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UNDERISSUANCE OF NATIONAL BANK NOTES

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ABSTRACT

The puzzle of underissuance of national bank notes disappears when one disaggregates data, takes account of regulatory limits, and considers differences in opportunity costs. Banks with poor lending opportunities maximized their issuance. Other banks chose to limit issuance. Redemption costs do not explain cross-sectional variation in issuance, and the observed relationship between note issuance and excess reserves is inconsistent with the redemption risk hypothesis of underissuance. National banks did not enter primarily to issue national bank notes, and a "pure arbitrage" strategy of chartering a national bank only to issue national bank notes would not have been profitable. Indeed, new entrants issued less while banks exiting were often maximum issuers. Economies of scope between note issuing and deposit banking included shared overhead costs and the ability to reduce costs of mandatory minimum reserve and capital requirements.

I. Introduction

During the Civil War, the federal government began to charter national banks. These banks enjoyed the privilege of being licensed to issue national bank notes, which were default-risk-free liabilities of the banks, backed 111% by U.S. Treasury bonds deposited by issuing banks at the U.S. Treasury.[1] The creation of these new banks, combined with a 10% annual tax on state bank note issues, soon resulted in the supplanting of state banks' notes by the new national bank notes.

Scholars have long puzzled over the observation that national banks did not take greater advantage of the authority to issue notes. The aggregate supply of notes never reached its maximum permissible level, despite calculations measuring the profitability of allocating capital toward bank note supply collateralized by bonds (e.g., as derived by Cagan 1965), indicating that national bank note issuance was more profitable than the typical profit earned by allocating bank capital toward lending funded by a combination of deposits and capital. Friedman and Schwartz (1963, p. 23) write:

> Before 1890 the amount outstanding ranged around 20 per cent of the possible maximum, by 1900 it had risen to about 28 per cent, and by World War I to about 80 percent. The maximum was in fact approached only in the twenties, when for the first time U.S. bonds deposited to secure circulation and government deposits (which also required such security) nearly equaled the total of eligible bonds. Before 1905, the capital stock of national banks set narrower limits to their maximum possible note issue than did the total of eligible bonds, but the actual issue did not approach this lower limit either. Thereafter, the capital stock of national banks exceeded the total of eligible bonds and hence was not the effective limit on note issue. Yet, despite the failure to use fully the possibilities of note issue, the published market prices of government bonds bearing the circulation privilege were apparently always low enough to make note issue profitable except in the years 1884 to 1891. The fraction of the maximum issued fluctuated with the profitability of issue, but the fraction was throughout lower than might have been expected. We have no explanation for this puzzle.

[1] After 1874, banks also had to deposit a 5% minimum cash redemption fund at the Treasury in addition to these bonds.

Friedman and Schwartz (1963) and Cagan (1965) argued that profits from note issue were large on the margin, because bond issues to back note issues remained cheap and because banks could easily leverage their capital devoted to those bond purchases.[2] In their discussions of potential constraints on bank note issues, they pointed to the more than adequate *aggregate* supply of bonds, and while they recognized that regulations constrained bank note issuing relative to bank capital, they argued that bank capital was not a constraint because its *aggregate* amount exceeded the amount required for increased note issues.

The reasoning typically advanced to explain low issuance of national bank notes posits hidden transacting costs, either in the form of the costs of redeeming physical notes or the costs of maintaining cash balances in support of bank note issues. Authors such as Bell (1912), Cagan (1965), Goodhart (1965), Cagan and Schwartz (1991), Duggar and Rost (1969), Champ, Wallace, and Weber (1992), and Wallace and Zhu (2004) argue that redemption costs may have been large enough to explain bankers' reluctance to issue despite the seeming profitability from expanding the supply of notes.

James (1978) was the first to suggest that aggregate calculations, like those provided by Cagan and Friedman and Schwartz, might be providing a misleading picture of national bank note profitability. He showed that cross-sectional variation in the regional supply of bank notes was large and consistent with regional variation in the opportunity cost of note issuance (that is, regional variation in the profitability of bank

[2] Cagan and Schwartz (1991) point out that we can restate the puzzle of underissuance as the puzzling absence of a large premium on U.S. Treasury bonds (i.e., lower bond yields). High profits from note issuing should have led national banks to bid up the price of bonds (in order to satisfy legal backing requirements for note issues), which should have raised the premium on bonds and, thus, eliminated allegedly excess profits.

lending). In James's view, at least some of the puzzle of low bank note issuance was explained by the high profitability of bank lending in the South and West, where note issuance was relatively low. But James's explanation was not a complete one. After 1874, there were no regional limits on note issuance, suggesting that banks in the East (where loan profitability was relatively low) should have substantially increased their outstanding notes. Why did the banks in the East not issue more notes?

Hetherington (1990) showed that some of the time variation in the extent of note issue could be explained by changes in rules governing note issues. But that approach did not explain the puzzle posed by Friedman and Schwartz (1963) and Cagan (1965); like James's (1978) explanation of cross-state variation in note issuance, Hetherington's (1990) explanation of some of the variation in supply over time did not address the persistent underissue of bank notes: the level of bank notes remained far below its maximum despite the high profitability of note issuing.

In this paper, we test the various theories of note underissuance with microeconomic data. We are able to resolve much of the puzzle of note underissuance by disaggregating data on national banks and analyzing individual banks' note issuing incentives and constraints. Friedman and Schwartz (1963) and Cagan (1965) compared average profitability of note issuing and lending and considered the aggregate supply of bonds and the aggregate amount of bank capital. But that is not the correct way to take account of regulatory constraints on note issues. It is possible that regulatory limits on bank note issues were binding on many individual banks. If, as James argued, some banks faced high opportunity costs (leading them to limit note issuing), and if other banks earning lower profits from lending were issuing the maximum amount of notes they were

permitted to issue by law, then it may be that there is no puzzle of "underissuance." We take account of the legal constraints facing individual banks that limited their maximum (and minimum) permissible note issuance.

In fact, we will show that many banks (40% of national banks in 1880, 5% in 1890, and 21% in 1900) were at a "corner solution" (issuing the maximum amount of notes they could legally issue), while other banks (which we are able to identify as banks with observably higher opportunity costs) chose to issue less than their legal maxima. Thus, the puzzle of national bank note issuance turns out to be largely an artifact of aggregation error.

We develop a data set linking the note-issuing behavior of individual banks, the specific legal constraints on note issuing faced by each bank, and the profitability of bank lending. Our data set consists of individual bank data for all reporting national banks in 1880, 1890, and 1900. Our measures of the opportunities for lending include banks' characteristics as well as characteristics of the economic environment (county, state, or nationwide) in which banks operated.

Section II models the equilibrium supply and demand for national bank notes and describes the legal limits on note supply. Section III reviews our data and summarizes the note-issuing behavior of national banks in 1880, 1890, and 1900. Section IV tests and rejects the redemption risk theory of underissuance. Section V documents and explains the absence of pure note-issuing "arbitrage" strategies by national banks; that is, we show why national banks did not enter solely with the purpose of issuing notes. Section VI provides a Tobit regression analysis of the extent of individual bank note issues relative to their maximum potential level in 1880, 1890, and 1900. The results lend support to

James's opportunity cost theory of note issuing. Section VII analyzes patterns of entry and exit by national banks between 1880 and 1900. Entry and exit patterns confirm the findings in Sections V and VI, which indicate that note issuing was not a primary profit center in U.S. banking. Section VIII concludes. Overall, we find that a combination of legal restrictions on maximum note issuing and banks' opportunity costs explain the extent of bank note issuing in a manner consistent with bank profit maximization.

II. Supply and Demand for National Bank Notes

The quantity of national bank notes in circulation should be determined by supply and demand in the market for bank notes. While there were legislative limits placed on the aggregate quantity of notes outstanding and on the geographic distribution of note issuing, those aggregate limits were never binding constraints on individual bank issuance. Prior to 1874, whenever the amount of notes came close to reaching the maximum allowable supply, the law was changed to accommodate more note issues. In 1874, the law was changed to remove any aggregate limits on note issues, although the limited supply of U.S. Treasury bonds (to serve as 111% collateral for note issues) effectively placed a non-binding upper bound on the potential supply of notes.

National bank notes were essentially perfect substitutes for transactions purposes with U.S. notes (greenbacks) and coins and traded at par with those alternative transacting media (except briefly during 1873, when the special value to banks of holding greenbacks, which were a legal reserve currency, led their value to temporarily exceed that of bank notes – see Friedman and Schwartz 1963, pp. 21-2). National bank notes and greenbacks were always inframarginal sources of transacting media whose quantity was

set by suppliers and which were unresponsive to shifts in the demand for transacting media; increases in demand for transacting media on the margin were met by changes in the supply of specie currency (see Calomiris 1988, 1994, Hetherington 1990).

Equilibrium in international markets under the classical gold standard simultaneously determined gold-denominated interest rates and specie flows to equilibrate the markets for goods and money (Calomiris and Hubbard 1996). The supply of national bank notes adjusted endogenously to the level of interest rates set in the money market. Calomiris (1988, 1994) shows that (so long as the supply of Treasury bonds to back national bank notes was greater than the amount demanded for that purpose) the supply of national bank notes for banks that were not at a corner solution should have been determined by (a) the yield on government bonds, (b) the profitability of bank lending, and (c) the tax rate charged on national bank note issues. The supply of notes, in this model, is set by the profit-maximizing choices of national banks about whether to allocate marginal capital toward (a) the business of deposit taking and lending or (b) the business of producing national bank notes, backed by government bond purchases. In any empirical model of cross-sectional differences in note issuance (for example, for national banks in 1880), the profitability of lending is the primary influence that should predict cross-sectional differences in the propensity to issue notes, since the taxation rate and market yield on bonds are the same for all banks.[3]

Of course, this model does not apply on the margin to banks that are at a corner solution, either because of legal limits on maximum issues that require them to issue less than they would like, or legal limits on minimum issues that require them to issue more

[3] It is also possible that banks with comparative advantage in taking deposits (e.g., banks that had an advantage in obtaining interbank deposits) would issue fewer notes, holding constant their loan opportunities. We investigate this possibility in our empirical analysis below.

than they would like. Among banks issuing the maximum permissible amount of notes, cross-sectional variation in bank characteristics should have no explanatory power for marginal note issuing, although those cross-sectional characteristics should help explain which banks are at a corner solution. Thus, before applying the model to individual bank data, we first take account of the various limits on note issuing that might constrain banks to operate at a corner solution.

Prior to 1882, the limits on note issues relating to capital for national banks were a complex function of the capital levels and bond holdings of banks, and these limits varied by the size of the bank and (because of grandfathering) by the date the bank was chartered. These constraints, which are summarized in Table 1, are take from *Laws of the United States Concerning Money, Banking, and Loans, 1778-1909*, compiled by the National Monetary Commission (1910). A bank chartered before March 1865 could not issue notes in excess of 100% of the bank's paid-in capital. A bank chartered from March 1865 through July 1870 was governed by the following limits on note issue relative to capital: A bank with capital less than $500,000 could issue up to 90% of capital; a bank with capital between $500,000 and $1,000,000 could issue up to 80% of capital; a bank with capital between $1,000,000 and $3,000,000 could issue up to 75% of capital; and a bank with capital in excess of $3,000,000 could issue up to 60% of capital. Banks chartered after July 12, 1870 were governed by the following limits: No bank could issue more than $500,000 in notes; banks with capital less than $500,000 could issue up to 90% of capital; and banks with capital between $500,000 and $625,000 could issue up to 80% of capital. In 1882, those requirements were supplanted by a single measure of maximum note issue of 90% capital for all banks. (The complexity of regulations on the

maximum before 1882 is the primary reason why previous literature has focused nearly exclusively on the period after that year.) National banks that also had outstanding state bank issues (dating from the time before they became national banks) had to include those notes in any measure of total permissible note issues.

All banks also faced an effective minimum note-issuing requirement, since all national banks were required to maintain government bond holdings of at least $30,000 or an amount equal to one-third of bank capital, whichever was higher. (That requirement was reduced to a maximum of $25,000 or 25% of capital for banks with capital less than $150,000 in 1882.) To the extent that a bank was constrained to hold the minimum amount of government bonds, issuing notes backed by those bonds would have always been profitable (Hetherington 1990). As we shall show below, these ceilings and floors on permissible note issues were often binding on individual banks.

III. Data on Individual Banks

Our data set consists of hand-collected information on 2,090 national banks in 1880, 3,540 national banks in 1890, and 3,861 national banks in 1900. We also collected data about the states and counties in which those banks resided. Data on counties are available only for decadal census dates. We chose 1880 as a starting date for several reasons. First, by 1880, it is reasonable to assume that banks had adjusted to the effects of the changes on note-issuing limits in 1874. Second, in January 1879, the U.S. resumed convertibility of dollars into gold, an event that had been anticipated for several years prior to that time (Calomiris 1988). Analyzing note supply after resumption of convertibility simplifies the discussion by permitting us to abstract from various

complications associated with deflationary expectations during the 1870s (Calomiris 1988). Third, as the above quotation from Friedman and Schwartz (1963) shows, they regard the underissuance of national bank notes during the periods before 1884 and after 1891 as especially puzzling. According to Cagan (1965, p. 93), profitability on note issuing rose during the 1890s and accelerated as the result of the Gold Standard Act of March 1900. Like 1880, 1900 was a time of relatively high profitability from note issuing; both years have been viewed by previous scholars as times of puzzling underissuance of profitable national bank notes.

The dependent variable we analyze is the extent to which banks issued their maximum permissible amount of national bank notes. Specifically, the dependent variable, Issue Propensity (IP), is defined as:

IP = (Actual Notes – Minimum Required Issuance) /
(Maximum Permissible Notes – Minimum Required Issuance)

Here, the "minimum required issuance" is defined as the amount of note issuance that would have been backed by the minimum amount of required government bond holdings. Issuing notes backed by government bonds that had to be held in any case did not impose any lending opportunity cost on the issuer. Since the sum of interest cost on notes (zero) plus note taxes was always less than the interest cost on deposits, absent any additional cost of issuing notes (e.g., redemption costs), banks would choose to issue notes as allowed by law to finance their minimum required holdings of bonds. Of course, in the presence of redemption costs, banks may choose to issue less than the "minimum

required issuance." Nevertheless, in light of evidence we present below that rejects the importance of such redemption costs, we define the minimum required issuance as the amount allowed by the minimum required bond holdings. If we had, instead, defined the minimum level of note issuance as zero, our results would not be materially affected.[4]

Table 2 provides definitions of all the variables used in this study. Table 3 provides summary statistics. We assume that banks with IP greater than 98% are effectively at their maximum amount of note issue (given potential rounding effects from the minimum denomination of bond issues and random variation in outstanding notes associated with redemptions). Thus, we assign all banks with a value of IP greater than or equal to 0.98 a truncated value of IP equal to 0.98. Similarly, we assign banks with a value of IP less than 0.02 a truncated value of IP equal to 0.02. Our truncated measure of IP, therefore, varies between 0.02 and 0.98. As shown in Table 3, in 1880 the median value of IPTRUNC is 0.8571 and the mean is 0.7640. Fully 75% of national banks in 1880 have values of IPTRUNC greater than 0.7007.

