Share Liquidity, Participation, and Growth of the Boston Market for Industrial Equities, 1854-1897

by

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Abstract

There is a strong belief among financial economists that share liquidity promotes participation in equity markets and is thus central to their deepening. The volatility of today's emerging markets, however, renders the identification of liquidity effects challenging in a modern context. In this study I look back at the effects of growing liquidity and participation on the expansion of the first organized U.S. market for industrial equities that had formed in Boston by the mid-1830s, a time when capital flows were considerably less volatile than they are now. From primary sources hitherto unused for scholarly investigations, namely the running annual worksheets of securities price fluctuations that underlie broker Joseph Martin's volumes on the history of the Boston stock market, I construct broad-based indices of annual prices and returns for banking and industrial equities traded from 1854 to 1897, as well as measures of overall market capitalization. Vector autoregressive models then relate increases in liquidity, as measured by the falling par values of industrial shares, to rising prices and capitalizations of traded firms. The findings support the view that share liquidity was a key factor in sustaining Boston's position as the nation's premier industrial market until finally overtaken by New York near the end of the 19th century.

Keywords: stock splits, liquidity, industrialization, New England.

JEL categories: E44, N11, N21

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1. Introduction

Recent financial crises in the emerging markets of East Asia, Latin America and Eastern Europe have heightened the urgency of policy debates aimed at evaluating the macroeconomic impact of equity markets and any complementarities that they may share with more traditional financial intermediaries such as banks. The task is formidable in the context of emerging markets, however, since the impact of an equity market appears to depend as much on the web of capital controls, exchange rate policies and banking practices that characterize individual economies as on the structural and regulatory features of their stock exchanges.[1] At the same time, there remains a strong belief among many macro economists that liquidity, defined here as the ability to purchase or sell shares at a price that reflects the "intrinsic" value of the underlying enterprise, can lead to financial deepening by mobilizing savings and ultimately improve the efficiency with which resources are delivered to productive uses (Levine and Zervos 1998; Rousseau and Wachtel 2000).

Given the insights that the past can sometimes provide for current policy, it is perhaps surprising that the 19th-century United States has only recently seen renewed interest as a case of growth sparked by emerging financial markets (Sylla 1998; Rousseau and Sylla 2005). Continuing this line of inquiry, I explore in this study the impact of increasing liquidity on the growth of Boston's market for industrial securities using newly-uncovered information on share prices, dividends, par values, and authorized capitalizations between 1854 and 1897. The historical lens offers an advantage because capital flows across regional and national boundaries were considerably less volatile in New England during the second half of the 19th century than those that we associate

[1] For example, the liquidity provided by equity markets could in the presence of a exchange rate pegs and freely-moving capital actually exacerbate the instability of international flows (Radelet and Sachs 1998).

with emerging markets today. This allows attention to focus on liquidity and its role in promoting the development of a specialized yet well-integrated capital market.

Even though a national market for government securities and several local markets for the equity shares of banks and insurance companies emerged very early in the nation's Federal history and helped to lay the foundation for its vigorous growth, New England was the only region in which a market for industrial equities arose to complement bank financing prior to 1850. These stocks traded in Boston at public auctions as early as 1817 and on a formal stock exchange after 1834, but their market (as well as that for bank equities) thickened considerably in the 1850s. This places Boston's market more than fifty years ahead of the industrial market in New York that Navin and Sears (1955) describe.

One problem commented upon by dealers and brokers in the early days of the Boston market and described by Martin (1856) was that high par values of industrial equities (usually $1,000) limited demand for these securities by placing some potentially interested and willing savers outside of their budget constraints at a time when annual per capita incomes ranged from $100 to $300. This study suggests that declining par values of traded industrial shares between 1854 and 1897 increased market liquidity by easing participation constraints, thereby advancing securities prices and allowing the market to grow.

The paper is organized as follows. Section 2 describes Boston's equity market between 1854 and 1897, presents new indices of price and total return performance for banking and industrial shares, and documents the growth in market size and liquidity. Section 3 outlines testable hypotheses that emerge from the analysis in Section 2, outlines a methodology for their formal investigation, and presents the empirical findings. Section 4 concludes.

2. The Performance of the Boston Stock Market, 1854-1897

A. Data

Until recently, little was known about the nation's first market for industrial securities. The most comprehensive record of trading covering Boston's formal exchange from its inception appears in a series of volumes by Joseph G. Martin (1856; 1871; 1898). Martin was a Boston broker who also organized information on equity market activity for sale in various forms to local newspapers, other brokers, and potential investors starting in the early 1850s. These volumes contain par values, dividends, authorized capital, and annual high and low stock prices in each calendar year from 1835 to 1898 for banks, insurance companies, railroads and industrials.[2] These data, though limited by the imprecise timing of price observations, when combined with the descriptions of trading practices in Barron and Martin (1893) and newspapers of the period reveal several characteristics of the equity market that are particularly important for this study.[3] First, price movements were an important source of fluctuations in returns. This contrasts with the traditional view that steady prices and dividends led 19th-century equities to function essentially like bonds in a regime of stable interest rates. Second, the market for banking and industrial shares in Boston was a decentralized one. Even though the formal exchange (called the "Broker's Board") was established in 1834 to focus the liquidity of the market in a single location for twice-daily calls, shares in most firms were also traded at auctions conducted by local securities dealers.[4] Finally, given the many auctions that were

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[2] Martin obtained price and dividend quotes for the 1835-1850 period from records of the exchange's founding member P. P. F. DeGrand and auctioneer Stephen J. Brown.

[3] Atack and Rousseau (1999) use annual high and low prices from Martin's volumes to construct price and return indices for 1835-1869, and it is the imprecise timing of these annual prices that renders their indices not directly comparable to those presented here for the period of their overlap (1854-1869).

[4] Several members of the Board officiated as auctioneers in the early days of the exchange. As this was judged to interfere with the business of the Board, however, it was ruled in March 1848 that

regularly announced in the local press, it appears that the actual transactions which occurred in a significant subset went unreported.[5]

The decentralized nature of the industrial market makes the construction of a continuous and accurate picture of prices and trading volumes prior to 1900 from newspapers and the exchange's "Official Report" virtually impossible. In fact, the relative thinness of the industrial market appears to have strengthened the preference of investors to trade these shares at auction on Wednesdays and Saturdays as the century progressed, with the auction market for industrials (and banks) eclipsing the formal exchange by 1886.[6, 7] As a result of these problems, previous researchers including

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with the exceptions of estate transactions and cases of special permission "any member of the Board who shall attend a public sale of stocks, or who shall, directly or indirectly, buy or sell at such sale, shall vacate his seat at the Board" (Martin 1856). The rule seems to have had little effect on the extent of auction trading in industrials. In 1854, for example, Martin (whose year-end summary of equity trades in the Boston market was reported in the January 10, 1855 edition of the *Boston Daily Advertiser*) reports that 41 industrials were quoted at the Board and 2,237 shares traded in that market during the year. My own analysis of all issues of the *Boston Daily Advertiser* in 1854 uncovered off-exchange trades of 702 additional industrial shares, including several issues that were inactive at the Board.

[5] For example, the *Boston Daily Advertiser* in 1854 regularly announced stock auctions by dealers N. Thompson, S. Brown, Dupee and Perkins, Hayward and Dorr, and Brewster, Sweet and Co., yet reported results from only the first two. Results of auctions which did appear in the *Boston Daily Advertiser* and the *Boston Evening Transcript* were often compiled by Martin. Indeed, it seems that the gathering and selling of financial information were among the central activities of his brokerage.

