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Explorations in Economic History 45 (2008) 327–355
Explorations in Economic History
www.elsevier.com/locate/eeh

Resolving the puzzle of the underissuance of national bank notes ☆

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Received 9 February 2007
Available online 1 February 2008

Abstract

Much of the puzzle of underissuance of national bank notes can be resolved for the period 1880–1900 (the period when detailed, bank-level data are available) by disaggregating, taking account of regulatory limits, and considering differences in banks' opportunity costs cross-sectionally and over time. Banks with poor lending opportunities issued more, within regulatory limits. Banks tended to issue more when bond yields (the backing for notes) were high relative to lending opportunities. The profitability of note issuance was insufficient to attract entrants primarily or mainly for the purpose of note issuance. The observed lack of a general relationship between note issuance and reserve demand is inconsistent with the view that redemption costs from note issuance explain low note issuance in general. However, some variation in the propensities of urban banks to issue notes is associated with variation in reserve demand costs associated with the note issues of those banks. Generally, however, note issuance enjoyed economies of scope with deposit banking, including reduced costs of reserve requirements.

Keywords: National bank; Bank notes; Scope economies

1. 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.[3] The creation of these

☆ We thank Bruce Champ, Eugene White, Bob Margo, two anonymous referees, and conference participants at the Federal Reserve Bank of Atlanta and the Annual Meetings of the Cliometric Society for helpful comments.
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[3] After 1874, banks also had to deposit a 5% minimum cash redemption fund at the Treasury in addition to these bonds.

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doi:10.1016/j.eeh.2008.01.001

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) wrote:

> Before 1890 the amount outstanding ranged around 20% of the possible maximum, by 1900 it had risen to about 28%, and by World War I to about 80%. 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 1884–1891. 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.

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.[4] 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. Cagan and Schwartz (1991) showed that the apparent excessive profitability of bank note issuance increased in the 20th century.

The story typically advanced to explain low issuance of national bank notes conjectures hidden transacting costs faced by issuers. Authors such as Bell (1912), Cagan (1965), Goodhart (1965), Cagan and Schwartz (1991), Duggar and Rost (1969), Champ et al. (1992), and Wallace and Zhu (2004) have pointed to the possibility that redemption costs may have been large, and these hidden costs may explain bankers' reluctance to issue despite the seeming profitability from expanding the supply of notes. Champ et al. (1992) argue that banks had an incentive to return national bank notes to their issuing banks (or to the Treasury) because national bank notes were not as good as greenbacks for purposes of satisfying national banks' legal reserve requirements. They plot "redemptions" at the Treasury as a fraction of outstanding notes, and show that annual redemptions averaged about half of outstanding notes. This is the primary evidence offered in favor of their view that national banks were unwilling to hold each other's notes, and routinely returned each other's notes either to the Treasury or to the issuing banks, which imposed redemption costs on issuers.

But the redemption evidence cited in Champ et al. (1992) suffers from some problems of interpretation. Much of the Treasury redemptions do not represent redemption demands by other banks to redeem notes because the notes were inferior to greenbacks as legal reserves. When one considers the stated causes of the reported redemption flows, it is not clear whether there were large redemption costs associated with those flows. The Annual Report of the Comptroller for 1890, for example, describes and quantifies the causes of the $67 million in "redemptions" that were received at the U.S. Treasury Redemption Agency for the period

[4] 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.

November 1889 through October 1890, which consisted in large part of (1) the replacement of worn out notes with newly printed notes ($24 million), (2) reductions in circulation related to legal requirements that required issuing banks to reduce their circulation ($21 million), and (3) reductions in circulation associated with insolvent and liquidating banks ($11 million). The remainder, about 20% of notes received by the Treasury, were not in any of these three categories; they were "fit for circulation, and [were] returned to the issuing banks." Clearly, $32 million of the $67 million in notes were related to issuing banks' reductions in circulation or bank liquidation. Most (nearly $24 million) of the remaining $36 million in notes appear to have been returned because they were worn out and needed to be replaced, leaving about $11 million in notes that were redeemed at the Treasury for other reasons (including, possibly, the hypothesized preference for greenbacks as bank reserves by banks receiving notes).

Furthermore, there are reasons to doubt whether banks interested in swapping other banks' notes for greenbacks would have chosen to return bank notes to the issuing bank or to the Treasury. Banks could pay out bank notes to the public instead. National bank notes were free of default risk and were perfect substitutes for greenbacks as cash in the hands of the public. Friedman and Schwartz (1963, pp. 21–22) point out that national bank notes virtually never traded at a discount relative to greenbacks. The public apparently was willing to accept national bank notes at par in lieu of greenbacks. Given the willingness of the public to accept national bank notes, it is not clear why notes would be presented at the Treasury or at any national bank for redemption, which would be more costly than just passing them on to the public.

Of course, if the notes were worn out, the public might not accept them, and the notes could have to be returned to the Treasury, but predictable wear and tear might not entail very high costs of redemption for issuing banks.[5] National banks had many ways of dealing with redemptions that could limit costs associated with disruptions to their operations or the need to maintain large cash balances to fund redemptions. They could instruct the Treasury to sell bonds on deposit at the Treasury to pay for redemptions, but they might be more likely to borrow in the interbank market (from a bank that could deliver funds to the Treasury as needed at low physical cost) to finance redemptions of worn out notes that would be immediately replaced. Presumably, in the case of worn out notes that were being immediately replaced by new ones, interbank lending would have been especially low in cost, given the knowledge that the issuing bank would soon be receiving fresh notes from the Treasury with which to repay the loan. Physical costs of moving notes back and forth were likely quite small.[6] And even if notes could not be reissued immediately after being returned from the Treasury, this delay was not likely very costly, particularly since banks could still invest them in the interbank deposit market in the meantime, which yielded about 2% throughout our period.

An alternative approach to explaining the low amounts of national bank notes issued was proposed by James (1978). He 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 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 per-

[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] Transportation costs associated with note redemption were likely low, since the Treasury routinely accepted notes for redemption at subtreasury offices located in large reserve cities. Cagan and Schwartz (1991) cite estimates that some 85–90% of banks whose notes were redeemed were located in those large reserve cities (p. 300).

sistent underissue of bank notes: the aggregate level of bank notes remained far below its maximum despite the high apparent profitability of note issuing.

In this paper, we are able to largely resolve the puzzle of note underissuance, at least for the period up to 1900, for which detailed individual national bank data are available. To do so requires a model of bank note issuing profitability, and a two-part empirical analysis. Section 2 describes the legal limits on note supply, and discusses the determinants of supply and demand for national bank notes. In the first part of our empirical analysis, in Section 3, we examine the behavior of existing banks, taking as exogenous their available amount of capital. By disaggregating data on national banks, and analyzing individual banks' note issuing incentives and constraints, we show that the behavior of these banks is not puzzling: Banks with low opportunity costs issued the maximum amount of notes they could. Banks with high opportunity costs issued less than the maximum amount they could. Differences over time in propensities to issue notes are closely associated with variation in bond yields (the backing for note issues), ceteris paribus. In the second part of our empirical analysis, in Section 4, we consider implications of the opportunity cost view for entry and exit behavior. We show that exiting banks focused more on note issuing than average banks, and entering banks focused less on note issuing. In other words, lending and deposit taking, as opposed to holding government bonds and issuing national bank notes, appears to have been the business line that most attracted new entrants and improved bank survival.[7]

In Section 5, we consider whether redemption risk can provide an alternative or additional perspective to opportunity cost as an explanation for cross-sectional variation in note issuance. We find that, in general, bank note issuance does not raise redemption costs as measured by reserve demand. For urban banks, however, we do find some evidence of higher reserve demand associated with note issues, although this varies over time. Interestingly, that pattern of variation is associated with changes in urban banks' residual propensities to issue notes (estimated in Section 3). Section 6 concludes that our results lend support to James's opportunity cost theory of note issuing. A combination of legal restrictions on maximum note issuing and banks' opportunity costs best explains the extent of bank note issuing in a manner consistent with bank profit maximization. Redemption costs, however, may have played a small role in discouraging urban banks from issuing notes in some places at some times.

2. 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. Prior to 1874, there were legislative limits placed on the aggregate quantity of notes outstanding and on the geographic distribution of note issuing, but those aggregate limits were never binding constraints on individual bank issuance. 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 they 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. 21–22). Assuming that bank notes, greenbacks, and coins were all substitutes for transactions purposes, national bank notes and greenbacks were always inframarginal sources of transacting media whose quantity was set by suppliers and which

[7] In calculations and empirical analysis not reported here, we considered whether it would have been profitable to establish a bank primarily for the purpose of issuing national bank notes. In those calculations, we showed that conservative assumptions about the fixed costs of establishing a national bank solely for that purpose, as well as estimated costs of interest rate risk, made that strategy unprofitable. In fact, during our period, no national bank existed primarily for the purpose of issuing bank notes. All national banks were involved in lending/investment and deposit taking to a significant degree. For example, Montpelier National Bank, which maintained the lowest ratio of non-government bond assets to total assets of all national banks in 1880, maintained 31.6% of its assets in non-government bond assets and deposits accounted for 50.8% of its liabilities.

