Working Paper Series

The Credibility of Exchange Rate Pegs and Bank Distress in Historical Perspective: Lessons from the

WP 13-18

Scott Fulford
Boston College

Felipe Schwartzman
Federal Reserve Bank of Richmond

THE FEDERAL RESERVE BANK OF RICHMOND
RICHMOND ▪ BALTIMORE ▪ CHARLOTTE

The Credibility of Exchange Rate Pegs and Bank Distress in Historical Perspective: Lessons from the National Banking Era

Scott Fulford and Felipe Schwartzman*

October 2013
Working Paper No 13-18

Abstract

We examine a period during the prevalence of the gold standard in the United States to provide evidence that speculation about a currency peg can have damaging effects on bank balance sheets. In particular, the defeat of the pro-silver candidate in the 1896 presidential election was associated with a large and permanent increase in bank leverage, with the initial impact most pronounced among states where banks held more specie in proportion to their assets and were, therefore, also more committed to paying out deposits in specie. Based on the cross-sectional pattern of changes in leverage observed in 1896, we construct a measure of the credibility of the gold standard spanning the entire sample period. Changes in this measure correlate with changes in aggregate bank leverage, suggesting that uncertainty about the monetary standard played an important role in the 1893 banking panic and its aftermath.
JEL classification: E42, E44, F33, G01
Keywords: Gold Standard; National Banks; Fixed Exchange Rate; Exchange Rate Credibility; Financial Crisis

*Scott Fulford: Boston College department of economics, scott.fulford@bc.edu (617 552 2425, 140 Commonwealth Ave, Chestnut Hill, MA 02467). Felipe Schwartzman: Federal Reserve Bank of Richmond, Felipe.Schwartzman@rich.frb.org (804 697 8000, Post Office Box 27622, Richmond, VA 23261). We thank John Maney for research support and Boston College for research support. The views expressed here are those of the authors and do not reflect those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

1 Introduction

Can the lack of credibility in a currency peg inflict damage to an economy? This possibility drives multiple equilibria models of currency crises: Market expectations that a currency will devalue can generate costs that lead policymakers to let the currency devalue, thus becoming self-fulfilling. It also underpins the view that fixed exchange rate regimes work best the stronger the institutional commitment to them is, which is an important part of the rationale behind the creation and expansion of the European Monetary Union. Conversely, it suggests that, for example, the current speculation about Greece or Cyprus abandoning the Euro zone exacerbates the economic problems faced by these economies and could lead to wider damage if it spreads to other members of the European Monetary Union.

We examine a period during the prevalence of the gold standard in the United States to provide evidence that speculation about a currency peg can have damaging effects on bank balance sheets. We find that the resolution of uncertainty about the commitment of the United States government to the gold standard following the defeat of the pro-silver candidate in the 1896 presidential election was associated with a large and permanent increase in bank leverage, with the initial impact most pronounced among banks that had the strongest commitment to paying deposits in specie. A nearly symmetrical situation occurred during the panic of 1893 when large gold outflows similarly threatened the credibility of the commitment to the gold standard. The findings are consistent with a monetary mismatch theory of the costs of currency crises, a channel that has been emphasized by "third generation" models developed after the Asian crisis.

We use a relatively high frequency panel of the balance sheets of the national banks in each state to learn about the underlying mechanism. Unlike modern economies, there was a large number of banks in the United States, and they could not branch, providing us with a panel of states in a currency union with each state populated by a large number of independent financial institutions. [1] The uses for gold and other currencies differed across states yet the banks were affected by the

[1] Although other financial institutions existed at the time, the national banks were the largest and were constrained by similar laws and regulations across states.

same fluctuations in the probability of a currency devaluation, allowing us to examine how the effects of possible devaluation differed across states during a volatile time period.

We examine the correlation between changes in bank leverage and specie holdings around the 1896 election and find a strong positive association. The election of 1896, in which William Jennings Bryan famously declared that "mankind shall not be crucified on a cross of gold" (Jones, 1964), offered a particularly clear resolution of uncertainty over the gold standard. The monetary system was a key focus of the race and the outcome was uncertain, but Bryan's loss to the the pro-gold candidate, William McKinley, gave a clear signal that the United States would stay with gold. We use this episode to examine how banks that held different amounts of specie responded. First, we show that specie holdings within each state were largely determined by gold production and participation in international trade, so we can take them as largely outside the control of banks. Second, we show that following the election, banks that held more specie increased their leverage substantially more.

The positive correlation between changes in bank leverage and specie holdings suggests that there was problem of monetary mismatch. To examine this channel, we introduce a model in which, for a given leverage, banks holding large amounts of gold have a greater incentive to suspend when a devaluation becomes imminent. Without suspending they might be forced to transfer gold to depositors at the unfavorable, pre-devaluation, exchange rate. The model suggests a relationship between the levels and changes of debt, specie holdings, and liquid assets when the expected value of the exchange rate is changing. We test these relationships around the election and find strong support for the model.

While the election offered a particularly clear resolution of uncertainty about the adherence of the United States to the gold standard, there was doubt about the exchange rate for much of the period, and narratives of the period emphasize capital flight and exchange rate uncertainty as causes of the 1893 panic (Noyes, 1909). We investigate the strength of these claims by constructing a credibility index that examines how much the changes in leverage within each state resemble the change in leverage around the election of 1896. The index suggests that, indeed, the credibility

of the gold standard was much in doubt during the height of silver agitation, from the Sherman Silver Purchase Act of 1890 until the presidential election of 1896. It is also correlated with other potential measures of the credibility of the gold standard that are not part of its construction: It tracks gold in the Treasury very closely and is strongly correlated with interest rates spreads between the United States dollar and British pound. Lastly, we find that during the period of analysis, changes in bank leverage were correlated with changes in the credibility of the gold standard. Given the theoretical literature that has associated such contractions in leverage with output contractions (Gertler and Kiyotaki, 2010), and the fact that the contraction in employment accompanying the 1893 panic was one of the largest in United States history, this evidence suggests large real costs to the economy from exchange rate uncertainty. The results are thus of independent interest for the literature analyzing the 1893 panic and, more broadly, and determinants of business cycles in the United States[2]

2 Relation to the Literature on Currency Attacks

Models of currency attacks are typically categorized in three "generations" (see Jeanne (1999) for a discussion of this and other taxonomies), with first generation models built around ad-hoc monetary policy rules that prove to be unsustainable, second generation models focusing more strongly on incentives faced by policymakers to defend or abandon a currency peg and third generation models emphasizing the role of the financial sector and, in particular, monetary mismatch.[3]

Our focus on the balance sheet of the banking sector ties our paper most closely to third generation models. In those models banks and/or firms have liabilities in foreign currency. In the event of a devaluation, their liabilities suddenly increase relative to their assets. Given the costs of being

[2]Given their relative rarity, the study of financial crises can greatly benefit from historical research. Other examples of recent papers that analyze the experience of banking panics in the nineteenth century United States with a similar motivation are Schularick and Taylor (2012) and Bordo and Haubrich (2012). Also see Carlson (2005), Dupont (2009) and Ramirez (2009) for work on the 1893 panic and Davis, Hanes, and Rhode (2009) for an analysis of nineteenth century United States business cycles.

[3]For canonical examples of first, second and third generation models see Flood and Garber (1983), Obstfeld (1996) and Aghion, Bacchetta, and Banerjee (2001), respectively

heavily leveraged, this then forces them to either reduce borrowing sharply or default altogether. If the monetary authority does not defend the currency, devaluations can become self-fulfilling as the inability to borrow abroad leads to a sudden stop in capital flows and an ensuing devaluation (Krugman (1999); Aghion, Bacchetta, and Banerjee (2001)).

One interesting aspect of third generation models is that the cost of devaluing the currency arises endogenously because of its impact on the financial system. However, these models also suggest that the monetary authority has a strong reason to defend the currency by tightening the money supply. The calculation might change to the extent that the expectation of a devaluation is also costly. In that case, policymakers have fewer reasons to defend the currency if the devaluation is already expected. Our paper provides a measurement of these ex ante effects.

There is a wide theoretical literature on the determinants of currency mismatches. The key theoretical question is what would lead borrowers to take the exchange rate risk of borrowing in foreign currency. The proposed explanations range from bailout guarantees and other forms of government induced moral hazards (Burnside, Eichenbaum, and Rebelo, 2001) to particular forms of market incompleteness (Caballero and Krishnamurthy, 2001). In the particular historical setting that we analyze, we view currency mismatches as stemming from a mix of the structure of deposit contracts, which obligated banks (except in the case of suspension) to pay deposits on demand and at par irrespective of the kind of currency used for repayment as well as technological and institutional constraints that forced banks in regions where gold was produced or used for foreign trade to hold much of their currency reserves in gold.

There is also a large empirical literature quantifying the importance of currency mismatches in propagating movements in the exchange rate. That is important not only because of the potential of those mismatches generating exchange devaluations through the multiple equilibria mechanism described above, but also because they can increase the cost of exchange rate fluctuations more generally (Calvo and Reinhart, 2002). Much of that literature focuses on cross-country data (Calvo, Izquierdo, and Meja, 2008; Calvo, Izquierdo, and Mejia, 2004) or data from nonfinancial corporations (see Galindo, Panizza, and Schiantarelli (2003) for a review, and also Cowan et al.

