Federal Reserve Bank of Chicago

The Cost of Banking Panics in an Age before "Too Big to Fail"

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Abstract:

How costly were the banking panics of the National Banking Era (1861-1913) ? I combine two hand-collected data sets - the weekly statements of the New York Clearing House banks and the monthly holding period return of every stock listed on the NYSE - to estimate the cost of banking panics in an era before "too big to fail". The bank statements allow me to construct a hypothetical insurance contract which would have allowed investors to insure against sudden deposit withdrawals and the cross-section of stock returns allow us to draw inferences about the marginal utility during panic states. Panics were costly. The cross-section of gilded-age stock returns imply investors would have willing paid a 14% annual premium above actuarial fair value to insure $100 against unexpected deposit withdrawals The implied consumption of stock investors suggests that the consumption loss associated with National Banking Era bank runs was far more costly than the consumption loss from stock market crashes.

The existence of *too big to fail* banks poses a difficult problem for prudential bank regulation. The only credible way to prevent financial firms from becoming too big to fail is to convince bank creditors that large banks will actually be allowed to fail. Bank panics are costly, however, so regulators have a difficult time convincing market participants that large banks will fail when participants know that "in the midst of the crisis, providing support to a too-big-to-fail firm usually represents the best of bad alternatives"[1].

The regulatory response to the recent crisis attempts to end *too big to fail* by minimizing the consequences of a bank failure. The hope is that by increasing capital buffers and limiting the size, complexity, and interconnectedness of financial firms, regulators will be free to let banks fail without grave consequences for the rest of the financial system and economy. If bailouts are seen as unlikely, the argument goes, self-interested creditors will limit the leverage and risk taking of financial firms by demanding compensation for behaviors that increase the likelihood of bankruptcy and equity holders with plenty of their own *"skin in the game"* will devote more resources to monitoring risky behavior.

Simple declarations that banks will hereafter be allowed to fail are not credible unless the costs of bank failures are relatively small. With this in mind, much of the regulatory overhaul since the 2008 crisis has sought to limit the cost of a bank failure. If history is any guide, this goal will be difficult to achieve. For more than 50-years the United States had a regulatory framework that resulted in a banking system remarkably similar to the "ideal" system proposed in Dodd-Frank and the new Basel Capital Accords. Banks were small, well capitalized and insulated from counterparty risk, yet bank panics were extremely costly.

During the national banking era (1861-1913) no bank was too big to fail and the lenders of last resort seldom intervened to save illiquid banks. Aware that they would suffer losses if a bank's balance sheet became too leveraged or risky, creditors and counterparties monitored risk taking. As a result, banks were less levered, less

[1] September 2, 2010 testimony of Federal Reserve Chairman Bernanke before the Financial Crisis Inquiry Commission

interconnected and, when banks failed, losses were largely borne by equity holders. Contagious failures due to counterparty default were exceedingly rare during the national banking era[2]. Nonetheless, bank panics were extremely costly.

How costly were the banking panics of the national banking era? A natural way to think about this question is to ask how much consumers would have paid to insure against the consumption loss experienced during banking panics. Panic insurance did not exist and consumption data is unavailable but it is possible to use balance sheet and stock return data to draw inferences about the cost of bank panics. I create a measure of bank funding from hand-collected weekly balance sheet statements of the New York Clearing House (NYCH) banks. I use these balance sheets to construct a time series of historical bank funding during the national banking era. I combine this measure of bank funding with another hand collected data set - the cross section of all monthly NYSE stock returns - to draw inferences about investor marginal utility during panics of the national banking era. The results suggest investors cared a great deal about banking panics. Unexpected changes in bank deposits were far more important to the consumption of stock investors than changes in the stock market itself. The cross-section of stock returns imply that national banking era investors would have paid approximately XXX per year to insure against unexpected withdrawals from NYCH banks.

Why were panics so costly? Many real investments have high expected returns but are either irreversible or can only be liquidated at a loss. Savers are aware that they may face unpredictable future liquidity shocks. These two facts combine to create a role for financial intermediaries to pool savings and offer intertemporal risk sharing through a demand deposit or overnight lending contract. In such a setting, a well-functioning intermediary can have a real effect on the level of investment and consumption in the economy[3].

For example, in the classic model of Diamond and Dybvig (1983) agents know that they may be subject to an unpredictable future liquidity shock. They are endowed

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[2] The Comptroller of the Currency was tasked with liquidating failed national banks. The Comptroller appointed investigators to ascertain the reason for bank failures. Of the 586 national banks liquidated between 1865 and 1917 the Comptroller concluded only 12 (or 2.1%) failed due to a counterparty default. See 1917 *Report of the Comptroller of the Currency* p.63

[3] Allen and Gale (1997). See Allen and Carletti (2008) for a recent survey.

with investment opportunities that, once completed, will yield high real returns but are costly to liquidate early. In the absence of financial intermediation, risk-averse consumers may choose to forgo investment in high return but irreversible technologies if the risk of experiencing a liquidity shock before completion is too high. In such a setting, financial intermediaries can increase aggregate investment and consumption by offering depositors liquidity on demand and investing a portion of their deposits in the high return irreversible technology[4]. Demand deposits improve total welfare but the promise of liquidity on demand creates a mismatch between the maturity of the intermediary's assets and liabilities. This temporal mismatch exposes the intermediary to the risk of a bank run and the economy to the risk of lost output if otherwise high return investments have to be forgone out of fear of a run or liquidated early to satisfy withdrawal requests.

A bank run is characterized by a sudden withdrawal of deposits from the banking system. Runs may be caused by irrational mob psychology[5], a switch between completely random sunspot equilibria[6] or a rational response to a common signal about future liquidity demands or investment returns[7]. Regardless of the cause, bank runs lower welfare by forcing banks to forgo high return investments or liquidate previous investments at a loss. Traditional remedies like temporary suspension of convertibility, interbank money markets or lenders of last resort (clearing house certificates) were all employed during the national banking era. These remedies can lower the risk of an individual bank failure but create linkages that can result in systematic risks of contagious liquidity withdrawals[8].