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).[8]

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.[9] The supply of notes, in this model, is set by the profit-maximizing choices of national banks 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 should be a 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.[10] Differences in banks' redemption costs could, in theory, also explain cross-sectional differences in the supply of notes.

Of course, a model of bank note supply profitability may not apply, on the margin, to banks' note issuing decisions if those banks 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 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 take account of the limits on 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 taken 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 issues 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 limit note issue limit of 90% capital for all banks increased to 100% in 1900 is expensed to 100% in 1900. (The complexity of regulations

[8] There are additional complications to the modeling of equilibrium in the market for national bank notes that would arise from (1) alternatively assuming that coins and paper money were not perfect substitutes, and (2) considering the effect of silver certificates and silver token coins. If one modeled the market for paper money (greenbacks, national bank notes, and silver certificates) separately, and took into account the differences in opportunity costs faced by banks supplying national bank notes (which we show were important), then exogenous growth in silver certificates would produce an outward shift in paper money supply and a movement along the aggregate paper money demand function, which could result in lower equilibrium bond yields and reduce the real supply of national bank notes. There is some evidence from the composition of the paper money supply that the creation of silver certificates had this effect. Regardless of which modeling approach one adopts, however, our approach to analyzing the supply of national bank notes by individual banks is not affected, since in either case it is appropriate to assume that national banks are price takers in the bond market, and thus take bond yields as exogenously determined (inter alia, potentially by shifts in the supply of silver certificates relative to total paper money demand).

[9] The federal tax rate on national bank notes was set initially at 1%, but was lowered to 1/2% in 1900.

[10] 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.

Table 1
National banking laws specifically constraining note issue

Constraints on maximum note issue:

(1) Before 1882, 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) Before 1882, 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) Before 1882, if bank chartered after July 1870 and before July 1882, 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 1882 and before March 1900, 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 $33\% * \text{Capital} * (1/1.11)$

(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. US Government Printing Office, Washington, DC, 1910, Senate Document 580, part 2, 61st Congress, 2nd session.

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 generally have been profitable (Hetherington, 1990).[11] As we shall show below, these ceilings and floors on permissible note issues were often binding on individual banks.

3. National banks' note issuance

Our data set consists of hand-collected information on 2090 national banks in 1880, 3540 national banks in 1890, and 3861 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

[11] Some banks issued less than the amount of notes implied by the minimum bond holding requirement. Specifically, 79 banks in 1880, 1201 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. The fact that some banks consistently issued zero notes, rather than a positive amount equal to 90% of the minimum required bond purchase, is consistent with the view that, at least for some banks, there were fixed physical costs to note issuance. Given the small number of banks for which these fixed costs seem to have been important, we abstract from fixed cost in our modeling of bank note issues.

changes in 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. The 20th century was a time of relatively high profitability from note issuing, but 1900 is the last census year before the Comptroller ceased reporting highly detailed individual bank data for national banks. Thus, despite the desirability of expanding our sample to the post-1900 period, when profits from note issuance appeared particularly high according to Cagan and Schwartz (1991), we are unable to do so.

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:

$$\text{IP} = (\text{Actual Notes} - \text{Minimum Required Issuance})/(\text{Maximum Permissible Notes} - \text{Minimum Required Issuance})$$

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 against 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.

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. Fig. 1 plots a histogram of the distribution of the truncated value of IP for all banks in 1880. Fig. 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 1890 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. Fig. 3 plots a histogram of the distribution of the truncated value of IP for all banks in 1890. Fig. 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 again changed considerably by 1900. In 1900 the median of IPTRUNC is 0.0667 and the mean is 0.3410. Only 25% of national banks in 1900 have values of IP greater than

Table 2
Variable definitions

Variable name	Definition
IP	(Actual notes − Minimum required issuance)/(Maximum permissible notes − Minimum required issuance)
IPTRUNC	IP truncated 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 receiving 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	[(Total capital in manufacturing$_t$ − Total capital in manufacturing$_{t-10}$)/Total capital in manufacturing$_{t-10}$)] ∗ [Total capital in manufacturing$_t$/(Total capital in manufacturing$_t$ + Total capital in agriculture$_t$)]
WDFK	[(Total capital in agriculture$_t$ − Total capital in agriculture$_{t-10}$)/Total capital in agriculture$_{t-10}$] ∗ [1 − Total capital in manufacturing$_t$/Total capital in manufacturing$_t$ + 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, Pittsburgh, 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, Pittsburgh, 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, 1-year lagged value (derived in Appendix A)

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 min-

Table 3
Summary statistics

	1880				1890				1900			
Variable Name	N	Mean	Median	Std Dev	N	Mean	Median	Std Dev	N	Mean	Median	Std Dev
IP	2090	0.7590	0.8571	0.3496	3540	0.0200	0.0000	0.3113	3861	0.2881	0.0667	0.4596
IPTRUNC	2090	0.7641	0.8571	0.2974	3540	0.1101	0.0200	0.2486	3861	0.3410	0.0667	0.3962
TER	2079	0.0012	0.0000	0.0063	3540	0.0003	0.0000	0.0015	3860	0.0004	0.0000	0.0030
NER	2077	−0.0001	−0.0027	0.0507	3539	−0.0171	−0.0191	0.0458	3859	−0.0299	−0.0304	0.0333
BER	2077	0.0040	−0.0154	0.0909	3539	−0.0291	−0.0525	0.1010	3859	−0.0383	−0.0642	0.1000
NYC	2090	0.0225	0.0000	0.1483	3540	0.0133	0.0000	0.1145	3861	0.0114	0.0000	0.1062
URBAN	2090	0.0531	0.0000	0.2243	3540	0.0398	0.0000	0.1956	3861	0.0277	0.0000	0.1642
LNTA	2079	13.203	13.031	0.928	3540	13.017	12.850	0.992	3861	13.195	13.058	1.093
AGE	2090	12.396	15.000	4.730	3540	13.160	9.000	9.919	3861	18.990	17.000	12.287
SIZEAGE	2079	165.220	194.709	66.129	3540	175.599	123.663	135.998	3861	256.462	218.405	172.012
ROAL	2056	0.0168	0.0173	0.0071	3535	0.0248	0.0237	0.0057	3810	0.0182	0.0167	0.0076
LOANRAT	2090	0.9180	0.9685	0.1192	3540	0.9482	0.9906	0.0948	3861	0.8859	0.9417	0.1456
WDMK	1683	0.1322	0.0397	0.5782	2684	0.8510	0.2512	3.4717	3203	0.2776	0.1165	0.7867
WDFK	1683	0.0652	−0.0231	0.6952	2719	0.5777	0.0556	3.4569	3222	0.2542	0.0561	0.7225
WROAM	1702	0.1126	0.0550	0.1287	2894	0.0919	0.0483	0.1150	3247	0.1107	0.0760	0.1144
TLTA	2079	0.6388	0.6384	0.1003	3540	0.6237	0.6343	0.1190	3860	0.7192	0.7359	0.1093
LNTL	2079	12.7422	12.5699	0.9834	3540	12.5237	12.3798	1.0884	3860	12.8510	12.7264	1.1827
NTL	2079	0.3675	0.3449	0.1863	3540	0.1277	0.0994	0.1092	3860	0.1301	0.1000	0.1109
NTLSQ	2079	0.1698	0.1190	0.1592	3540	0.0282	0.0099	0.0609	3860	0.0292	0.0100	0.0570
USDTD	2088	6.69E-07	0.00E + 00	2.93E-05	3539	2.87E-08	0.00E + 00	3.55E-07	3860	2.96E-08	0.00E + 00	3.89E-07
IBDTD	2088	0.0649	0.0157	0.1216	3539	0.0629	0.0199	0.1083	3860	0.0550	0.0091	0.1235
RCITY	2090	0.0914	0.0000	0.2882	3540	0.0664	0.0000	0.2490	3861	0.0785	0.0000	0.2690
CRCITY	2090	0.0225	0.0000	0.1483	3540	0.0201	0.0000	0.1402	3861	0.0158	0.0000	0.1247
NEWENGL	2090	0.2632	0.0000	0.4405	3540	0.1647	0.0000	0.3710	3861	0.1448	0.0000	0.3519
MIDATL	2090	0.2947	0.0000	0.4560	3540	0.2203	0.0000	0.4145	3861	0.2432	0.0000	0.4291
MIDWEST	2090	0.3158	0.0000	0.4649	3540	0.3794	0.0000	0.4853	3861	0.3701	0.0000	0.4829
SOUTH	2090	0.0431	0.0000	0.2030	3540	0.1020	0.0000	0.3027	3861	0.1075	0.0000	0.3098
APPALACH	2090	0.0593	0.0000	0.2363	3540	0.0585	0.0000	0.2347	3861	0.0629	0.0000	0.2429
WEST	2090	0.0182	0.0000	0.1336	3540	0.0669	0.0000	0.2500	3861	0.0523	0.0000	0.2227
NOTEOUT	2090	151,929	90,000	166,545	3540	34,747	22,500	41,323	3861	73,512	45,000	202,919
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