(2005), Pratap, Lobato, and Somuano (2003), and Gilchrist and Sim (2007)), with no study that we are aware of, apart from ours, focusing exclusively on bank data from within a single country, even though the theoretical literature and historical narratives often emphasize currency mismatch among financial firms. Diaz-Alejandro (1985) provides an early discussion of the role of currency mismatch at the bank level in the Chilean 1981 crisis, and more recently Choi and Cook (2004) introduce a model in which currency mismatch operates by constraining bank's lending ability.

3 The Monetary System at the End of the Nineteenth Century

Political factors played a substantial role in the credibility of the gold standard, peaking around the 1896 election. That was a particularly interesting event because the election was very polarized and the result uncertain. As we will see, it also had a significant impact on the banking system. We start by examining the politics around money at the end of the nineteenth century and then examine the particulars of the different types of money and bank holdings since the details matter for the model of currency of mismatch.

3.1 The Politics of the Monetary System

The monetary system of the United States was a contentious political and economic issue from the Civil War until around 1900, reaching a peak of division during the 1890s. While the United States was technically on a bi-metallic standard until 1900, whether the federal government would buy silver and at what price were crucial questions that came up again and again. During the war, the United States had abandoned direct convertibility into specie and large scale printing of "greenbacks" had led to substantial inflation. In 1875, the United States committed to resume convertibility of dollars into gold by 1879. Since the Coinage Act of 1873 had not made any provision for minting silver—for which it was later dubbed the "Crime of 73" by silver proponents—silver was largely left out of the monetary mix (Friedman and Schwartz, 1963, pp. 114-15). A new political movement, "free silver," emerged to try to bring silver back into circulation.

The most successful silver legislation was the Sherman Silver Purchase Act of 1890, which committed the Treasury to buying much more silver than it had before (Friedman and Schwartz, 1963, pp. 132-133). The passage of the act was required as a *quid pro quo* to get Western senators to vote for higher tariffs (Hughes and Cain, 2007, p. 399). The resulting purchase of silver put a large strain on Treasury gold. Friedman and Schwartz (1963, pp. 133) suggest that from 1890 to 1893 the purchase of silver by the Treasury was so large that it would have driven the United States off gold purely from the increase in the money stock. This was not felt immediately thanks to drought in Russia which increased demand for American wheat and brought gold into the country. Nevertheless, gold flows did reverse in 1892 and 1893 at least in part because of European fears that the United States would be unable to maintain the gold standard (Sprague, 1910, pp. 157-160). These purchases caused Sprague (1910, p. 179) to argue that the Silver Purchase Act was one of the reasons for the crisis in 1893 and its repeal was helpful in restoring confidence. Still, the silver issues became an even more disturbing factor after the outbreak of the 1893 panic. The difficulty of the Treasury in maintaining the gold standard was increased, and the suspension of gold payments became imminent (Noyes, 1909). The Sherman Silver Purchase Act was repealed in late 1893, and while this was not enough to bring about renewed business activity, it did enable the United States to secure temporary assistance from Europe.

The 1893 crisis did not resolve the question of silver money. The silver producers in the West were joined by a loose coalition of mainly agrarian interests from the Northwest and South in calling for silver. Moreover, the repeal of the Sherman Silver Purchase Act in response to the panic seemed just further evidence to the Populists of what they regarded as a betrayal of agrarian debtors to mortgage holders in the East (Friedman and Schwartz, 1963, p. 116).

Frieden (1997) suggests that not only the monetary status of silver, but also the exchange rate between dollar and gold was of central importance for the populist movement. Agricultural commodities were sold on a world market. Devaluation would have increased the price in dollars for agricultural commodities and thus increased the purchasing power of farmers. That suggest that immediate devaluation was an important part of Populist demands.

The selection of William Jennings Bryan as the Democratic and Populist party candidate for the presidential election of 1896 marked the height of the divisions over the silver issue. Prior to the 1896 election the leaders of both the Democratic and Republican parties had generally tried to avoid taking a clear stand on the issue since there were varied interests within both parties. The rise of the Populist party helped make ambiguity impossible and split both parties as Gold Democrats and Silver Republicans moved away from their respective parties (Jones, 1964, pp. 168-70, 264-75). Bryan's famous speech at the Democratic National Convention that earned him the nomination set the tone for an election with the gold standard at its heart: "Having behind us the commercial interests and the laboring interests and all the toiling masses, we shall answer their demands for a gold standard by saying to them, you shall not press down upon the brow of labor this crown of thorns. You shall not crucify mankind upon a cross of gold" (Jones, 1964, pp. 228-229).

Who would win in 1896 was in doubt all the way to the end. Bryan lost the election, but the election was close and a few hundred votes in close states might have swung the election the other way (Jones, 1964, p. 341). Moreover the lack of systematic polling would have left everyone uncertain. The possibility of a Bryan win had bankers and financial interests very concerned and buying gold (Jones, 1964, pp. 339-40) and in the fall of 1896 a small banking panic ensued.

While Bryan would run again in 1900, after 1896 the support for silver was substantially weaker. The relationship of the dollar to gold was not formally settled until the passage of gold standard Act in March of 1900 set the United States officially on a pure gold standard. The subsequent re-election of McKinley by a wide margin was viewed as an endorsement of the gold standard (Hepburn, 1903, p. 405), although silver featured much less prominently than in the campaign of 1896. Of considerable help in strengthening the credibility of the gold standard was the increase in the world supply of gold starting in the 1890s from discoveries in South Africa, Alaska, and Colorado. The greater supply of gold led to an increase in the monetary supply in the United States after the election of 1896 and also substantially reduced the economic reasons for silver agitation (Friedman and Schwartz, 1963, p. 137).

3.2 Details on Monetary Arrangements and Potential Changes

Before discussing the impact of the uncertainty about monetary arrangements on bank balance sheets, it is important to have a clear notion of the monetary arrangements during the period and what were the proposals to modify them. After the resumption of specie payments in 1879, there were many different currencies circulating simultaneously, each with slightly different properties and all denominated in dollars. During normal periods they traded at a more or less fixed exchange rate sometimes set by law. During a panic or in the event of a depreciation the differences among them could become important, and the composition of what banks held would then affect their decisions.

Starting in the 1880s the largest forms of circulating currency were metallic or metallic derivatives (Hughes and Cain, 2007, pp. 390-91). These took two distinct forms: gold coins and gold certificates, as well as silver coins and silver certificates.[4] One major reason for their issue was that customs duties were payable in gold and paying with certificates was substantially simpler and less costly (Simmons, 1936). Paper money was largely composed of "greenbacks" and national bank notes. United States notes or greenbacks were issued by the federal government and after resumption in 1879 were redeemable for gold at the Treasury. National bank notes were issued by individual national banks but backed by a requirement that the national bank acquire government bonds worth 100 percent of the note issue (in 1882 the capital requirement was reduced to 90 percent). The strong backing of the national bank notes meant that they traded on par throughout the country rather than being discounted based on the individual bank (see James (1976, pp. 74-78) and James (1978)).

How United States notes would have been redeemed in the event of a change in the gold standard is not clear, but there was certainly confusion at the time. For example, in April 1893 the suggestion by Treasury Secretary Carlisle that, due to diminishing gold reserves, it might be

[4]Gold certificates were issued by the Treasury and represented a large portion of circulating gold. Gold certificates proclaimed that "there had been deposited in the Treasury" a certain number of dollars in gold coin "repayable to the bearer on demand." These certificates had been authorized during the Civil War, but became much more important after 1882 when an act of Congress directed the Treasury to issue them (Simmons, 1936).

necessary to redeem Treasury notes in silver rather than gold (Wicker, 2000, p. 58) prompted an immediate sell-off in the stock market. The market settled somewhat only after President Cleveland issued an emergency statement that notes would be paid in gold.

Since in both the panic of 1893 and in the 1896 election the monetary status of silver was a central issue, it seems likely that any change in the currency standard would involve making payments of some debts in silver. That might have included dollar notes as well as Treasury bonds.

Bryan's speeches are probably the best guide as to what would have happened had the Populists won the presidency and managed through legislation or executive power to change the monetary system, although it is not entirely clear that he understood the consequences. Bryan was committed to buying substantial quantities of silver to raise the price and called for the "free and unlimited coinage" of silver (Bryan, 1909, p. 274). The claim was that the government would by the "law of supply and demand" raise the price of silver bullion enough to fix the ratio between them since they are both in "limited" supply (p. 275).

> "At the present time and under present laws a silver dollar when melted loses nearly half its value but that will not be true when we again establish a mint price for silver and leave no surplus silver upon the market to drag down the price of bullion. Under bimetallism silver bullion will be worth as much as silver coin just as gold bullion is now worth as much as gold coin and we believe that a silver dollar will be worth as much as a gold dollar"" (Bryan, 1909, pp. 280-81, from speech given in Madison Square Garden, New York, August 10, 1896).