[6] To observe that 19th-century industrial markets were *relatively* thin by no means implies inactivity. Though volume records that include activity both on and off the exchange are generally unavailable, some information about share turnover can be gained from the surviving transfer books of several of the larger manufacturing firms. My examination of these records, which are on deposit in the Historical Collections of the Baker Library at the Harvard Business School (Mss: 442), indicate that on average 11.5 percent (172 shares of par $1,000) of the outstanding stock in Lawrence Manufacturing Company officially changed hands annually between 1854 and 1897. These figures were 15.3 percent (245 shares with par $1,000 before 1870 and 330 shares with par $500 between 1870 and 1891) for the Dwight Manufacturing Company and 20.6 percent (428 shares with par $500 between 1854 and 1880) for the Pepperell Manufacturing Company. A transfer was usually recorded when the new shareholder first appeared at the Boston office to claim a dividend. Since some transfers were estate distributions to relatives which did not pass through an organized market and others represented shares which may have traded several times between semiannual dividends (Lowell and Lowell 1884), these figures are only suggestive of actual activity in the

McGouldrick (1968) and Fenstermaker et al. (1988) have relied exclusively on Martin's published annual highs and lows for Boston share prices.

However, I have uncovered the supporting worksheets that Martin compiled and printed annually for sale to local investors. These worksheets contain end-of-quarter prices as well as quarterly high and low prices for all securities traded in the Boston market from 1854 until the turn of the century. This level of detail exceeds that of any other source which has been compiled for a U.S. equity market in the mid-19th century.[8] The worksheets, which are on deposit in the Baker Library at the Harvard Business School and have been hitherto unused for scholarly investigations, even achieved a degree of official recognition at the time of their regular publication.[9] Importantly, they include prices that were realized at public auctions as well as quotations on the formal exchange. In addition, the worksheets offer a key advantage for building measures of market performance over the use of annual high and low prices—the well-defined holding periods over which prices and dividends are reported eliminate distortions that would otherwise appear in derived

organized equity market.

[7] The twice-weekly auction calls were presumably an efficient mechanism for focusing liquidity in the industrial market. Indeed, by the time that the exchange adopted continuous trading in 1885 (Boston Stock Exchange, 1930, p. 15), nearly all trades in banks and industrials were made at auction. In fact, the transaction record book of Boston brokers Foote and French show only 26 transactions in industrial equities and no transactions in bank equities on the stock exchange between March and October of 1881. To allow brokers to participate in the burgeoning auction market, industrials were removed as an official "department" of the exchange on March 1, 1886 and no longer appeared on the "Official Report," although handwritten records of quotations recorded by the clerk of the exchange indicate that industrial stocks continued to be called (Mss. 785, Historical Collections, Baker Library). In contrast, the *Boston Evening Transcript* reported that 93 bank shares and 91 industrial shares changed hands in the two auctions which were covered by the paper on Saturday, January 2, 1886 alone. These auction volumes were not atypical by the late 1860s.

[8] For example, the indices prepared by Alfred Cowles and Associates in their 1938 study of the New York Stock Exchange begin only in 1871 and use the average of monthly high and low prices.

[9] The printed worksheets were deposited annually with the District Court of Massachusetts prior to 1862 and with the Library of Congress thereafter.

price and return indices due to the mixing of observations that are likely to be unsynchronized.[10] The precise timing of the observations permits a more thorough analysis of fluctuations in the early Boston market than had been previously possible and facilitates the statistical investigation of timing relationships between market deepening and regional economic growth.

B. Prices and Returns of Traded Banks and Industrials

Figures 1 and 2 present indices of price performance for traded banks and industrials on or about January 1 of each year from 1854 to 1897. Periods of cyclical contraction as defined by the National Bureau of Economic Research are shaded. The indices weight firms by their shares in the total market capitalization of their respective sectors, with market capital for each firm given by the product of share price and the number of authorized shares.[11]

Bank stock prices rose by 43 percent in nominal terms between 1862 and 1875 before falling by 20 percent over the three years of general price deflation that preceded the successful resumption of gold payments in 1879. They returned to their 1877 levels shortly after resumption, appreciated very little in the 1880s, and fell by 14 percent from between 1890 and 1897. Using the index of consumer prices published by the Bureau of Labor Statistics (BLS) as a deflator, real bank stock prices fell by 39 percent between 1854 and 1865 before nearly doubling in the course of a sustained

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[10] Indices constructed from annual high or low prices have components of price appreciation with durations that can range from 1 to 729 days.

[11] For a given year, the indices include firms with observations on January 1 of both the current and previous year. The weighted sum of the percentage changes in price for the included firms then serves as a multiplier to update the preceding index number. The indices use 100 as the base value in 1854. This "chaining" technique is similar to that used by Cowles and Associates (1938). I also computed price indices with firms weighted by their book (or authorized) capitalizations. Since these series correspond very closely to those in Figures 1 and 2 and market value is more representative of a firm's sectoral importance than book value, the discussion in this section and my subsequent empirical work refer exclusively to the market-weighted indices.