Using 0.98 as our truncated measure of maximum note issuance, 40% of national banks in 1880 were issuing the maximum amount of notes permitted. In other words, 40% of national banks were at a maximum corner solution in their issuing of national bank notes. Another 7% of national banks in 1880 were at a minimum corner solution (with a truncated value of IP equal to 0.02). The remaining 53% of national banks in 1880 had IP values between the truncated minimum and maximum values. Figure 1 plots

[4] It is true that some banks issued less than the amount of notes implied by the minimum bond holding requirement. Specifically, 79 banks in 1880, 1,201 banks in 1890, and 895 banks in 1900 issued fewer notes than the "minimum note issuance" as we define it. Some of this seems to reflect newly chartered banks, which possibly had not received their notes yet. Rounding problems or temporarily low levels of note issuance may explain other observations. Only 24 banks maintained note issues below the "minimum note issuance" amount for all three years in our sample.

a histogram of the distribution of the truncated value of IP for all banks in 1880. Figure 2 plots a histogram of IP for the 53% of national banks that were neither at the maximum nor at the minimum in 1880.

Table 3 shows that the distribution of IP changed considerably by 1890. In 1890 the median value of IPTRUNC is 0.0200 and the mean is 0.1100. Only 10% of national banks in 1890 have values of IP greater than 0.3300. Using 0.98 as our truncated measure of maximum note issuance, 5% of national banks in 1880 were issuing the maximum amount of notes permitted. A full 82% of national banks in 1890 were at a minimum corner solution (with a truncated value of IP equal to 0.02). The remaining 13% of national banks in 1890 had IP values between the truncated minimum and maximum values. Figure 3 plots a histogram of the distribution of the truncated value of IP for all banks in 1890. Figure 4 plots a histogram of IP for the 13% of national banks that were neither at the maximum nor at the minimum in 1890.

Table 3 shows that the distribution of IP had again changed considerably by 1900.In 1900 the median value of IPTRUNC is 0.0667 and the mean is 0.3410. Only 25% of national banks in 1900 have values of IP greater than 0.7675. Again using 0.02 as our truncated measure of minimum note issuance, 49% of national banks in 1900 were issuing the minimum amount of notes permitted. In other words, 49% of national banks were at a minimum corner solution in their issuing of national bank notes. Another 21% of national banks in 1990 were at a maximum corner solution (with a truncated value of IP equal to 0.98). The remaining 30% of national banks in 1900 had IP values between the truncated minimum and maximum values. Figure 5 plots a histogram of the distribution of the truncated value of IP for all banks in 1900. Figure 6 plots a histogram

of IP for the 30% of national banks that were neither at the maximum nor at the minimum in 1900.

Figure 7 plots the geographical distribution of national banks in 1880, 1890, and 1900 according to whether they were minimum issuers, maximum issuers, or other issuers (which we call "discretionary" issuers). We divide the United States into six regions: the Middle Atlantic (MIDATL), the Midwest (MIDWEST), the South (SOUTH), Appalachia (APPAL), the West (WEST), and the New England (NEWENGL). Given the high physical costs of operating banks in cities and the potentially more profitable lending opportunities there, we expected major cities' national banks to display less propensity to issue bank notes. Banks in New York City (NYC) are separately considered. We also consider the more general category of urban (URBAN) banks (defined as banks located in the major cities of New York, Philadelphia, Boston, Chicago, New Orleans, or San Francisco).

Figure 7 shows that there were average differences across regions in IPTRUNC in 1880 and that those differences often appear in 1890 and 1900, with some exceptions. For each year, Figure 7 plots the ratio of each region's mean value of IPTRUNC divided by the national average value of IPTRUNC in that year. Values greater than one are above the national average; values less than one are below the national average. In all three years, New England and the Middle Atlantic display above-average note issuance. Appalachia shows above-average issuance in 1880 and 1900 but below-average issuance in 1890. The Midwest, the South, and the West have IPTRUNC values below the national average in all three years. Interestingly, urban banks issue below average in all three years. New York City banks issue below average in 1880 and 1890 but above the national

average in 1900. Changes over time in the propensity to issue may reflect fundamental changes in the profitability of note issuing within a given location, a possibility we explore in more detail below.

The evidence on regional variation in note issuance is consistent with James's (1978) opportunity cost explanation for cross-sectional differences in note issuance, but it is conceivable that other factors (e.g., regional variation in redemption risks and their associated costs) could also explain these patterns. Thus, before returning to an empirical investigation of the James hypothesis, we first investigate the extent to which redemption risk might explain cross-sectional variation in note issuance.

IV. The Redemption Risk Theory of Underissuance

Cagan (1965, p. 95) was the first to specifically point to redemption risk as the most likely explanation for the low issuance of national bank notes:

> The slow expansion [of national bank notes] suggests that national banks waited until it seemed certain that no reason to withdraw the notes would arise in the near future. Why a withdrawal need be feared, however, is not clear.

Cagan (p. 89) argued that the amount national banks held on deposit at the Treasury in excess of the 5% minimum required redemption fund likely reflected, at least in part, a form of precautionary reserve holdings, which should be included in the cost of issuing notes. More generally, advocates of hidden redemption costs as the solution to the puzzle of national bank note issuance have focused on the risks of unpredictable redemption. For example, Wallace and Zhu (2004) argue that issuers limited note issues because higher issuance increased the propensity for redemption; in their formulation, the amount of notes that could be profitably "floated" was "subject to diminishing returns."

As Cagan recognized, it is not obvious that redemption risk should have been significant in practice. National banks could pay out to the public each other's notes received from the public, and notes were free of default risk; thus, it is not clear why notes would be presented at the Treasury or at any national bank for redemption, rather than continuing to circulate among banks and the public at par (except for reasons of wear and tear).[5] Furthermore, national banks could instruct the Treasury to sell bonds on deposit at the Treasury to pay for redemption or borrow in the interbank market (from a bank that could take funds to the Treasury as needed) to finance redemption on short notice. To the extent that transportation costs and idle notes may have represented hidden redemption costs, the Treasury routinely accepted notes for redemption at subtreasury offices located in large reserve cities.[6] Even if notes could not be reissued quickly after being returned from the Treasury, banks could still invest them in the interbank deposit market, which yielded about 2% throughout our period.

Cagan's discussion suggests a straightforward test of the proposition that the costs of unpredictable redemption were important and that the 5% minimum redemption fund did not adequately eliminate the risk of redemption. If unpredictable redemption costs were important, then national banks would have maintained excess reserves on deposit at the Treasury (or perhaps in their vaults) to ensure their ability to redeem notes on demand.

[5] Indeed, Cagan and Schwartz (1991) provide detailed criticisms of various arguments advanced by other authors in support of the idea that redemption costs were significant. Cagan and Schwartz also note (p. 303) that, circa 1900, notes were redeemed on average only once every 32 months.

[6] Cagan and Schwartz (1991) cite estimates that some 85% to 90% of banks whose notes were redeemed were located in those large reserve cities (p. 300).

Empirically, we can test whether higher amounts of note issuance result in a greater demand for reserves. Because the size of excess reserves maintained at the Treasury and in bank vaults by each national bank is observable, we can test whether national banks held precautionary balances against note issues and whether the need for excess reserves to mitigate the costs of redemption risk rises with greater note issuance. Furthermore, given the possibility of exogenous differences across regions in redemption costs, we can test for regional effects in the demand for reserves to see if these regional differences can explain regional differences in the propensity to issue notes.

The first thing to note about national banks' excess balances at the Treasury is that they were quite small. In 1880, aggregate total excess reserves at the Treasury were 0.47% of total outstanding national bank notes. In 1890, they were 0.66% of national bank notes, and in 1900, they were 0.56% of national bank notes. The cross-sectional (bank-level) average of Treasury reserves to national bank notes outstanding was 0.6153% in 1880, 0.6377% in 1890, and 0.7505% in 1900, while the standard error of the ratio of excess Treasury reserves to national bank notes outstanding was 0.0010701 in 1880, 0.0013104 in 1890, and 0.0012383 in 1900. Clearly, the average precautionary demand for excess reserves at the Treasury to mitigate the risk of sudden redemption was small.[7]

We employ regression analysis to test for a relationship between the scale of bank note issue and the amount of excess reserves. If banks were concerned about redemption risk, and if the desired excess reserve ratio is a constant fraction of notes outstanding

[7] Note that in 1880 the comptroller reports the *sum* of the 5% redemption fund and excess reserves, while in later years, the redemption fund and excess reserves are broken into separate data fields.

(after controlling for regional differences and other bank characteristics), then banks with larger amounts of notes should hold larger amounts of excess reserves.

Table 4 presents a simple regression analysis of narrow reserves held at the Treasury (since Cagan emphasized that component) as a ratio of total bank liabilities (assets minus net worth), which we call TER, and the ratio of excess cash reserves (including funds at the Treasury as well as those in the bank's vault) relative to total bank liabilities, which we call NER, for 1880, 1890, and 1900. The model of the determinants of reserve demand is taken from Calomiris and Mason (2004).

The excess reserve demand regressions measure the relationship between excess reserve holdings and various bank characteristics. Characteristics include bank balance-sheet characteristics and bank-location characteristics. Location is captured both by regional indicators and by indicators that capture whether the bank is located in a "reserve city" or a "central reserve city". Banks located in reserve cities or central reserve cities faced different regulatory requirements for deposits and also different business opportunities, which may have affected their demand for reserves.

Bank balance-sheet characteristics include bank leverage (total liabilities relative to total assets, TLTA), the total amount of bank liabilities (log of total liabilities, LNTL), and various measures of the mix of liabilities, the mix of assets, and the location of the bank. Economies of scale in transactions demand for reserves are a common feature of all empirical money demand models (Baumol 1952, Tobin 1956, Miller and Orr 1966) and implies a negative relationship between total liabilities and the demand for reserves.

Our measures of liability mix allow the demand for reserves to depend on liability composition, which is likely to reflect differences in the volatility of withdrawals or

redemptions (as modeled in Miller and Orr 1966). These variables include the ratio of bank notes relative to total liabilities (NTL), its square, NTLSQ (to allow for non-linearity in this effect), and measures of deposit mix. Deposits are divided into three categories: U.S. government deposits, interbank deposits, and deposits of the public. The ratio of U.S. government deposits to total deposits is USDTD, and the ratio of interbank deposits to total deposits is IBDTD. The ratio of public deposits to total deposits is the omitted category of deposits.

We also include the ratio of loans and discounts relative to securities (after omitting U.S. government securities held as backing for bank notes), which we call LOANRAT. LOANRAT can be thought of as a measure of the attractiveness of bank lending opportunities as reflected in banks' asset mix decisions. Calomiris and Wilson (2004) show that superior lending opportunities result in lower reserve demand, ceteris paribus.

We focus here on the relationship between increases in bank notes and the demand for excess reserves. Cagan's precautionary reserve-demand hypothesis implies that an increase in the total amount of national bank notes issued by the bank should result in an increase in excess reserve holdings of the issuing bank.

The regressions in Table 4 show that there is no statistically significant relationship between the amount of national bank notes and the level of excess cash reserves (measured either by TER or NER). Banks that issued larger amounts of notes, ceteris paribus, did not hold larger amounts of excess cash reserves. Furthermore, with the exception of the South, there is no evidence of regional variation in the target excess reserve ratio of reserves held at the Treasury (TER). There is some evidence of regional

variation in NER, but that variation is not consistent over time, and it does not correspond with the regional variation in note issuing described by James or by Figure 7. We conclude that narrowly defined excess cash reserves (whether held at the Treasury or in the bank vault) were generally unrelated to bank note issue. That evidence suggests that banks believed that their 5% minimum redemption fund was more than adequate to handle redemption risks from note issuance. Consequently, we conclude that the hypothesized costly maintenance of cash balances to mitigate redemption risk cannot explain the puzzle of underissuance of national bank notes.

In Table 5, we broaden our definition of excess reserves to include total reserves (specie, legal tender, deposits at the Treasury, plus deposits held at other banks) minus the amount of required reserves (either at the bank or at the Treasury), relative to total liabilities, which we call BER. We find that broadly defined reserve holdings are *negatively* related to note issue and that this relationship is statistically significant.

It is important to remember that the relationship between notes and excess reserves in Tables 4 and 5 is not univariate. As noted before, expanding the bank size to increase note issuance implies not only an additional effect through NTLSQ but also a commensurate (111%) increase in assets and liabilities. Hence, Table 6 presents the total marginal effects on excess reserves of a $100,000 increase in bank size brought about by increasing note issuance accounting for the appropriate changes in TLTA, LNTL, NTL, and NTLSQ at the variable means. The resulting marginal effect of increased note issue is zero in 1880 and 1890 for the narrowest classes of reserves and negative for all other classes of reserves and time periods in Table 4, and negative for the broadest class of

reserves estimated in Table 4. Hence, it appears that note redemption was not a risk that was magnified by increased note issue.

The results in Tables 4 and 5 not only contradict the redemption risk hypothesis, but they also suggest a significant reduction in reserve management costs from issuing notes for the average bank. We interpret this result as reflecting a complementarity (economy of scope) between, on the one hand, note issuing, and on the other hand, deposit taking and lending, which resulted from the fact that the 5% minimum cash reserve requirement on notes was more than the amount warranted by actual redemption risk on notes. Under that hypothesis, note-issuing banks could economize on the costs of maintaining desired reserves associated with deposit taking and lending (motivated, for example, by portfolio risk reduction) because the unwarranted high required reserves against notes could be applied toward reducing the amount of excess reserves needed in the deposit taking and lending arm of the bank. In other words, taken together, the results in Tables 4 and 5 indicate that redemption risks for notes were unusually low and were more than adequately dealt with by the minimum cash reserves held at the Treasury. Excessive required reserves on note issues, however, reduced the demand for excess reserves for other purposes. The economies of scope in reserve management also help to explain why national banks combined deposit taking and note issuing, rather than specializing in note issuing, since combining the two reduced the cost of note issuing (more on this point in Section V below).

V. The Absence of Pure Arbitrage Strategies

The fact that many banks issued the maximum permissible amount of notes in 1880 and 1900 presents us with two related puzzles of underissuance. First, we must explain why some banks in existence did not issue the maximum amount of notes they could (we return to that question in Section VI below). Second, we must also explain the lack of entry by pure "arbitragers" into the note-issuing business. That second question is addressed here.