Yet it is unclear where the revenues to do so would have come from and the experience from the Sherman Silver Purchase Act suggests that the federal government could not have persisted in substantial silver purchases for long without depleting reserves. That suggests the very real probability that, despite his protestations, a Bryan victory would mean an abandonment of the gold standard and a devaluation of the dollar.

4 A Model of Bank Leverage and Gold Holdings

We now introduce a model of bank leverage and gold holdings. The main purpose of the model is to clarify our argument as to why currency mismatch was a relevant problem during the period before the 1896 election, and why it was likely to be most severe in locations where banks held relatively more gold. The model is similar to the one in Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) in that a bank can renege on its prior promises but by doing so risks losing part of its net worth. Unlike those models, and more in line with the practice in the period, we focus not on outright default, but on suspension of payments. We analyze that problem in the context of a three-period model.

The model relies on two key assumptions. The first is that demand deposits are payable in either paper money or gold at the discretion of the bank. The bank can substitute one for the other at a fixed ratio but cannot pre-commit to paying in either form of currency. This conforms to the notion that short-term contracts such as demand deposits were unlikely to be explicitly denominated in either currency.

The second key assumption is that, apart from the choice about which currency to pay deposits in, banks have little discretion on how much gold and paper money they hold between periods. In particular, we assume that the bank does not have access to an open market where it can exchange the two types of currency. While the assumption is probably extreme at the level of a single bank, it is less so at the level of the state, since moving specie across states involved significant transportation costs. One piece of evidence in support of this assumption is that, as we show in Section 5 below, within each state the holdings of specie by the banks is largely a function of exogenous geographic patterns such as the need to pay import duties on behalf of depositors, and the production of gold.

In line with the discussion in Section 3.2, we model the effects of Bryan's proposal as a straight exchange rate devaluation. We set units so that before the devaluation the Treasury commits to paying one unit of gold for each unit of paper money, but afterwards pays only $q < 1$ units of gold for each unit of paper money.

The model has three periods, $\{0, 1, 2\}$. Banks start out in period 0 with some equity S and raise some liabilities D_0 in the form of deposits from individuals and from other banks (we are abstracting from bank notes, which by law were almost completely backed by purchases of Treasury bonds). Banks use the funds thus secured to make loans L and acquire reserves in paper money M_0 and gold G_0. The loans generate flows of paper money and gold in the last period mL and gL.

In period 1 banks receive some information about the probability of the government abandoning the gold standard. Within that same intermediate period depositors request payment of a fraction γ of the liabilities. Banks cannot pay depositors with the proceeds from its loans, since they only become due in the final period. The bank has two options: i) pay out depositors using its reserves of paper money and gold or ii) suspend payment of deposits and wait for the final period.

In period 2, the government makes the decision whether to exit the gold standard or not. Also, proceeds from loans are realized and all remaining deposits are paid out. The bank maximizes the value of its final period position in gold and paper money.

Consider first the problem of the bank in period 2. Let $\tilde{q}$ be the realized ex post relative price of paper money relative to gold, so that $\tilde{q}$ is equal to q in the event of an exit from the gold standard and 1 otherwise. Also, let D_1 be the amount of deposits that it still has to pay out, M_1 its remaining amount of paper money, and G_1 its remaining amount of gold. In the last period the bank wants to maximize it value, and its only remaining choice is in what type of currency to pay its depositors. The problem of the bank is:

$$\begin{aligned} V_2\left(L, G_1, M_1, D_1; \tilde{q}\right) = \max_{G_2, M_2, \phi_2} & \; G_2 + \tilde{q} M_2 \\ s.t. : & \; G_2 = gL + G_1 - \left(1 - \phi_2\right) D_1 \\ & \; M_2 = mL + M_1 - \phi_2 D_1 \\ & \; \phi_2 \in [0, 1] \end{aligned}$$

where G_2 and M_2 are its final positions in gold and paper money, ϕ_2 is the fraction of deposits paid out in paper money and $\tilde{q} < 1$ is the realized relative price of paper money relative to gold.

It is immediate that if $\tilde{q} = q < 1$, $\phi_2 = \max\left\{1, \frac{mL+M_1}{D_1}\right\}$, that is, the bank will pay as much of the deposits with paper money as possible. If $\tilde{q} = 1$, the bank is indifferent.

We focus on the case where the bank always chooses deposits and loans ex ante so that it can pay deposits in full with paper money so long as it is able to wait for final period cash flows. This case is the relevant one so long as the following assumption is satisfied:

Assumption 1. $mL + M_0 > D_0$.

Since $D_0 \geq D_1$, this assumption is sufficient to guarantee that $mL + M_1 > D_1$, so that $\phi_2 = 1$ under any circumstance.[5] It follows that:

$$V_2\left(L, G_1, M_1, D_1; \tilde{q}\right) = \left(g + \tilde{q}m\right) L + G_1 + \tilde{q}M_1 - \tilde{q}D_1. \tag{1}$$

Consider now the problem for the bank in period 1. It needs to decide between suspending the payment of deposits or not. If it suspends payment, it loses a fraction ξ of its last period value. Under suspension the bank cannot alter its portfolio in any way so it still owes its first period deposits. Conditional on suspending, its value is:

$$\begin{aligned} V_1^s\left(L, G_0, M_0, D_0; E_1\left[\tilde{q}\right]\right) &= \left(1-\xi\right) E_1\left[V_2\left(L, G_1, M_1, D_1; \tilde{q}\right)\right] \\ &= \left(1-\xi\right)\left(\left(g + E_1\left[\tilde{q}\right] m\right) L + G_0 + E_1\left[\tilde{q}\right] M_0 - E_1\left[\tilde{q}\right] D_0\right). \end{aligned}$$

Now consider the problem of the bank given that it decides not to suspend. We focus on the case where banks choose their period 0 asset allocation so that they always have enough currency at hand to pay early withdrawals, that is,

Assumption 2. $M_0 + G_0 > \gamma D_0$.

[5] To see this, consider the scenarios:
1) The bank suspends in period 1. Then $M_1 = M_0$, $D_1 = D_0$ and $mL + M_1 = mL + M_0 > D_0 = D_1$.
2) The bank dues not suspend in period 1 and $M_0 > \gamma D_0$. Then $M_1 = M_0 - \gamma D_0$ and $D_1 = (1-\gamma) D_0$ so that $mL + M_1 = mL + M_0 - \gamma D_0 > D_0 - \gamma D_0 = D_1$.
3) The bank does not suspend in 1 and $M_0 < \gamma D_0$. Then $M_1 = 0$ and $D_1 = (1-\gamma) D_0$. Then $D_1 < D_0 - M_0 < mL = mL + M_1$.

This assumption rules out straight out illiquidity as a cause for suspension. This is of course not entirely realistic, since much of the literature on banking panics emphasizes the role of the overall lack of liquid assets available to banks. Rather, the reason for the assumption is that it allow us to focus our attention on incentives to suspend that are related to the composition of liquid assets rather than the total quantity, since those are the ones closely related to variations in the credibility of the gold standard.

If the bank does not suspend, its problem is:

$$\begin{aligned} V_1^{ns}\left(L, G_0, M_0, D_0; E_1\left[\tilde{q}\right]\right) = & \max_{M_1, G_1, D_1, \phi_1} \left(g + E_1\left[\tilde{q}\right] m\right) L + G_1 + E_1\left[\tilde{q}\right] M_1 - E_1\left[\tilde{q}\right] D_1 \\ & s.t. : M_1 = M_0 - \phi_1 \gamma D_0, \\ & G_1 = G_0 - \left(1 - \phi_1\right) \gamma D_0, \\ & D_1 = \left(1 - \gamma\right) D_0 \\ & M_1 \geq 0, G_1 \geq 0, \ \phi_1 \in [0, 1] \end{aligned}$$

The bank will again choose to pay as much of the deposits as possible with currency. If it does not suspend but has enough cash on hand so $M_0 > \gamma D_0$, then $\phi_1 = 1$, $M_1 = M_0 - \gamma D_0$ and $G_1 = G_0$. Otherwise, it pays some gold and $\phi_1 = \frac{M_0}{\gamma D_0}$, $M_1 = 0$, and $G_1 = G_0 + M_0 - \gamma D_0$. So:

$$V_1^{ns}\left(L, G_0, M_0, D_0; E_1\left[\tilde{q}\right]\right) = \begin{cases} E_1\left[V_2\left(L, G_0, M_0 - \gamma D_0, (1-\gamma) D_0; \tilde{q}\right)\right] & \text{if } M_0 > \gamma D_0 \\ E_1\left[V_2\left(L, G_0 + M_0 - \gamma D_0, 0, (1-\gamma) D_0; \tilde{q}\right)\right] & \text{if } M_0 \leq \gamma D_0 \end{cases}$$

Note that if $M_0 > \gamma D_0$, V_1^s is just a fraction $(1 - \xi)$ of V_1^{ns}. Hence, there is no reason for the bank to suspend. If, however, $M_0 < \gamma D_0$, then there is a reason for the bank to suspend, since this allows it to wait for the exchange rate to depreciate, exchange its gold for paper money and use those to pay-out deposits at a favorable rate. From this point onward, we focus on the more interesting case:

Assumption 3. $\gamma D_0 > M_0$.