Despite the popular folk history, before the great depression, bank runs seldom resulted in direct losses for creditors or counterparties[9]. Instead, the cost of panics was

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[4] Diamond and Rajan (2001), Allen and Gale (2004)
[5] Kindleberger (1978)
[6] Bryant (1980), Diamond and Dybvig (1983)
[7] Mitchell (1941), Chari and Jagannathan (1988), Gorton (1988), Allen and Gale (1998, 2004)
[8] Friedman and Schwatz (1963), Allen and Gale (2000), Diamond and Rajan (2005,2006), Brusco and Castiglionesi (2007).
[9] Although bank failures were common, losses to depositors were rare. Loss estimates come from the 1919 *Annual Report of the Comptroller of the Currency*. The comptroller's report noted that 586 national banks were liquidated between 1865 and 1917. The report concluded depositors and creditors lost an annual 3/10th of 1% of their assets due to the bank failures between 1865-1913.

likely due to market freezes and curtailed lending. In the era before *too big to fail*, creditors were aware that they would not be bailed out and disciplined banks by withdrawing funding whenever they feared a sudden change in actual or perceived solvency[10]. During panics the liquidity of interbank lending vanished and banks responded much like today – by curtailing lending, calling outstanding loans and hoarding excess reserves. The fear of creditor runs disciplined bank risk taking and leverage but to the extent that this fear forced banks to hoard liquidity and forgo investments with high social returns, the panics of the national banking era were costly even in the absence the failure of systemically important banks.

In the sections that follow I 1) describe the regulatory system and runs of the national banking era, 2) describe unique balance sheet data and 1866-1913 stock market data, 3) describe the estimation of a stochastic discount factor to draw inferences about the cost of banking panics, and 4) conclude.

1. The National Banking Act and "Poverty Corner"

The National Banking Acts (NBA) of 1863 & 1864 reorganized the United States banking system. The NBA unified the national currency, established a national regulator and through regulation of reserve requirements encouraged a national inter-bank money market centered in New York City. The NBA established limits on leverage through reserve requirements, capital requirements including double liability for shareholders, limits on note circulation and the requirement that national bank notes be backed by US government bonds deposited with the comptroller of the currency at a 10% haircut. Finally, the NBA created explicit lenders of last resort by allowing clearing house certificates issued by reserve and central reserve city clearing houses to be counted as lawful money toward reserve requirements[11].

[10] Friedman Schwartz (1963), Gorton (1988), Calomiris and Gorton (1991) and Wicker (2000) each provide excellent reviews of the facts and theory of late 19th and early 20th century banking panics.
[11] NBA or 1864 sec 31. Gorton (1985) argues these are the origin of central banks in the United States.

The National Banking Act encouraged an interbank lending market by divided the nation's national banks into three groups and providing regulatory incentives to pool excess reserves in central cities. The NBA divided banks into Central Reserve City banks (those chartered in New York City, Chicago & St. Louis), Reserve City banks (those chartered in regional trade hubs) and country banks (those chartered outside of Reserve and Central Reserve cities). Country banks were required to hold 15% of their deposits plus notes outstanding as liquid reserves (specie or treasury notes). This 15% reserve requirement placed a limit on bank leverage but to encourage an interbank market country banks were allowed to keep 3/5ths of this 15% on deposit in reserve or central reserve cities. Reserve City banks were required to hold 25% reserves but they could keep half of their reserves on deposit with Central Reserve City banks. These regulations encouraged banks to pool excess reserves that could not be employed profitably at home and deposit them at interest in Reserve and Central Reserve City banks. In practice, excess reserves migrated to New York City to be employed in the overnight repo market.

Banks have always desired liquid low-risk investments for their excess reserves. Before the Federal Reserve System and the development of the modern federal funds market, national banking era banks looked to the New York securities market for low-risk, overnight lending of excess reserves. Country banks embraced the opportunity to deposit reserves in New York city banks and gain access to the New York money market. By holding a portion of their reserves in New York, country banks were able to manage their reserve ratios by accessing the New York call money market.

> *Under the National Banking Act the [New York Call] Money Market was the recipient of all those surplus funds of the country banks which they desired to invest in some liquid form which they could count upon as a secondary reserve. As a result, in times when the country banks had very little use for their funds at home, these funds were sent to New York, where they were either invested in call loans or put on deposit at the New York banks, who in their turn sought investment for them. – Griffiss (1923) The New York Call Money Market p. 65-66*

Banks looked to the New York call market because repo loans made against security collateral offered an attractive combination of high return, liquidity and low default risk. Brokers and banks could lend or borrow against security collateral at "poverty corner" and the New York Stock Exchange money post. Depending on the quality of the collateral, a borrower could typically borrow between 80-90% of the market value of a pledged security[12]. The rate of interest charged varied with the volatility and liquidity of the pledged security but the minimum call rate was always equal to the rate of interest charged on loans with long-term government bonds as collateral. As the name implies, call loans gave the lender the right to call in the loan at any time. The borrower of a call loan signed the pledged security into the name of the lender. If the lender called the loan and the borrower was not forthcoming with the money, the lender could sell the collateral to satisfy the obligation. If the collateral fell in value the lender could issue a margin call and demand the borrower raise his collateral back to the original level. Thus lenders suffered a partial default only when the borrower defaulted and the collateral declined by more than 10-20% before the lender could liquidate. Given these margins and the liquidity and the low volatility of the government bond market, call loans on government bond collateral were, for all practical purposes, default-risk free[13]. Despite the right to call for payment at any time a call loan did commit the lender's money for a brief period. Even in the event of a collateral sale the lender would not receive his cash until the sale cleared one day after the trade date. The call loan rate therefore reflected the marginal opportunity cost of a bank holding excess reserves in their vault as a defense against unexpected withdraws rather than loaning it risk-free for a minimum of one day.

Although the NBA allowed for the pooling of reserves in Chicago and St. Louis, the liquidity offered by the active market in hypothecated NYSE securities attracted excess reserves from across the nation and made poverty corner in New York the de facto interbank funding market. The practice of lending excess reserves against collateral in New York created a single nationwide money market. Banks anywhere in the nation could safely employ their excess reserves with a simple cable to a New York clearing

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[12] Stock investors could borrow 90% of the value of a security from their brokers at the prevailing margin rates. The brokers extended this loan but generally did not carry the whole loan on their books. Instead, brokers typically financed 10% of the value of the stock from their own capital and financed the remaining 80% by rehypothecating the pledged security at poverty corner.