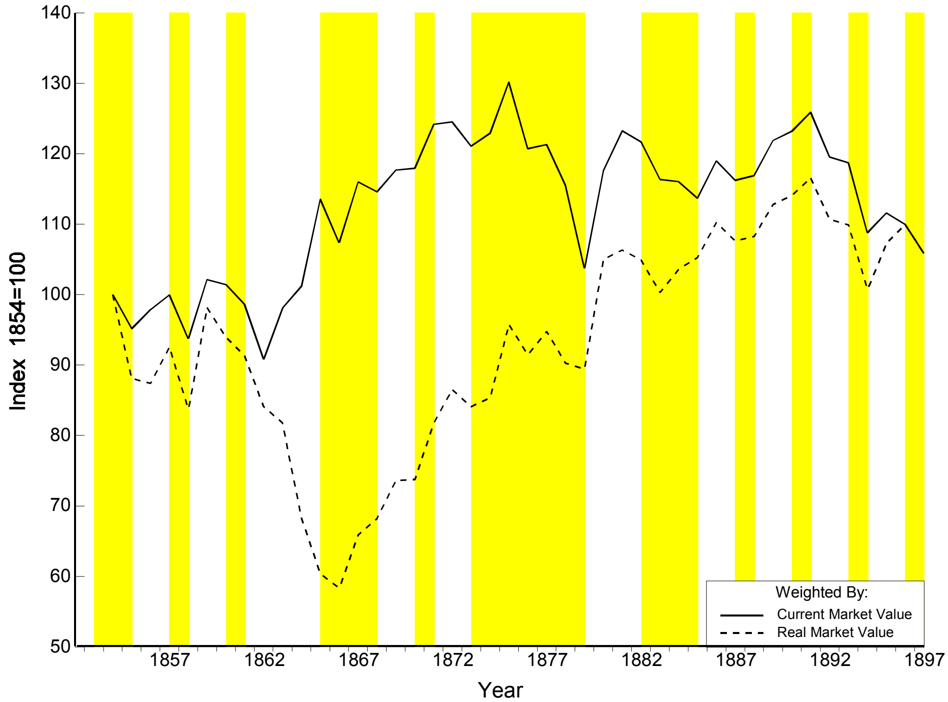

Figure 1. Bank Stock Price Indices

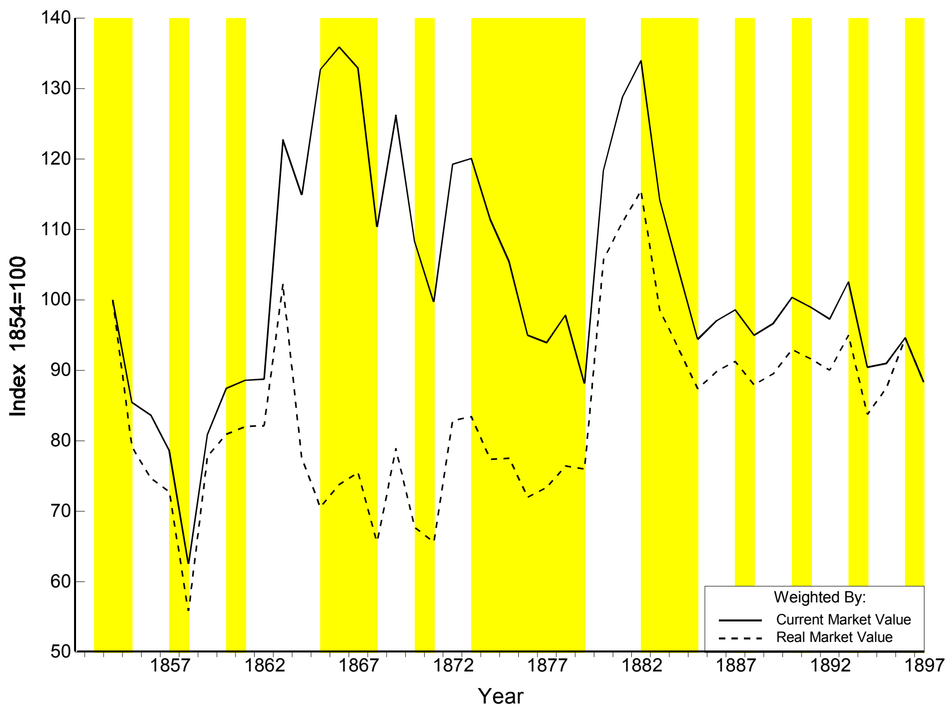

Figure 2. Industrial Stock Price Indices

rise from 1866 to 1891.[12, 13] Declines in bank stock prices also appear to lead the business cycle in seven of the ten downturns that occur over the sample period. Industrials experienced wider price fluctuations, with the index rising by 116 percent between 1858 and 1867. The appreciation is smaller but more prolonged in real terms, with prices rising 102 percent between 1858 and 1882 before falling 24 percent by 1885. Fluctuations in industrial prices match the NBER reference cycles closely, especially after 1860. Since the pre-1900 reference dates were constructed from a set of series in which industrial activity is strongly represented (Burns and Mitchell 1946, Table 17, p. 82), it is reassuring that these independent estimates are mutually supportive.

The number of firms included in the price indices for banks rises rapidly from 35 in 1854 to 61 by 1876. It remains relatively steady thereafter, with 59 banks included in 1897, which was the eve of a flurry in merger activity. Coverage for the industrial price indices rises from 39 firms in 1854 to 48 by 1872 and remains steady until 1879. The number then increases to 52 by 1887 and ends with 51 firms in 1897. Prices of both banking and industrial equities exhibited their strongest advances during periods of rapid growth in the number of listed firms. This may reflect the types of price effects that are often associated with a deepening equity market.

Value-weighted annual returns to bank shareholders (Figure 3) are usually positive and become visibly smaller and less variable after 1879.[14] Industrials (Figure 4) offered investors higher

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[12] The real price indices are for comparison only, since the BLS index (U.S. Bureau of the Census 1975, series E135) summarizes "retail prices of goods and services bought by city wage earners and clerical workers" and can thus capture at best only broad trends in consumer prices.

[13] The decline of ex-post real bank prices during the Civil War was largely the result of the enormous and largely unanticipated increase in the supply of currency (i.e., the “greenbacks”) that accompanied the heightening of the Union's war efforts.

[14] Bank returns average 8.4 percent through 1879 and 3.9 percent thereafter with standard deviations of 6.8 and 3.5 percent in these sub-periods. Ex-post real returns (deflated with BLS inflation rates) average 8.1 percent through 1879 and 4.6 percent thereafter, with respective standard deviations of 9.3 and 3.8 percent.

but much more variable returns which also fall in level and variability around 1880.[15] The decline in bank returns after 1879 is consistent with a tightening of competitive pressures in the wake of rapid growth in the number of banks over the preceding two decades, but the lower variability of both banking and industrial stock returns may also reflect a deepening, increasingly specialized and more liquid capital market. At the same time, an expanding market for industrials shifted the provision of long-term finance away from banks and into directly-held instruments which had become accessible to an increasing subset of New England savers.[16]

C. Market Size and Liquidity

The growth in the real value of equity capital for banks and industrials (Figure 5), especially prior to 1880, reflects rapid market deepening. These series use the value-weighted share price indices (Figures 1 and 2) to deflate the product of price and quantity for all outstanding shares to reflect 1885 prices. These "share price-adjusted" measures of market size have several advantages over the available alternatives. For one, using the total of authorized capital would neglect depreciation and the growth of internal equity, and would weight all inflows of fresh capital identically regardless of their timing. Further, the nominal market value of shares takes much of its year-to-year variation from fluctuations in the general price level and temporary deviations from the long-run supply and demand for shares. Choosing a general index of consumer prices (such as the BLS) to deflate market value would at best neglect the latter. For these reasons, I use the share

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[15] Industrial returns average 10.7 percent through 1879 and 3.6 percent thereafter with respective standard deviations of 16.9 and 7.2 percent. Real returns fall from 10.1 to 4.4 percent across the sub-periods, with standard deviations decreasing from 15.2 to 6.7 percent.

[16] Movements along a risk-return tradeoff were not the only reasons for a decline in industrial returns. New England also faced increasing competition in the provision of cloth and demand for cotton from the Southern and mid-Atlantic states, especially after 1880 (see Copeland 1917).