The bank will suspend if

$$V_1^{ns}\left(L, G_0, M_0, D_0; E_1\left[\tilde{q}\right]\right) < V_1^{s}\left(L, G_0, M_0, D_0; E_1\left[\tilde{q}\right]\right) \tag{2}$$

Given the assumptions, rearranging and dividing through by total assets $A \equiv L + G_0 + M_0$ yields:

$$\begin{aligned}\Delta \equiv \left(1-\xi\right)\left(1-E_1\left[\tilde{q}\right]\right)\frac{G_0}{A} + \left(\xi E_1\left[\tilde{q}\right] + \gamma\left(1-E_1\left[\tilde{q}\right]\right)\right)\frac{D_0}{A} \\ - \left(\left(1-\xi\right)\left(1-E_1\left[\tilde{q}\right]\right) - \xi\left(g + E_1\left[\tilde{q}\right]m - 1\right)\right)\frac{G_0+M_0}{A} - \xi(g + E_1\left[\tilde{q}\right]m) > 0\end{aligned} \tag{3}$$

where Δ is a measure of the bank's incentive to suspend. Thus, a bank has a stronger incentive to suspend if holds more gold in its balance-sheet (higher $\frac{G_0}{A}$) and if it is more levered (higher $\frac{D_0}{A}$).

Applying the law of iterated expectations and taking total-differentiation, we have that:

$$\begin{aligned}d\frac{D_0}{A} = \left(\frac{1-\xi}{\lambda}\frac{G_0}{A} + \frac{\gamma-\xi}{\lambda}\frac{D_0}{A} - \frac{1-\xi\left(1-m\right)}{\lambda}\frac{G_0+M_0}{A} - \xi m\right)dE_0\left[\tilde{q}\right] \\ - \frac{\left(1-\xi\right)\left(1-E\left[\tilde{q}\right]\right)}{\lambda}d\frac{G_0}{A} \\ + \frac{\left(1-\xi\right)\left(1-E_0\left[\tilde{q}\right]\right) - \xi\left(g + E_0\left[\tilde{q}\right]m - 1\right)}{\lambda}d\frac{G_0+M_0}{A} + dE_0\left[\Delta\right] + \eta\end{aligned} \tag{4}$$

where $\lambda = \xi E_0\left[\tilde{q}\right] + \gamma\left(1-E_0\left[\tilde{q}\right]\right) > 0$ is the effect of the change in $d\frac{D_0}{A}$.

The term $dE_0\left[\Delta\right]$ denotes the change in the expected incentive to suspend. In general, banks will choose to change $dE_0\left[\Delta\right]$ in response to a change in the probability of an exit from the gold standard, so that it is endogenously determined. The determination depends on details of the period 0 problem faced by the bank, including the extent to which the probability of suspension, which is related to $dE_0\left[\Delta\right]$), affects the ease with which the bank can attract deposits, the specification of the distribution of random variables determining Δ in period 1, and the costs of changing the quantity and composition of liquid assets. Given that we cannot directly measure $dE_0\left[\Delta\right]$, in order for the model to have empirical content, we assume that the reaction of $dE_0\left[\Delta\right]$ to $dE_0\left[\tilde{q}\right]$ is small enough to keep the signs in the equation unchanged. This will follow, for example, if depositors

are very sensitive to the probability of suspension so that a small shift in that probability leads depositors to demand a large increase in the interest on deposits.

Given the assumption that $dE_0[\Delta]$ is sufficiently insensitive to $dE_0[\tilde{q}]$, the model predicts that in a time period where there was a large reduction in the probability of a devaluation (thus, an increase in $E_0[\tilde{q}]$), for a given change in liquidity and holdings of specie, leverage D/A should increase more strongly in states where $\frac{G_0}{A}$ is large and $\frac{G_0+M_0}{A}$ is low. The effect of the level of $\frac{D_0}{A}$ is ambiguous and depends on the sign of $\xi - \gamma$.

The model presented so far gives a general framework for understanding how the possibility of future devaluation affects the decisions banks make. The main result is that banks with greater holdings of specie reduce the loans they make to a greater degree since in a devaluation they may be forced to pay depositors in gold that is suddenly much more valuable. That produces a link between cross-sectional changes in leverage, bank holdings of specie, and the likelihood of devaluation that we explore in the empirical section that follows.

5 Data Analysis

5.1 Data Source and Construction

Our main data consists of the balance sheets of National Banks between 1880 and 1910 as reported in five call dates distributed over the year, consolidated at the state level. The National Banking Act required National Banks to report several balance sheet items to the Office of the Comptroller of the Currency (O.C.C.) at five annual call dates, and the O.C.C. would in turn publish the data in annual reports to Congress. Weber (2000) provides these data in electronic form. We have independently checked the call reports during much of the period, and the Weber (2000) data matches the call reports. To our knowledge, our work is the first to explore both the cross-sectional and the time series dimensions of this data.[6]

[6]See also Champ (2007a) for a discussion of aggregate bank balance sheet data constructed using that same data and Champ (2007b) for a detailed discussion of the legal and institutional background of the era.

We construct our main variables of interest from the individual balance sheet items. Consistent with the model presented in Section 4, we analyze the behavior of leverage as measured by the ratio between debt and assets.[7] The emphasis on leverage is in contrast to much of the previous work, which has emphasized bank suspensions as an indicator of bank distress (Carlson, 2005; Wicker, 2000). It is in line with recent work by Gertler and Karadi (2011) and Gertler and Kiyotaki (2010) as well as with the model presented in Section 4 above. One further advantage of bank leverage as an indicator of bank distress is that good and bad news have symmetric effects. In contrast, suspensions are only observed in extreme negative states. Therefore, using leverage allows us to investigate the impact of positive as well as negative shocks to the credibility of the gold standard, including periods in which there were few if any bank suspensions in the data.

The other indicator that previous discussions suggests ought to be relevant is the ratio of gold to assets. The data does not discriminate between gold and other metals, combining all of them in a single "specie" category. However, gold coin and gold certificates (assets payable in gold on demand) accounted for the largest fraction in the value of specie held. For example, in 1891, out of $183 million held by banks in specie, $151 million or about five-sixths were held in gold or gold certificates issued either by the Treasury or by clearinghouses, and the remainder was held in silver coin and Treasury silver certificates.

5.2 Descriptive Statistics

We start by showing how the aggregate balance sheet of national banks across the country broke down into the various balance sheet items, and how these evolved over time. Figure 1 shows the breakdown for total assets. The total value of assets increases slowly up to the panic in 1893, at which point it falls and then stagnates. Assets resume their upward growth with renewed vigor after the 1896 election. It is important to bear in mind that the increase in assets is *nominal*, so that part of it can be accounted for price movements. Throughout we mark the call date immediately

[7] Leverage is typically defined as assets/(assets-debt). Our definition is a monotonic transformation of this more typical form.

preceding important events during the period: the Sherman Silver Purchase Act in July 1890, the peak of the financial crisis in July and August 1893, and the presidential election in November 1896.

By far the largest single item in assets were "loans and discounts". These were typically working capital loans given to merchants and local businesses in exchange for "real bills." They were reasonably short term and fairly safe. National banks could not lend using mortgages as collateral. Except for the 1893-96 period, loans and discounts grow noticeably faster than total assets. All the other items are comparably much smaller.

National banks were legally required to hold reserves. Banks could hold up to a certain fraction of their reserves in accounts with correspondent banks in designated reserves cities, with the rest held in specie or other lawful money, including Treasury notes. The system had a pyramid structure, with country banks allowed to hold reserves with banks in the reserve cities, and banks in reserve cities forced to hold liabilities in one of three central reserve cities (New York, Chicago and St Louis). Banks in central reserve cities had to hold all of their reserves in specie or other lawful money. The item "correspondent reserves" separates these interbank positions. There is also a separate line "due from other banks," which corresponded to balances held with other banks that could not be counted as reserves, including loans to state banks. It is striking that specie accounts for a value comparable to reserves held with correspondent banks, thus forming in the aggregate a major item in banks reserves.

Figure 2 provides a similar breakdown for bank liabilities. The largest fraction is accounted for by "individual deposits". This, together with "due from national banks" and "due from state banks" also clearly accounted for much of the growth in bank balance sheets after 1896. While national banks could finance themselves with the issuing of notes, these formed a comparatively small part of their liabilities. Strikingly, the combination of the capital stock and other equity does not increase nearly as much after 1896, implying a strong increase in leverage. The change in leverage is apparent in Figure 3, which shows the evolution of bank leverage, defined as the ratio between nonequity liabilities and assets. There are noticeable breaks around the 1893 panic and

the 1896 election, with the latter date marking a strong and sustained increase in bank leverage.

The aggregates for both leverage and balance sheets hide a great deal of heterogeneity across states (we also separate out New York City, given its special importance). For example, banks in different states held very different shares of specie in their asset mix ranging from 13.3 percent in New York City to 1.6 percent of assets in Rhode Island in 1890, with the national average being 4.9 percent. As a fraction of reserves, it ranged from 17 percent to 78 percent between these two locations with the average of 32 percent.