If note issuing were profitable, and if existing banks willing to issue notes had already issued their legal maximum or had deployed their equity capital in the pursuit of profitable alternative opportunities, we might still expect bank entry by new, purely note-issuing banks. The scarcity of financial or human capital in the banking industry (which was already being employed in other banks) would not constrain such investors, since they had no need for knowledge of the businesses of lending and deposit taking. We characterize entry by investors to establish a wholly note-issuing national bank as a "pure arbitrage" strategy for issuing notes. In essence, such an arbitrage strategy would be a means of taking advantage of an interest rate subsidy on "margin loans" from the government for the purpose of purchasing government bonds.

Interestingly, no national banks pursued this pure arbitrage strategy. As shown in Table 7, which summarizes data on the 10 banks in 1880 that had the lowest ratios of assets other than government bonds relative to total assets (OTHASS) and the 10 banks in 1880 that had the lowest ratios of deposits to assets (DEPASS), all national banks were involved in lending/investment and deposit taking to some degree. For example, Montpelier National Bank, which maintained the lowest OTHASS ratio, had an OTHASS

ratio of 31.6% and a DEPASS ratio of 50.8%. Casco National Bank, which maintained the lowest DEPASS ratio of any seasoned bank, had an OTHASS ratio of 97.2% and a DEPASS ratio of 33.2%. Results for 1890 and 1900 (not reported here) are similar to those reported in Table 7, although two banks in 1890 displayed low DEPASS ratios of 6.0% and 19.6% and two banks in 1900 displayed low DEPASS ratios of 5.5% and 5.6%. But those four banks displayed OTHASS ratios of 76.5% and 59.8%, and 52.7% and 53.7%, respectively.

When we consider the practical obstacles to pursuing a profitable pure arbitrage strategy, it is not surprising that no national banks did so. A bank in 1880 establishing itself solely to issue notes would have pursued only one of two strategies (summarized, respectively, in Figures 8 and 9). The first strategy (illustrated in Figure 8) – to issue the maximum amount of notes, equal to $500,000 – implied a required capital investment of $625,000 in initial equity capital and an additional $125,000 in surplus capital, for a total equity investment of $750,000.[8] The bank would also have been required to maintain a $25,000 redemption fund at the Treasury. The remaining $1,225,000 could be held in government bonds. Long-term government bonds yielded roughly 3.5% in 1880.[9] The pre-tax annual earnings on these bonds would have been $42,875. The bank also had to pay a tax equal to 1% of its outstanding national bank notes, or $5,000. Thus, even if the bank faced no physical costs of operating, its after-tax earnings would equal $37,875, implying a return on equity capital of 5.05%.

[8] The initial capital investment is necessary to satisfy the regulation that notes must be less than 80% of capital if capital is above $500,000. The surplus capital requirement is set according to the requirements of Sections 33 and 38 of the National Bank Act of June 3, 1864, which requires that banks accumulate and retain surplus equal to 20% of paid-in capital.

[9] According to Homer and Sylla (1991), p. 316, in 1880, U.S. government bonds maturing in 1891 had a yield to maturity of 3.45%, and U.S. government bonds maturing in 1907 had a yield to maturity of 3.63%.

A second possible strategy for 1880 is summarized in Figure 9. Here the bank issues fewer notes ($449,999) in order to maintain paid-in capital just below $500,000 and, thus, be able to issue 90% of its capital in notes (as opposed to only 80% of capital). Assuming zero operating expenses, this bank has after-tax earnings of $31,463, and a return on equity of 5.24%.

Interest rates on government bonds declined over the period 1880 to 1900. By 1890, long-term yields on the 4s of 1907 had fallen to 2.37%. In 1900, long-term Treasury bond yields were even lower, ranging from 1.7% on the 4s of 1907 to 2.12% on the 4s of 1925, implying substantially lower returns on equity from a pure arbitrage strategy.[10] Assuming a Treasury bond yield of 2% for 1900, and using the same methods for computing profitability as in Figures 8 and 9, the banks issuing $500,000 and $449,999 in notes, respectively, would earn returns on equity of 2.6% and 2.8%.

This method for computing returns on equity results in values that are lower than those described by Cagan or Friedman and Schwartz, but they are still unrealistically high. A national bank would have undoubtedly had some minimal costs of operation, even if it did not engage in lending or deposit taking. National banking law required at least five members of the board of directors (who would have to meet and be compensated for their time), and the hiring of employees (a president, vice president, and cashier), the regular filing of accounts, the maintenance of a headquarters, and regular bank examinations paid for by the national bank being examined. Section 54 of the Bank Act of 1864 requires that examiners be compensated at the rate of $5 a day, plus $2 per 25 miles traveled on their way to the bank, all billed to the bank. We conservatively estimate the physical costs of running a bare bones bank (rent, maintenance costs, wages,

[10] Homer and Sylla (1991), p. 343.

examination fees, and accounting costs) at roughly $1,000 per year. That estimate assumes that directors and officers serve at no cost, assumes a wage cost of $750 per year (the estimated cost of employing a cashier to keep the bank's premises, manage its accounts, and meet with the examiner, assuming that the cashier is paid $2.50 per day), and rental, maintenance, and examination costs of an additional $250 per year. We add to those costs the comptroller's initial redemption cost estimates in the range of $62.50 per $100,000 of notes, which Goodhart and others argued rose considerably owing to seasonal fluctuations in demand for monetary medium. Under these assumptions, total operating costs for the banks operating in 1880, described in Figures 8 and 9, equal $1,313 and $1,281, respectively. Those costs imply returns on equity of 4.87% and 5.03%, respectively. For the analogous banks operating in 1900, the implied returns on equity would be 2.43% and 2.54%, respectively. Our estimates of physical costs are very conservative, which may explain why the implied returns on equity are still above the comptroller's minuscule estimates of returns to note issuance of 50-175 basis points in 1880 (Annual Report, p. 8). Nevertheless, these returns are quite modest, especially considering the fact that note issuing did imply substantial interest rate risk.[11]

Another way to think about the profit from the pure arbitrage strategy, which takes into account interest rate risk, is to compare it to a similarly leveraged purchase of government bonds. For example, assume that a state-chartered bank had established itself purely with the intent of investing in government bonds and had borrowed on the interbank deposit market to fund that investment. Assume also that it chose to maintain the same balance sheet amounts as in Figures 8 and 9, but substituted interbank deposits for national bank notes as a source of finance. That state-chartered bank would have been

[11] For further discussion of interest rate risk, see Kuehlwein (1992).

in a somewhat inferior position to a national bank pursuing a pure arbitrage strategy for two reasons: (1) the interest cost on interbank deposits is greater than the cost of finance from bank notes (which is just the 1% tax on note issues), and (2) the national bank does not bear as much interest rate risk as the state-chartered bank, since increases in interest rates have no effect on the required return paid on national bank notes (which are always zero).

Interbank deposit funding imposes an interest cost of roughly 2% during our time period.[12] Thus, abstracting from interest rate risk differences, the annual after-tax national bank "subsidy" for its zero-interest margin loan from the government for investing in government bonds would have been roughly 1% of the amount of notes issued ($5,000 in the first example, and $4,500 in the second example).

The difference in interest rate risk can be captured by considering the difference in the sensitivity of bank equity to variation in the yields on long-term bonds for the two hypothetical banks. For concreteness, assume that both the national and state-chartered hypothetical banks had a Macaulay duration of assets of 10 years (reflecting their holdings of government bonds with average maturities in excess of 10 years). Alternatively, assume that the arbitragers expected to operate the banks for 10 years and then liquidate them, implying a duration of 10 years for bank notes.[13] Assume that interbank deposits used to finance the state-chartered bank had a duration of 90 days and

[12] John James (1976, p. 200) writes: "…explicit payment of interest was becoming a pervasive practice in New York by the late 1880s, and at that time also the rate of interest stabilized at 2 percent…"

[13] Alternatively, one could assume an indefinite maturity of bank notes, if the founders of the bank could have sold their stock in the bank to others upon their retirement. In the event, changes in monetary regime rules brought an end to the license to issue national bank notes, and this was a risk that arguably was known in advance. Thus, we think a 10-year expectation for the operation of a representative national bank's license to issue notes is reasonable. Reasonable variation in that assumption will not change our conclusions.

assume (to be consistent with the examples in Figures 8 and 9) that the ratio of debt to assets was 0.4. In a simple, one-factor model of interest rate risk, the sensitivity (percentage decline) of bank equity value resulting from a 1% rise in interest rates for the banks we consider is given by the following equation:

$$D_K = A/K\,[D_A - (L/A)\,D_L].$$

Under the above assumptions, the values of D_K for the national and state-chartered banks would be as follows: For the national bank, $D_K = 1.67\,[10 - (0.4)10] = 10$. For the state-chartered bank, $D_K = 1.67\,[10 - (0.4)(0.25)] = 16.53$.

How much would this difference in interest rate risk have mattered for the value of the national bank? Judging from the small yield differences in 1880 on government bonds with *maturity* dates of 1891 and 1907 (the first of which had a duration less than 10 years, and the second of which had a duration greater than 17 years), the market did not view the added risk as very great. According to Homer and Sylla (1991, p. 316), in 1880, U.S. government bonds maturing in 1891 had a yield to maturity of 3.45%, and U.S. government bonds maturing in 1907 had a yield to maturity of 3.63%, implying a difference of 18 basis points.[14] We conservatively estimate the value of the reduced risk to the national bank at roughly 20 basis points of return on equity per year. In the example in Figure 8, for 1880, that would amount to $1,500 of added annual value, bringing the total subsidy to a pure arbitrager (before expenses) of $6,500 per year. In the example in Figure 9, for 1880, the 20-basis-point premium would add $1,200 of added annual value, raising the total subsidy (before expenses) to $5,700 per year. The analogous additions for 1890 and 1900 would be smaller.

[14] The difference for 1900 was even smaller. The Treasury bond maturing in 1907 had a yield of 1.70%, while the bond maturing in 1925 had a yield of 2.12% (Homer and Sylla 1991, p. 343).

Thus, around 1880, the annual gain (gross of physical expenses) from pursuing the pure arbitrage strategy, taking into account the value from interest payments savings and reduced interest rate risk, was roughly $6,500 on an equity investment of $750,000, or $5,700 on an equity investment of $600,000 – in both cases, less than 1% of equity invested. The gain from the subsidy net of physical expenses would have been substantially lower and possibly negative. In other words, the gain from using a national bank charter as a vehicle for investing in U.S. government securities was nearly zero, and perhaps negative, after we take into account physical costs and the cost of risk. For 1890 and 1900, that gain was even smaller.

In summary, as an empirical matter, banks did not pursue the pure arbitrage strategy. When we consider the limitations on leverage from the banking regulations, the taxes on note issues, and the cost of operating even a "bare bones" national bank, it is not surprising that pure arbitrage remained a hypothetical opportunity. Note issuance was not profitable as a stand-alone strategy for a bank; note issuing was profitable only when combined with lending and deposit taking. Note issuing was not the primary profit center for a national bank. Note issuing, by itself, was not a viable business; its profitability depended on economies of scope between note issuing and other banking functions due to sharing physical costs of operating and diversifying risks. The empirical work in Section VII further confirms that note issuing was of small and declining profitability over time, as indicated by the low propensity to issue notes by banks entering between 1880 and 1900.

VI. Regression Analysis

We turn to regression analysis of our truncated measure of IP. We consider whether observable differences in the attributes of issuers related to the opportunity cost of issuing notes (i.e., lending profitability) explain their propensities to issue notes. As we discussed above, and as James (1978) hypothesized, a bank's opportunities other than note issuing should have been important determinants of IP. Our measures of bank opportunity costs, which we expect to be negatively associated with IP, take account of a variety of those potentially relevant factors.

First, as a measure of lending opportunities we include a measure of asset returns – for assets other than U.S. Treasury securities held to secure note circulation – of banks in the state in which the national bank is located, as one measure of bank profitability (bank-level or county-level data on banks' revenues and costs are not available). ROAL is constructed by adjusting state-level ROA to remove the effect of interest earned on U.S. Treasuries securing note circulation, using data on that year's Treasury yields and data on state-level note circulation to calculate the amount of Treasury securities backing note issues. Of course, ROAL is a noisy indicator of lending opportunities for individual banks because it is a state-level aggregate and also because it fails to capture dynamic growth or contraction in expected loan opportunities, which would be relevant to bank decisions about allocating capital between note production and lending. Thus, as additional bank-level proxies, we also consider two other measures.

We include the individual bank's ratio of loans and discounts relative to its holdings of securities (other than the U.S. Treasury bonds held to secure note circulation). Banks with superior lending opportunities should maintain a higher LOANRAT. This

measure captures the portfolio allocation decisions of each bank and takes into account expectations of loan profitability.

Finally, we include additional measures of opportunity cost related to the growth and profitability of agriculture and manufacturing within the county (or counties) in which the bank is located, weighted by the importance of those sectors in the county economy. For 1880, 1890, and 1900, decadal census years, data on the amount of capital in manufacturing and in agriculture are available. These variables can be used to measure the relative importance (weight) of each of the two sectors in the local county economy and also the growth rate of capital for each 10-year period prior to 1880, 1890, and 1900. The variables WDFK and WDMK measure the weighted growth in farm and manufacturing capital within the county (or counties) in which the bank is located, for 1880, 1890, and 1900. Additionally, for 1890 and 1900, census data are also available on the profitability of the manufacturing sector. Hence, for 1890 and 1900, we include the weighted return on capital assets in manufacturing (WROAM) instead of WDMK as an alternative measure of manufacturing profitability.

We also include various control variables in our analysis related to the size, age, and urban location of banks. Size is defined as asset size (SIZE) and bank age (AGE) is defined as years since its national bank charter. The relationships between IP and bank size and age are potentially complex. Ceteris paribus, because older banks were initially allowed different maximum issue sizes, their IPs could be lower (because, ceteris paribus, they are less likely to be constrained in their desired amounts of issues). Larger banks, ceteris paribus, could have higher IP because they are more likely to be constrained by the maximum issuance limit. But those implications about ceteris paribus associations

may not hold true in measured associations between IP and size and age variables because size and age might be associated with marginal lending opportunities (more on this point in Section VII below). Older and larger banks might have surplus capital relative to new lending opportunities, for example, which could lead to a higher value of IP. Thus, we include SIZE, AGE, and SIZExAGE as controls, since all three may be relevant for predicting note issuing propensity, although we recognize that there are multiple interpretations of the measured effects associated with these variables.

We also include separate indicator variables to control for any special characteristics of banks located in New York City (NYC) and for banks located in other major cities listed above (URBAN).