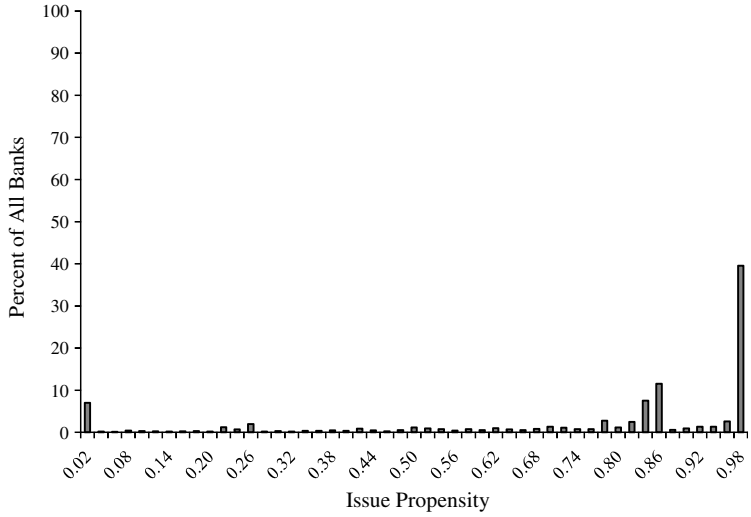


Fig. 1. Histogram for issue propensity—all issuers, 1880.

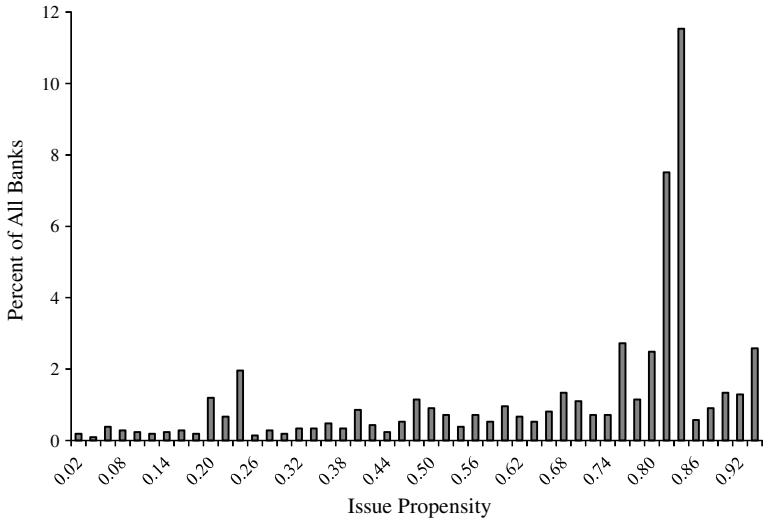


Fig. 2. Histogram for issue propensity—discretionary issuers only, 1880.

imum 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. Fig. 5 plots a histogram of the distribution of the truncated value of IP for all banks in 1900. Fig. 6 plots a histogram of IP for the 30% of national banks that were neither at the maximum nor at the minimum in 1900.

Fig. 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 diverse 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).

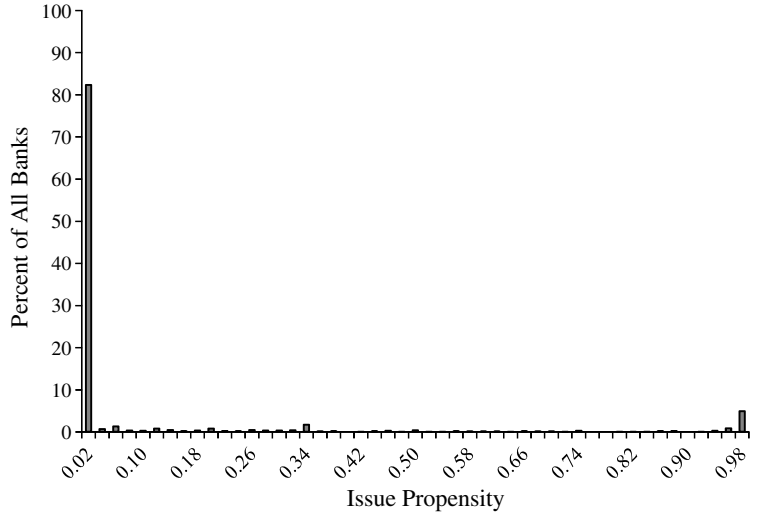


Fig. 3. Histogram for issue propensity—all issuers, 1890.

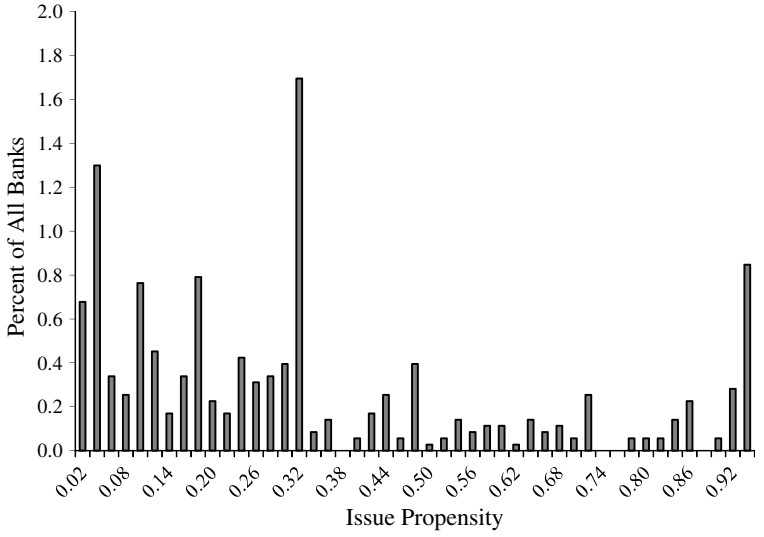


Fig. 4. Histogram for issue propensity—discretionary issuers only, 1890.

Fig. 7 shows that there were differences across regions in IPTRUNC in 1880 and that those differences often appear in 1890 and 1900, with some exceptions. For each year, Fig. 7 plots the ratio of the region's mean value of IPTRUNC divided by the national mean 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 show above-average 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.

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 some of these patterns. In particular, the fact that New York banks (who operated in an environment of relatively low interest rates compared to, for example, the West) issued lower amounts of notes could reflect higher redemption risks faced

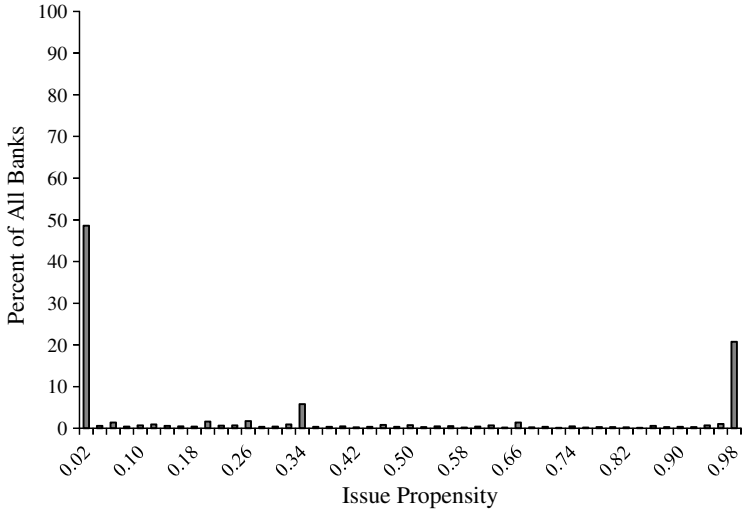


Fig. 5. Histogram for issue propensity—all issuers, 1900.