Our analysis suggests that the share of specie was largely determined by the importance of gold in the local economy rather than a portfolio choice made by the banks.[8]

To measure the importance of gold across the states we combine measures of gold production, gold imports, and customs duties.[9] Each of these represents a flow associated to an economic agent acquiring additional gold or making a payment in gold locally but it does not exhaust the uses for gold. Four states had no recorded production, customs, or imports. These states had lower specie holdings in general in 1890.[10]

The relationship between gold holdings by banks and our measure of the importance of gold in the local economy is shown in Figure 4. The top panel shows the combined imports, production, and customs against the average of each state's national bank specie holdings from 1880-1889.[11] The bottom panel shows only the somewhat more comparable imports and mining production. The relationship is nonlinear and so we show the gold use in logs, normalized by the overall national

[8] In the case of the City of New York and other central reserve cities, regulations required banks to hold all of their reserves in either gold or silver coins or certificates, or legal-tender notes of the United States (Dunbar and Sprague, 1917, p. 235). We examine the correlation with specie in assets with three measures that are external to bank choices and together determine much of the variation in the specie share: local gold production, gold imports, and customs receipts. The federal government received a great deal of its revenues from customs and required that they be paid in gold or gold certificates. Similarly, some states, particularly in the West, mined substantial quantities of gold.

[9] We use the following sources: For gold imports in each state we use the average gold imports over 1886-90 for each city recorded in the Statistical Abstract of the United States 1895 pp. 72-82. We aggregate these together by state and New York City and use the five-year average since imports are quite volatile. For gold production we use the average production in 1889 and 1890 by state from the Statistical Abstract of the United States 1895, p. 39. For customs receipts we use the aggregate receipts from each custom district from the Annual Report of the Secretary of the Treasury in 1890 pp. 785-88.

[10] The four states are Arkansas, Kansas, West Virginia, and Wyoming. They have an average specie/assets ratio on the 17 May 1890 call date of 4.15%, well below the average of 4.87%.

[11] Using the average over the 1880s smooths out some noise. The relationship is nearly the same, however, if we were to use specie and assets for the May 17, 1890 call date.

bank assets. It is clear there is a strong positive relationship. New York City banks hold a great deal of gold and have a large import and export sector. Similarly California is a large producer of gold and, through San Francisco, has sizable customs receipts. Other states such as New Jersey have small imports and produce no gold and the banks in New Jersey hold relatively little gold. We interpret the relationship between gold uses and specie holdings by banks as evidence that banks' holding of specie was largely about their customers' use of specie rather than a strategic decision by the bank.

5.3 Bank Balance Sheets Around the 1896 Election

5.3.1 Aggregate changes

Table 1 shows the percentage change in the individual items around the 1896 election. The election was clearly a watershed event. In nominal terms, bank balance sheets increased by 13.5 percent between October 1896 and October 1897, with a 3.2 percent growth between October and December 1896, the call dates right before and right after the election. This year-on-year growth of banks' total assets was much above the already strong increase in loans of 9.3 percent over that period. Furthermore, the growth in loans was relatively delayed, growing only 0.4 percent between October and December 1896. This delayed growth in loans is compatible with the narratives in Noyes (1909) and Sprague (1910), which date the recovery in industrial output to late 1897. In contrast, the growth in assets was dominated by an increase in interbank deposits. Deposits held with banks in reserve cities (which could be counted as part of reserves) increased by a staggering 56.3 percent between October 1896 and October 1897, while deposits held with other banks (state and national) increased by 39.6 percent. The growth in all of these items was already strong in the call-dates around the election, at 15.7 percent and 11.4 percent, respectively. Banks also increased their holdings of specie. Specie holdings increased by 19.2 percent year-on-year and 12.3 percent in the months around the election. This increase was much larger than the increase in other types of money which increased only 6 percent in the months around the election and *dropped* by 1.3 percent year-on-year. Also, stocks and bonds remained comparatively unchanged.

On the liability side, while individual deposits, which are the biggest single component, grew year-on-year slightly above assets at 16 percent, this rate of increase was also delayed, with growth between October 1896 and December 1897 somewhat below that of total assets, at 2.6 percent. Compatible with the numbers on the asset side, the action was concentrated on interbank borrowing, with deposits from other national banks increasing by 18.1 percent between October and December 1896 and 55.6 percent year-on-year, and deposits from other state banks increasing by 15.5 percent and 55.5 percent respectively in the same two time spans.

Summing up, one of the key immediate changes in bank balance sheets around the time of the election was an increase in interbank holdings, with a consequent strong increase in the size of banks balance sheets. At a somewhat delayed pace, banks also increased their holdings of individual deposits and their loans. Historians of the period have offered many explanations for the recovery starting in 1897 that are independent from the resolution of uncertainty about the gold standard, including favorable crops and gold inflows from abroad (see Noyes (1909) and Sprague (1910), for example). While these certainly account for the comparatively slow increase in loans and individual deposits over the course of the year, these explanations cannot account for the sharp rise in interbank balances right around the election period.

5.3.2 Cross-sectional changes

To further examine the existence of a causal link from the election to the increase in bank balance sheets via a change in the credibility of the gold standard, we look at the cross-section of states. The model introduced in Section 4 suggests that banks that hold a large fraction of gold in their assets are more likely to be negatively affected by an increase in the probability of an exchange devaluation, because this gives them an incentive to suspend payments in order to give them time to exchange their gold for dollar denominated assets at a favorable rate. The scatterplots in Figure 5 show changes in bank leverage between call-dates against the average in each location of the share of specie in lawful money held by banks in their asstets between 1880 and 1889, together with the correlations and regression coefficients. The correlation coefficient in December 1896 is

53 percent. This is in part a reversal of the negative correlation in October 1896, a period in which the probability of an election win by W.J Bryan's Democratic party was relatively high, and which some authors identify as containing a systemic banking panic (see, for example, Gorton (1988)). The strong correlation in December 1896 suggests, however, that this was not a simple rebound from a panic.

5.3.3 Regression analysis

We run a series of regressions that come directly from the model introduced in Section 4. On the call dates surrounding the 1896 election, there was a large change in the likelihood of going off the gold standard and so $dE_0\left[\tilde{q}\right]$ was positive and dominated any other changes over the same period. Equation (4) then suggests an estimation of the form:

$$d\frac{D_i}{A_i} = a_0 + a_1\frac{G_i}{A_i} + a_2\frac{D_i}{A_i} + a_3\frac{G_i + M_i}{A_i} + b_1 d\frac{G_i}{A_i} + b_2 d\frac{G_i + M_i}{A_i} + \epsilon_i \tag{5}$$

where D_i/A_i is the debt to assets ratio, G_i/A_i is the specie to assets ratio, and $(G_i + M_i)/A_i$ is the fraction of liquid assets. The model predicts that $a_0 < 0$, $a_1 > 0$, $a_2 \gtrless 0$, $a_3 > 0$, $b_1 < 0$, and $b_2 \gtrless 0$. Note that from the model the a coefficients depend on their sign and size on $dE_0\left[\tilde{q}\right]$. That is why the election is so important for our empirical strategy: It is an instance in which the uncertainty surrounding a devaluation was resolved in a clear direction. Our key parameter of interest is a_1, which examines how banks that hold more specie reacted to the election.

Taking the model to the data requires some judgment since the model simplifies away many of the complexities of a bank's balance sheet. First, as in the model, we do not consider the secondary function of bank issuance of bank notes. Since these were backed by purchases of Treasury bonds and have their own line item on the balance sheet, it is easy to remove them. Then from the model we define D_i as the "demand deposits" or all liabilities (except bank notes) that are not equity, and liquid assets $(G_i + M_i)$ as all assets that are not loans. These definitions include some items that are not strictly short term assets or liabilities but capture the broad flavor of the model as it relates

specie holdings to leverage. Specie holdings contained mostly gold and gold certificates and are a separate line item so that G_i is straightforward to calculate.

Table 2 shows the results of estimating equation (5) around the election of 1896. The first column uses the values of G/A, D/A and (G+M)/A from the call date immediately preceding the election. We might expect, however, that the levels then were strongly correlated with the possibility of expected changes in the exchange rate. To the extent that banks could be choosing their balance sheets immediately before December 1896 as a preparation for a large exchange rate devaluation, the that introduces the worry that we might be biasing the estimates. The second column therefore replaces the levels from the call date before the election with the average level before 1890. Since silver agitation was the highest after 1890, that gives the regional differences in the level of bank balance-sheet ratios that are not directly related to the exchange rate news in 1896.

In both approaches the coefficients conform to the model predictions although many are insignificant. That is not a surprise given that the estimation is from a cross-section of only 48 to 50 observations. Of most interest, the areas where specie was more important had large and significant increases in their nonequity liabilities D/A.

Together the empirical results confirm the basic predictions of the model in Section 4: A drop in the probability of exchange rate devaluation leads banks to increase their leverage, more so the greater the importance of specie in their balance sheets. Also, the finding that specie holdings increased faster after the election than the holdings of other lawful money is further confirmation that, as suggested by the model, in an environment with high probability of exit from the gold standard, large holdings of specie were actually a hindrance to raising liabilities. One aspect that the model does not address is interbank balances. However, it is easy to see how, with a slight extension of the model, the increased credibility of the gold standard could be associated with an increased capacity by banks to lend to other banks, with an increase in interbank positions ensuing. Together, these findings establish a causal link from the election results to the subsequent increase in bank leverage.