In Tables 8, 9, and 10 (for national banks in 1880, 1890, and 1900, respectively) we report Tobit regressions, which take into account the truncations that result from minimum and maximum note issuing rules and which measure the effects of opportunity cost and control variables. For each year, we report specifications that alternately include or exclude regional indicator variables. We begin with regressions that exclude all the opportunity cost variables but include regional indicators (a regression that is analogous to James's 1978 results). For 1880, we report three regressions: (1) with regional indicators but without opportunity costs, (2) without regional indicators but with opportunity costs, and (3) with both regional indicators and opportunity costs. For 1890 and 1900, we report four regressions, since we have two alternative measures of county-level profitability of manufacturing (WDMK and WROAM).

The results are broadly consistent with one another and with our hypothesized opportunity cost effects. They indicate substantial variation in the propensity to issue

national bank notes that is traceable to county, state, and bank-specific characteristics related to the profitability of lending. State-level ROAL enters negatively in 1890 and 1900, and it is statistically significant. Bank-level LOANRAT enters negatively and significantly in all years. County-level WDFK enters negatively and significantly in all years, although it is less significant in 1900. WDMK enters negatively and insignificantly for 1880, 1890, and 1900, but the alternative measure of manufacturing profitability (WROAM) enters negatively and significantly in both 1890 and 1900 (the only years for which that variable is available).

It is also interesting to note that the coefficients for the regional indicator variables for MIDWEST, SOUTH, and WEST remain negative and statistically significant in the presence of the opportunity cost variables, which indicates that our measures of opportunity cost still do not capture all of the important regional influences on note issuing.

Controls for SIZE, AGE, and SIZExAGE are almost always significant and remain significant in the presence of regional indicator variables. NYC and URBAN enter negatively and most times significantly, becoming stronger across time. Those effects may also indicate an opportunity cost effect, since banks in cities may have had special lending opportunities that reduced their propensity to issue notes.

Our results provide support for James's (1978) view that the opportunity costs of lending varied across banks, and they explain the variation in the propensity to issue notes. Many banks (with low lending opportunity costs) were at a corner solution with respect to note issuing. Other banks (with high lending opportunity costs) issued less than the maximum permissible amount of notes.

We also explore variation over time in note issuance in Table 11. Here we pool the data for 1880, 1890, and 1900 into a single regression model, constraining the coefficients to be the same over time. To capture changes in the profitability of note issuing over time, in addition to our measures of opportunity costs from lending, we include the yield on government bonds as a regressor. We report two different versions of regressions that include the interest rate: one includes the current year's interest rate (USCURR); the other includes the previous year's interest rate (USLAG). Delays in issuing and redeeming notes suggest that using the previous year's interest rate may be preferable (especially since innovations in long-term interest rates should not be predictable). For purposes of comparison, to see how much of the variation by year is captured by the interest rate, we also report a specification that includes annual indicator variables for each year. In order to include an interest rate in the regressions that is comparable over time, we had to adjust for differences in the maturity of government bonds to produce a constant-maturity U.S. government yield to maturity. Our procedure for doing so is explained in Appendix A.

As discussed in Section V, the profitability of bond holding and note issuing (compared to deposit taking and lending) should be an increasing function of the yield on bonds. Table 11 reports that the sign on bond yields is positive and statistically significant. Remarkably, the specification that uses the previous year's interest rate captures virtually *all* of the variation captured by the time dummies. That is, the improvement in log likelihood from adding the lagged interest rate is the same as the improvement from adding time dummies (an increase from -6956.4 to -6308.8). This

provides strong support for the view that variation in note issuance across banks and over time was strongly responsive to the relative profitability of note issuance.

VII. Entry, Exit, and Bank Note Issuance

The declining propensity to issue notes over time was reinforced by the exit of high note issuers and the entry of low note issuers. Furthermore, the tendency for banks in the MIDWEST, SOUTH, and WEST to issue fewer bank notes in 1880, 1890, and 1900 was true of banks that survived the entire period, as well as those that entered between 1880 and 1900.

Figure 10a illustrates that of the many national banks that entered the industry between 1880 and 1900, only 17% of those that entered (412 of 2,381 entering banks) chose a maximum note issue strategy, while a full 55% (1,312 of 2,381) chose to issue at the minimum. Furthermore, Figure 10b shows that 40% of those exiting the industry during the period (186 out of 470 exiting banks) were maximum issuers, while only 10% (46 of 470) were minimum issuers. Figure 7 illustrates that the majority of entry was in the MIDWEST, SOUTH, and WEST, where issuance was already low. Because entering banks predominantly issued at the minimum possible level, it appears (consistent with the discussion in section V) that those banks were interested in opportunities other than note issuance. Hence, despite 103% growth in the number of banks in the MIDWEST, 301% in the SOUTH, and 524% in the WEST, note issuance remained suppressed in those regions.

Figure 10c illustrates that of banks that survived the period 1880-1900, 38% (577 of 1,508) were minimum issuers and a roughly equal amount, 27% (400 of 1,508), were

maximum issuers. Figure 10d shows that among those surviving banks, 17% maintained a constant IPTRUNC (despite changes in the method for computing IP in 1882) and 63% *reduced* their IPTRUNC across the period (35% reduced issuance by 95% or more). Hence, only around 26% (395 banks) of banks that survived the period and 17% (412 banks) of entering banks, for a total of 807 banks out of 3,861 in 1900, showed an interest in maximizing their note issuance in the period 1880-1900.

The fact that exiting banks tended to rely more on note issuing than average and that entering banks focused less on note issuing than average while remaining banks reduced their issuance over our period provides further evidence that note issuing was not the primary profit center for national banks during our period. The regional patterns of entry and the fact that new entrants in the low-issuing regions were especially low note issuers corroborate the James (1978) hypothesis that opportunities other than note issuing were particularly high in those regions.

VIII. Conclusion

The long-standing puzzle of underissuance of national bank notes disappears when we disaggregate the data to the level of individual banks, take account of the limits banks faced on their maximum permissible note issues, and consider differences in opportunity costs of note issuing across banks. In 1880, 40% of national banks, in 1890, 5% of national banks, and in 1900, 21% of national banks were maximum note issuers. Banks with low lending opportunities maximized their ability to issue notes but could not issue more than a certain amount. Other banks, with high lending opportunities, rationally chose not to issue more notes.

Models of redemption costs do not explain the substantial cross-sectional variation in the extent to which national banks chose to issue national bank notes. The theory that redemption risk explains underissuance of bank notes is inconsistent with the observed lack of any relationship between bank note issuance and excess reserve holdings.

Furthermore, there seem to have been substantial economies of scope between note issuing, on the one hand, and deposit taking and lending, on the other hand. Those economies of scope probably included shared overhead costs as well as the ability to economize on the costs of maintaining mandatory minimum levels of reserves and capital when issuing notes. Combining deposit taking and note issuing allowed banks to make full use of capital and reserves that were legally required in support of note issuing but which exceeded warranted levels.

National banks did not enter solely to issue national bank notes (what we call the pure "arbitrage" strategy). Once we take proper account of the regulatory limits on issuance and of the costs and benefits of entering purely to issue notes, that fact is not surprising. Indeed, over the period 1880 to 1900, new entrants focused less on note issuing, while banks exiting were more likely to be maximum issuers. Note issuing was profitable only when combined with lending and deposit taking, and note issuing seems to have been a relatively unprofitable line of business for successful bankers.

The puzzle of underissuance of national bank notes appears in large part to be an object lesson in the importance of disaggregating data and thus avoiding misleading "representative bank" analysis relating average bank behavior and average bank opportunities.

Appendix A

This appendix explains the construction of a constant-maturity yield to maturity for U.S. government bonds for 1879, 1880, 1889, 1890, 1899, and 1900, which we employ in our regression analysis in Section VI. Homer and Sylla (1991, pp. 310, 317 and 343) is our source for redemption yields on government securities. The data we use from that source are as follows:

Redemption Yields of U.S. Government Securities

	6s of 1881	5s of 1891	4.5s of 1891	4s of 1907	4s of 1925
1879	2.95	3.87		3.96	
1880			3.45	3.63	
1883			2.60	2.88	
1884			2.55	2.76	
1889			1.04	2.13	
1890				2.37	
1899				2.22	
1900				1.70	2.12

Our procedure for constructing a constant-maturity yield for a 12-year government bond is as follows. First, we assume that the shape of the yield curve looking forward from two years is constant relative to the two-year yield. For example, we assume that the difference between the yield on a two-year (remaining maturity) government bond and a 12-year (remaining maturity) government bond is constant over time.

When a 12-year (or 11-year) yield is observable in any of our six years for which we construct estimates, we use that number. Thus, in 1879 and 1880, the constant-maturity yields are 3.87 and 3.45 percent, respectively.

For the other years, we use all available information on term spreads to adjust the information we do have, under the assumption of constancy of term structure over time. Since we often have two or more such term spreads, and they need not imply the same constant-maturity yield, we average across estimates. For example, for 1889, we have three alternative estimates of the yield: (2.13-0.18=1.95); (2.13-0.09=2.04); (1.04+0.92=1.96). We average these three estimates to arrive at an estimate of 1.98%. Similarly, for 1890, we have two alternative estimates of yield: (2.37-0.18=2.19): (2.37-0.09=2.28). We average these two estimates to arrive at an estimate of 2.24%.

For 1899 and 1900, we have only an eight-year bond. In addition to the previous method, we also perform an interpolation, and our estimates for 1899 and 1900 represent an average of the observed spreads in earlier years and the interpolation method. Specifically, we average two estimates of a 12-year yield for 1899 to arrive at our estimate. First, we adjust the eight-year rate (2.22%) by adding 0.28 (from 1883) to arrive at a 24-year yield, then we subtract the average of the 0.09 and 0.18 spread (0.13) to convert that 24-year yield into a 12-year yield. This results in an estimate of 2.37%. Second, we linearly interpolate using the two 12-year term spreads from 1879, which

implies a term spread of 0.37 to be added to the 2.22% eight-year yield to convert it into a 12-year yield of 2.59%. Averaging those two estimates results in our estimate of 2.48% for the 12-year yield in 1899. Following a similar method results in an estimated yield of 1.97% in 1900. For 1900, we have an additional piece of information, which is the yield on the bond maturing in 1925 (2.12%). If we adjust that yield by subtracting 0.13 (the average of 0.09 and 0.18), we arrive at an estimate of 1.99%. Averaging across the three methods for 1900, we thus arrive at an estimate of 1.97%.

Estimated Constant-Maturity (12-year) Yields to Maturity

1879	1880	1889	1890	1899	1900
3.87	3.45	1.98	2.24	2.48	1.97

Our conclusions are not very sensitive to the assumption of attaching equal weights to the various estimation approaches that underlie our final estimates of each number. Specifically, the consistency across the various estimation methods leads us to be reasonably confident that the true constant-maturity yields are not likely to be no more than 10 basis points different from our final estimates.

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Figure 1: Histogram for Issue Propensity -- All Issuers, 1880