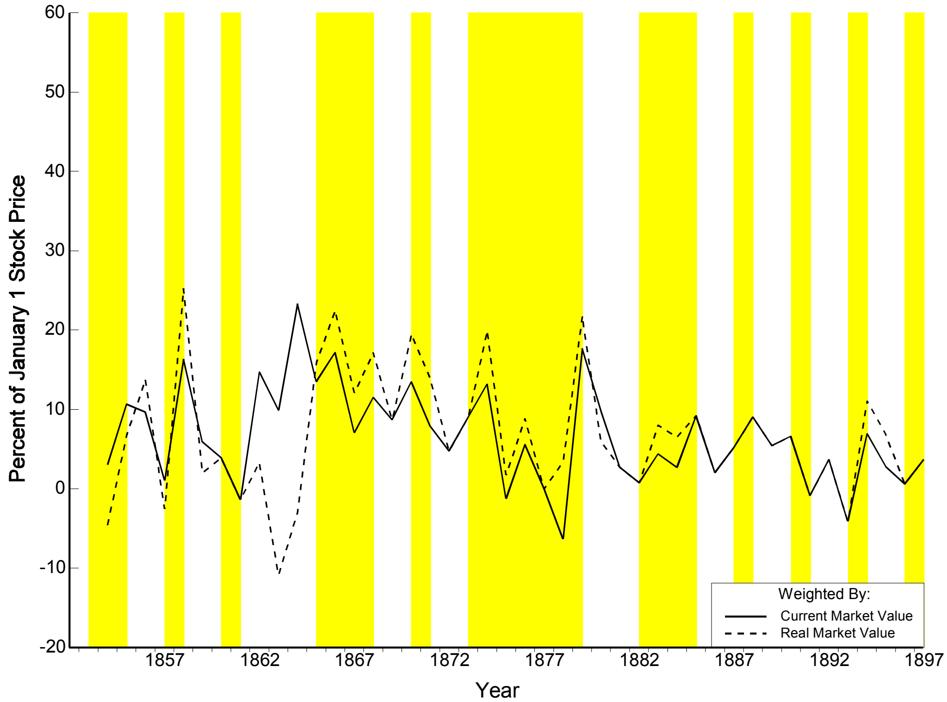

Figure 3. Total Returns For Traded Bank Stocks

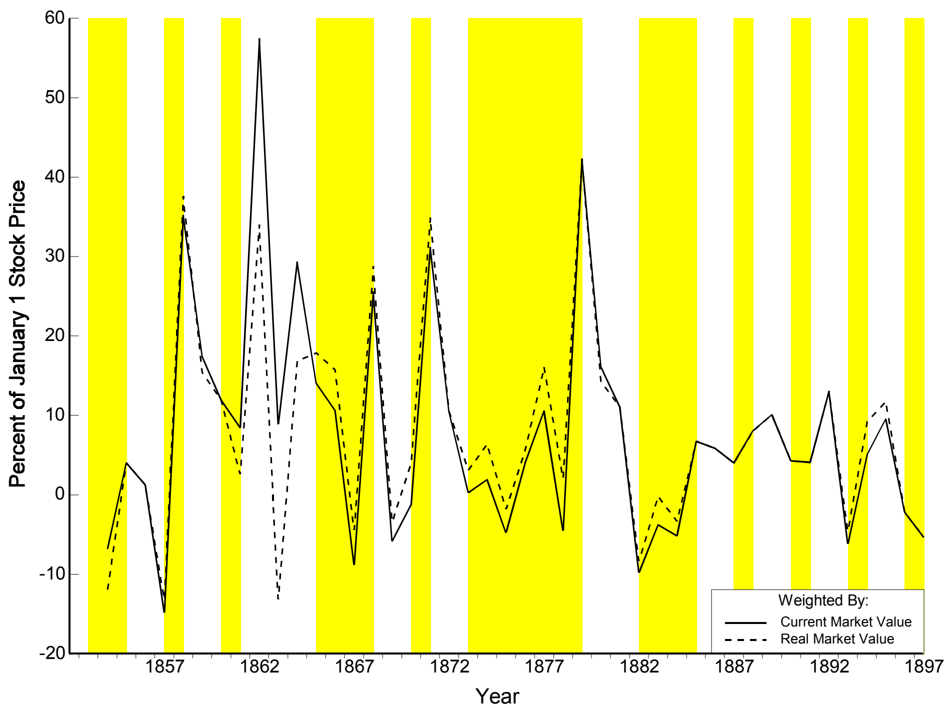

Figure 4. Total Returns For Traded Industrial Stocks

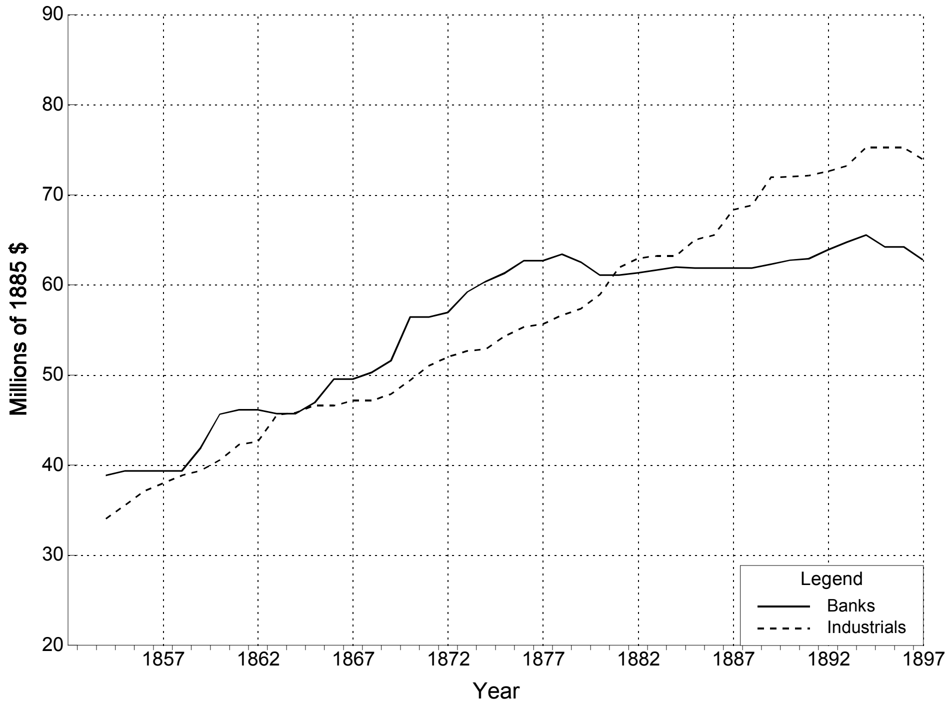

Figure 5. Share Price-Adjusted Stock Market Capitalization

price-adjusted measures of capitalization in the empirical analysis that follows in Section 3.

The real market capitalization of traded industrials doubles between 1854 and 1897 and continues to advance after 1880 despite returns that were lower and more variable. Bank capitalization advances by 62 percent in real terms between 1854 and 1878 and rises very little thereafter.[17] The period of sharp increase in bank capitalization coincides with that of rapid appreciation in stock prices (Figure 1).

[17] The lack of growth in the market capitalization of banks after 1879 suggests market saturation. The continued advance of deposits, however, does not imply stagnation in the banking sector. In fact, using the BLS price index as deflator, individual deposits in traded banks rose by an average annual rate of 4.6 percent between 1880 and 1897 (U.S. Comptroller of the Currency, various issues). This was a considerable decline from the annual growth of 6.9 percent recorded between 1865 and 1879, but does imply a continued expansion of banking activities. Overall, real individual deposits rose from about half to nearly double the amount of real bank capital between 1865 and 1897, with 57 percent of the total increase of $109 million occurring after 1879.

Earlier studies of manufacturing in New England (e.g., Knowlton, 1948; McGouldrick, 1968; Atack and Rousseau, 1999) have noted the high par values attached to industrial equities early in the 19th century and the participation constraints that they implied. The participation constraints were real because shares of industrial firms were generally issued at par value and most appear to have been paid in full at the time of subscription.[18] The high par values presumably helped to concentrate firm ownership and control, shielded shares from speculation, and reduced the costs of maintaining transfer books. What these studies do not emphasize is a general and marked decline in par values that began in the 1850s and continued steadily through 1900. Both new entry and markdowns of existing par values by stock splits account for this decline prior to 1870. For example, 11 of the 35 industrial firms with continuous price listings between 1854 and 1870 lowered their par value at least once, with seven of these cases involving firms with par values of $1,000 in 1854. The average par value of the 12 firms which became listed between 1854 and 1870 was $258. Entry was a more important factor after 1870, with only three firms lowering their par values but an average par value of $190 for the 10 firms which entered between 1871 and 1897.

The fall in par values allowed more individuals to participate in the market and choose from a wider selection of industrials. As such, it provided investors with more potential matches for conducting asset exchanges, and increased the liquidity of their holdings.[19] Since a liquid market

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[18] It is not possible to determine whether capital was fully paid for each and every industrial firm in the sample because many had been in business for years prior to listing. Nonetheless, the extent to which par values of new firms exceeded market prices at initial listing offers some idea of common practice. Between 1854 and 1897, 14 of the 16 firms that made their first equity issues near the time of their listing sold immediately at a premium from par value. Martin's (1871, pp. 64-65) annual high prices for earlier years also indicate that 16 of 17 firms listed between 1846 and 1854 and 22 of 23 firms listed between 1835 and 1844 sold at some time during the first year of their listing at prices that exceeded 90 percent of par value.