5.4 Credibility of the gold standard from 1880 to 1910

We now use the cross-sectional pattern of changes in bank balance sheets around the election of 1896 to construct an index of credibility of the gold standard throughout the whole period from 1880 to 1910. Since the election results were unclear beforehand, the most important event in the last months of 1896 was the revelation that Bryan was not going to win the election and hence the abandonment of the gold standard was not imminent. Given the lack of other important news in the same period, we take this as strong evidence that the uncertainty about the gold standard had an economically significant influence on the composition and leverage of bank balance sheets.[12] The model also makes clear what the mechanism would be: a lower probability of devaluation implied a lower incentive for banks that had high holdings of specie to suspend, allowing them to borrow more. The election was associated with a strong spike in the leverage of national banks, with the spike most pronounced in states where banks held a large fraction of their liquid assets in specie.

Apart from providing us with an interesting and fairly clean natural experiment about the effect of the gold standard's credibility on bank balance sheets, the 1896 episode gives us information to create an indicator of changes in the credibility of the gold standard, which we can then use to construct a time series of how that credibility evolved over time. The idea is that, given that this was the main force moving bank balance sheets around December 1896, similar patterns of balance sheet changes observed in other periods are plausibly linked to the same kind of shock.

Formally, let ΔX_{it} be the change in leverage (D_i/A_i) in state i at date t and ΔZ_t be an unobservable "credibility" shock, with Z_t being overall credibility. Assume changes in leverage are well captured by the following linear model:

$$\Delta X_{it} = d_t + f_i \Delta Z_t + \varepsilon_{it}.$$

Thus, leverage changes for all banks in date t according to an aggregate time varying shift factor d_t,

[12] The lack of *news* is literally true, even if the lack of relevant events is not. Gold was discovered along the Klondike River in Alaska in August 1896, but the news only arrived in San Francisco after the winter, in June 1897 (Berton (2001)).

the credibility shock Z_t and other state and date specific shocks ε_{it}. The coefficients f_i specify the differential impact of the credibility shock in different states. Our strategy is to normalize $\Delta Z_t = 1$ in December 1896 and use the data to identify f_i. Given the f_i's, we can then invert the process to identify Z_t in different dates.

It is useful to go through the econometric procedure in detail, since this will make evident what identifying assumptions are needed for the procedure to be meaningful. The first step is to calculate the change in leverage for each state in December 1896, $\Delta X_{i,1896/12}$. We then run for each call date the regression:

$$\Delta X_{it} = \alpha_t + \gamma_t \Delta X_{i,1896/12} + u_{it}$$

Since the regression is run for different call-dates separately, we obtain a sequence of $\hat{\gamma}_t$. The sequence is the correlation between the cross-sectional change in leverage around the election in 1896 and the cross-sectional change in leverage at every other date. We argue that $\hat{\gamma}_t$ is a consistent estimator of Z_t, so long as the following assumptions holds:

Assumption 1: $E\left[\varepsilon_{it} f_i\right] = 0$

Assumption 2: $E\left[\varepsilon_{it}\varepsilon_{i,1896/12}\right] = 0 \; \forall t \neq 1896/12$.

Assumption 1 states that the cross-sectional pattern induced by shocks other than the shock to credibility are uncorrelated with the one generated by the credibility shock. It is easy to see why this assumption is necessary. If there is a significant shock that has the same pattern of cross-sectional impact as a credibility shock, then this method cannot tell them apart. As for Assumption 2, it states that other shocks in December 1896 were either not important (the assumption holds if $\varepsilon_{i,1896/12} = 0$), or to the extent that they mattered, they had an impact on the cross-section that was uncorrelated with the impact of shocks affecting the cross-section in other periods. Given these assumptions, $\hat{\gamma}_t$ is proportional to ΔZ_t and is a direct estimate of the credibility of the gold standard.[13]

[13] We can calculate $\hat{\gamma}_t$ as

Figure 6 shows the time series for the credibility index, overlayed with the time series for leverage. The credibility index oscillates around a stable level until the passage of the Sherman Silver Purchase Act in July 1890, at which point it drops abruptly, signalling deteriorating credibility for the gold standard. It bottoms out after a further steep drop at the 1893 panic. After that point, it oscillates somewhat until the 1896 election when it shoots up again, remaining at a high level for the rest of the sample. The time-series for leverage is different in that there is no noticeable reduction in leverage following the Sherman Silver Purchase Act, but otherwise the two series share similar peaks and troughs. The lack of immediate reaction of aggregate bank leverage to the Sherman act implies that the two series have a low correlation, at around 28 percent. However, on closer inspection it is apparent that, with the exception of the Sherman Act, the two series share numerous peaks and troughs. When converted to year-on-year changes, the two correlate much more strongly, at 56 percent.

To validate this measure, we first compare it with a measure of confidence in the gold standard introduced by Calomiris (1992). The idea is to look at the discounts charged in New York for different types of assets tradeable directly in dollars and tradeable in London for sterling. Then the "gold premium" is the difference between top rated commercial paper and the rate of exchange in London which, given that there were no reasons to believe that Britain would abandon exchangeability, is the value of funds in a gold pegged currency. Under the assumption that uncovered interest parity holds, the gold premium measures the expected devaluation of the dollar. This mea-

$$
\begin{aligned}
\hat{\gamma}_t &= \frac{cov\left(\Delta X_{i,1896/12}, \Delta X_{it}\right)}{var\left(\Delta X_{ii,1896/12}\right)} \\
&= \frac{cov\left(a_{i,1896/12} + f_i \Delta Z_{1896/12} + \varepsilon_{i,1896/12}, a_t + f_i \Delta Z_t + \varepsilon_{it}\right)}{var\left(a_{1896/12} + f_i \Delta Z^*_{1896/12} + \varepsilon_{i,1896/12}\right)} \\
&= \frac{var\left(f_i \Delta Z_{1896/12}\right)}{var\left(f_i Z_{1896/12}\right) + var\left(\varepsilon_{i,1896/12}\right)} \frac{\Delta Z_t}{\Delta Z_{1896/12}} \text{ if } t \neq t^* \\
&= 1 \text{ if } t = t^*
\end{aligned}
$$

Since $\frac{var\left(f_i \Delta Z_{1896/12}\right)}{var\left(f_i Z_{1896/12}\right) + var\left(\varepsilon_{i,1896/12}\right)}$ does not vary in time, $\hat{\gamma}_t$ provides up to a proportionality constant a measure of how ΔZ_t changes overtime.

sure is not without its own problems, as transaction costs preventing arbitrage between gold and dollars were substantial (see Coleman (2012) for recent a detailed discussion of the failures of uncovered interest parity at the time). Figure 7 compares the negative of the gold premium with our measure of the credibility Z_t. The series for the negative of the gold premium starts later in the sample, in 1890. Like the measure of credibility, it drops abruptly around the 1893 panic and right before the 1896 election, after which it switches to a higher and more stable path. The correlation between the two series is 52 percent.

A more striking validation of the series is provided by a comparison with the amount of gold held by the Treasury, depicted in Figure 8. The amount of gold held by the Treasury is a good indicator of the credibility of the gold standard for two reasons. First, as emphasized by Grilli (1990), higher gold reserves give the Treasury more "fire power" to defend the gold standard in the event of a speculative attack. Second, an increase in the probability of an exit from the gold standard was itself an incentive for agents to redeem gold from the Treasury in exchange for dollars, depleting gold reserves. As Figure 8 shows, the correlation between the two measures is very high, with both series peaking together in the beginning of 1889, bottoming around the 1893 panic, and rising again after the 1896 election. The correlation between the two series is 71 percent. If converted to year-on-year changes the correlation is a smaller but still high 47 percent.

In all, the pattern of changes in bank leverage across states around the December 1896 election repeated itself in other periods of strengthening of the credibility of the gold standard and occurred with opposite sign in periods in which that credibility was put in question, in particular the period after the Sherman Act and the period around the 1893 panic. The strong correlation with bank leverage suggests that uncertainty about the gold standard likely played a key role in the financial distress of the period.

6 Conclusion

The modern view of exchange rate pegs is that they work best the more credible they are. When analyzing the costs of abandoning a peg, the negative impact of a devaluation on the balance sheets of financial institutions appears as a major source of problems. The evidence we show informs both views. We find that, in the gold standard era, the prospect of a devaluation was costly, and that the cost was exactly on the balance sheet of banks most vulnerable to a currency mismatch problem. The more general lesson from our findings is that, to the extent that policymakers view currency mismatch as an important cost of devaluations ex post, they may also have reasons to worry about effects that the expectation of a devaluation will have on bank's ability to raise funds ex ante.

References

Aghion, Philippe, Philippe Bacchetta, and Abhijit Banerjee. 2001. "Currency crises and monetary policy in an economy with credit constraints." *European Economic Review* 45 (7):1121 – 1150.

Berton, Pierre. 2001. *Klondike:The Last Great Gold Rush, 1896-1899*. Canada: Anchor Canada.