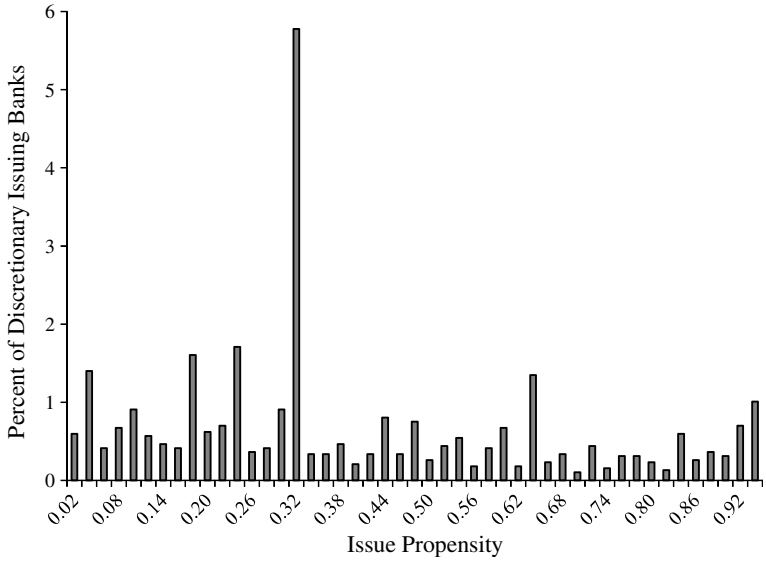
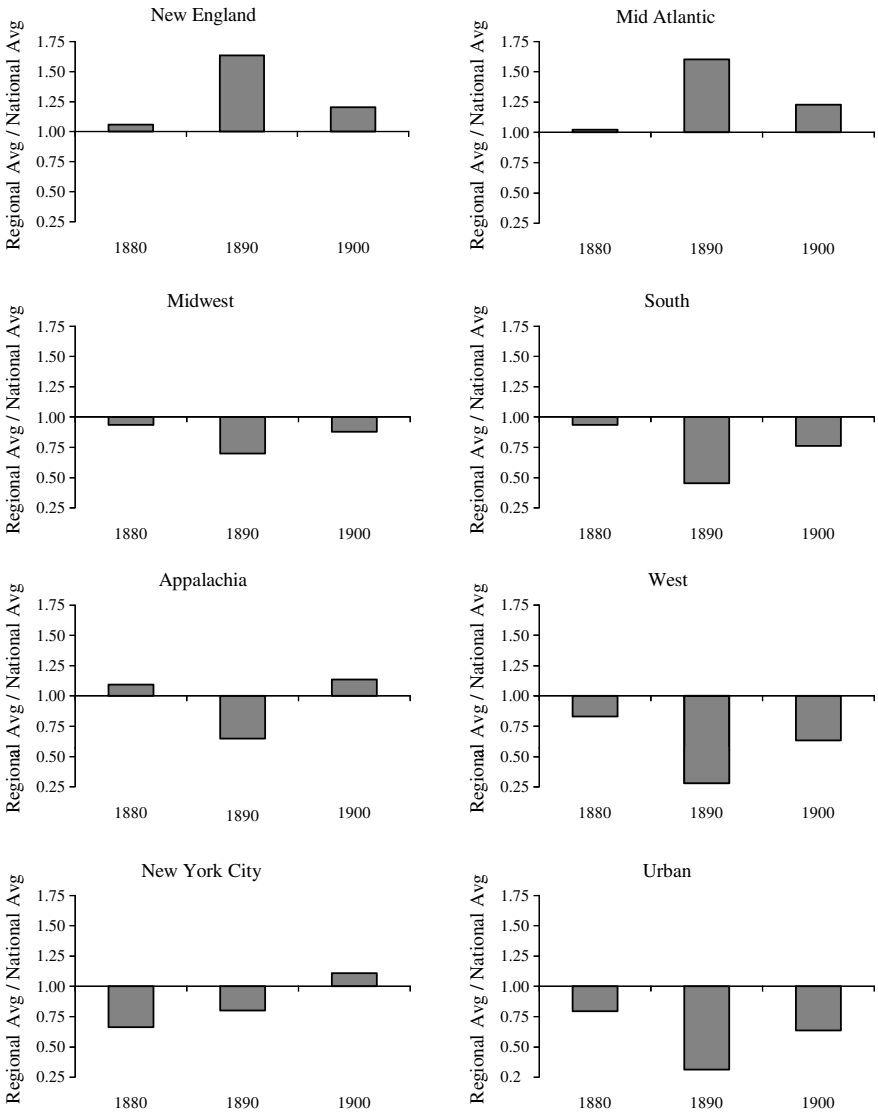


Fig. 6. Histogram for issue propensity—discretionary issuers only, 1900.

by those banks. We investigate the opportunity cost explanation in the regressions presented in the remainder of this Section and examine the potential explanatory power of the redemption risk explanations in Section 5 below.

3.1. 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.



	# 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

Fig. 7. Distribution of issuance (IPTRUNC) across decades and regions.

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. In constructing this variable, LOANRAT, we exclude the U.S. Treasury bonds held to secure note circulation from the definition of securities to avoid generating a correlation between LOANRAT and issuing propensity simply by construction of the definition of LOANRAT. 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.

All of our measures of profitability abstract from potential risk differences. That is, we implicitly assume that differences in profitability are good proxies for differences in risk-adjusted profitability. Location-specific differences in profit opportunities were the result of a persistent segmentation of capital markets during this period, as documented by Atack et al. (1982) and Atack and Bateman (2000).

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 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. 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 SIZE $\times$ AGE 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 4–6 (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 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

Table 4
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	2079	1649	1658
Log-likelihood	−1647.7	−1305.6	−1287.8
Restricted Log-likelihood	−1766.5	−1766.5	−1766.5
χ^2	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	−0.6483	−0.2292
	0.6766	*0.7677*	*0.7749*
NYC	−0.2715	−0.2821	−0.2812
	0.0959	*0.1011*	*0.1005*
URBAN	−0.0981	−0.0955	−0.1105
	0.0615	*0.0647*	*0.0646*
SIZE	0.1089	0.1591	0.1323
	0.0534	*0.0599*	*0.0601*
AGE	0.2201	0.2239	0.2180
	0.0470	*0.0526*	*0.0524*
SIZEAGE	−0.0176	−0.0183	−0.0179
	0.0037	*0.0041*	*0.0041*
MIDATL	−0.0253		−0.0243
	0.0337		*0.0480*
MIDWEST	−0.1910		−0.1661
	0.0335		*0.0410*
SOUTH	−0.1474		−0.2625
	0.0667		*0.0940*
APPALACH	0.1228		0.1224
	0.0610		*0.0765*
WEST	−0.3419		−0.1844
	0.0977		*0.1467*
ROAL		1.8668	1.3557
		2.2071	*2.8715*
LOANRAT		−0.3407	−0.3197
		0.1223	*0.1213*
WDFK		−0.1276	−0.0817
		0.0294	*0.0270*
WDMK		−0.0262	−0.0212
		0.0229	0.0232
Scale	0.5239	0.5207	0.5132
	0.0121	*0.0134*	*0.0132*

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 years for which it 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, indicating that our opportunity cost measures do not capture all of the important regional influences on note issuing. Of course, our opportunity cost measures are imperfect (in particular, they are static rather than forward looking), and it may be that noisiness in the measurement of opportunity cost explains the marginal significance of regional indicators.

Controls for SIZE, AGE, and SIZE × AGE 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 indicate an opportunity cost effect, since banks in cities

Table 5
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	3540	2681	2681	2719
Log-likelihood	−1847.4	−1364.9	−1350.5	−1351.7
Restricted Log-likelihood	−2087.6	−2087.6	−2087.6	−2087.6
χ^2	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	1.7525	1.2605	0.5658
	0.8282	*1.2285*	*1.2205*	*1.2265*
NYC	−0.0626	0.0531	−0.0544	0.4549
	0.2950	*0.3398*	*0.3377*	*0.3572*
URBAN	−1.0534	−1.2494	−1.2103	−0.6908
	0.2619	*0.3521*	*0.3395*	*0.3606*
SIZE	−0.0142	−0.0634	−0.0519	0.0291
	0.0652	*0.0904*	*0.0895*	*0.0922*
AGE	0.3071	0.3016	0.3229	0.2924
	0.0460	*0.0628*	*0.0630*	*0.0619*
SIZEAGE	−0.0202	−0.0197	−0.0216	−0.0194
	0.0035	*0.0048*	*0.0048*	*0.0047*
MIDATL	0.2612		0.2787	0.0823
	0.0828		*0.1141*	*0.1228*
MIDWEST	−0.3100		−0.2052	−0.4254
	0.0838		*0.1180*	0.1308
SOUTH	−0.3011		−0.3526	−0.4377
	0.1305		*0.1973*	0.1937
APPALACH	−0.2688		−0.1471	−0.3090
	0.1393		*0.1778*	*0.1830*
WEST	−0.6095		−0.3553	−0.6142
	0.1764		*0.3107*	*0.3061*
ROAL		−20.9815	−9.8059	−12.0428
		6.4864	*6.6455*	*6.5606*
LOANRAT		−2.3235	−2.1370	−2.0061
		0.3639	*0.3591*	*0.3529*
WDFK		−0.1766	−0.1107	−0.1404
		0.0524	*0.0520*	*0.0493*
WDMK		−0.0158	−0.0086	
		0.0177	*0.0171*	
WROAM				−2.7270
				0.6981
Scale	1.1459	1.2558	1.2376	1.2207
	0.0443	*0.0595*	*0.0585*	*0.0574*

may have had special lending opportunities (that is, greater opportunities for loan portfolio diversification) that reduced their propensity to issue notes. At the same time, according to the redemption cost view, banks in cities may have suffered larger risks of redemption from note issuance. We consider that possible redemption cost explanation for the negative residual effects of cities further in Section 5 below.