[19] The modern finance literature (e.g., Copeland 1979) finds that increases in transactions costs associated with stock splits actually *reduce* liquidity. This is because stocks for the most part now trade at prices that make ownership possible for individuals in a wide range of income brackets.

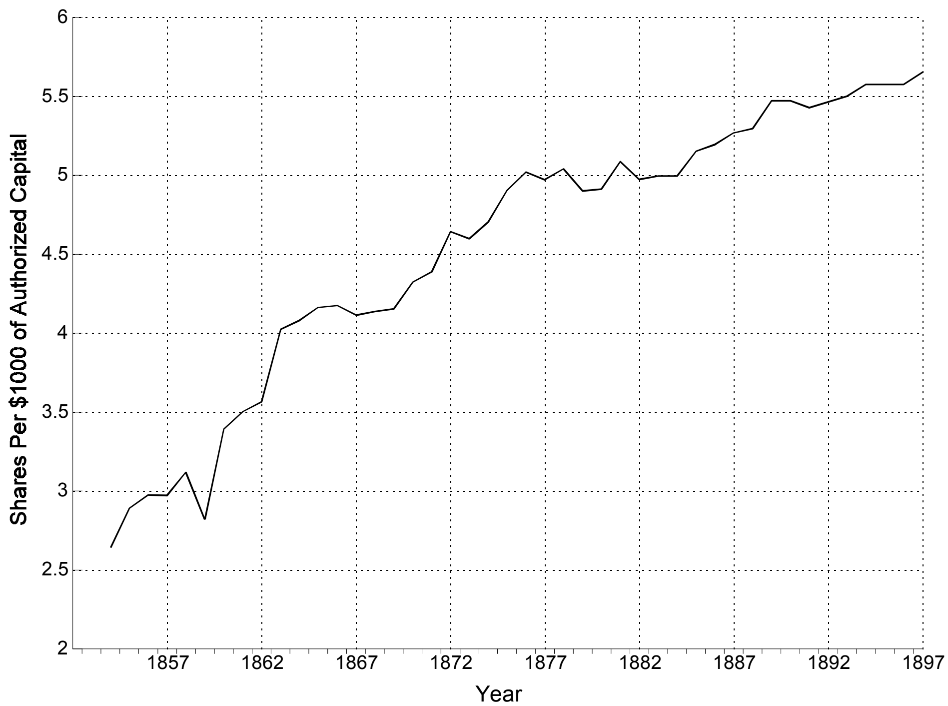

Figure 6. Shares Per $1000 of Authorized Industrial Capital

should value an otherwise identical security more highly than an illiquid one, increases in liquidity also encouraged firms to raise funds through the long-term equity market in which organized trading was possible. Figure 6 shows the number of shares per $1,000 of authorized capital on or around January 1 for all traded industrial firms, which should reflect the degree of market liquidity. This measure rises by 88 percent between 1854 and 1876, and gains an additional 25 percent of its 1854 value between 1877 and 1897. Since bank stocks generally had fixed par values of $100, information

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The situation was quite different for industrial securities in late 19th century where par values of $1,000 excluded all but the wealthiest individuals from buying them. Since the surviving auction records and those of the exchange show that trading in fractional shares did not occur and that typical transactions involved one, five, or ten shares, a decline in par value from $1,000 to $200 per share would clearly encourage participation while not imposing prohibitively high new transactions costs on those that had held and traded the higher-priced shares.

about their liquidity cannot be inferred in this way; at the same time, it is likely that liquidity in the market for industrials also reflected increases in the liquidity of bank stocks, since both types of equities traded predominantly at the same public auctions. I return to this point in Section 3.

The gradual yet steady rise in the number of shares per $1,000 of authorized capital is likely to reflect tradeoffs faced by the main owners of New England's manufacturing interests between losses in control over firm-related decisions, increased accounting costs, and the potential for higher market valuations that accompanied the reduction of par values and active use of the equity market. The severity of these individual tradeoffs varied across firms according to their structural and financial characteristics and thus influenced a firm's par value only when the benefits of wider ownership became sufficiently attractive to its directors. It was these types of frictions, which persist to the present day in the U.S. equity market but are less commonly manifested in extraordinarily high share prices, that restrained owners of 19th-century industrial firms from lowering the high par values of their shares through even more frequent stock splits.[20]

It is not possible to verify from the surviving company records whether participation constraints became less binding for all listed firms as the market for industrial equities emerged, but information about the growing diffusion of share ownership can be obtained for a subset of industrial firms from their dividend records. In particular, the number of checks claimed after a declaration should closely reflect the number of shareholders in a given firm.

Figure 7 plots these numbers for the first dividend in each calendar year for the Dwight, Lawrence, Lyman, Massachusetts Cotton and Pepperell Manufacturing Companies. The gaps in the

[20] The Berkshire-Hathaway company, whose closely-held nature is ensured by a share price of about $100,000 for its class-A shares, is one (perhaps extreme) example of the continued prevalence of generally high share prices in the U.S. equity market.

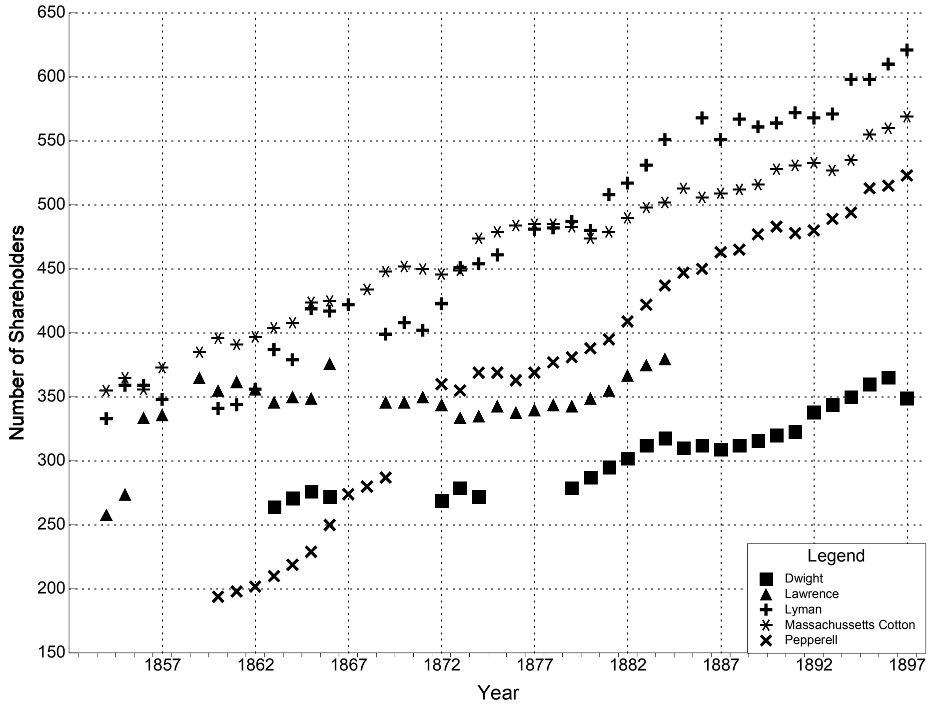

Figure 7. Number of Shareholders in Selected Industrial Firms

individual series reflect missed dividends.[21] Four of the five firms show a marked increase in the number of shareholders, with ownership nearly tripling for the Pepperell Manufacturing Company between 1860 and 1897, doubling for Lyman Mills between 1854 and 1897, and rising by 60 percent for Massachusetts Cotton Mills between 1854 and 1897 and 47 percent for the Dwight Manufacturing Company between 1863 and 1897.[22] Pepperell, Lyman, and Dwight had par values of

[21] The handwritten records from which I derived these figures are on deposit in the Historical Collections Department of the Baker Library (Mss: 442).