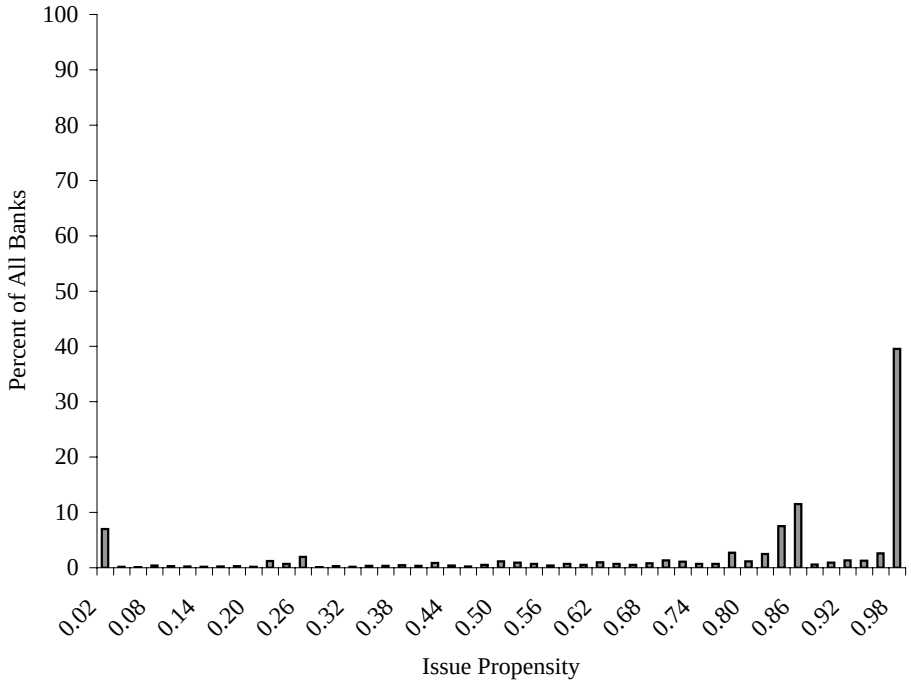


Figure 2: Histogram for Issue Propensity -- Discretionary Issuers Only, 1880

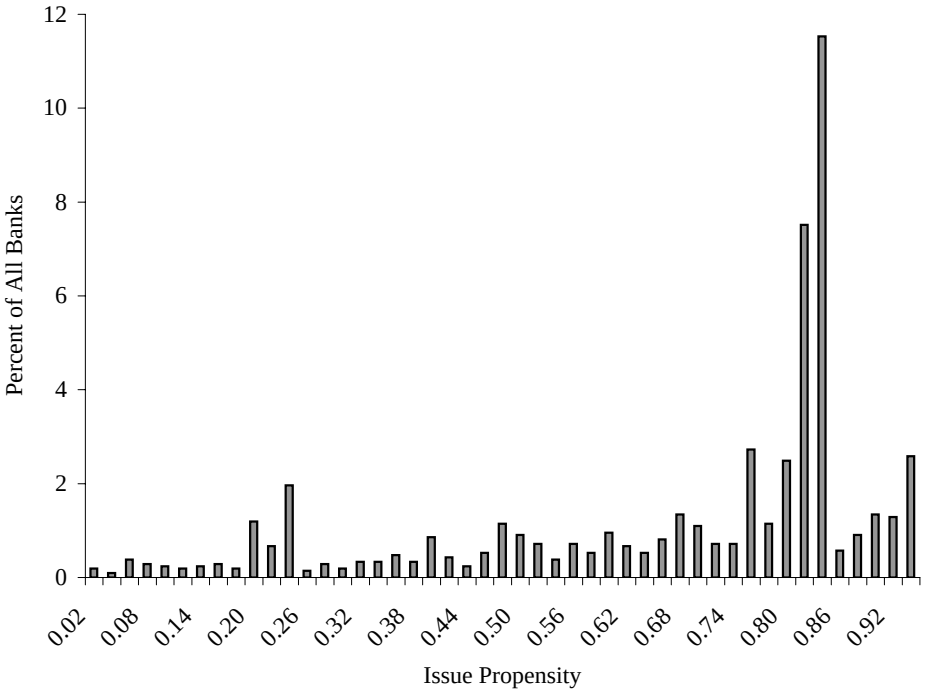


Figure 3: Histogram for Issue Propensity -- All Issuers, 1890

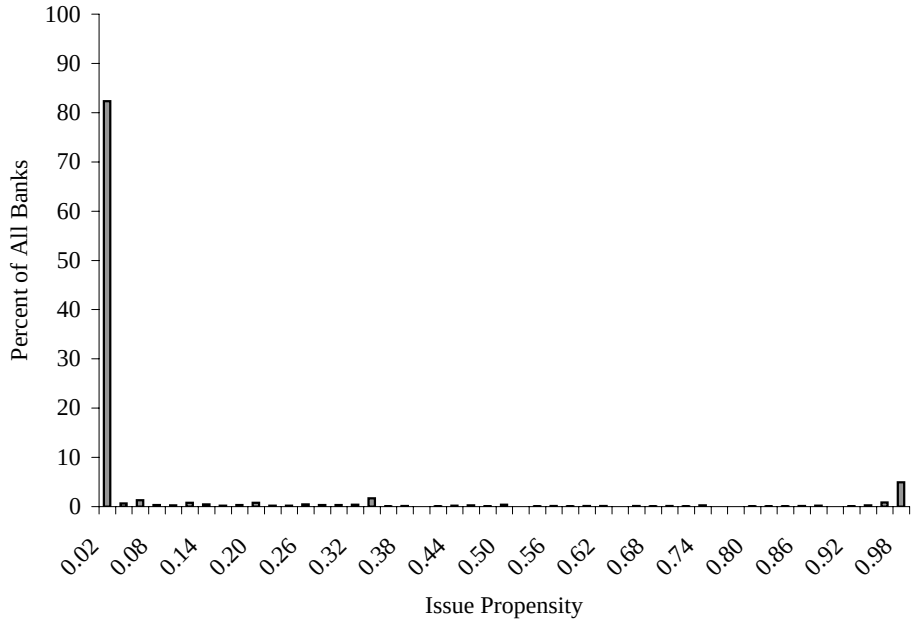


Figure 4: Histogram for Issue Propensity -- Discretionary Issuers Only, 1890

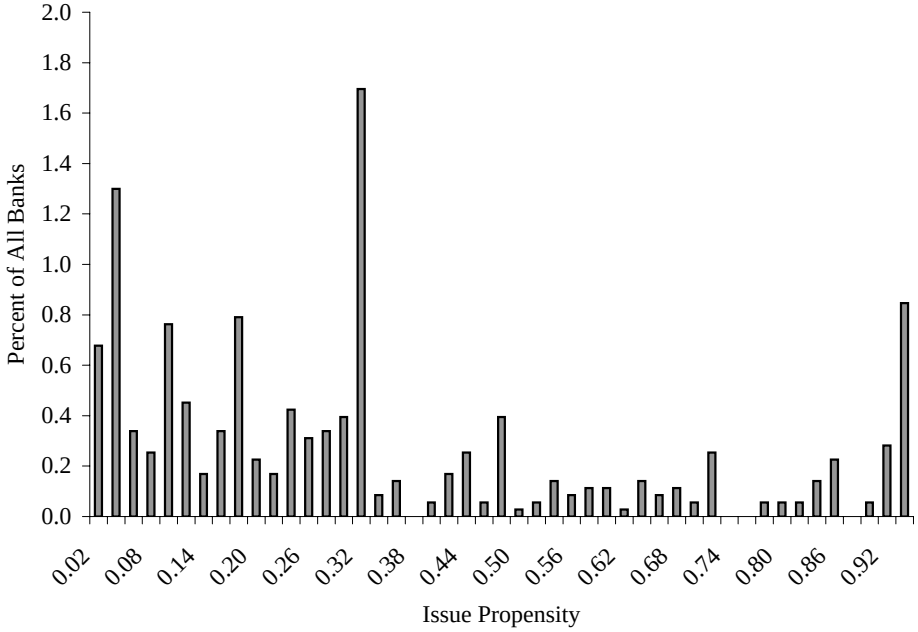


Figure 5: Histogram for Issue Propensity -- All Issuers, 1900

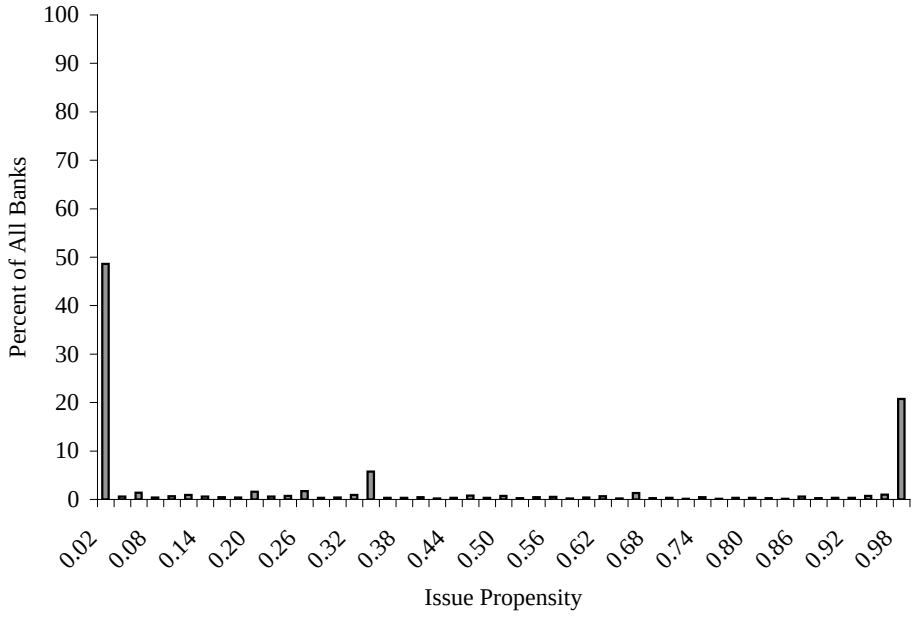


Figure 6: Histogram for Issue Propensity -- Discretionary Issuers Only, 1900

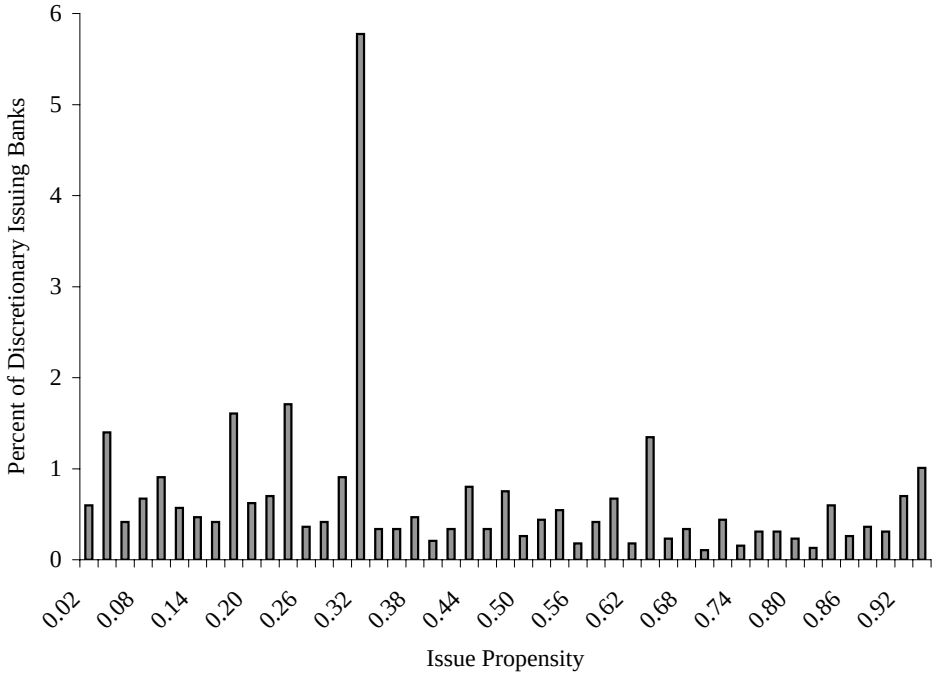
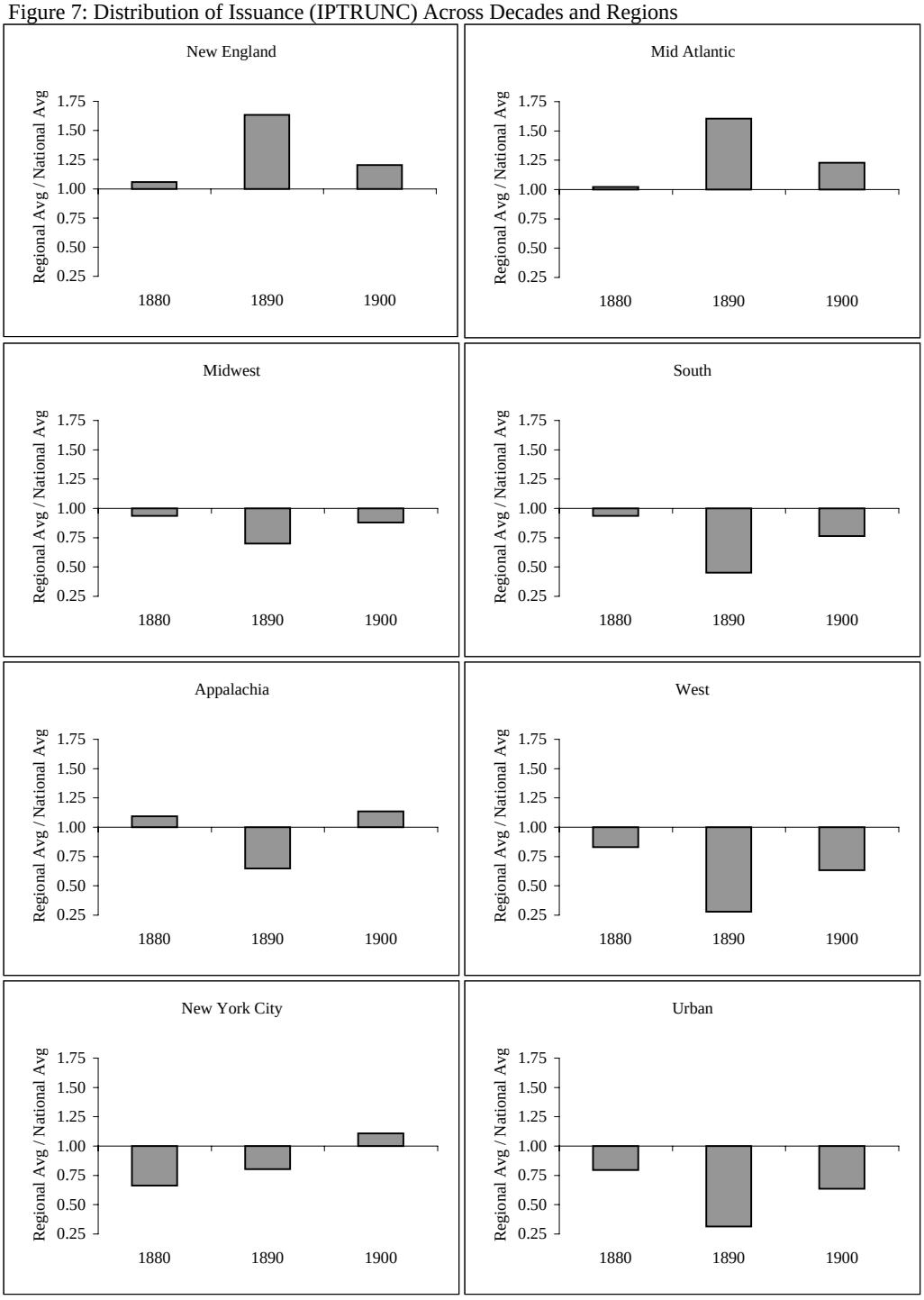


Figure 7: Distribution of Issuance (IPTRUNC) Across Decades and Regions



	# of banks in each region			% change in # banks in each region		
	1880	1890	1900	1880-1890	1890-1900	1880-1900
NE	550	559	583	1.64	4.29	6.00
MA	616	939	780	52.44	-16.93	26.62
MW	660	1429	1343	116.52	-6.02	103.48
SO	90	415	361	361.11	-13.01	301.11
AP	124	243	207	95.97	-14.81	66.94
WE	38	202	237	431.58	17.33	523.68

Figure 8: The Financial Effects of Note Issue Arbitrage in 1880

Assets		Liabilities	
Bonds to back Circulation	1,225	Notes	500
Legal Tender	25	Capital	625
		Surplus	125
	1,250		1,250

Assuming that government bonds earn 3.5% and taking into account the 1% tax on notes issued:

Profits = 3.5% * 1,225 - 1% * 500
Profits = 42.875 - 5.000
Profits = 37.875

Dividing profits by capital and surplus yields:

37.875 / (625 + 125) = 5.05% ROE

Figure 9: The Financial Effects of Note Issue Arbitrage in 1880

Assets		Liabilities	
Bonds to back Circulation	1,028	Notes	450
Legal Tender	22.5	Capital	499.99
		Surplus	100
	1,050		1,050

Assuming that government bonds earn 3.5% and taking into account the 1% tax on notes issued:

Profits = 3.5% * 1,050 - 1% * 450
Profits = 35.9625 - 4.500
Profits = 31.4625

Dividing profits by capital and surplus yields:

31.4625 / (499 + 100) = 5.24% ROE

Figure 10a: 1900 IPTRUNC of Banks Entering 1880-1900

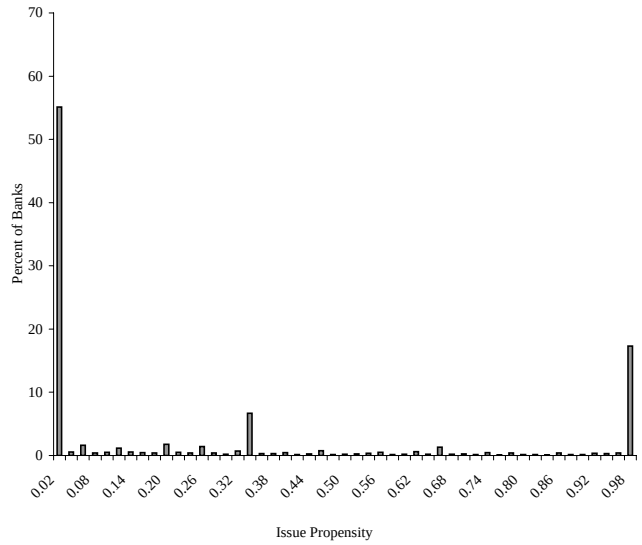


Figure 10b: 1880 IPTRUNC of Banks Exiting 1880-1900

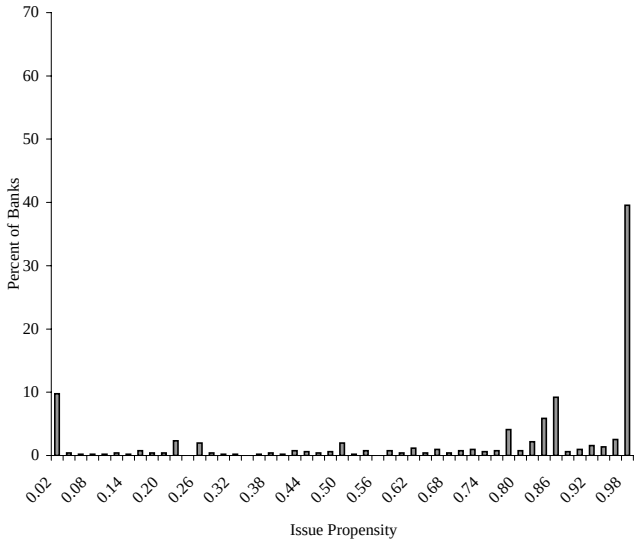


Figure 10c: 1900 IPTRUNC of Banks Surviving 1880-1890

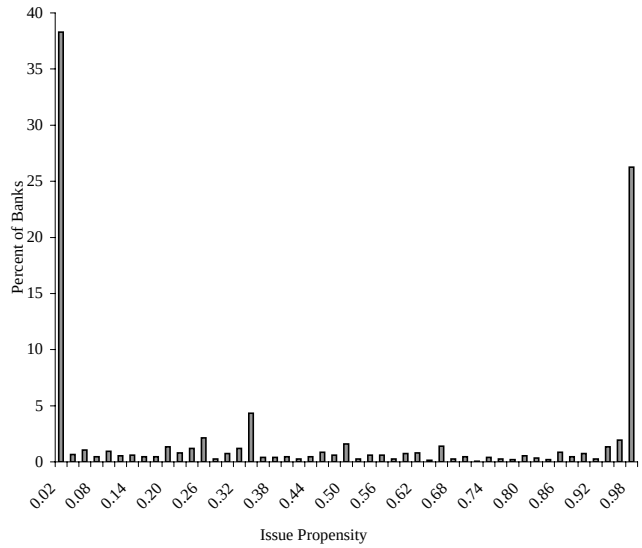


Figure 10d: Survivors' Change in IPTRUNC, 1880-1900

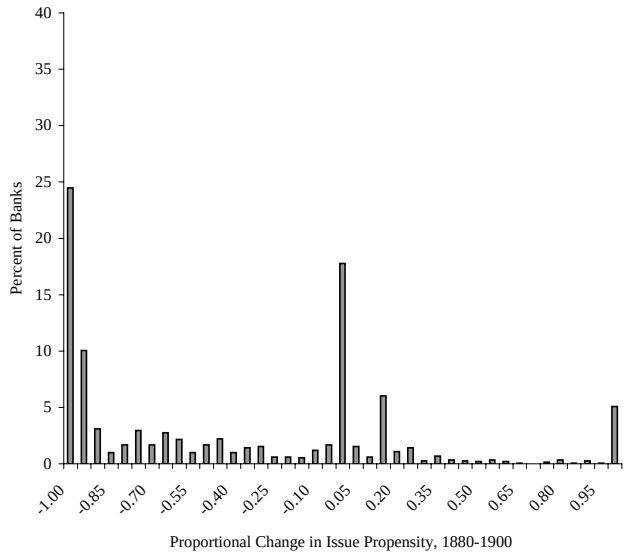


Figure 11a: 1890 IPTRUNC of Banks Entering 1880-1890

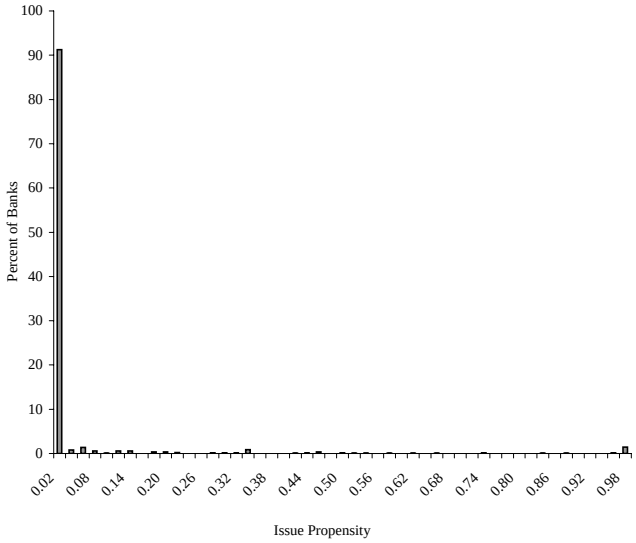


Figure 11b: 1880 IPTRUNC of Banks Exiting 1880-1890

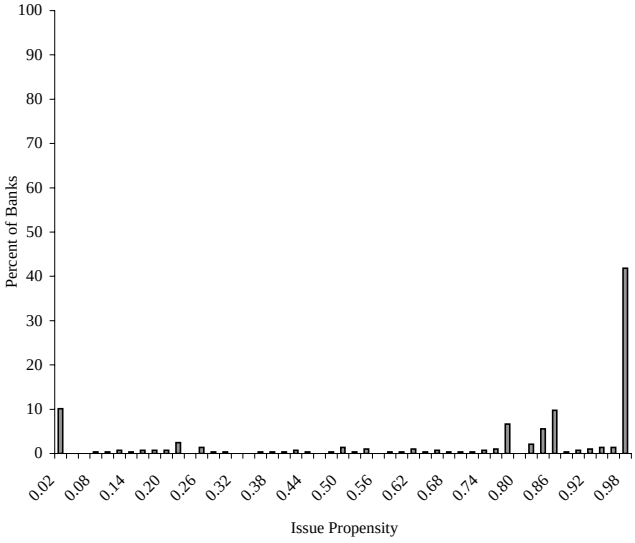


Figure 11c: 1890 IPTRUNC of Banks Surviving 1880-1900

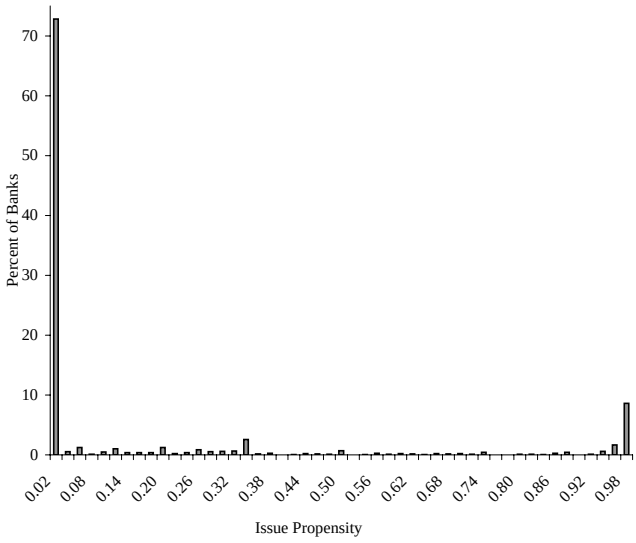


Figure 11d: Survivors' Change in IPTRUNC, 1880-1890

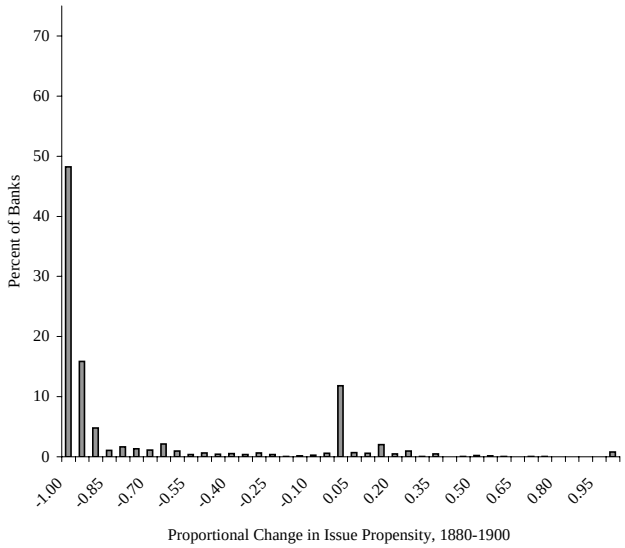


Figure 12a: 1900 IPTRUNC of Banks Entering 1890-1900

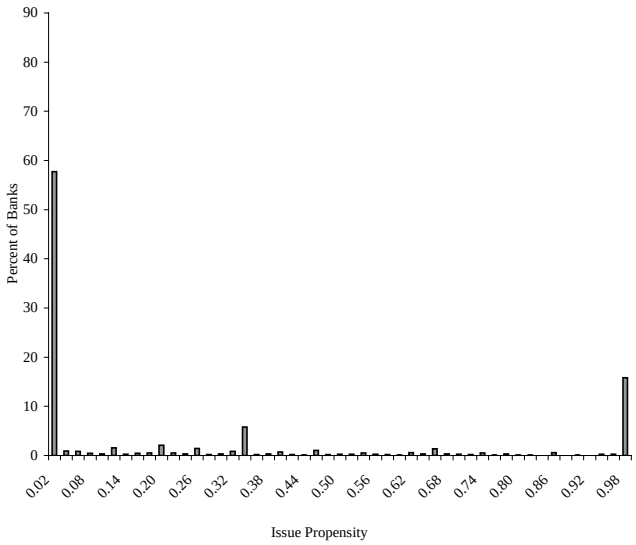


Figure 12b: 1890 IPTRUNC of Banks Exiting 1890-1900

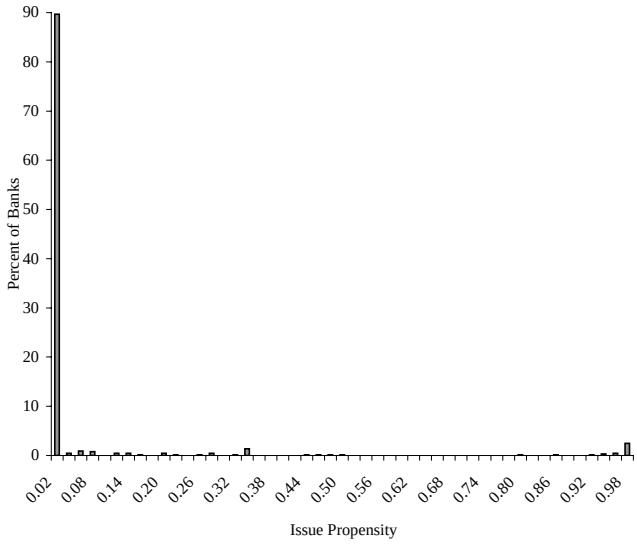


Figure 12c: 1900 IPTRUNC of Banks Surviving 1890-1890

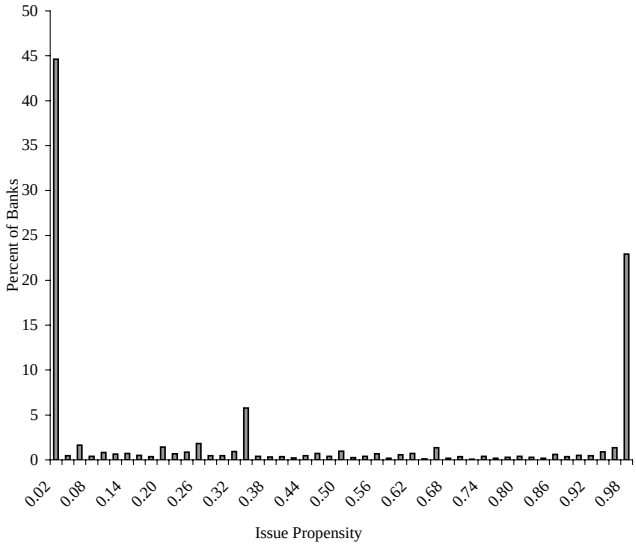


Figure 12d: Survivors' Change in IPTRUNC, 1890-1900

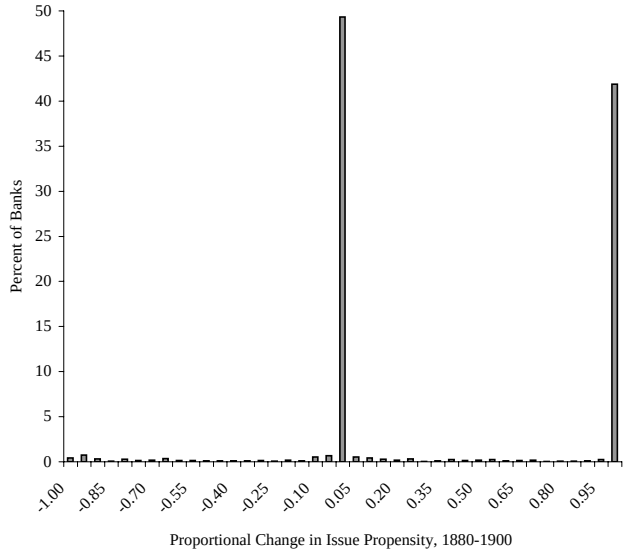


Table 1: National Banking Laws Specifically Constraining Note Issue

Constraints on Maximum Note Issue:

1. If bank chartered before end of 1864, can issue up to 90% market value of bonds (not to exceed 90% of par if bonds pay greater than 5% interest), though not exceeding 100% capital (p. 340 Act of March 3, 1863).

2. If bank chartered from beginning of 1865 to July 1870 (p. 364 Act of March 3, 1865):
• Banks with capital less than $500,000, can issue up to 90% capital;
• Banks with capital more than $500,000 and less than $1,000,000 can issue up to 80% capital;
• Banks with capital more than $1,000,000 and less than $3,000,000 can issue up to 75% capital;
• Banks with capital greater than $3,000,000 can issue up to 60% capital.

3. If bank chartered after 1870 then (p. 370 Act of July 12, 1870):
• No bank chartered after July 12, 1870 may issue more than $500,000 total.
-- Banks with capital less than $500,000, can issue up to 90% capital (previous provision unaltered);
-- Banks with capital more than $500,000 and less than $625,000 can issue up to 80% capital (previous provision unaltered and 0.80*625,000=500,000);

4. After July 12, 1882, all banks may issue up to 90% of the par value of bonds backing the note issue, not exceeding 90% of capital.

5. On March 14, 1900, the requirement was further relaxed to 100% of the par value of the bonds, not exceeding 100% of capital.

State bank notes not yet redeemed subsequent to conversion count as national bank notes in calculations of maxima.

