00	3	0.021	0.114	0.114
1840	1.88	0.66	1.000	3.000	1.875	0.68	100.00	3	0.035	0.116	0.091
1841	2.33	0.76	1.500	4.000	2.333	0.78	100.00	3	0.036	0.115	0.130
1842	3.96	2.30	2.000	10.000	8.958	2.37	100.00	3	0.054	0.147	0.143
1843	1.88	0.30	1.500	2.500	1.875	0.31	100.00	3	0.045	0.136	0.160
1844	1.27	0.07	1.250	1.500	1.271	0.07	100.00	3	0.035	0.113	0.152
1845	1.46	0.14	1.250	1.750	1.458	0.14	100.00	3	0.047	0.139	0.166
1846	1.78	0.22	1.500	2.250	1.729	0.23	100.00	3	0.061	0.150	0.176
1847	1.40	0.19	1.250	1.750	1.396	0.20	100.00	3	0.046	0.136	0.190
1848	2.08	0.38	1.750	2.750	2.083	0.39	100.00	4	0.039	0.118	0.176
1849	1.73	0.26	1.500	2.250	1.729	0.27	100.00	4	0.037	0.106	0.182
1850	1.35	0.12	1.250	1.500	1.354	0.13	100.00	4	0.050	0.139	0.176
1851	1.38	0.19	1.250	1.750	1.375	0.20	100.00	5	0.051	0.149	0.172
1852	1.34	0.17	1.000	1.500	1.344	0.18	100.00	7	0.051	0.149	0.172
1853	1.00	0.00	1.000	1.000	1.000	0.00	100.00	6	0.037	0.141	0.145
1854	2.64	2.75	1.000	15.000	1.796	0.68	81.98	11	0.043	0.164	0.129
1855	1.95	0.54	1.500	3.000	1.958	0.56	100.00	13	0.029	0.109	0.094
1856	1.38	0.13	1.250	1.500	1.375	0.13	100.00	13	0.022	0.099	0.095
1857	2.70	3.56	1.000	30.000	2.500	2.76	98.08	13	0.024	0.100	0.076
1858	3.43	4.13	1.000	30.000	2.458	1.77	91.78	13	0.026	0.098	0.072

*The missing values do not mean that the bank note reporter did not report the data. Rather, the reporter would list all the bank notes of the state as "uncertain."

**The average mode is the annual average of the twelve monthly modal discounts.

***The annual standard deviation of the mode measures the variation of the monthly modal discounts during the year.

†The model percentage is the percentage of total banks with modal discounts. The average modal percentage is the annual average of the twelve monthly modal percentages.

‡The number of banks in existence during the year.

TABLE 5

Summary of 1839 Discount Data

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1) Alabama	–	3.50	3.50	10.00	10.00	10.00	14.00	12.50	15.00	12.50	10.00	2.00
2) Arkansas	–	12.50	15.00	15.00	15.00	15.00	15.00	15.00	–	–	–	–
3) Connecticut	–	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	−3.00	−5.00
4) Delaware	–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5) Washington, D.C.	–	0.50	0.50	0.88	0.88	0.88	0.88	0.88	0.88	1.50	2.00	1.00
6) Georgia	–	3.50	3.75	5.50	5.50	5.50	5.50	4.50	5.00	10.00	10.00	5.00
7) Illinois	–	3.25	3.25	4.00	4.00	4.00	4.00	4.00	5.50	5.50	6.50	6.50
8) Louisiana	–	1.25	1.25	3.50	3.50	3.50	3.50	5.00	7.00	7.00	6.00	0.00
9) Maine	–	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	−5.00
10) Massachusetts	–	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	−3.00	−3.00	−5.00
11) Michigan	–	1.50	10.00	10.00	10.00	10.00	10.00	8.00	5.00	−3.00	7.00	7.00
12) Montana	–	4.00	4.00	4.00	4.00	4.00	4.50	4.50	6.00	7.00	7.00	5.00
13) Maryland	–	0.50	0.50	1.00	0.50	0.375	0.375	0.50	0.50	2.00	0.75	0.75
14) North Carolina	–	2.50	2.50	3.00	3.00	3.00	3.00	3.00	4.00	5.00	5.00	2.00
15) Nebraska	–	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	0.00	–	–
16) New Hampshire	–	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	−5.00
17) New Jersey	–	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	−3.00	−5.00
18) New York	–	0.75	0.75	1.00	1.00	1.00	0.75	1.00	1.00	−6.00	−5.00	−5.00
19) Ohio	–	3.25	3.25	4.00	4.50	4.00	4.00	4.50	5.00	5.50	5.50	5.00
20) Pennsylvania	–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21) Rhode Island	–	0.75	0.75	1.00	1.00	1.00	0.75	1.00	1.00	−3.00	0.00	0.00
22) South Carolina	–	2.50	2.50	3.00	3.00	2.75	2.75	3.00	5.00	7.00	3.00	0.00
23) Tennessee	–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24) Vermont	–	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	−2.00	−3.00	−5.00
25) Virginia	–	0.75	0.75	1.00	1.25	1.25	1.00	1.00	1.50	4.00	2.00	1.00

TABLE 6

Correlations between Discounts and Distance*

	1839			
	Cost of Trip	Trip Duration	Modal Discount	Avg. NonModal Discount
Cost of Trip	1.000 (0.000)	0.96 (0.000)	0.656 (0.001)	0.525 (0.021)
Trip Duration		1.000 (0.000)	0.653 (0.001)	0.523 (0.022)
Modal Discount			1.000 (0.000)	0.593 (0.008)
Avg. Nonmodal Discount				1.000 (0.000)