[13] Daily bond prices are unavailable but prices are available on the same 28-day frequency as our stock sample. The riskiest government bond had a 28-day standard deviation of 1.3% and a maximum 28-day decline of 4.56% during the panic of 1896.

house bank. The call rate prevailing at poverty corner provided a single price that equalized the opportunity cost of excess reserves across the nation.

> *"And bankers know that they can always depend to a greater or less extent on the supply of floating capital in ' the street.' In ordinary times, this supply is enormous, and ample for all demands. It is made up of the deposits of individuals and corporations from every section of the civilized world. On " Poverty Corner," as the brokers styled a favorite gathering-place of borrowers and lenders before the panic, one might see clerks of New York banking houses which represented similar institutions in various parts of the country, mingling with the agents of wealthy firms In London, Amsterdam, and Berlin. But it is dangerous to place too much dependence on this supply. It vanishes when most needed, and is ever keenly alive to the slightest suspicion of danger." - "Wall Street and the Crisis" Old and New Magazine January 1874 p.43*

This system required the New York Clearing House (NYCH) banks to expand or contract their balance sheets with the nationwide demand for currency. The tendency of loaned reserves to "vanish when most needed" exposed the NYCH banks to liquidity shocks anywhere in the nation and was often cited as the leading cause of pre-FDIC banking panics.

> *"The immediate cause of the money drain which started the[1873] panic was, as before, the sudden demand by out-of-town banks for their cash reserves on deposit. It was found that the $60,000,000 of call loans on which the New York banks had relied was 'entirely unavailable' "*- Lainer (1922) *A Century of Banking in New York p.238*

During panics depositors fled from NYCH banks and the "price" of excess reserves in New York city reached astronomical levels.

> *"On the corner of Broad and Exchange, almost any time between the hours of 10 and 3, can be seen a crowd of men who are especially active. The Gold Board is one thing, the Stock Exchange is another; but Poverty Corner differs from both … Here men gather out in the rain and cold, who have money to lend or money to hire. Here the price of money from day to day is fixed. In a panic the first thing is to get money, and men who have margins to keep up, or Stocks to carry, make a rush for Poverty Corner. The language of this locality is peculiar. From 200 to 500 men are assembled, all shouting at the top of their lungs, making an offer for money, or making offers of a loan. On Thursday the crash in this locality was fearful. One man shouts out, " I want 10;" another, "I want 20;" another, "I want 40;" which means, "I want 40 thousand." A hard-looking, banged up Jewish youth, who would hardly make a respectable ragman, shouts out, " I have got 50 —," and everybody goes for him. He jerks down his hat over his eyes, buttons up his coat, and prepares for the tussle. " 1 1-2," he shouts, which means that he has $50,000 to loan at the rate of 450 per cent a year ! This is snapped at, for speculators must have money. Then comes the question of security. At the high rate named, millions were denied, because the security was not U.S. Bonds, N. Y. Central, or some other gilt-edged Stock."*

- Smith (1875) Bulls and Bears of New York. p. 558

The above quotation requires some translation. In normal times repo loans at poverty corner were quoted in annual percentage rates by type of collateral. Thus if you were to read the money section of the New York Times in a period of relative calm the column would report the annual rates to borrow against US government bond collateral and mixed collateral. Mixed collateral was a portfolio of non-US government bonds where the haircut on each security was adjusted in relation to its risk until the basket was considered homogenous. Therefore, if a broker came with a basket of stocks of varying quality the "gilt-edged" stocks (Vanderbilt lines etc) would be haircut 20% and lent against at the mixed collateral rate. Stocks of lower quality would be assigned a larger haircut for the same interest rate or charged a higher interest rate for the same haircut. During the panic described in the quote above, the haircut on all but the best collateral went to 100%. That is, no loan could be obtained except with "*U.S. Bonds, N. Y. Central, or some other gilt-edged Stock"* as collateral and even in the case of acceptable collateral the interest rate was 1.5% per day[14]!

New York balance sheets were extremely sensitive to strain anywhere in the country. Contemporaries viewed this as a weakness and one of the impetuses for the founding of the Federal Reserve. In fact, 1911 *The National Monetary Commission* report to Congress, which recommended the establishment of the Federal Reserve, devoted an entire volume to the topic. The volume's very first sentence summarized the contemporary view of the New York centered, finance-led business cycle.

"Attention has been repeatedly called to the vicious circle in which the American money market moves; how the volume of banking credit is rigidly inelastic, being determined as to circulation by bond security and as to loans and discounts by a fixed ratio to legal reserve; how the surplus funds which pile up with seasonal fluctuation in the interior flow inevitably to New York City, there to stimulate speculation at times when general economic conditions suggest quiescence, and how, conversely, when returning activity draws back funds to the interior, the recovery is impeded by the strain and cost of speculative liquidation" – Bank Loans & Stock Exchange Speculation (1911) p. 3. National Monetary Commission

[14] Smith arrives at an annual rate of 450% by taking the stock market convention of 300 trading days a year and ignoring compounding.

The sensitivity of the New York money market to nationwide deposit shocks makes the NYCH balance sheets an ideal source for this study. Stress anywhere in the national banking system was quickly reflected in the NYCH statements and the panics of the national banking era were largely New York City affairs. In fact, "*With the single exception of the 1893 panic, pre-1914 banking panics were restricted mainly to the New York money market with relatively few bank suspensions in the rest of the country*"[15]. Although panics inevitably occurred in New York their effects were felt nationwide.

> *"when they suspended, and by so doing locked up their many millions of deposits, on which thousands of people in various parts of the country were depending to make their settlements, it was easy to see that the disturbance was not one of passing moment." – "Wall Street and the Crisis" Old and New Magazine January 1874 p.42*

Therefore, a measure of excess reserves in New York City is likely to reflect the excess reserves in the entire national banking system and serve as an excellent proxy for nationwide bank funding stress.

2. 1866-1913 Bank Balance Sheet and Stock Return Data

I wish to construct a relatively high frequency historical measure of the health of the banking system that can be used to draw inference about the cost of national banking era panics. This measure should capture both the overall health of the banking system and be observable at the same frequency as stock returns. An excellent candidate is the deposit information contained in the weekly balance sheets of New York City banks. Contemporaries understood that asymmetric information about the health of individual banks could transform a run on a single bank into a system-wide panic. The NYCH attempted to minimize information asymmetries by requiring its member banks to publish weekly balance sheet statements. These statements appeared in the Saturday morning *New York Times, Wall Street Journal and Commercial and Financial Chronicle*. The condensed balance sheets reported the average weekly and Friday closing values of each bank's loans, deposits, excess reserves, specie, legal tenders, circulation and clearings.