Overall, 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.

How important are these effects? In Tobit, there is no analog to an R-squared measure. To capture importance of opportunity cost variables, we compute the mean and the standard deviation of IPTRUNC for the

Table 6
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	3861	3203	3203	3222
Log-likelihood	−3950.1	−3287.2	−3260.9	−3256.2
Restricted log-likelihood	−4122.4	−4122.4	−4122.4	−4122.4
χ^2	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	−4.2189	−4.6769	−5.2917
	0.4752	*0.5643*	*0.5727*	*0.5858*
NYC	−0.4443	−0.1878	−0.3377	−0.1151
	0.2152	*0.2223*	*0.2237*	*0.2262*
URBAN	−0.8828	−0.8242	−0.8698	−0.6633
	0.1457	*0.1556*	*0.1555*	*0.1593*
SIZE	0.4081	0.3844	0.4130	0.4848
	0.0369	*0.0416*	*0.0417*	*0.0442*
AGE	0.2121	0.2156	0.2261	0.2133
	0.0209	*0.0242*	*0.0241*	*0.0240*
SIZEAGE	−0.0152	−0.015	−0.0165	−0.0157
	0.0016	*0.0018*	*0.0018*	*0.0018*
MIDATL	0.1563		0.1430	0.0373
	0.0668		*0.0841*	*0.0858*
MIDWEST	−0.1540		−0.1252	−0.2833
	0.0641		*0.0836*	*0.0891*
SOUTH	−0.2418		−0.2011	−0.3305
	0.0878		*0.1150*	*0.1169*
APPALACH	0.1016		0.1990	0.0882
	0.0975		*0.1113*	0.1126
WEST	−0.5126		−0.5895	−0.7500
	0.1127		*0.1353*	*0.1370*
ROAL		−6.6085	−5.6572	−6.7638
		3.0832	*3.5910*	*3.5654*
LOANRAT		−0.9292	−0.7657	−0.7449
		0.1634	*0.1697*	*0.1685*
WDFK		−0.0894	−0.0146	−0.0702
		0.0408	*0.0406*	*0.0382*
WDMK		−0.0180	−0.0078	
		0.0315	*0.0313*	
WROAM				−1.6159
				0.3180
Scale	1.1355	1.1393	1.1266	1.1177
	0.0276	*0.0304*	*0.0301*	*0.0298*

sub-sample of *non-truncated* observations in a given year. Then we compute the mean and standard deviation of each of the four opportunity cost variables for this same sub-sample of non-truncated observations (e.g., of ROAL, LOANRAT, WDFK, and WROAM in 1900). Next, we compute, at the mean of IPTRUNC for this sub-sample, the marginal effect on IPTRUNC of increasing each of the opportunity cost variables in this sub-sample by its standard deviation for this sub-sample, and compare the magnitude of these effects to the standard deviation of IPTRUNC for this sub-sample as a measure of importance.

In 1900, the mean of IPTRUNC for the sub-sample of 1043 non-truncated issuers is 0.42 and the standard deviation for this sub-sample is 0.27. The standard deviations of the four opportunity cost variables multiplied by their coefficient values reduces IPTRUNC by 0.38 to a value of 0.04, which is a response greater than its standard deviation for this sub-sample. In 1890, the non-truncated sub-sample of 349 banks has a mean of 0.36 and a standard deviation of 0.30. A one standard deviation increase in the four opportunity cost variables

reduces IPTRUNC by 0.64 (meaning that such a change could have reduced IPTRUNC from almost twice its mean value to its minimum value of near zero). In 1880, only LOANRAT and WDFK are statistically significant. For the truncated sub-sample of 939 banks, a standard deviation increase in these two variables reduces IPTRUNC from its sub-sample mean of 0.69 to 0.63, which is small compared to the standard deviation for this sub-sample of 0.24. We conclude that opportunity cost variables were economically important as well as statistically significant, although their explanatory power is low in 1880.

We also explore variation over time in note issuance in Table 7. 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. Government bonds served as required backing for bank note issues; thus note issuance should be positively related to bond yields, ceteris paribus. 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. 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.

The profitability of bond holding and note issuing (compared to deposit taking and lending) increases with the yield on bonds. Table 7 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.

4. Entry and exit, and capital augmentation

An empirical analysis of the patterns of entry and exit into national banking confirms the implications of our findings above, namely that lending and deposit taking seem to have been a relatively profitable strategy during our period, as indicated by their association with entry and exit patterns. Note issuance, in contrast, was not a motive for entry into national banking in the period 1880–1900. Note issuing was of small and declining expected profitability over time, as indicated by the low propensity to issue notes by banks entering between 1880 and 1900, and the fact that exiting banks tended to have higher note issuing propensities.

The declining propensity to issue notes was reinforced by the exit of high note issuers and the entry of low note issuers. Furthermore, the tendency 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.

Fig. 8 shows that of the national banks that entered between 1880 and 1900, only 17% (412 of 2381 entering banks) chose a maximum note issue strategy, while a full 55% (1312 of 2381) chose to issue at the minimum (Figs. 9 and 10 illustrate patterns for the sub-periods 1880–1890 and 1890–1900). Furthermore, Fig. 8 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. Fig. 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 3) 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.

Fig. 8 illustrates that of banks that survived the period 1880–1900, 38% (577 of 1508) were minimum issuers and a roughly equal amount, 27% (400 of 1508), were maximum issuers. Fig. 8 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 3861 in 1900, showed an interest in maximizing their note issuance in the period 1880–1900.

Table 7
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	7533	7533	7533	7533
Log-likelihood	−6956.4	−6543.6	−6308.8	−6308.8
Restricted log-likelihood	−10136.5	−10136.5	−10136.5	−10136.5
χ^2	6360.1	7185.7	7655.3	7655.3
Significance (α)	0.000	0.000	0.000	0.000
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
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	
Y 1880				0.9434
				0.0562
Y 1890				−0.8812
				0.0355
Scale	1.0637	0.9648	0.9317	0.9315
	0.0189	*0.0170*	*0.0163*	*0.0164*

The fact that exiting banks issued more than average, entering banks issued less than average, and surviving 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.