Constraints on Minimum Note Issue:

1. Banks must hold bonds to back circulation amounting to the maximum of $30,000 or 33% of capital. Since banks must hold 111% of the notes in bonds to back the circulation, these note constraints mean that banks may issue minimum notes amounting to the greater of $30,000*(1/1.11)=$27,000 or 33%*Capital*(1/1.11).

2. After July 12, 1882, the minimum bond requirement was revised to 25% of capital for banks with capital less than $150,000.

Source: National Monetary Commission. Laws of the United States Concerning Money, Banking, and Loans, 1778-1909. Washington, DC: US Government Printing Office, 1910. Senate Document 580, part 2, 61st Congress, 2nd session.

Table 2: Variable Definintions

Variable Name	Definition
IP	(Actual Notes – Minimum Required Issuance) / (Maximum Permissible Notes – Minimum Required Issuance)
IPTRUNC	IP trucated from above at 0.98 and from below at 0.02.
TER	Amount due from the Treasury in Excess of the 5% Redemption Fund / Total Liabilities
NER	For central reserve cities: (Legal Tender Notes+Due from the Treasury in Excess of the 5% Redemption Fund-0.25*Total Deposits) / Total Liabilities; For reserve cities: (Legal Tender Notes+Due from the Treasury in Excess of the 5% Redemption Fund-0.125*Total Deposits) / Total Liabilities; For other cities: (Legal Tender Notes+Due from the Treasury in Excess of the 5% Redemption Fund-0.06*Total Deposits) / Total Liabilities.
BER	For central reserve cities: (Legal Tender Notes+Due from the Treasury in Excess of the 5% Redemption Fund+Due from Other Banks and Bankers-0.25*Total Deposits) / Total Liabilities; For other cities: (Legal Tender Notes+Due from the Treasury in Excess of the 5% Redemption Fund+Due from Other Banks and Bankers-0.15*Total Deposits) / Total Liabilities.
NYC	1 if bank is located in New York City, 0 otherwise.
URBAN	1 if bank is located in Philadelphia, Boston, Chicago, New Orleans or San Francisco, 0 otherwise.
LNTA	Natural log of Total Assets
AGE	Number of years since treceiving a National Bank charter.
SIZEAGE	LNTA * AGE
ROAL	For 1880: State-level: (Net Income)/(Total Assets)-(0.0345-0.0100)*(Notes Outstanding)/(Total Assets) For 1890: State-level: (Net Income)/(Total Assets)-(0.0224-0.0100)*(Notes Outstanding)/(Total Assets) For 1900: State-level: (Net Income)/(Total Assets)-(0.0197-0.0100)*(Notes Outstanding)/(Total Assets)
LOANRAT	Loans and Discounts/(Loans and Discounts+US Bonds on Hand+Other Stocks, Bonds, and Mortgages)
WDMK	$[(\text{Total Capital in Manufacturing}_t\text{-Total Capital in Manufacturing}_{t-10})/\text{Total Capital in Manufacturing}_{t-10})]$* $[\text{Total Capital in Manufacturing}_t/(\text{Total Capital in Manufacturing}_t\text{+Total Capital in Agriculture}_t)]$
WDFK	$[(\text{Total Capital in Agriculture}_t\text{-Total Capital in Agriculture}_{t-10})$ / $\text{Total Capital in Agriculture}_{t-10}]$* $[1\text{-Total Capital in Manufacturing}_t/(\text{Total Capital in Manufacturing}_t\text{+Total Capital in Agriculture}_t)]$
WROAM	[(Value of Products in Manufacturing-Total Wages in Manufacturing-Total Cost of Materials in Manufacturing) / Total Capital in Manufacturing]*[Total Capital in Manufacturing/(Total Capital in Manufacturing+Total Capital in Agriculture)]
TLTA	Total Liabilities / Total Assets
LNTL	Natural log of Total Liabilities
NTL	Notes Outstanding / Total Liabilities
NTLSQ	NTL squared.
USDTD	US Deposits / Total Deposits
IBDTD	Due to Other Banks / Total Deposits
RCITY	For 1880: 1 if bank is located in: Boston, Albany, Philadelphia, Pittsburgh, Baltimore, Washington, New Orleans, Louisville, Cincinnati, Cleveland, Chicago, Detroit, Milwaukee, St. Louis, or San Francisco; 0 otherwise. For 1890: 1 if bank is located in: Boston, Albany, Philadelphia, Pittsburg, Baltimore, Washington, New Orleans, Louisville, Cincinnati, Cleveland, Detroit, Milwaukee, Kansas City, St. Joseph, Omaha, or San Francisco; 0 otherwise. For 1900: 1 if bank is located in: Boston, Albany, Brooklyn, Philadelphia, Pittsburg, Baltimore, Washington, Savannah, New Orleans, Louisville, Houston, Cincinnati, Cleveland, Columbus, Indianapolis, Detroit, Milwaukee, Des Moines, St. Paul, Minneapolis, Kansas City, St. Joseph, Lincoln, Omaha, Denver, San Francisco, Los Angeles, or Portland; 0 otherwise.
CRCITY	For 1880: 1 if bank is located in New York City; 0 otherwise. For 1890 and 1900: 1 if bank is located in New York City, Chicago, or St. Louis; 0 otherwise.
NEWENGL	1 if bank is located in CT, ME, MA, NH, RI, or VT; 0 otherwise.
MIDATL	1 if bank is located in DE, NJ, NY, or PA; 0 otherwise.
MIDWEST	1 if bank is located in IL, IN, MI, OH, WI, IA, KS, MN, MO, NE, SD, ND, or DK (Dakota for 1880); 0 otherwise.
SOUTH	1 if bank is located in VA, AL, AR, FL, GA, LA, NC, SC, or TX; 0 otherwise.
APPALACH	1 if bank is located in KY, MD, TN, or WV; 0 otherwise.
WEST	1 if bank is located in CO, CA, OR, AZ, ID, MT, NV, NM, UT, WY, WA, AK, or HI; 0 otherwise.
NOTEOUT	Bank notes outstanding.
USCURR	Constant Maturity (12-year) Government Bond Yield to Maturity, Current Year (derived in Appendix A)
USLAG	Constant Maturity (12-year) Government Bond Yield to Maturity, One Year Lagged Value (derived in Appendix A)

Table 3: Summary Statistics

	1880				1890				1900			
Variable Name	N	Mean	Median	Std Error	N	Mean	Median	Std Error	N	Mean	Median	Std Error
IP	2090	0.7590	0.8571	0.0076	3540	0.0200	0.0000	0.0052	3861	0.2881	0.0667	0.0074
IPTRUNC	2090	0.7641	0.8571	0.0065	3540	0.1101	0.0200	0.0042	3861	0.3410	0.0667	0.0064
TER	2079	0.0012	0.0000	0.0001	3540	0.0003	0.0000	0.0000	3860	0.0004	0.0000	0.0000
NER	2077	-0.0001	-0.0027	0.0011	3539	-0.0171	-0.0191	0.0008	3859	-0.0299	-0.0304	0.0005
BER	2077	0.0040	-0.0154	0.0020	3539	-0.0291	-0.0525	0.0017	3859	-0.0383	-0.0642	0.0016
NYC	2090	0.0225	0.0000	0.0032	3540	0.0133	0.0000	0.0019	3861	0.0114	0.0000	0.0017
URBAN	2090	0.0531	0.0000	0.0049	3540	0.0398	0.0000	0.0033	3861	0.0277	0.0000	0.0026
LNTA	2079	13.203	13.031	0.020	3540	13.017	12.850	0.017	3861	13.195	13.058	0.018
AGE	2090	12.396	15.000	0.103	3540	13.160	9.000	0.167	3861	18.990	17.000	0.198
SIZEAGE	2079	165.220	194.709	1.450	3540	175.599	123.663	2.286	3861	256.462	218.405	2.768
ROAL	2039	0.0168	0.0173	0.0002	3535	0.0247	0.0246	0.0001	3810	0.0182	0.0167	0.0001
LOANRAT	2090	0.9180	0.9685	0.0026	3540	0.9482	0.9906	0.0016	3861	0.8859	0.9417	0.0023
WDMK	1683	0.1322	0.0397	0.0141	2684	0.8510	0.2512	0.0670	3203	0.2776	0.1165	0.0139
WDFK	1683	0.0652	-0.0231	0.0169	2719	0.5777	0.0556	0.0663	3222	0.2542	0.0561	0.0127
WROAM	1702	0.1126	0.0550	0.0031	2894	0.0919	0.0483	0.0021	3247	0.1107	0.0760	0.0020
TLTA	2079	0.6388	0.6384	0.0022	3540	0.6237	0.6343	0.0020	3860	0.7192	0.7359	0.0018
LNTL	2079	12.7422	12.5699	0.0216	3540	12.5237	12.3798	0.0183	3860	12.8510	12.7264	0.0190
NTL	2079	0.3675	0.3449	0.0041	3540	0.1277	0.0994	0.0018	3860	0.1301	0.1000	0.0018
NTLSQ	2079	0.1698	0.1190	0.0035	3540	0.0282	0.0099	0.0010	3860	0.0292	0.0100	0.0009
USDTD	2088	6.69E-07	0.00E+00	6.42E-07	3539	2.87E-08	0.00E+00	5.96E-09	3860	2.96E-08	0.00E+00	6.26E-09
IBDTD	2088	0.0649	0.0157	0.0027	3539	0.0629	0.0199	0.0018	3860	0.0550	0.0091	0.0020
RCITY	2090	0.0914	0.0000	0.0063	3540	0.0664	0.0000	0.0042	3861	0.0785	0.0000	0.0043
CRCITY	2090	0.0225	0.0000	0.0032	3540	0.0201	0.0000	0.0024	3861	0.0158	0.0000	0.0020
NEWENGL	2090	0.2632	0.0000	0.0096	3540	0.1647	0.0000	0.0062	3861	0.1448	0.0000	0.0057
MIDATL	2090	0.2947	0.0000	0.0100	3540	0.2203	0.0000	0.0070	3861	0.2432	0.0000	0.0069
MIDWEST	2090	0.3158	0.0000	0.0102	3540	0.3794	0.0000	0.0082	3861	0.3701	0.0000	0.0078
SOUTH	2090	0.0431	0.0000	0.0044	3540	0.1020	0.0000	0.0051	3861	0.1075	0.0000	0.0050
APPALACH	2090	0.0593	0.0000	0.0052	3540	0.0585	0.0000	0.0039	3861	0.0629	0.0000	0.0039
WEST	2090	0.0182	0.0000	0.0029	3540	0.0669	0.0000	0.0042	3861	0.0523	0.0000	0.0036
NOTEOUT	2090	151,929	90,000	3,643	3540	34,747	22,500	695	3861	73,512	45,000	3,266
USCURR	2090	3.4500	3.4500	0.0000	3540	2.2400	2.2400	0.0000	3861	1.9700	1.9700	0.0000
USLAG	2090	3.8700	3.8700	0.0000	3540	1.9800	1.9800	0.0000	3861	2.4800	2.9000	0.0000

Table 4: OLS Models of Excess Reserves, 1880, 1890, and 1900

	(A)	(B)	(C)	(D)	(E)	(F)
Dependent Variable	Treasury Excess Reserves, TER	Treasury Excess Reserves, TER	Treasury Excess Reserves, TER	Narrow Excess Reserves, NER	Narrow Excess Reserves, NER	Narrow Excess Reserves, NER
Sample	All Banks, 1880	All Banks, 1890	All Banks, 1900	All Banks, 1880	All Banks, 1890	All Banks, 1900
N	2,077	3,539	3,859	2,077	3,539	3,859
R-squared	0.003	0.006	0.010	0.511	0.471	0.448
Adj. R-squared	-0.004	0.002	0.006	0.508	0.469	0.446
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
Intercept	0.0036 *0.0038*	-0.0009 *0.0006*	0.0018 *0.0008*	0.1152 *0.0215*	0.0706 *0.0132*	0.0459 *0.0067*
TLTA	0.0005 *0.0024*	-0.0003 *0.0003*	-0.0025 *0.0006*	-0.0371 *0.0135*	-0.0427 *0.0068*	-0.0490 *0.0052*
LNTL	-0.0001 *0.0002*	0.0001 *0.0000*	0.0000 *0.0001*	-0.0065 *0.0013*	-0.0055 *0.0009*	-0.0028 *0.0005*
NTL	-0.0005 *0.0032*	0.0008 *0.0007*	0.0006 *0.0011*	-0.0247 *0.0183*	-0.0367 *0.0164*	0.0118 *0.0090*
NTLSQ	0.0011 *0.0034*	-0.0002 *0.0011*	-0.0029 *0.0022*	0.0289 *0.0193*	0.0772 *0.0254*	-0.0002 *0.0177*
LOANRAT	-0.0017 *0.0012*	0.0001 *0.0003*	0.0000 *0.0004*	-0.0176 *0.0067*	0.0010 *0.0061*	-0.0044 *0.0030*
USDTD	-0.7970 *4.7200*	-0.8484 *71.0782*	-66.1297 *126.0965*	3.7549 *26.7519*	1,217 *1,590*	5,747 *1,040*
IBDTD	-0.0001 *0.0014*	-0.0001 *0.0003*	-0.0001 *0.0005*	0.0022 *0.0077*	0.0031 *0.0065*	0.0299 *0.0040*
RCITY	0.0000 *0.0006*	-0.0001 *0.0001*	0.0003 *0.0002*	-0.0379 *0.0033*	-0.0441 *0.0026*	-0.0411 *0.0018*
CRCITY	-0.0002 *0.0011*	0.0000 *0.0002*	0.0004 *0.0004*	-0.1667 *0.0065*	-0.1484 *0.0046*	-0.1246 *0.0037*
MIDATL	0.0002 *0.0004*	0.0000 *0.0001*	0.0001 *0.0002*	0.0124 *0.0024*	0.0100 *0.0019*	0.0011 *0.0014*
MIDWEST	0.0003 *0.0004*	0.0001 *0.0001*	0.0002 *0.0002*	0.0351 *0.0025*	0.0206 *0.0018*	-0.0003 *0.0014*
SOUTH	0.0009 *0.0008*	0.0003 *0.0001*	0.0005 *0.0002*	0.0452 *0.0043*	0.0428 *0.0024*	0.0096 *0.0017*
APPALACH	-0.0005 *0.0006*	0.0001 *0.0001*	-0.0002 *0.0002*	0.0255 *0.0037*	0.0176 *0.0028*	0.0004 *0.0019*
WEST	-0.0002 *0.0011*	0.0000 *0.0001*	0.0001 *0.0003*	0.0186 *0.0063*	0.0002 *0.0027*	-0.0080 *0.0022*