Bordo, Michael D. and Joseph G. Haubrich. 2012. "Deep Recessions, Fast Recoveries, and Financial Crises: Evidence from the American Record." Working Paper 18194, National Bureau of Economic Research. URL http://www.nber.org/papers/w18194.

Bryan, William Jennings. 1909. *The Speeches of William Jennings Bryan, Revised and Arranged by Himself*, vol. Vol. I. New York: Funk & Wagnalls.

Burnside, Craig, Martin Eichenbaum, and Sergio Rebelo. 2001. "Hedging and financial fragility in fixed exchange rate regimes." *European Economic Review* 45 (7):1151 – 1193. International Seminar On Macroeconomics.

Caballero, Ricardo J. and Arvind Krishnamurthy. 2001. "International and domestic collateral constraints in a model of emerging market crises." *Journal of Monetary Economics* 48 (3):513 – 548.

Calomiris, Charles W. 1992. "Greenback Resumption and Silver Risk: The Economics and Politics of Monetary Regime Change in the United States, 1862-1900." NBER Working Papers 4166, National Bureau of Economic Research, Inc. URL http://ideas.repec.org/p/nbr/nberwo/4166.html.

Calvo, Guillermo A., Alejandro Izquierdo, and Luis-Fernando Meja. 2008. "Systemic Sudden Stops: The Relevance Of Balance-Sheet Effects And Financial Integration." Working Paper 14026, National Bureau of Economic Research. URL http://www.nber.org/papers/w14026.

Calvo, Guillermo A., Alejandro Izquierdo, and Luis-Fernando Mejia. 2004. "On the Empirics of Sudden Stops: The Relevance of Balance-Sheet Effects." Working Paper 10520, National Bureau of Economic Research. URL http://www.nber.org/papers/w10520.

Calvo, Guillermo A. and Carmen M. Reinhart. 2002. "Fear of Floating." *The Quarterly Journal of Economics* 117 (2):379–408.

Carlson, Mark. 2005. "Causes of bank suspensions in the panic of 1893." *Explorations in Economic History* 42 (1):56 – 80.

Champ, Bruce. 2007a. "The National Banking System: A Brief History." *Federal Reserve Bank of Cleveland, Working Paper* 0723R.

———. 2007b. "The National Banking System: Empirical Observations." *Federal Reserve Bank of Cleveland, Working Paper* 0719R.

Choi, Woon Gyu and David Cook. 2004. "Liability dollarization and the bank balance sheet channel." *Journal of International Economics* 64 (2):247 – 275.

Coleman, Andrew. 2012. "Uncovering uncovered interest parity during the classical gold standard era, 1888-1905." *The North American Journal of Economics and Finance* 23 (1):20–37.

Cowan, Kevin, Erwin Hansen, , and Luis Oscar Herrera. 2005. "Currency Mismatches, Balance-Sheet Effects and Hedging in Chilean Non-Financial Corporations." Tech. rep., IDB Working Paper No. 432. URL http://dx.doi.org/10.2139/ssrn.1818721.

Davis, Joseph H., Christopher Hanes, and Paul W. Rhode. 2009. "Harvests and Business Cycles in Nineteenth-Century America." *The Quarterly Journal of Economics* 124 (4):1675–1727.

Diaz-Alejandro, Carlos. 1985. "Good-bye financial repression, hello financial crash." *Journal of Development Economics* 19 (12):1 – 24.

Dunbar, Charles F. and Oliver M. W. Sprague. 1917. *Chapters on the theory and history of banking*. New York: G.P. Putnam's Sons, third ed.

Dupont, Brandon. 2009. "Panic in the plains: agricultural markets and the panic of 1893." *Cliometrica* 3:27–54. 10.1007/s11698-007-0024-2.

Flood, Robert P. and Peter M. Garber. 1983. "A Model of Stochastic Process Switching." *Econometrica* 51 (3):pp. 537–551.

Frieden, Jeffry A. 1997. "Monetary Populism in Nineteenth-Century America: An Open Economy Interpretation." *The Journal of Economic History* 57 (2):pp. 367–395.

Friedman, Milton and Anna Jacobson Schwartz. 1963. *A monetary history of the United States, 1867-1960*. Princeton: Princeton University Press, ninth paperback printing, 1993. ed.

Galindo, Arturo, Ugo Panizza, and Fabio Schiantarelli. 2003. "Debt composition and balance sheet effects of currency depreciation: a summary of the micro evidence." *Emerging Markets Review* 4 (4):330 – 339.

Gertler, Mark and Peter Karadi. 2011. "A model of unconventional monetary policy." *Journal of Monetary Economics* 58 (1):17 – 34. ¡ce:title¿Carnegie-Rochester Conference Series on Public Policy: The Future of Central Banking April 16-17, 2010¡/ce:title¿.

Gertler, Mark and Nobuhiro Kiyotaki. 2010. *Handbook of Monetary Economics*, chap. Chapter 11: Financial Intermediation and Credit Policy in Business Cycle Analysis. Available: http://www.gaia.e.u-tokyo.ac.jp/utipe/news/macro0622.pdf, accessed 30 April 2013.

Gilchrist, Simon and Jae W. Sim. 2007. "Investment during the Korean Financial Crisis: A Structural Econometric Analysis." Working Paper 13315, National Bureau of Economic Research. URL http://www.nber.org/papers/w13315.

Gorton, Gary. 1988. "Banking Panics and Business Cycles." *Oxford Economic Papers* 40 (4):751–781.

Grilli, Vittorio. 1990. "Managing exchange rate crises: evidence from the 1890s." *Journal of International Money and Finance* 9 (3):258 – 275.

Hepburn, Alonzo Barton. 1903. *History of Coinage and Currency in the United States and the Perennial Contest for Sound Money*. New York: The Macmillan Company.

Hughes, Jonathan and Louis P. Cain. 2007. *American Economic History*. Boston: Pearson Education.

James, John A. 1976. "Banking Market Structure, Risk, and the Pattern of Local Interest Rates in the United States, 1893-1911." *The Review of Economics and Statistics* 58 (4):453–462.

———. 1978. *Money and Capital Markets in Postbellum America*. Princeton: Princeton University Press.

Jeanne, Olivier. 1999. "Currency Crises: A Perspective on Recent Theoretical Developments." *CEPR Discussion Papers* 87 (2170).

Jones, Stanley L. 1964. *The Presidential Election of 1896*. Madison: The University of Wisconsin Press.

Krugman, Paul. 1999. "Balance Sheets, the Transfer Problem, and Financial Crises." In *International Finance and Financial Crises*, edited by Peter Isard, Assaf Razin, and AndrewK. Rose. Springer Netherlands, 31–55.

Noyes, Alexander Dana. 1909. *Forty Years of American Finance: A Short Financial History of the Government and People of the United States Since the Civil War, 1865-1907*. G.P. Putnam's Sons.

Obstfeld, Maurice. 1996. "Models of currency crises with self-fulfilling features." *European Economic Review* 40 (35):1037 – 1047. ¡ce:title¿Papers and Proceedings of the Tenth Annual Congress of the European Economic Association¡/ce:title¿.

Pratap, Sangeeta, Ignacio Lobato, and Alejandro Somuano. 2003. "Debt composition and balance sheet effects of exchange rate volatility in Mexico: a firm level analysis." *Emerging Markets Review* 4 (4):450 – 471.

Ramirez, Carlos D. 2009. "Bank fragility, "money under the mattress", and long-run growth: U.S. evidence from the "perfect" Panic of 1893." *Journal of Banking and Finance* 33 (12):pp. 2185–2198.

Schularick, Moritz and Alan M. Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008." *American Economic Review* 102:1029–61.

Simmons, Edward C. 1936. "The Gold Certificate." *Journal of Political Economy* 44 (4):pp. 534–543.

Sprague, Oliver Mitchell Wentworth. 1910. *History of crises under the national banking system*. Washington, D.C.: Government Printing Office.

Weber, Warren E. 2000. "Disaggregated Call Reports for U.S. National Banks, 1880-1910. Research Department, Federal Reserve Bank of Minneapolis." Research Department, Federal Reserve Bank of Minneapolis. Available: http://research.mpls.frb.fed.us/research/economists/wewproj.html, accessed 30 April 2013.

Wicker, Elmus. 2000. *Banking panics of the Gilded Age*. Cambridge: Cambridge University Press.