[22] Estate distributions by large shareholders to multiple heirs account for part of the upward movement in Figure 7. For example, after counting the number of checks distributed by each firm to shareholders with unique last names, this "adjusted"ownership still rose by 27.5 percent for Dwight from 1864 to 1894, 22.1 percent for Lawrence between 1859 and 1884, 47.2 percent for Lyman between 1854 and 1894, 66.7 percent for Massachusetts Cotton between 1854 and 1894, and 150.7 percent for Pepperell between 1864 and 1894. It is thus unlikely that estate distributions accounted for more than half of the observed increases in the number of owners.

less than $500. Dwight lowered its par value in 1871, just before resuming payments after several missed dividends, and the number of shareholders increased rapidly. The only firm whose ownership did not increase considerably after 1865 was the Lawrence Manufacturing Company. Significantly, it was one of only 14 listed industrial firms to maintain its initial par value of $1,000 throughout the sample period.

Several facets of liquidity that are reflected in the falling par values of industrials traded in Boston over a century ago are still relevant in today's emerging markets. In particular, widespread participation in equity markets remains central to their depth and stability, since the marketing of an individual's entire holdings in a firm with concentrated ownership may have startling price effects that lower market value significantly. To encourage participation and enjoy the price benefits of higher liquidity, owners today often choose to raise fresh capital publicly, implicitly accepting the possibility of initial underpricing and some dilution of control. In 19th-century Boston, the listing of a firm for public trading at what might be considered a reasonable par value also served to broaden ownership and reduce the price impact of large sales by individual investors, yet involved similar costs. Lower par values also made new securities easier for the Boston market to absorb, and the very existence of a viable exit mechanism for successful entrepreneurs appears to have encouraged entry. This may have had effects on the industrial sector that reached well beyond those firms that actually used the market. The availability of entrepreneurial exit remains a key channel through which equity markets can effect the start of innovative projects.

3. Liquidity and Stock Market Expansion

A. Model Selection and Methodology

It was noted in Section 2 that periods of rapid advance in the prices (Figure 1 and 2) and real capitalizations (Figure 5) of both traded banks and industrial firms coincided with those of falling industrial par values (Figure 6). These observations suggest that liquidity in the equity market may have been importantly related to its size in the second half of the 19th century. In this section, I describe a set of vector autoregressive (VAR) models and a testing strategy that can be used with the newly-constructed data series to evaluate more formally the direction, size and timing of these relationships.

The appropriateness of the number of shares per $1,000 of equity capital (LIQUID hereafter) as a measure of market liquidity is central to the analysis, since recent macroeconomic models relate liquidity directly to the size of the market. Bencivenga, Smith, and Starr (1995) and Greenwood and Smith (1997), for example, model this liquidity as reductions in transactions costs that shift resources towards illiquid but socially optimal projects with long gestation periods. The mechanism that I examine empirically, like those above, is consistent with Hicks' (1969) view that liquid markets can promote more socially favorable resource allocations, but considers a case where participation was constrained by wealth rather than simple transactions costs. In fact, the wealth constraint can be viewed as a severe transactions friction that poor individuals, if required to purchase equities on credit, would have been unable to overcome.

Since banks and industrials traded at the same public auctions and together accounted for the vast majority of securities traded by auction, the LIQUID measure may also reflect liquidity in the market for banks, which for the most part maintained par values of $100 throughout the sample period. The empirical analysis thus begins by examining dynamic links in a tri-variate system that includes LIQUID and the real market capitalizations of industrials (ICAP) and banks (BCAP).

Increases in liquidity may be related to permanent movements in the level of stock prices. A second tri-variate VAR that includes LIQUID and the market value-weighted indices of industrial prices (IPRICE) and total bank returns (BRET) is estimated to evaluate this effect. Bank equity returns are included as a control because industrial firms relied heavily on banks for short-term finance from at least the mid-1850s (Davis, 1960; McGouldrick, 1968, pp.16-17). Further, since the tendency for bank directors to make longer-term loans to industrial firms in which they maintained a personal stake (Lamoreaux, 1994) seems to have persisted in New England during the early part of the sample, there was quite likely a link between the borrowing ability of industrial firms and the condition of the banks upon which they relied. Finally, Atack and Rousseau (1999) link lower bank returns in the Boston market before 1870 to monetary stringencies which raised the cost of working capital and inhibited its use. This central role for banks in business activity suggests that banking conditions may be linked to the performance, both expected and actual, of industrial firms.

The VAR methodology permits an investigation of dynamic interactions in a stationary multivariate system that does not impose *a priori* structural restrictions. It involves estimating a separate regression equation for each variable on its own lags and those of the other variables in the system. For example, the first VAR described above has the form

$$x_{1,t} = a_{1,0} + \sum_{i=1}^{k} a_{1,i} x_{1,t-i} + \sum_{i=1}^{k} b_{1,i} x_{2,t-i} + \sum_{i=1}^{k} c_{1,i} x_{3,t-i} + u_{1,t}$$

$$x_{2,t} = a_{2,0} + \sum_{i=1}^{k} a_{2,i} x_{1,t-i} + \sum_{i=1}^{k} b_{2,i} x_{2,t-i} + \sum_{i=1}^{k} c_{2,i} x_{3,t-i} + u_{2,t}$$

$$x_{3,t} = a_{3,0} + \sum_{i=1}^{k} a_{3,i} x_{1,t-i} + \sum_{i=1}^{k} b_{3,i} x_{2,t-i} + \sum_{i=1}^{k} c_{3,i} x_{3,t-i} + u_{3,t} \qquad \text{(1a,b,c)}$$

where x_1 and x_2 are the respective real market capitalizations of the industrial (ICAP) and banking (BCAP) sectors, x_3 is LIQUID, and k is the number of lags.

Stationarity of a VAR is critical in interpreting tests for Granger non-causality, that is the hypothesis that past values of one variable do not improve one-step ahead forecasts of another. The null hypothesis implies the following joint restrictions on the coefficients in (1):

$$\hat{l}_{j,i} = \hat{l}_{j,i+1} = \dots = \hat{l}_{j,k} = 0 \qquad l = a,b,c\,; \quad j = 1,2,3\,. \qquad (2)$$

In general, the distributions of these tests are affected by nuisance parameters (Toda and Phillips 1993) and are thus nonstandard when a VAR contains variables with unit roots, and differencing is usually required to ensure stationarity. Sims, Stock, and Watson (1990) show, however, that Granger tests conform to standard distributions in tri-variate VARs with unit roots so long as a single cointegrating relationship exists among the system variables. This result is particularly important in the tri-variate VARs estimated here because the null hypothesis of a unit root cannot be rejected with standard tests for any of the variables and there appears to be single cointegrating relationship in each system.[23, 24] This implies that VAR specifications in levels are appropriate for drawing Granger-causal inferences.

The ability to construct valid tests for block exclusion from a levels specification of the VAR is advantageous because it permits the joint evaluation of both short- and long-term effects of movements in one variable upon the others which make up each system. Indeed, as persistent yet gradual increases in market size and liquidity might be expected to have real effects on the performance of the industrial sector that accumulate over time, the implicit inclusion of long-run effects in the cointegrated VARs makes them particularly well suited for this type of analysis.

Granger-causality tests must be interpreted with caution, however, since rejection of the null

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[23] Augmented Dickey-Fuller (ADF) and Phillips-Perron (1988) tests for unit roots were computed for all series. Both tests suggest non-stationarity in levels and stationarity in first differences for all but one case. The tests conflict only for bank stock returns, where ADF tests with two to five lags do not reject the unit root hypothesis while the Phillips-Perron test rejects the null. Since the price appreciation component of returns appears to be stationary and the dividend yield component appears to be non-stationary, the analysis proceeds by allowing bank stock returns to enter its tri-variate system in levels. Table A1 in the Appendix presents the full set of results and details of the test regressions.