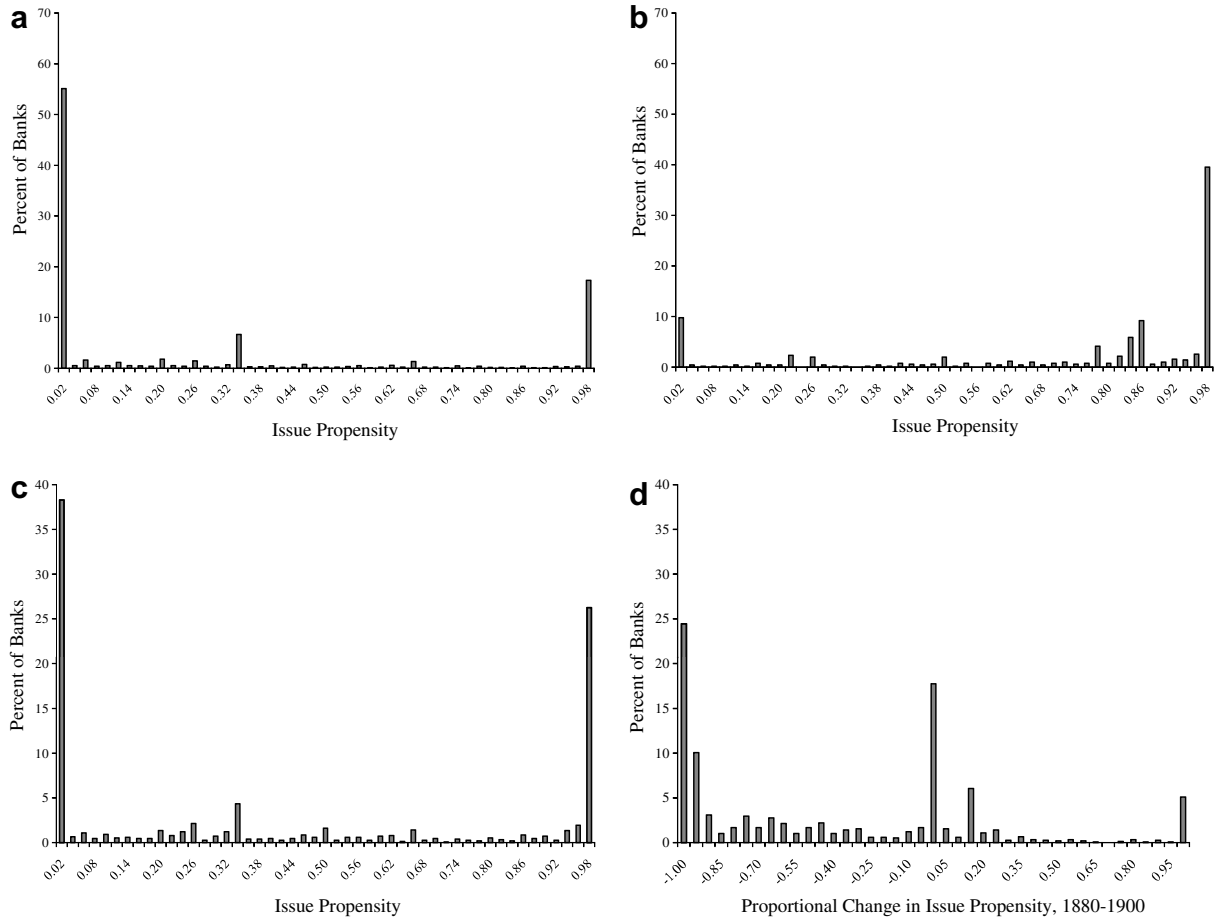


Fig. 8. (a) 1900 IPTRUNC of banks entering 1880–1900. (b) 1880 IPTRUNC of banks exiting 1880–1900. (c) 1900 IPTRUNC of banks surviving 1880–1890. (d) Survivors' change in IPTRUNC, 1880–1900.

Banks seemed loath to increase capital in order to boost note issuance in the period, as well. Although capital growth also varied across banks during our period, consistent with our analysis above of the low profitability of raising capital to finance note issues, few banks both increased their note issues and their capital from 1880 to 1900. There were 1531 national banks present both in 1880 and 1900. Of those banks, 1088 had the same paid in capital in 1900 as in 1880. Of the remaining 443 banks, 238 decreased their paid in capital and 205 increased their paid in capital. Of the 205 banks that increased their capital, 85 decreased their note issuance, and 120 increased their note issuance. The total amount of note issuance increase for the 120 banks that raised capital while increasing their note issues between 1880 and 1900 was $21.8 million, which constituted less than 7% of outstanding note issues in 1880. This $21.8 million gross increase did not compensate for the decline in other banks' note issues; total national bank notes fell from $317.1 million in 1880 to $283.8 million in 1900. We conclude that banks did respond on the margin to incentives to issue or contract note issues over time, and that they saw little incentive to raise capital to support an increase in bank notes from 1880 to 1900. This confirms our analysis of the relatively high marginal profitability of devoting new capital during our period to supporting growth in lending and deposit taking rather than note issuance.

5. The redemption cost theory of underissuance

Cagan (1965, p. 95) was the first modern writer to point to redemption cost as a possible explanation for the low issuance of national bank notes:

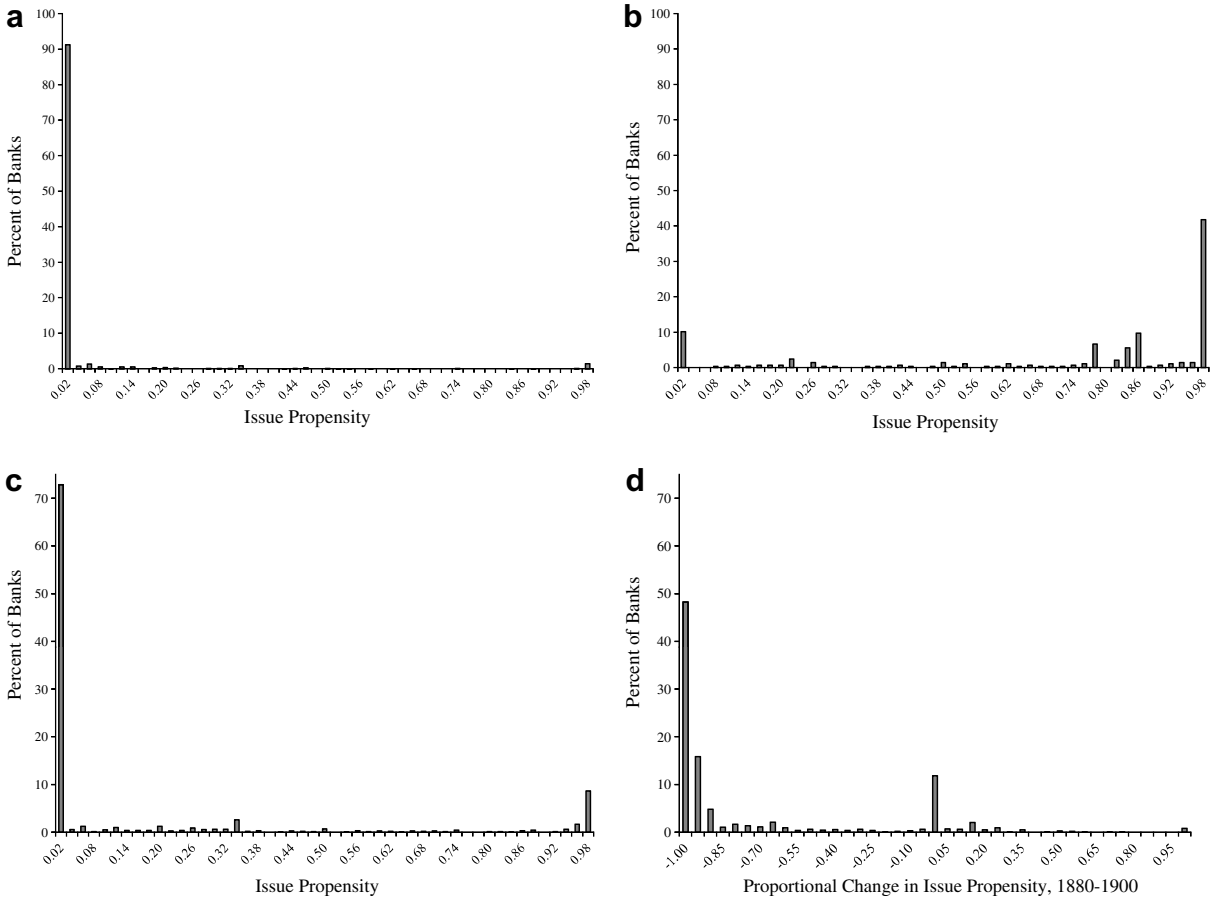


Fig. 9. (a) 1890 IPTRUNC of banks entering 1880–1890. (b) 1880 IPTRUNC of banks exiting 1880–1890. (c) 1890 IPTRUNC of banks surviving 1880–1900. (d) Survivors' change in IPTRUNC, 1880–1890.

> 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." Of course, even if redemption flows were predictable, they might entail high costs if banks had to maintain cash balances to fund redemptions (as in Baumol, 1952 and Tobin, 1956).

Cagan's discussion of redemption cost suggests a straightforward test of the proposition that the costs of redemption were important and that the 5% minimum redemption fund did not adequately eliminate the risk of redemption. If 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. If note issues were not associated with a costly increase in the demand for more reserves to mitigate redemption costs, then one can reasonably conclude that banks did not see significant costs associated with potential note redemption.