[15] Wicker (2001)

Bank statements were carefully scrutinized by investors and unexpected changes in leverage could set off a stock market rally or decline[16].

I use the NYCH balance sheet reports to construct a measure of bank funding stress. The most natural measure of funding stress is the flow of deposits into and out of NYCH banks. Define Δdep_{t+1} as the percentage change in deposits from time $t-1$ to time t.

$$\Delta dep_{t} = \{(\text{NYCH aggregate deposits})_t / (\text{NYCH aggregate deposits})_{t-1}\} - 1 \qquad (1)$$

I construct a time series of Δdep_{t} sampled every fourth Friday between Jan 1866 and December 1913. The series is corrected for entry and exit by computing the growth rate between time t and $t+1$ using all banks in existence at both dates. The index therefore reflects the change in deposits of surviving banks and does not mechanically fall when a bank fails and exits the clearing house or mechanically increase when a new bank is chartered.

The 28-day sampling frequency was selected to correspond with dates for which I have previously collected the price, shares outstanding and dividends of every NYSE stock. The stock data was hand collected from the NYSE closing quotations published in the *Commercial and Financial Chronicle*. In total, I observe 70,014 individual 28-day holding period returns on 466 unique NYSE equities. The price, share and dividend data allows me to compute the market value and 28-day holding period return for each stock trading on the NYSE between 1866 and 1913. *The Chronicle's Investor's Supplement* also contains information that allows me to correct the returns for stock splits, mergers and bankruptcy.

3. Using Stock Returns to Draw Inference about the Cost of Banking Panics

[16] The New York Stock Exchange was open on Saturdays throughout our period of study.

We can use the deposit growth series and the restrictions of a factor pricing model to draw inferences about the marginal utility of national banking era investors during banking panics. Consider hypothetical insurance contracts that would have allowed national banking era investors to hedge against deposit consumption loss due to withdrawals from NYCH banks. If banking panics were associated with consumption loss and such a derivative existed, risk-averse investors would have paid a premium above the actuarially fair price to purchase this insurance. The size of the premium above actuarial fair price is a natural measure of the cost of banking panics. Of course panic insurance did not exist but we can use the observable returns on other assets to draw inferences about the marginal utility of stock investors during panic and non-panic states and use these marginal utility estimates to make inferences about the price a national banking era investor would have willingly paid had panic insurance been available.

Insurance Contracts:

Consider a simple asset that pays a discrete amount $\$X_p$ if a banking panic occurs next period and $\$X_{np}$ if no panic occurs. The asset is an insurance contract so $\$X_p > \$X_{np}$. If this security trades in a market where investors face the same price to buy or sell the price of the security must satisfy $P = E[mX]$ or

$$P = \pi_p m_p X_p + (1 - \pi_p) m_{np} X_{np} \qquad (2)$$

Where π_p is the expected probability of a banking panic and m is the investors' stochastic discount factor – the marginal utility of wealth in each state. (2) is derived from the first order condition of investors who can purchase or sell the security until the expected marginal gain from buying $E[mX]$ equals the marginal cost P .

Next consider a nominally risk-free asset that pays \$1 in both the panic and no panic states. This asset will trade at $P = E[m]$. The gross risk-free rate is therefore equal to $R_f = \frac{1}{E[m]}$. If we use this definition of the risk-free rate and divide both sides of (2) by P we can express the expected excess return of the insurance contract as a function of the covariance between the insurance return and the stochastic discount factor.

$$\begin{aligned} 1 &= E[mR] = E[m]E[R] + \text{cov}(m,R) \\ E[R] - R_f &= -R_f \text{ cov}(m,R) \end{aligned} \tag{3}$$

Insurance contracts pay high returns when times are bad and the marginal utility of money is high. For an insurance contract, $\text{cov}(m,R)$ is therefore positive and the expected excess return of an insurance contract is negative. Equation (3) provides a testable prediction about the cost of banking panics. If *R* is the return of any asset positively correlated with banking panics, and banking panics were costly in terms of marginal utility, then the expected excess return of *R* should be negative.

Securities based on changes in deposits series Δdep_t appear to be excellent candidates for insurance contracts. An insurance contract should pay a high rate of return in the states of nature we wish to insure against and a low return otherwise. Consider the following hypothetical security: A series of 28-day, cash-settled future contracts that trade each observation date and have a time $t+1$ payout of Δdep_{t+1}. If such a security existed a national banking era investor would have been able to bet on or insure against changes in NYCH balance sheets by buying or shorting these contracts. If this contract traded at an actuarially fair price but banking panics were associated with consumption loss, all investors would wish to short it. But in the aggregate we can't all hedge. For every investor that shorts the derivative contract another investor must be willing to hold it. If panics were costly, the derivative contract must trade below actuarially fair value to clear the market. How far below depends on how costly banking panics were in terms of marginal utility.

Were banking panics correlated with consumption and the marginal utility of national banking era investors? In other words, were banking panics costly in a utility sense → $cov(m_t, \Delta dep_t) < 0$, beneficial → $cov(m_t, \Delta dep_t) > 0$ or neither → $cov(m_t, \Delta dep_t) = 0$? Had these contracts actually existed for a long enough time series we could simply compare the sample average price and payout to infer the sensitivity of national banking era marginal utility to banking panics. Alas, no deposit insurance contracts existed so we must infer the covariance of historical marginal utility with bank deposits in another way.

Estimating a Stochastic Discount Factor implied by a Factor Model

We wish to measure the covariance between national banking era marginal utility, *m,* and the payout to holding an derivative contract settled against deposit growth rates Δdep_t, and test the null hypothesis that $cov(m_t,\Delta dep_t) = 0$. If we could observe a time series of *m* and Δdep_t a natural way to test if $cov(m_t,\Delta dep_t) = 0$ would be to estimate a regression of *m* on Δdep_t and test the null that $\beta=0$

$$m_t = \alpha + \beta\Delta dep_t + \varepsilon_t \qquad (4)$$

The marginal utility of national banking era investors, m_t, is unobservable, however. In most cases an unobservable LHS variable is a considerable burden when estimating a regression! In our case of many observable asset returns, however, we can estimate α and β from the moment restrictions $P = E[mX]$ and the law of one price.