[24] Inferences about the cointegration space are based the Johansen (1991) test, which identifies the number of cointegrating relationships in a VAR system with non-stationary variables and delivers maximum likelihood estimates of the cointegrating vector, that is a set of loadings that yields a stationary result. Table A2 of the Appendix presents the results of the Johansen tests.

hypothesis does not necessarily imply "economic causality." In particular, the validity of the tests is predicated on the inclusion of the full information set in the VARs. Since this condition is necessarily violated in any finite regression framework, the results presented in the following subsections can only be interpreted as strongly suggestive of the nature of linkages among the variables in each multivariate system.

When an investigator can specify a reasonable causal ordering for the variables in a VAR system (based on economic theory and perhaps the results of Granger tests), the nonlinear responses of each variable in the system to one-time shocks in the other variables can be traced through time with an impulse response function. This allows an evaluation of the economic significance (or size) of dynamic effects. For this reason, I augment the results of the Granger tests with an examination of the impulse responses for each system.

B. The Effects of Liquidity on Market Size

The empirical investigation begins with estimation of the system that includes logs of the liquidity measure (LIQUID), bank capitalization (BCAP) and industrial capitalization (ICAP). Nested likelihood ratio tests select a specification with two lags.[25] Table 1 reports the regression coefficients, with the significance level of the F-test for Granger causality for each block of coefficients in parentheses. LIQUID Granger-causes ICAP at the 7 percent level and BCAP at the 15 percent level. There is no evidence of feedback from the capitalization of either sector to LIQUID, which suggests that the effects of market liquidity are unidirectional.

[25] This method starts with a sufficiently large lag length and then tests successively that the coefficients on the final lag are zero, stopping when the restrictions are rejected.

Table 1
The Effects of Liquidity on Equity Market Depth, 1854-1897[a]

Dependent Variable	$ICAP_{-1}$	$ICAP_{-2}$	$BCAP_{-1}$	$BCAP_{-2}$	$LIQUID_{-1}$	$LIQUID_{-2}$	R^2
Market Capitalization of Industrials (ICAP)	0.922 (0.168)	0.054 (0.165)	-0.010 (0.126)	0.142 (0.120)	0.070 (0.082)	-0.178 (0.080)	0.995
F-test (p-value)	324.81 (.000)		2.625 (.087)		2.822 (.073)		
Market Capitalization of Banks (BCAP)	-0.346 (0.222)	0.308 (0.219)	1.095 (0.167)	-0.216 (0.159)	0.219 (0.109)	-0.113 (0.105)	0.986
F-test (p-value)	1.337 (.275)		61.60 (.000)		2.089 (.139)		
Shares Per $1000 of Book Capital (LIQUID)	-0.462 (0.352)	0.549 (0.347)	0.087 (0.265)	0.116 (0.252)	0.824 (0.172)	-0.147 (0.167)	0.974
F-test (p-value)	1.750 (.189)		1.231 (.304)		15.903 (.000)		

[a] All variables are in log levels. The columns report the regression coefficients with standard errors in parentheses. F statistics for the null hypothesis of Granger non-causality appear beneath each block of coefficients with significance levels in parentheses.

Since regression coefficients can be sometimes misleading about the general direction of dynamic linkages in VAR systems, it is often informative to examine the impulse responses. These responses, shown in Figure 8 for selected cases, orthogonalize the error terms by ordering LIQUID first, BCAP second, and ICAP last. The ordering is consistent with increasing endogeneity as implied by the Granger causality tests.

The impulse response functions suggest positive overall effects of LIQUID on both BCAP and ICAP, and the sizes of the effects are considerable. For example, the left panel of Figure 8 implies that an increase of 10 percent in LIQUID from its sample mean of 4.55, which corresponds to a $20 decrease in the par value of a typical share from its sample mean of $220, is related to a rise of about 4 percent in real bank capitalization after three years from its sample mean of $55.65 million (or about $2.23 million). The same shock implies a rise in real industrial capital (right panel

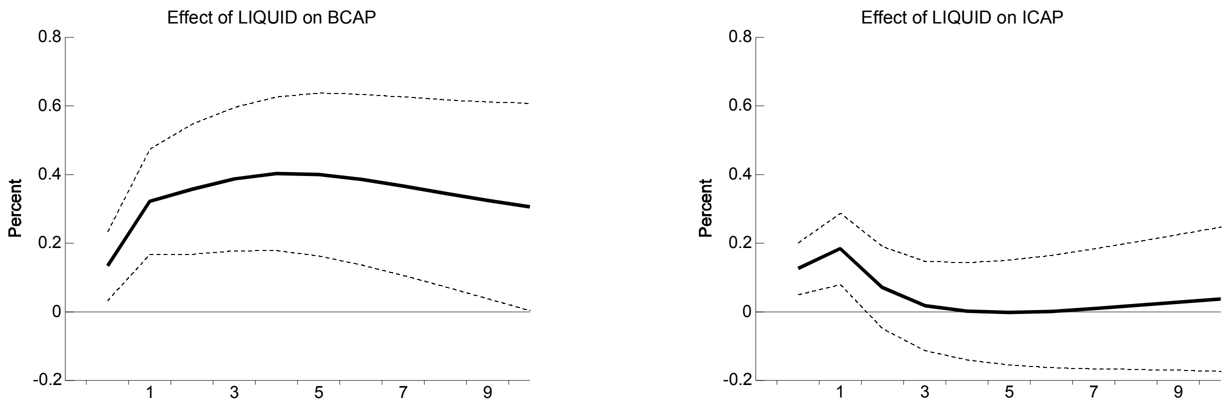

Figure 8. Selected impulse responses from system with LIQUID, BCAP, and ICAP

Note: The impulse responses correspond to the system reported in Table 1. Each plot traces the percent change in market capitalization over a ten-year horizon from a 1 percent change in the orthogonalized innovation to the liquidity measure. The variable ordering places LIQUID first, BCAP second, and ICAP third. Using Monte Carlo integration, the thick solid lines plot the mean impulse responses that result from 10,000 random draws from the posterior distribution of the estimated VAR coefficients. The dotted lines are one standard error bands.

of Figure 8) of 1.85 percent after one year from its sample mean of $55.46 million (or about $1.03 million).

The prominent response of bank capital to increases in the liquidity measure reflects the growth and increasing sophistication of auctions conducted outside of the exchange in which trades of both banking and industrial equities strongly dominated. The smaller yet positive response of industrial capitalization to increases in the liquidity measure reflects par values which, even after the reductions depicted in Figure 7, continued to pose some participation constraints to potential investors. At the same time, the decline in par values that occurred year after year throughout the sample period ensures that impulses and responses such as those summarized in the right panel of Figure 8 occurred frequently enough to have an important effect on the accumulation of real industrial capital.

C. Liquidity and the Centrality of Banking

The next system includes the log of the industrial price index (IPRICE), annual bank returns (BRET), and the log of LIQUID. In this case, nested likelihood ratio tests select a specification with three lags. Table 2 presents the results. LIQUID Granger-causes IPRICE at the 10 percent level, while BRET Granger-causes IPRICE at less than the 1 percent level. There is no evidence of feedback from industrial prices to bank returns or market liquidity.