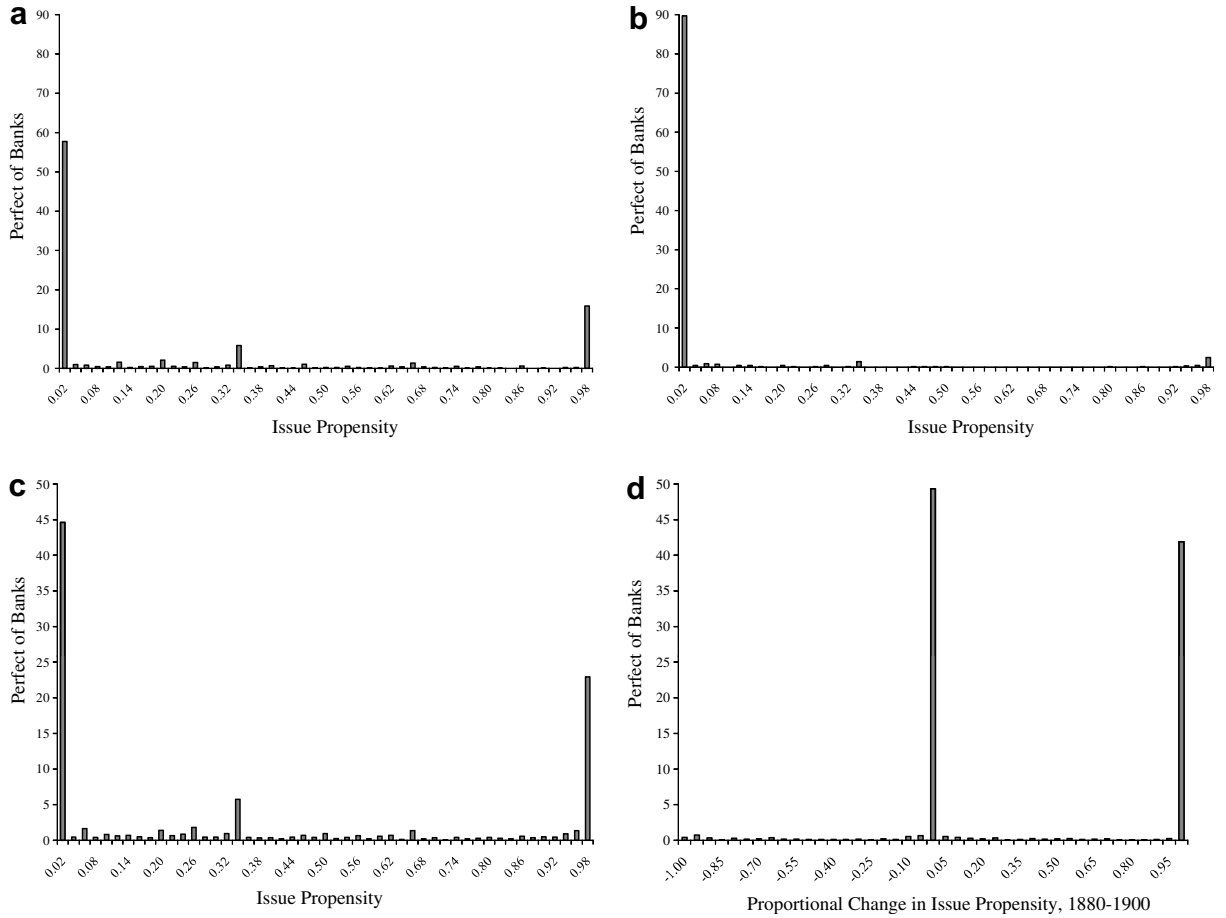


Fig. 10. (a) 1900 IPTRUNC of Banks Entering 1890–1900. (b) 1890 IPTRUNC of Banks Exiting 1890–1900. (c) 1900 IPTRUNC of Banks Surviving 1890–1900. (d) Survivors' Change in IPTRUNC, 1890–1900.

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 liquid balances against note issues and whether the need for excess reserves to mitigate the costs of redemptions 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 excess reserves to national bank notes outstanding was 0.6153% in 1880, 0.6377% in 1890, and 0.7505% in 1900, while the standard deviation of the ratio of excess Treasury reserves to national bank notes outstanding was 0.0487 in 1880, 0.0776 in 1890, and 0.0752 in 1900. Clearly, the average demand for excess reserves at the Treasury to mitigate redemption costs was small.[12]

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 cost, and if the desired excess reserve

[12] 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.

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

Table 8 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.

Table 8
OLS models of excess reserves, 1880, 1890, and 1900

	(A)	(B)	(C)	(D)	(E)	(F)
Dependent variable	Treasury excess reserves, TER			Narrow excess reserves, NER		
Sample	All banks, 1880	All banks, 1890	All banks, 1900	All banks, 1880	All banks, 1890	All banks, 1900
N	2077	3539	3859	2077	3539	3859
R^2	0.003	0.006	0.010	0.511	0.471	0.448
Adj. R^2	−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	−0.0009	0.0018	0.1152	0.0706	0.0459
	0.0038	*0.0006*	*0.0008*	*0.0215*	*0.0132*	*0.0067*
TLTA	0.0005	−0.0003	−0.0025	−0.0371	−0.0427	−0.0490
	0.0024	*0.0003*	*0.0006*	*0.0135*	*0.0068*	*0.0052*
LNTL	−0.0001	0.0001	0.0000	−0.0065	−0.0055	−0.0028
	0.0002	*0.0000*	*0.0001*	*0.0013*	*0.0009*	*0.0005*
NTL	−0.0005	0.0008	0.0006	−0.0247	−0.0367	0.0118
	0.0032	*0.0007*	*0.0011*	*0.0183*	*0.0164*	*0.0090*
NTLSQ	0.0011	−0.0002	−0.0029	0.0289	0.0772	−0.0002
	0.0034	*0.0011*	*0.0022*	*0.0193*	*0.0254*	*0.0177*
LOANRAT	−0.0017	0.0001	0.0000	−0.0176	0.0010	−0.0044
	0.0012	*0.0003*	*0.0004*	*0.0067*	*0.0061*	*0.0030*
USDTD	−0.7970	−0.8484	−66.1297	3.7549	1217	5747
	4.7200	*71.0782*	*126.0965*	*26.7519*	*1590*	*1040*
IBDTD	−0.0001	−0.0001	−0.0001	0.0022	0.0031	0.0299
	0.0014	*0.0003*	*0.0005*	*0.0077*	*0.0065*	*0.0040*
RCITY	0.0000	−0.0001	0.0003	−0.0379	−0.0441	−0.0411
	0.0006	*0.0001*	*0.0002*	*0.0033*	*0.0026*	*0.0018*
CRCITY	−0.0002	0.0000	0.0004	−0.1667	−0.1484	−0.1246
	0.0011	*0.0002*	*0.0004*	*0.0065*	*0.0046*	*0.0037*
MIDATL	0.0002	0.0000	0.0001	0.0124	0.0100	0.0011
	0.0004	*0.0001*	*0.0002*	*0.0024*	*0.0019*	*0.0014*
MIDWEST	0.0003	0.0001	0.0002	0.0351	0.0206	−0.0003
	0.0004	*0.0001*	*0.0002*	*0.0025*	*0.0018*	*0.0014*
SOUTH	0.0009	0.0003	0.0005	0.0452	0.0428	0.0096
	0.0008	*0.0001*	*0.0002*	*0.0043*	*0.0024*	*0.0017*
APPALACH	−0.0005	0.0001	−0.0002	0.0255	0.0176	0.0004
	0.0006	*0.0001*	*0.0002*	*0.0037*	*0.0028*	*0.0019*
WEST	−0.0002	0.0000	0.0001	0.0186	0.0002	−0.0080
	0.0011	*0.0001*	*0.0003*	*0.0063*	*0.0027*	*0.0022*

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), implying 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 associated with differences in the volatility of withdrawals or redemptions (as in Miller and Orr, 1966). These variables include the ratio of bank notes to 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 the public's deposits to total deposits is the omitted category of deposits.

We also include LOANRAT 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 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 8 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 Fig. 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% required minimum redemption fund at the Treasury was more than adequate to mitigate redemption costs from note issuance. Consequently, we conclude that the hypothesized cost of maintaining cash balances to mitigate redemption costs cannot explain the puzzle of underissuance of national bank notes.

In Table 9, 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, contrary to the redemption cost theory, broadly defined excess reserve holdings are *negatively* related to note issue and that this relationship is statistically significant.

In interpreting the regressions in Tables 8 and 9 it is important to remember that the decision to increase bank notes had implications for several regressors, not just NTL, and thus the effect on excess reserves is captured by the sum of several coefficients in these tables. As noted before, expanding the bank's size to increase note issuance implies not only an additional effect through NTLSQ but also a commensurate (111% of notes) increase in assets and liabilities. One computes the total marginal effect on excess reserves of a $100,000 increase in bank note issuance by calculating the implied changes in TLTA, LNTL, NTL, and NTLSQ at the variable means. The resulting marginal effect of increased note issuance is *zero* in 1880 and 1890 for the narrowest classes of reserves, negative for all other classes of reserves and time periods in Table 8, and negative for the broadest class of reserves estimated in Table 8. Hence, it appears that, in general, note redemption was not a cost that was magnified by increased note issue.