The law of one price requires the same m_t price all assets. Therefore the unobservable m_t that prices our hypothetical insurance contract must also price the observable gilded-age NYSE stock returns. We can estimate the regression of unobservable marginal utility on our hypothetical futures contracts via GMM by choosing α and β to best satisfy $P = E[mX]$ for observable national banking era stock returns.

Our strategy takes advantage of the fact that observable stock returns contain information about investors' aggregate consumption. If aggregate production unexpectedly and temporarily declines, risk-averse investors will want to smooth intertemporal consumption by selling claims to future consumption. While any individual can smooth consumption by borrowing against the future, in the aggregate we cannot all borrow. If aggregate production is lower someone, somewhere, must consume less. Asset prices must therefore fall (and expected returns rise) until investors are willing to consume less today. We can use this insight to draw inference about aggregate consumption from observable stock returns.

Recall that the expected excess return of any asset can be linked to covariance with marginal utility via equation (3). An asset that does relatively well during good times pays a lot in states where the marginal utility of extra wealth is low and a little in states where the marginal utility of extra wealth is high. Holding this asset adds to consumption volatility. All things equal, this is not an appealing asset for a risk-averse investor. Of course all things are not equal. Markets must clear and even risky assets must be held. Therefore the price of a risky asset must fall relative to its expected payout until its expected return is high enough to compensate investors for the extra consumption risk.

This link between observable asset returns and $cov(m_t,\Delta dep_t)$ is the key to measuring the effect of banking panics on marginal utility. Given a cross-section of assets with different expected returns a true unobservable stochastic discount factor should explain any cross-sectional differences in these asset returns. Equation (4) constrains the stochastic discount factor to be a linear function of NYCH deposit growth. If a regression of a true unobservable discount factor on deposit growth had high explanatory power then the specification in (4) should do a good job of explaining cross-sectional differences in observable asset prices. On the other hand, if the true discount factor isn't correlated with NYCH deposit growth the candidate discount factor in (4) will have a hard time explaining cross-sectional differences in gilded-age stock returns.

A test of the null hypothesis that banking panics were costly amounts to a test that the candidate discount factor in (4) can explain cross-sectional differences in the return of gilded-age stocks. Many authors have used macroeconomic factors and linear specifications like (4) to test the null hypothesis that a given macroeconomic measure of "good times" explains stock returns. Rather than ask if a given measure of "good times" can explain asset returns I let asset returns tell me when times were good and test whether changes in our measure of banking panics were correlated with the unobservable utility of national banking era investors.

Estimation:

Suppose we observe N test assets. Let $R_{n,t}$ denote the time t gross returns on the n-th asset and Δdep_t denote the time t growth rate of NYCH deposits. The law of one price implies the moment condition $E\left[m_t R_{n,t}\right] = 1$ for each of the n assets. Impose the constraint $m_t = \alpha + \beta\Delta dep_t$ and define the following error model:

$$u(\theta)_{n,t} = (\alpha + \beta\Delta dep_t)R_{n,t} - 1 \qquad (5)$$

Our goal is to pick the free parameters $\theta = [\alpha, \beta]$ to best price the observable asset returns. Let $g(\theta)_n$ denote the average pricing error of n-th asset:

$$g(\theta)_n = \frac{1}{T}\sum_{t=1}^{T} u(\theta)_{n,t} \qquad (6)$$

To estimate θ via GMM, form the vector of average pricing errors $\mathbf{G}(\theta) = [g(\theta)_1 ... g(\theta)_n ... g(\theta)_N]'$ and choose $\theta = [\alpha, \beta]$ to minimize $J(\boldsymbol{\theta}) = G(\boldsymbol{\theta})'\boldsymbol{W}G(\boldsymbol{\theta})$ for a positive definite weighting matrix **W**.

Throughout this paper I use the statistically efficient weighting matrix $\mathbf{W} = \mathbf{S}^{-1}$, where $\mathbf{S}^{-1}$ is the inverse of the pricing error spectral density matrix[17] (see Cochrane (2001) Ch10) and employ the traditional GMM two-step procedure to estimate $\mathbf{W} = \mathbf{S}^{-1}$.

1. Set **W** equal to the identity matrix and solve $min_\theta\, J(\boldsymbol{\theta}) = G(\boldsymbol{\theta})'\boldsymbol{I}G(\boldsymbol{\theta})$
2. Use the pricing errors from Step 1 to estimate $\mathbf{W} = \mathbf{S}^{-1}$
3. Set $\mathbf{W} = \mathbf{S}^{-1}$ and solve $min_\theta J(\boldsymbol{\theta}) = G(\boldsymbol{\theta})'\boldsymbol{W}G(\boldsymbol{\theta})$

[17] The results are robust to the use of the pre-specified weighting matrixes such the identity matrix or the Hansen and Jagannathan (1997) minimum distance matrix.

Test Assets: Size-sorted and Seasonally Managed Portfolios

We estimate $\boldsymbol{\theta}$ via GMM by choosing the regression coefficients to best price 10 size-sorted and five calendar-sorted NYSE stock portfolios. The size-sorted portfolios are formed by assigning stocks to deciles based on the market-value at the beginning of each 28-day period. Value-weighted returns are computed within each decile and stocks are reassigned each period based upon updated market values. The resulting 10 size-sorted portfolios exhibit wide cross-sectional differences in returns. If changes in bank balance sheets are correlated with changes in unobservable marginal utility, knowledge about the state of NYCH balance sheets should help explain these cross-sectional differences in returns.

All of our information about unobservable marginal utility must be inferred from the behavior of asset prices. We can sharpen our estimates by forming managed portfolios that follow time-varying investment strategies that are likely correlated with unobservable marginal utility. *Likely correlated* is a non-trivial statement when the correlation we desire is with respect to an unobservable variable. Any time varying investment rule must be based on information known at the time of portfolio formation and result in differences in expected return. Even in an informationally efficient market public information available at time t can predict cross-sectional differences in returns at time $t+1$ if the differences in return reflect compensation for risk.