	1849			
	Cost of Trip	Trip Duration	Modal Discount	Avg. NonModal Discount
Cost of Trip	1.000 (0.000)	0.95 (0.000)	0.794 (0.000)	0.280 (0.261)
Trip Duration		1.000 (0.000)	0.787 (0.000)	0.300 (0.226)
Modal Discount			1.000 (0.000)	0.422 (0.081)
Avg. Nonmodal Discount				1.000 (0.000)

	1858			
	Cost of Trip	Trip Duration	Modal Discount	Avg. NonModal Discount
Cost of Trip	1.000 (0.000)	0.96 (0.000)	0.800 (0.000)	0.674 (0.003)
Trip Duration		1.000 (0.000)	0.789 (0.000)	0.669 (0.003)
Modal Discount			1.000 (0.000)	0.317 (0.215)
Avg. Nonmodal Discount				1.000 (0.000)

*Pearson correlation coefficients. Probability of zero correlation in parentheses. 288 observations for each year. See Gorton (1989D) for details.

TABLE 7

Tobit Analysis of Modal Discounts ($N = 4434$)

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.82*	1.03*	0.60*	0.68*	.058*	0.64*
	(.067)	(.07)	(.066)	(.072)	(.065)	(.072)
Notes / Total Assets	−2.59*	–	−2.23*	–	−2.36*	–
	(.64)		(.63)		(.62)	
Notes + Deposits / Total Assets	–	−1.34*	–	−0.64*	–	−0.60*
		(.14)		(.15)		(.15)
Suffolk Member	−0.45*	−0.55*	−0.30*	−0.35*	−0.25*	−0.29*
	(.025)	(.023)	(.025)	(.030)	(.026)	(.031)
Free Banking	0.27*	0.32*	0.30*	0.32*	–	–
	(.026)	(.026)	(.025)	(.025)		
Good Free	–	–	–	–	0.20*	0.22*
					(.027)	(.027)
Bad Free	–	–	–	–	0.60*	0.62*
					(.045)	(.045)
Branch Banking	–	–	0.48*	0.43*	0.53*	0.49*
			(.035)	(.038)	(.035)	(.038)
Insurance	–	–	1.09*	1.05*	1.17*	1.12*
			(.098)	(.099)	(.099)	(.10)
Suspension	−0.83*	−0.85*	−0.74*	−0.76*	−0.73*	−0.75*
	(.033)	(.032)	(.032)	(.031)	(.031)	(.031)
Trip Time	0.008*	0.007*	0.006*	0.006*	0.006*	0.006*
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)
Stock Index	−0.002*	−0.002*	−0.0006	−.0005	−.0006	−.0005
	(.0007)	(.0007)	(.0007)	(.0007)	(.0007)	(.0007)
σ	0.66*	0.65*	0.63*	0.63*	0.62*	0.63*
	(.011)	(.011)	(.010)	(.010)	(.010)	(.010)
Log-Likelihood	-3583.1	-3542.4	-3412.3	-3409.5	-3375.3	-3374.4

Standard Errors in parentheses.

*indicates significance at the .05 confidence level.

TABLE 8

Implied Volatility Regressions ($N = 3384$)

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	38.86*	37.79*	38.87*	37.82*	51.41*	49.10*	51.61*	49.31*
	(1.73)	(3.33)	(1.71)	(3.30)	(1.64)	(3.03)	(1.65)	(3.033)
Suffolk Member	−1.82*	−2.37*	−0.93	−1.49	−10.89*	−11.93*	−11.16*	−12.25*
	(.671)	(.680)	(.670)	(.683)	(.70)	(.704)	(.737)	(.744)
Suspension	−11.32*	0.573	−11.33*	0.589	−14.56*	0.961	−14.50*	0.966
	(.941)	(2.54)	(.933)	(2.52)	(.863)	(2.29)	(.864)	(2.29)
Free Banking	1.89*	0.77	–	–	−0.82	−2.58*	–	–
	(.66)	(.736)			(.606)	(.674)		
Good Free	–	–	−0.43	−1.69	–	–	−0.54	−2.24*
			(.717)	(.791)			(.656)	(.720)
Bad Free	–	–	8.37*	7.19	–	–	−1.78	−3.68*
			(1.05)	(1.09)			(1.04)	(1.07)
Branch Banking	–	–	–	–	−17.11*	−17.50*	−17.41*	−17.85*
					(.76)	(.752)	(.805)	(.797)
Insurance	–	–	–	–	−22.67*	−23.28*	−22.98*	−23.66*
					(1.10)	(1.10)	(1.13)	(1.13)
Stock Index	−0.11*	−0.05	−0.12*	−0.05	−0.145*	−0.056	−0.145*	−0.056
	(0.19)	(0.05)	(.019)	(.051)	(.017)	(.046)	(.017)	(.046)
Year Dummies	No	Yes	No	Yes	No	Yes	No	Yes
R^2	.056	.081	.07	.10	.22	.25	.22	.25
F-value	51.94	14.04	54.64	16.34	164.52	46.98	141.20	45.25
(Prob > F)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)

Standard Errors in parentheses.

*indicates significance at the .05 confidence level.

FIGURE 1

Trip Time Indices for 10 states