Table 5: OLS Models of Broad Excess Reserves, 1880, 1890, and 1900

	(A)	(B)	(C)
Dependent Variable	Broad Excess Reserves, BER	Broad Excess Reserves, BER	Broad Excess Reserves, BER
Sample	All Banks, 1880	All Banks, 1890	All Banks, 1900
N	2,077	3,539	3,859
R-squared	0.211	0.220	0.195
Adj. R-squared	0.206	0.217	0.192
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
Intercept	0.4430 *0.0490*	0.3175 *0.0353*	0.3574 *0.0243*
TLTA	-0.2492 *0.0308*	-0.1438 *0.0183*	-0.1851 *0.0189*
LNTL	-0.0182 *0.0029*	-0.0233 *0.0023*	-0.0198 *0.0019*
NTL	-0.2863 *0.0418*	-0.4067 *0.0439*	-0.3154 *0.0325*
NTLSQ	0.2307 *0.0439*	0.8040 *0.0681*	0.5568 *0.0642*
LOANRAT	-0.0203 *0.0152*	0.0141 *0.0164*	-0.0200 *0.0107*
USDTD	2.0193 *60.9383*	1,645 *4,262*	-1,592 *3,764*
IBDTD	0.0367 *0.0176*	0.1084 *0.0175*	0.1476 *0.0146*
RCITY	0.0216 *0.0076*	0.0429 *0.0070*	0.0526 *0.0064*
CRCITY	-0.0872 *0.0147*	0.0049 *0.0123*	0.0221 *0.0134*
MIDATL	0.0199 *0.0054*	0.0224 *0.0052*	0.0063 *0.0050*
MIDWEST	0.0593 *0.0057*	0.0435 *0.0049*	0.0224 *0.0049*
SOUTH	0.1031 *0.0097*	0.1181 *0.0064*	0.0681 *0.0060*
APPALACH	0.0534 *0.0083*	0.0550 *0.0074*	0.0358 *0.0070*
WEST	0.0908 *0.0143*	0.0611 *0.0073*	0.0519 *0.0078*

Table 6: Marginal Effects from Reserves Models

Marginal Effect of a $100,000 increase in notes outstanding:

Dependent Variable	Treasury Excess Reserves, TER 1880	Treasury Excess Reserves, TER 1890	Treasury Excess Reserves, TER 1900	Narrow Excess Reserves, NER 1880	Narrow Excess Reserves, NER 1890	Narrow Excess Reserves, NER 1900	Broad Excess Reserves, BER 1880	Broad Excess Reserves, BER 1890	Broad Excess Reserves, BER 1900
Initial condition:	0.00110	0.00040	0.00047	-0.00612	-0.02692	-0.03061	0.00270	-0.07638	-0.05777
After $100,000 increase in notes:	0.00109	0.00046	0.00036	-0.00918	-0.02955	-0.03159	-0.02212	-0.09176	-0.07399
Difference:	0.00000	0.00006	-0.00011	-0.00306	-0.00263	-0.00097	-0.02483	-0.01538	-0.01622

Table 7: Examples of Issuers with Extreme of Arbitrage Possibilities in 1880

Ten banks with the lowest OTHASS (other assets/assets)

Bank Name	City	State	ln(Size)	Age	IP2	OTHASS	DEPASS	IP (Raw)
Montpelier	Montpelier	VT	13.726	15	0.851	0.316	0.508	0.851
First	Watertown	NY	12.337	17	0.813	0.364	0.474	0.813
First	Manchester	NH	13.010	15	0.980	0.396	0.597	0.989
NB	Middlebury	VT	13.226	15	0.980	0.401	0.568	0.988
N Landholders'	Kingston	RI	12.395	15	0.971	0.412	0.485	0.971
N Whaling B	New London	CT	12.973	15	0.980	0.419	0.559	1.016
First	Stonington	CT	13.262	15	0.844	0.422	0.534	0.844
Fourth	Pittsburgh	PA	13.659	16	0.857	0.426	0.597	0.857
Washington	Westerly	RI	12.882	15	0.980	0.440	0.491	0.999
Vineland	Vineland	NJ	12.021	2	0.980	0.448	0.684	1.000

Ten banks with the lowest DEPASS (other debt/assets)

Bank Name	City	State	ln(Size)	Age	IP2	OTHASS	DEPASS	IP (Raw)
First	Pensacola	FL	11.181	0	0.020	0.582	0.303	-1.500
Casco	Portland	ME	14.402	15	0.020	0.972	0.332	-0.488
Caledonia	Danville	VT	12.265	15	0.385	0.722	0.355	0.385
Roger Williams	Providence	RI	13.755	15	0.064	0.798	0.362	0.064
N Exchange	Houston	TX	12.100	7	0.025	0.805	0.365	0.025
American	Providence	RI	14.751	15	0.259	0.738	0.375	0.259
Commercial	Providence	RI	14.333	15	0.304	0.698	0.382	0.304
Phenix	Phenix	RI	12.059	15	0.387	0.652	0.398	0.387
Belvedere	Belvedere	NJ	13.407	15	0.028	0.850	0.398	0.028
N Warren B	Warren	RI	12.856	15	0.506	0.648	0.404	0.506

Table 8: Tobit Models of Truncated Issue Propensity (IPTRUNC), 1880

	(A)	(B)	(C)
Estimation Method	Tobit	Tobit	Tobit
Sample	All Banks, 1880	All Banks, 1880	All Banks, 1880
N	2,079	1,649	1,658
Log-likelihood	-1647.7	-1305.6	-1287.8
Restricted Log-likelihood	-1766.5	-1766.5	-1766.5
χ-squared	237.6	921.9	957.5
Significance (α)	0.000	0.000	0.000
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
Intercept	-0.2787 *0.6766*	-0.6483 *0.7677*	-0.2292 *0.7749*
NYC	-0.2715 *0.0959*	-0.2821 *0.1011*	-0.2812 *0.1005*
URBAN	-0.0981 *0.0615*	-0.0955 *0.0647*	-0.1105 *0.0646*
SIZE	0.1089 *0.0534*	0.1591 *0.0599*	0.1323 *0.0601*
AGE	0.2201 *0.0470*	0.2239 *0.0526*	0.2180 *0.0524*
SIZEAGE	-0.0176 *0.0037*	-0.0183 *0.0041*	-0.0179 *0.0041*
MIDATL	-0.0253 *0.0337*		-0.0243 *0.0480*
MIDWEST	-0.1910 *0.0335*		-0.1661 *0.0410*
SOUTH	-0.1474 *0.0667*		-0.2625 *0.0940*
APPALACH	0.1228 *0.0610*		0.1224 *0.0765*
WEST	-0.3419 *0.0977*		-0.1844 *0.1467*
ROAL		1.8668 *2.2071*	1.3557 *2.8715*
LOANRAT		-0.3407 *0.1223*	-0.3197 *0.1213*
WDFK		-0.1276 *0.0294*	-0.0817 *0.0270*
WDMK		-0.0262 *0.0229*	-0.0212 *0.0232*
Scale	0.5239 *0.0121*	0.5207 *0.0134*	0.5132 *0.0132*

Table 9: Tobit Models of Truncated Issue Propensity (IPTRUNC), 1890

	(A)	(B)	(C)	(D)
Estimation Method	Tobit	Tobit	Tobit	Tobit
Sample	All Banks, 1890	All Banks, 1890	All Banks, 1890	All Banks, 1890
N	3,540	2,681	2,681	2,719
Log-likelihood	-1847.4	-1364.9	-1350.5	-1351.7
Restricted Log-likelihood	-2087.6	-2087.6	-2087.6	-2087.6
χ-squared	480.5	1445.4	1474.3	1471.9
Significance (α)	0.000	0.000	0.000	0.000
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
Intercept	-1.3827 *0.8282*	1.7525 *1.2285*	1.2605 *1.2205*	0.5658 *1.2265*
NYC	-0.0626 *0.2950*	0.0531 *0.3398*	-0.0544 *0.3377*	0.4549 *0.3572*
URBAN	-1.0534 *0.2619*	-1.2494 *0.3521*	-1.2103 *0.3395*	-0.6908 *0.3606*
SIZE	-0.0142 *0.0652*	-0.0634 *0.0904*	-0.0519 *0.0895*	0.0291 *0.0922*
AGE	0.3071 *0.0460*	0.3016 *0.0628*	0.3229 *0.0630*	0.2924 *0.0619*
SIZEAGE	-0.0202 *0.0035*	-0.0197 *0.0048*	-0.0216 *0.0048*	-0.0194 *0.0047*
MIDATL	0.2612 *0.0828*		0.2787 *0.1141*	0.0823 *0.1228*
MIDWEST	-0.3100 *0.0838*		-0.2052 *0.1180*	-0.4254 *0.1308*
SOUTH	-0.3011 *0.1305*		-0.3526 *0.1973*	-0.4377 *0.1937*
APPALACH	-0.2688 *0.1393*		-0.1471 *0.1778*	-0.3090 *0.1830*
WEST	-0.6095 *0.1764*		-0.3553 *0.3107*	-0.6142 *0.3061*
ROAL		-20.9815 *6.4864*	-9.8059 *6.6455*	-12.0428 *6.5606*
LOANRAT		-2.3235 *0.3639*	-2.1370 *0.3591*	-2.0061 *0.3529*
WDFK		-0.1766 *0.0524*	-0.1107 *0.0520*	-0.1404 *0.0493*
WDMK		-0.0158 *0.0177*	-0.0086 *0.0171*	
WROAM				-2.7270 *0.6981*
Scale	1.1459 *0.0443*	1.2558 *0.0595*	1.2376 *0.0585*	1.2207 *0.0574*

Table 10: Tobit Models of Truncated Issue Propensity (IPTRUNC), 1900

	(A)	(B)	(C)	(D)
Estimation Method	Tobit	Tobit	Tobit	Tobit
Sample	All Banks, 1900	All Banks, 1900	All Banks, 1900	All Banks, 1900
N	3,861	3,203	3,203	3,222
Log-likelihood	-3950.1	-3287.2	-3260.9	-3256.2
Restricted Log-likelihood	-4122.4	-4122.4	-4122.4	-4122.4
χ-squared	344.7	1670.4	1723.2	1732.6
Significance (α)	0.000	0.000	0.000	0.000
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
Intercept	-5.4545 *0.4752*	-4.2189 *0.5643*	-4.6769 *0.5727*	-5.2917 *0.5858*
NYC	-0.4443 *0.2152*	-0.1878 *0.2223*	-0.3377 *0.2237*	-0.1151 *0.2262*
URBAN	-0.8828 *0.1457*	-0.8242 *0.1556*	-0.8698 *0.1555*	-0.6633 *0.1593*
SIZE	0.4081 *0.0369*	0.3844 *0.0416*	0.4130 *0.0417*	0.4848 *0.0442*
AGE	0.2121 *0.0209*	0.2156 *0.0242*	0.2261 *0.0241*	0.2133 *0.0240*
SIZEAGE	-0.0152 *0.0016*	-0.0155 *0.0018*	-0.0165 *0.0018*	-0.0157 *0.0018*
MIDATL	0.1563 *0.0668*		0.1430 *0.0841*	0.0373 *0.0858*
MIDWEST	-0.1540 *0.0641*		-0.1252 *0.0836*	-0.2833 *0.0891*
SOUTH	-0.2418 *0.0878*		-0.2011 *0.1150*	-0.3305 *0.1169*
APPALACH	0.1016 *0.0975*		0.1990 *0.1113*	0.0882 *0.1126*
WEST	-0.5126 *0.1127*		-0.5895 *0.1353*	-0.7500 *0.1370*
ROAL		-6.6085 *3.0832*	-5.6572 *3.5910*	-6.7638 *3.5654*
LOANRAT		-0.9292 *0.1634*	-0.7657 *0.1697*	-0.7449 *0.1685*
WDFK		-0.0894 *0.0408*	-0.0146 *0.0406*	-0.0702 *0.0382*
WDMK		-0.0180 *0.0315*	-0.0078 *0.0313*	
WROAM				-1.6159 *0.3180*
Scale	1.1355 *0.0276*	1.1393 *0.0304*	1.1266 *0.0301*	1.1177 *0.0298*

Table 11: Tobit Model of Truncated Issue Propensity (IPTRUNC), All Years Pooled

	(A)	(B)	(C)	(D)
Estimation Method	Tobit	Tobit	Tobit	Tobit
Sample	All Banks, All Years	All Banks, All Years	All Banks, All Years	All Banks, All Years
N	7,533	7,533	7,533	7,533
Log-likelihood	-6956.4	-6543.6	-6308.8	-6308.8
Restricted Log-likelihood	-10136.5	-10136.5	-10136.5	-10136.5
χ-squared	6360.1	7185.7	7655.3	7655.3
Significance (α)	0.000	0.000	0.000	0.000
Intercept	-1.3223	-4.1584	-4.0312	-1.2345
	0.3879	*0.3731*	*0.3573*	*0.3446*
NYC	-0.7898	-0.4557	-0.4475	-0.4464
	0.1253	*0.1146*	*0.1123*	*0.1124*
URBAN	-0.6792	-0.5715	-0.5645	-0.5642
	0.0825	*0.0763*	*0.0750*	*0.0750*
SIZE	0.1845	0.1060	0.1460	0.1454
	0.0284	*0.0260*	*0.0251*	*0.0253*
AGE	0.1733	0.1440	0.1705	0.1702
	0.0184	*0.0167*	*0.0162*	*0.0163*
SIZEAGE	-0.0123	-0.0094	-0.0120	-0.0119
	0.0014	*0.0013*	*0.0012*	*0.0012*
MIDATL	-0.1052	0.1691	0.1014	0.1029
	0.0472	*0.0443*	*0.0427*	*0.0434*
MIDWEST	-0.1936	0.0137	-0.1127	-0.1110
	0.0463	*0.0430*	*0.0416*	*0.0425*
SOUTH	0.0867	-0.1060	-0.2503	-0.2499
	0.0738	*0.0670*	*0.0665*	*0.0665*
APPALACH	0.1565	0.2246	0.1162	0.1173
	0.0695	*0.0642*	*0.0627*	*0.0629*
WEST	-0.2541	-0.1457	-0.3881	-0.3858
	0.0976	*0.0887*	*0.0872*	*0.0880*
ROAL	-0.4693	0.0576	-0.0171	-0.0146
	0.0152	*0.0208*	*0.0165*	*0.0206*
LOANRAT	-1.4143	-1.1999	-0.7981	-0.8002
	0.1196	*0.1089*	*0.1059*	*0.1064*
WDFK	-0.1155	-0.0584	-0.0247	-0.0747
	0.0163	*0.0143*	*0.0125*	*0.0218*
WDMK	-0.1425	-0.0854	-0.0749	-0.0248
	0.0255	*0.0220*	*0.0218*	*0.0125*
USCURR		1.3924		
		0.0502		
USLAG			0.9628	
			0.0292	
y1880				0.9434
				0.0562
y1890				-0.8812
				0.0355
Scale	1.0637	0.9648	0.9317	0.9315
	0.0189	*0.0170*	*0.0163*	*0.0164*