The history of banking panics and national banking era interest rates suggest some potential managed portfolio strategies. The *National Monetary Commision* (1911), Friedman and Schwartz (1963) and Miron (1986) all note the seasonality of interest rates and banking panics during the gilded-age. Contemporaries were also aware of both the seasonality of interest rates and the increased likelihood of banking panics during the fall. If consumption risk varied seasonally, portfolios based on seasonal investment strategies should contain information about seasonal variation (if any) in m.

I form 5 managed portfolios that reflect seasonal investment strategies. The first four are long-short strategies based on the calendar quarter. The long Q_N portfolio shorts the risk free asset and invests the proceeds in the value-weighted stock market portfolio in the n-th quarter and shorts the market and invests the proceeds in the risk-free asset in the other 3 quarters. The fifth calendar portfolio which I call “Long Harvest” shorts the risk-free asset and invests in the stock market portfolio during the harvest months of August-November and shorts the market portfolio and invests in the risk-free asset otherwise.

Table I reports the annualized average return and standard deviation for each size-sorted and calendar managed portfolio used in estimation. The size and calendar sorted portfolios exhibit wide variation in average returns. If unobservable gilded-age marginal utility varied with bank deposits, knowledge about the change in bank deposits should explain the spread in size and calendar sorted average returns.

Seasonally Adjusted Deposit Growth

The seasonality of deposits and interest rates suggest caution is in order. If $cov(m_t, \Delta dep_t)$ is not equal to zero, changes in the marginal utility of consumption should reflect only the *unexpected* changes in deposits. If changes in deposits were predictable these changes would already be reflected in investor’s consumption decisions and asset prices. Deposit growth was predictably seasonal during the gilded-age [18]. A simple time series regression on month dummies explains 19% of the time series variation in deposit growth. Deposits were predictably withdrawn from NYCH banks in the fall harvest season when the seasonal demand for currency in the interior was high. Failure to account for the predictable movement in bank balance sheets is equivalent to measuring our deposit growth variable with error. For example, if New York deposits witnessed a 2% decline in a month when investors expected a 5% decline this is actually an unexpectedly positive shock to bank balance sheets. In the estimation that follows Δdep_t is defined as the seasonally-adjusted change in NYCH deposits Where seasonally adjusted change is defined as the residual from the regression of the deposit growth series on a month dummies.

[18] Miron (1986)

Results

Tables 2 report the GMM regression coefficients and *t-stats* for the candidate discount factor $m_t = \alpha + \beta \Delta dep_t$. The table also reports the overidentifying T_{jt} statistic. Under the null hypothesis that our estimated *m* is a valid discount factor the T_{jt} statistic is distributed $\chi^2_{(N-k)}$ where *N* is the number of assets used in estimation and *k* is the number of estimated parameters.

Table 2 reports six separate regressions corresponding to different specifications of *m* or different test assets used in estimation. Specifications (1) & (4) report the coefficients from a univariate GMM regression of *m* on deposit growth. Regardless of test assets, the regression coefficient is negative and significant at the 1% level. Changes in NYCH deposits were significantly correlated with the marginal utility implied by asset returns. Furthermore, the negative sign of the coefficient on deposit growth tells us deposits were withdrawn from NYCH banks in states of the world where implied marginal utility of wealth was high.

A word of caution is in order. Are we really measuring the CAPM equation in disguise? Regressions (1) and (4) imply that deposit growth is correlated with the marginal utility of gilded-age investors. Before we place a price on deposit risk we should be certain that we aren't simply measuring stock market risk. Deposits leave New York banks during banking panics. The stock market also declines during banking panics as well. Both theory and the fact that the observable value-weighted stock market excess return $E[R^{sm}] - R_f$ is positive suggest the stock market is negatively correlated with marginal utility as well. When we exclude the stock market from our specification $m_t = \alpha + \beta \Delta dep_t$ we should worry that our estimated beta may be biased due to this omitted variable. If the true specification is the CAPM equation $m_t = \alpha + \beta(R_t^{sm} - R_{ft})$ but we estimate the regression with Δdep_t in place of $(R_t^{sm} - R_{ft})$ we could find a statistically significant β because changes in NYCH deposits are correlated with stock market returns.

In Table 2 specifications (2) and (5) we estimate the candidate stochastic discount factor implied by the CAPM: $m_t = \alpha + \beta_{rm}(R_t^{sm} - R_{ft})$. β_{rm} is negative and significant in both cases. Knowledge about the return on the aggregate market index did help explain differences in the cross-sectional of gilded-age stock returns[19].

To properly test the null hypothesis that banking panics affected marginal utility, holding the stock market fixed, we require a multiple regression of the stochastic discount factor on our hypothetical deposit contract *and* the return on the stock market

$$m_t = \alpha + \beta_{dep}(\Delta dep_t) + \beta_{Rm}(R_t^{sm} - R_{f,t}) \qquad (7)$$

The β coefficients in (7) have the same interpretation as multiple regression coefficients. β_{dep} tells us the affect of deposit growth on implied marginal utility holding the stock market fixed. In Table 2 specifications (3) & (6) we estimate eq.(7) via GMM. The change in NYCH deposits are significantly correlated with implied discount factors even when controlling for stock market changes. In fact, once one controls for changes in bank balance sheets knowledge about the stock market return contributes practically nothing to our understanding of national banking era asset returns!

The last point deserves clarification. Unexpected changes in bank deposits explain differences in 1866-1913 stock returns even after controlling for changes in the market portfolio. Figure 1 plots the average annual return of each portfolio against the predicted return implied by the CAPM and deposit growth factor model specifications. By itself the CAPM factor does a good job of explaining the cross-section of stock returns, however, the results in Table 2 demonstrate that the CAPM "works" because the market portfolio is correlated with bank deposits. Once one controls for changes in bank deposits knowledge about the aggregate market return adds no information about cross-sectional differences

[19] The overidentifying test is rejected in the CAPM specifications (2) & (5) but not in specifications where the candidate discount factor is a function of deposit growth (1) & (4). The reader should resist the urge to draw conclusions about the relative merits of the CAPM versus deposit factors based on differences in overidentifying test statistics. The statistic is a ratio.The deposit overidentifying statistic could be smaller because the discount factor based on bank deposits better explains stock returns or because the discount factor blows up the variance of the pricing errors. Each T_{jt} statistic is computed with a different weighting matrix rendering cross-specification comparisons unwise.

in stock returns.