The results in Tables 8 and 9 not only contradict the redemption cost 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 needs associated with notes. Banks that issued notes faced a lower marginal cost of maintaining reserves associated with deposit taking and lending because the (unwarranted) high required reserves against notes could be used to satisfy the demand for

Table 9
OLS models of broad excess reserves, 1880, 1890, and 1900

	(A)	(B)	(C)
Dependent variable	Broad excess reserves, BER		
Sample	All banks, 1880	All banks, 1890	All banks, 1900
N	2077	3539	3859
R^2	0.211	0.220	0.195
Adj. R^2	0.206	0.217	0.192
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
Intercept	0.4430	0.3175	0.3574
	0.0490	*0.0353*	*0.0243*
TLTA	−0.2492	−0.1438	−0.1851
	0.0308	*0.0183*	*0.0189*
LNTL	−0.0182	−0.0233	−0.0198
	0.0029	*0.0023*	*0.0019*
NTL	−0.2863	−0.4067	−0.3154
	0.0418	*0.0439*	*0.0325*
NTLSQ	0.2307	0.8040	0.5568
	0.0439	*0.0681*	*0.0642*
LOANRAT	−0.0203	0.0141	−0.0200
	0.0152	*0.0164*	*0.0107*
USDTD	2.0193	1645	−1592
	60.9383	*4262*	*3764*
IBDTD	0.0367	0.1084	0.1476
	0.0176	*0.0175*	*0.0146*
RCITY	0.0216	0.0429	0.0526
	0.0076	*0.0070*	*0.0064*
CRCITY	−0.0872	0.0049	0.0221
	0.0147	*0.0123*	*0.0134*
MIDATL	0.0199	0.0224	0.0063
	0.0054	*0.0052*	*0.0050*
MIDWEST	0.0593	0.0435	0.0224
	0.0057	*0.0049*	*0.0049*
SOUTH	0.1031	0.1181	0.0681
	0.0097	*0.0064*	*0.0060*
APPALACH	0.0534	0.0550	0.0358
	0.0083	*0.0074*	*0.0070*
WEST	0.0908	0.0611	0.0519
	0.0143	*0.0073*	*0.0078*

reserves associated with deposit taking and lending. This economy of scope in reserve management helps to explain why national banks combined note issuance with deposit taking and lending, rather than specializing in note issuing, since combining the two sets of activities reduced their combined cost.

Although the evidence reported thus far suggests that, in general, note issuance did not impose significant marginal redemption costs on national banks, it is possible that note issuance entailed greater redemption costs for some sub-samples of national banks—for example, those located in cities. Recall from Section 3 that we find a negative residual effect on IPTRUNC that was associated with urban locations. Specifically, in 1880 and 1900, but not in 1890, we find a significant negative residual associated with New York City, and in 1890 and 1900, we find a significant negative residual associated with other cities. As we noted above, it is possible that urban locations have higher redemption costs (perhaps because it is easier for national bank notes to be returned to urban banks), which could explain these residuals.

To test this hypothesis, we included interaction terms for NTL and NTLSQ, interacted with the reserve center and central reserve center indicator variables, for all three of our reserve regressions in each of the three years. For the broad (BER) definition of reserves, we find no significant or robust interaction effects. That is, using that measure of reserves as an indicator, there is no apparent relationship between being located in a

reserve center or central reserve center and experiencing a higher redemption risk from issuing national bank notes. The narrowest (TER) reserve measure regressions show a significant negative effect for the interaction of NTL and the indicator for reserve center banks in 1900 (contrary to the redemption risk hypothesis), but we find no effect for central reserve center banks in 1900, and neither the reserve centers nor central reserve centers shows a significant effect in 1880 or 1890 in the TER regressions.

In the augmented NER regressions, however (which we report in Table 10), we do find a significant positive interaction effect for the central reserve center banks in 1880 and 1900, but not in 1890, and for the reserve center banks we find a significant interaction effect for 1890, but not for 1880 or 1900.

Table 10
OLS models of narrow excess reserves, 1880, 1890, and 1900, with interaction variables

	(A)	(B)	(C)
Dependent variable	Narrow excess reserves, NER	Narrow excess reserves, NER	Narrow excess reserves, NER
Sample	All banks, 1880	All banks, 1890	All banks, 1900
N	2077	3539	3859
R^2	0.521	0.473	0.448
Adj. R^2	0.516	0.470	0.446
	Coefficient *Std. Error*	Coefficient *Std. Error*	Coefficient *Std. Error*
Intercept	0.1123	0.0664	0.0457
	0.0213	*0.0132*	*0.0067*
TLTA	−0.0390	−0.0430	−0.0493
	0.0134	*0.0068*	*0.0052*
LNTL	−0.0058	−0.0051	−0.0027
	0.0013	*0.0009*	*0.0005*
NTL	−0.0553	−0.0438	0.0103
	0.0193	*0.0165*	*0.0093*
NTLSQ	0.0595	0.0881	0.0019
	0.0203	*0.0255*	*0.0181*
LOANRAT	−0.0163	0.0006	−0.0044
	0.0066	*0.0061*	*0.0030*
USDTD	2.4244	1181	5720
	26.5126	*1587*	*1040*
IBDTD	0.0053	0.0068	0.0307
	0.0077	*0.0066*	*0.0041*
RCITY	−0.0568	−0.0547	−0.0412
	0.0092	*0.0047*	*0.0032*
CRCITY	−0.2162	−0.1567	−0.1315
	0.0114	*0.0066*	*0.0055*
MIDATL	0.0128	0.0098	0.0011
	0.0024	*0.0019*	*0.0014*
MIDWEST	0.0354	0.0205	−0.0003
	0.0025	*0.0018*	*0.0014*
SOUTH	0.0452	0.0426	0.0095
	0.0042	*0.0024*	*0.0017*
APPALACH	0.0252	0.0173	0.0003
	0.0036	*0.0028*	*0.0019*
WEST	0.0165	−0.0002	−0.0081
	0.0062	*0.0027*	*0.0022*
RCITY * NTL	0.0578	0.2057	−0.0228
	0.0614	*0.1135*	*0.0605*
RCITY * NTLSQ	0.0282	−0.1529	0.1699
	0.0951	0.4282	*0.2440*
CRCITY * NTL	0.8269	0.2522	0.2843
	0.2756	*0.3456*	*0.1549*
CRCITY * NTLSQ	−2.0420	−0.3080	−1.2072
	1.4489	*2.5502*	*0.6513*

The largest positive effect of national bank note issuance on reserve demand that we observe is for the 47 central reserve city national banks with respect to NER in 1880. At the means of NTL and NER for these banks, a one standard deviation (0.061) increase in NTL (from the mean of 0.074–0.135) results in a small estimated increase in NER of 0.029, from its mean of −0.188 to −0.159 (the standard deviation of NER for this subsample of national banks in 1880 is 0.048). For the 235 reserve city banks in 1890 a standard deviation (0.049) increase in NTL produces a small increase in NER of 0.008, from its mean of 0.046 to 0.054 (the standard deviation of NER for this subsample of national banks in 1890 is 0.035). At the means of NTL and NER for central reserve city banks in 1900, a one standard deviation (0.046) increase in NTL (from the mean of 0.038 to the higher level of 0.084) results in a small estimated increase in NER of 0.009 from its mean of −0.156 to −0.147 (the standard deviation of NER for this subsample of national banks in 1900 is 0.034).

These results provide some evidence consistent with the redemption risk hypothesis, and suggest that some of the unwillingness to issue national bank notes by central reserve city banks in 1880 and 1900, and by reserve city banks in 1890, may have reflected redemption costs. These results, however, indicate selective and small effects on reserve demand, and raise a new puzzle: if in fact New York and other urban banks experienced these changes over time in redemption costs associated with note issuance, what drove the observed differences over time and across urban locations? And why was NER, but not reserves at the Treasury (TER) or BER, affected by increased NTL?

6. Conclusions

For the period 1880–1900, we are able to explain much of the note issuing patterns of national bank notes 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, chose not to issue more notes. Years in which bond yields (the required backing for notes) were higher saw greater propensities to issue notes, holding constant lending opportunities.

Models of redemption costs associated with issuing national bank notes (per se) 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 cost explains underissuance of notes is inconsistent with the observed lack of a general relationship between bank note issuance and excess reserve holdings. At the same time, the redemption cost explanation may have relevance for the issuance behavior of urban banks. For urban banks, low residual note issuance in some years (estimated in Section 3) is associated with higher reserve needs related to issuing national bank notes in some of those years, at least for one definition of reserves (NER).

An examination of reserve demand indicates 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 mainly to issue national bank notes. Indeed, over the period 1880–1900, new entrants focused less on note issuing, while banks exiting were more likely to be maximum issuers. Nor did banks raise new equity capital mainly to finance additional note issuance. Note issuing was profitable only for some banks, and only when combined with lending and deposit taking. Note issuing seems to have been a relatively unprofitable line of business for relatively successful bankers.

During our period, understanding the low issuance of national bank notes is substantially improved by disaggregating data and thus avoiding misleading "representative bank" analysis relating average bank behavior and average bank opportunities. Unfortunately, data limitations prevent us from applying this same approach to the period after 1900, when the apparent profitability of bank note issuance was especially high.

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 3. 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%, 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% 8-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 more than 10 basis points different from our final estimates.

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