The impulse responses (Figure 9), which order LIQUID first, BRET second and IPRICE third, suggest that the effects indicated in Table 2 are indeed large. For example, a 1 percent increase in LIQUID (or a $2 decreases in the average par value of industrial shares from their sample mean of $220) is associated with a 1.3 percent increase in the level of industrial prices after four years. This suggests that the deepening and increasingly liquid equity market had considerable long-term price effects. To the extent that industrial prices reflect actual and anticipated economic performance in the sector, liquidity also appears to have improved the efficiency with which resources were delivered to productive uses. Banking sector fundamentals, as reflected by the total returns of shareholders, also influenced the short-term behavior of industrial prices, with an impulse response that rises rapidly and then gradually decays. Quantitatively, a single percentage point increase in bank returns is associated with a rise of more than 1 percent in industrial prices. Since the average par value of industrial firms in the sample over the 1854-1897 period was about $220 and share prices generally fluctuated around their par values, such a shock can be associated with an increase of more than $2 in the price of a typical share. The findings are consistent with the view that industrial firms relied extensively on banks for short-term financing.

Table 2

Market Liquidity, Bank Returns and Industrial Price Performance, 1854-1897[a]

Dependent Variable	$IPRICE_{-1}$	$IPRICE_{-2}$	$IPRICE_{-3}$	$BRET_{-1}$	$BRET_{-2}$	$BRET_{-3}$	$LIQUID_{-1}$	$LIQUID_{-2}$	$LIQUID_{-3}$	R^2
Industrial Prices (IPRICE)	0.736 (0.202)	-0.300 (0.256)	-0.107 (0.172)	1.253 (0.261)	-0.182 (0.343)	0.107 (0.320)	0.014 (0.499)	0.274 (0.617)	0.519 (0.430)	0.795
F-test (p-value)		5.580 (.004)			7.823 (.001)			2.259 (.101)		
Bank Returns (BRET)	0.212 (0.142)	-0.039 (0.180)	-0.062 (0.121)	-0.072 (0.183)	-0.140 (0.242)	-0.225 (0.225)	-0.308 (0.351)	0.277 (0.434)	0.087 (0.303)	0.311
F-test (p-value)		1.114 (.358)			0.536 (.661)			0.354 (.786)		
Shares Per $1000 of Book Capital (LIQUID)	0.059 (0.077)	-0.110 (0.097)	0.033 (0.065)	0.184 (0.099)	-0.161 (0.131)	-0.033 (0.122)	0.847 (0.190)	-0.164 (0.235)	0.244 (0.164)	0.976
F-test (p-value)		0.477 (.701)			1.687 (.191)			19.838 (.000)		

[a] The system includes a constant and time trend. IPRICE and LIQUID are in log levels. The columns report the regression coefficients with standard errors in parentheses. F statistics for the null hypothesis of Granger non-causality appear beneath each block of coefficients with significance levels in parentheses.

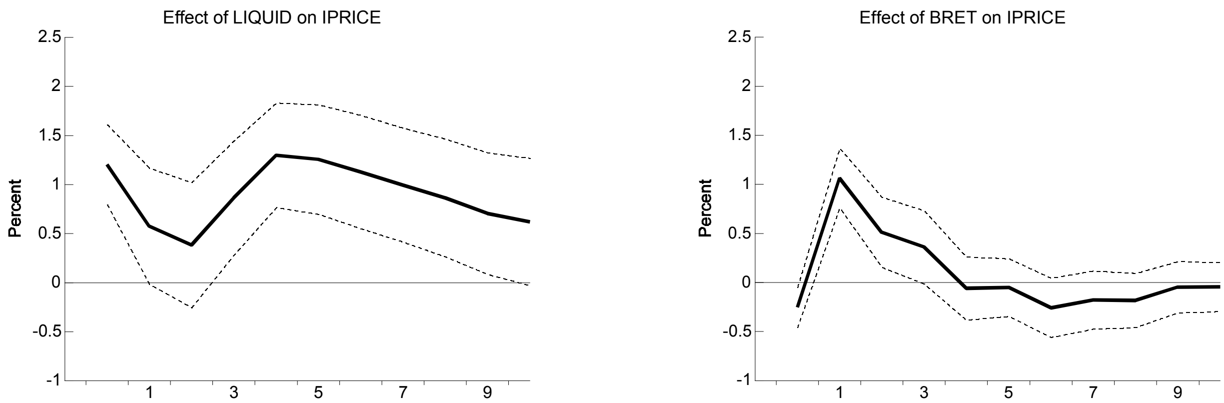

Figure 9. Selected impulse responses from system with LIQUID, BRET, and IPRICE

Note: The impulse responses correspond to the system in Table 2, with LIQUID placed first in the variable ordering, BRET second, and IPRICE third. See note to Figure 8 for further details.

4. Conclusion

Using recently-uncovered primary sources that underlie Joseph Martin's volumes on the history of the Boston stock market, this paper constructed synchronized annual series for prices, total returns and real market capitalizations of traded banks and industrials between 1854 and 1897. A set of VAR models and the associated impulse responses indicated that increases in liquidity, as measured by falling average par values of industrials, had positive and statistically significant effects on both prices and the size of the nation's first market in industrial equities.

The evidence suggests that emerging financial markets can have strong and relatively rapid effects on the accumulation and allocation of long-term capital and can thereby influence general economic conditions. Central to their effectiveness is confidence among investors that the market can absorb orders to buy and liquidate shares at prices which reflect the intrinsic values of the underlying claims, and that the availability of the trading mechanism will not be disrupted. New England investors had this assurance, and even innovated by expanding the use of public auctions to improve the efficiency with which prices were determined in a relatively thin market. Interestingly, by facilitating its exit in a market in which free flows of capital are ensured by statute, modern equity markets may also encourage the retention of capital from both foreign and domestic sources. Overall, the results suggest that occasional setbacks which seem to arise as consequences of rapid market development in modern economies are perhaps best viewed in light of the more optimistic long-run role for equity markets that is made clear by the record of a nation which developed strong financial foundations early in its history.

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Table A1
Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Statistics
for Indicators of Market Performance, 1854-1897

	Levels		1st Differences	
	ADF	PP	ADF	PP
Market Capital in Industrials, Adjusted for Stock Prices (ICAP)	-1.53	-2.33	-3.85**	-5.22**
Market Capital for Banks, Adjusted for Stock Prices (BCAP)	-0.78	-0.59	-3.17**	-4.49**
Price Index for Industrials (IPRICE)	-2.71	-2.44	-3.64**	-7.57**
Total Returns for Banks (BRET)	-2.12	-5.67**	-4.79**	-12.57**
Shares per $ of Traded Industrial Capital (LIQUID)	-1.97	-2.64	-3.88**	-7.02**

All variables are in logs. The test specifications include constant and trend for the levels variables (with the exception of BRET which includes a constant only) and constant only for first differences. The ADF regressions use three lags. * and ** denote rejections of the unit root hypothesis at the 10% and 5% levels respectively.

Table A2
Johansen Test Statistics for Cointegration, 1854-1897

	Trace		Max. Eigenvalue			Coint. Vector
System	r=0	r<=1	r=0	r<=1	r<=2	$\alpha_1 = 1$
ICAP, BCAP, and LIQUID (K=2)	27.46*	9.23	17.22	6.31	2.92	1, 9.409, -10.868
IPRICE, BRET, and LIQUID with trend (K=3)	43.55**	22.25	21.30	15.38	6.87	1,-0.866,-0.092

Each system includes the variables listed in the left column. K is the lag at which the levels terms enter the test regressions. The columns labeled r=0 test a null hypothesis of no cointegration, while the r<=1 (r<=2) columns test a null of at most one (two) cointegrating vectors. * and ** denote rejections of the null at the 10% and 5% levels respectively, with appropriate critical values from Osterwald-Lenum (1992), Tables 1 and 2*.