This result is different (and much stronger) than most findings that "the CAPM failed". Many papers have rejected the CAPM specification by finding additional factors that help explain differences in cross sectional stock returns even after controlling for the market portfolio. In this case, the additional factor not only explains returns after controlling for the market return but completely drives out the market index as an explanatory variable!

Measuring the Cost of Insuring Against National Banking Era Panics

Recall the hypothetical derivative contract that pays Δdep_t . Had such a contract existed a national banking era investor could have used it to insure against utility loss during banking panics. The question remains, just how costly were these panics? The regressions in Table 2 provide strong statistical evidence that marginal utility was higher during times of unexpected deposit withdrawals. With 625 time series observations and portfolios comprised of more than 70,000 individual stock returns even economically insignificant utility differences can be statistically significant. Before we draw conclusions about the economic cost of banking panics we require a price of panics in terms of forgone consumption.

A natural way to think about the cost of bad outcomes is to ask, what would one pay to avoid them? Consider the hypothetical insurance contract that pays its holder $X_{ins} = -\Delta dep_t$ if NYCH deposit growth is negative and zero otherwise. This contract would allow banks or investors to insure against deposit declines. The contract's payout increases during banking panics. If an investor expected his consumption to fall during a banking panic, he could insure against this panic risk by purchasing insurance contracts. Holding the insurance would eliminate the downside risk but it would come at a cost if $P = E[mX] > \frac{E[X]}{R_f}$. That is, it would be costly to insure if the expected return to buying the contract is lower than the return of holding the risk-free asset. From (3) we know that this is equivalent to saying it is costly to insure if $\text{cov}(m, X) > 0$ and our GMM regressions of *m* on deposit growth tell us it will be costly to insure with insurance contracts that pay the $-\Delta dep_t$. How costly amounts to an empirical question of what price would our hypothetical insurance contract would trade for if they were offered for sale during the national banking era?

We can price the contract from the time series of payouts and the moment condition $P = E[mX]$. The price depends upon the stochastic discount factor *m*. What *m* should we use? An obvious choice is the $\widehat{m}$ implied by our regression $m_t = \alpha + \beta_{dep}(\Delta dep_t) + \beta_{Rm}(R_t^{sm} - R_{f,t})$. With the realizations of insurance payouts and estimates of $\widehat{m}$ in hand, we can compute $P = E[mX]$ and measure the cost of insurance by comparing the expected gain (loss) from buying the insurance to the expected gain from buying the risk-free asset. From (2) we know the expected excess return from buying the insurance is

$$E\left[R^{insurance} - R_f\right] = -R_f cov\left(R^{insurance}, m\right) \qquad (8)$$

Plugging in our point estimates from $\widehat{m}$ estimates with all test assets and $m_t = \alpha + \beta_{dep}(\Delta dep_t) + \beta_{Rm}(R_t^{sm} - R_{f,t})$ yields the estimated cost of insuring *$100* of seasonally-adjusted deposits. The discount factor estimated with seasonally-adjusted deposit growth assigns a price *$1.10* above its actuarially fair value. An investor who wished to insure against any 28-day decline in seasonal-adjusted deposits would willingly pay an expected *(13 x $1.097) = $14.26* per annum to insure *$100*!

To place these costs in perspective we can compare the cost of buying our hypothetical 28-day insurance against national banking era deposit withdrawals to the cost of buying insurance against stock market declines today. Had an investor purchased 30-day, $100 at-the-money put options on the S&P 500 every month from Jan 1990 to the present the investor would have lost an average of *$13.97* per annum[20]. This is very close

[20] The CBOE reports historical VIX on S&P 500 options from 1990 to the present. I use the VIX, T-bill rate, and dividend yield on the S&P 500 to compute the time series of 30-day at-the-money S&P 500 put option prices via the Black Scholes formula. The difference between the average annual cost of at-the-money puts and the annual payout is - *$13.97.*

to the cost of insuring against seasonally-adjusted deposit withdrawals during the national banking era. The cost of unexpected deposit withdrawals between 1866-1913 was roughly similar to the cost of modern day stock market declines.

It’s important to remember that this asset based estimate of the cost of deposit withdrawals is inferred from observable asset returns. This is an estimate of cost rather than a counterfactual exercise. Had actually insurance existed the observable asset returns may well have been different. Our deposit based candidate discount factor does a good job of explaining asset returns because assets exposed to banking panics have high returns to compensate investors for this exposure. The size of this compensation tells us banking panics were costly but the equilibrium level of compensation would have likely been different had credible deposit insurance been available. Our observable return based estimates should be thought of as the equilibrium price of insurance a small price taking investor would willingly pay assuming his actions had no affect on the general equilibrium prices of the other assets.

Conclusion

Bank runs are costly even in the absence of large interconnected too big to fail institutions. Irreversible investments and risk-averse savers create an environment where financial intermediaries can increase welfare by pooling savings and smoothing consumption risk. However, irreversible investments combined with asymmetric information about the quality of loan portfolios or the patience of other depositors can expose an intermediary to runs and expose the economy to systematic risk. In the era before the Federal Reserve and too big to fail, banks looked to the New York money market for a relatively safe, liquid, high return investment for their excess reserves. By combining data from the balance sheets of NYCH banks and returns of NYSE stocks one can estimate the cost of national banking era bank panics.

Unexpected changes in NYCH deposits had a significant impact on investors’ stochastic discount factors. In fact, when tasked with explaining cross-sectional differences in size and calendar-sorted stock returns, knowledge about NYCH balance sheets was far more informative than knowledge about the return on the value-weighted market portfolio.

I measure the cost of national banking era bank panics by constructing hypothetical insurance contracts on NYCH deposits. These contracts would have allowed a price taking gilded-age investors to insure against changes in NYCH deposits. The price of these contracts implied by our estimated discount factors suggest banking panics were quite costly and investors would pay up to an annual 14% premium above actuarially fair value to insure against deposit losses – approximately the same premium modern day investors have willingly paid to insure against stock market declines over the past 20 years.

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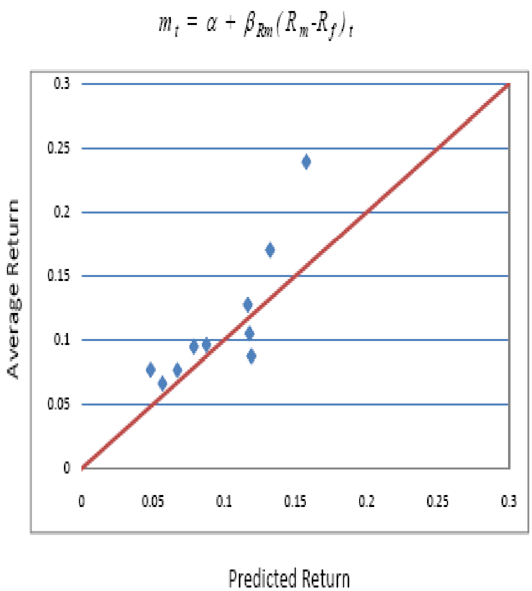
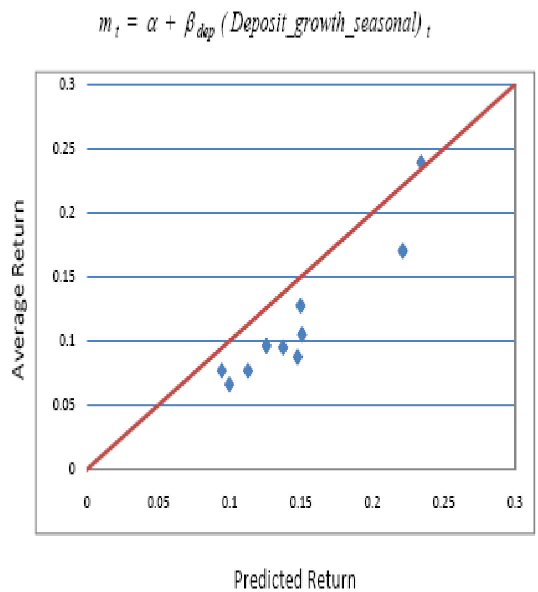
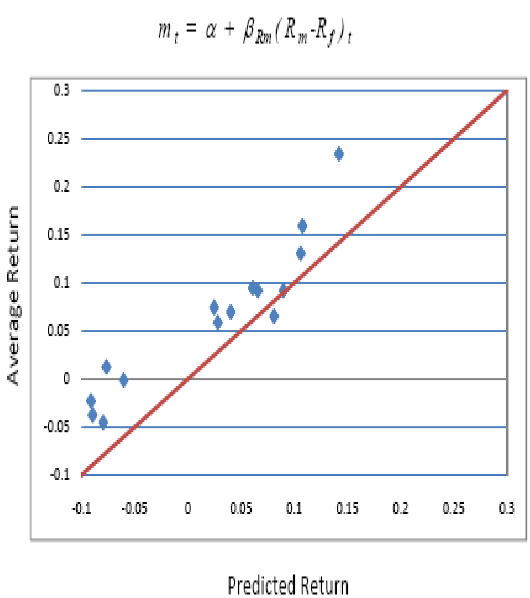
Average return versus predicted return

10 size-sorted portfolios





10size-sorted and 5 Calendar sorted portfolios



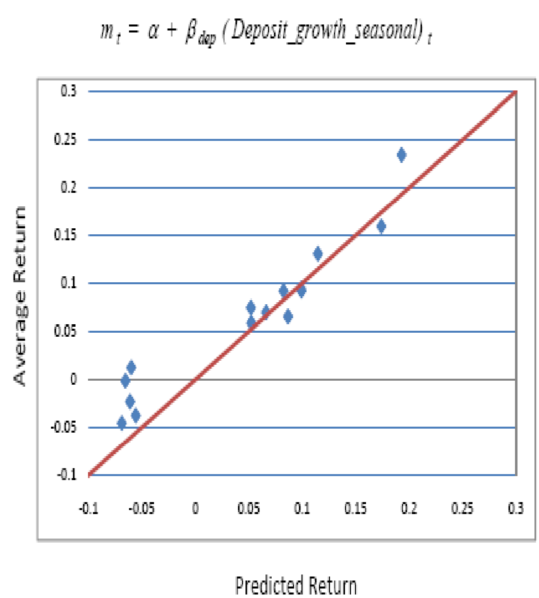


Table 1: Annualized Return and Standard Deviation

	Average Return	***Standard Deviation***
	1866-1913	
Size Sorted Portfolios		
Smallest	0.1461	0.471
Size 2	0.111	0.3357
Size 3	0.092	0.2967
Size 4	0.0607	0.2607
Size 5	0.0392	0.2319
Size 6	0.0738	0.205
Size 7	0.0801	0.1877
Size 8	0.0601	0.1499
Size 9	0.0515	0.1296
Largest	0.0695	0.1192
Managed Portfolios		
Long Q1	-0.0311	0.1316
Long Q2	-0.0452	0.1314
Long Q3	0.004	0.1317
Long Q4	-0.0525	0.1312
Long Harvest	-0.0098	0.1318

Average Ret = geometric annulized return

TABLE 2 :
Stochastic Discount Factors Estimated with 1866-1913 Data

$$m_t = \alpha + \beta_{dep}(\Delta dep_t) + \beta_{Rm}(R_t^{sm} - R_{f,t})$$

	Test Assets: 10 size-sorted portfolios				**Test Assets:** 10 size-sorted portfolios; 4 quarterly portfolios; 1 long- harvest portfolio		
	(1)	(2)	(3)		(4)	(5)	(6)
α	0.9994	1.0167	0.9959		1.0027	1.0204	1.0051
(t-stats)	(41.53)***	(72.08)***	(36.13)***		(54.76)***	(98.71)***	(45.93)***
β_{dep}	-15.3444		-16.6722		-15.8727		-14.8695
(t-stats)	(-3.72)***		(-2.76)**		(-5.19)***		(-3.07)***
β_{Rm}		-4.3343	0.7524			-4.7867	-0.5555
(t-stats)		(-2.69)***	(.30)			(-4.06)***	(-0.30)
$T_{jt} \sim \chi^2_{(N-k)}$	5.56	16.382	5.33		12.54	26.48	11.77
(p-value)	(0.70)	(0.04)**	(.62)		(.48)	(0.01)**	(.46)

Δdep_t = percentage change in seasonally-adjusted NYCH deposits

(R_m - R_f) = Excess return on the value-weighted NYSE portfolio

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