Table 1: Change in Balance Sheet Items

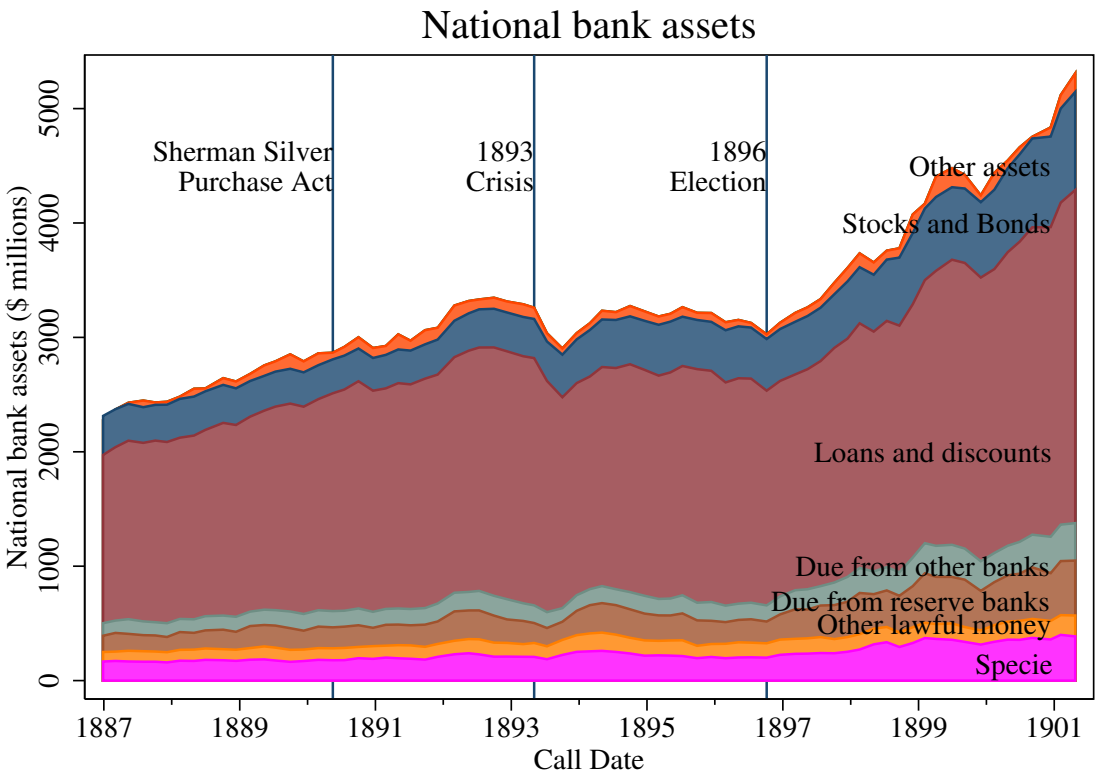
	Oct-1896 to Dec 1896	Oct 1896 to Oct 1897
a. Assets		
Specie	12.32%	19.21%
Other Lawful Money	6.05%	-1.32%
Due From Reserve Banks	15.72%	56.26%
Due from Other Banks	11.39%	39.58%
Loans	0.36%	9.29%
Stocks and Bonds	0.43%	3.86%
Other Assets	8.59%	18.46%
Total	3.17%	13.53%
b. Liabilities		
National Bank Notes	0.36%	-5.25%
Due from State Banks	15.46%	55.46%
Due from other National Banks	18.14%	55.60%
Other Equity	1.81%	-0.42%
Capital Stock	-0.21%	-2.63%
Individual Deposits	2.62%	15.99%

Table 2: Multivariate Regressions

VARIABLES	(1) dD/A	(2) dD/A
G/A	0.122**	0.211***
	(0.0478)	(0.0780)
D/A	-0.0277	-0.00313
	(0.0206)	(0.0149)
(G+M)/A	0.0373	-0.00649
	(0.0266)	(0.0274)
dG/A	0.296*	0.0786
	(0.175)	(0.203)
d(G+M)/A	0.197***	0.125*
	(0.0518)	(0.0626)
constant	-0.00650	-0.00669
	(0.0123)	(0.00710)
Observations	50	48
R-squared	0.446	0.412

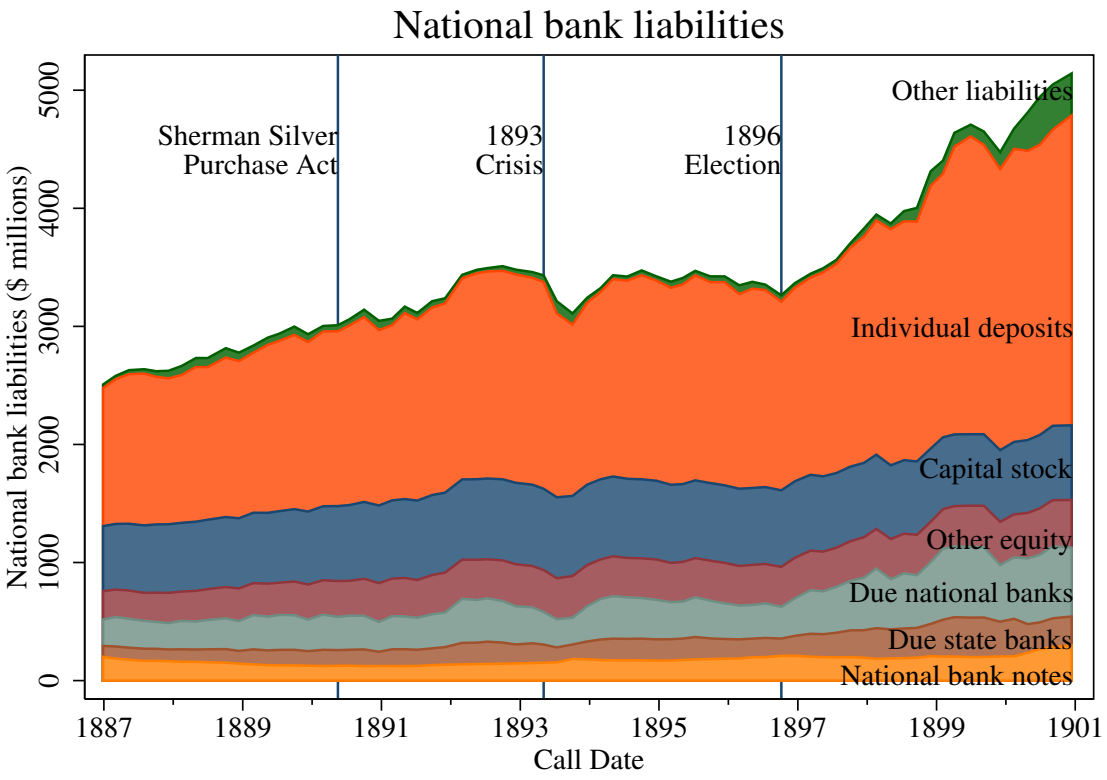
Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Column (1): G/A, D/A and (G+M)/A are lagged one period. Column (2): G/A, D/A and (G+M)/A are averages over pre-1890 period.

Figure 1: Aggregate National Bank Assets



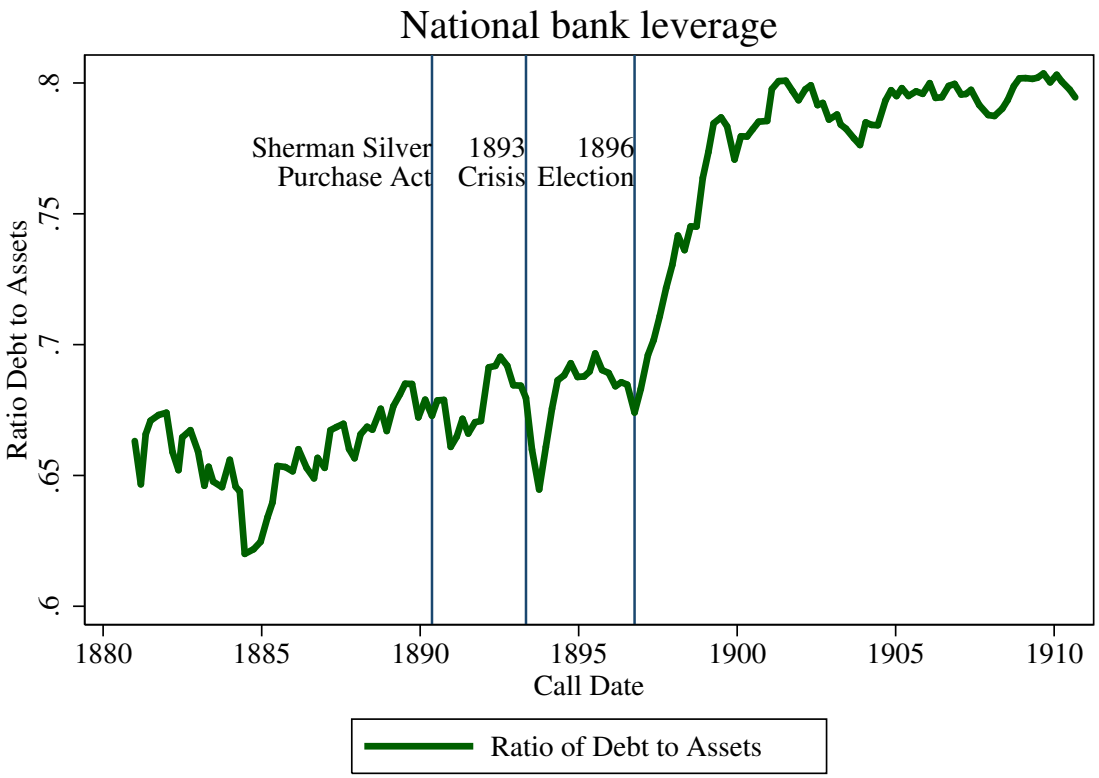
Source: Weber (2000) from the Annual Reports of the Comptroller of the Currency and author calculations.

Figure 2: Aggregate National Bank Liabilities



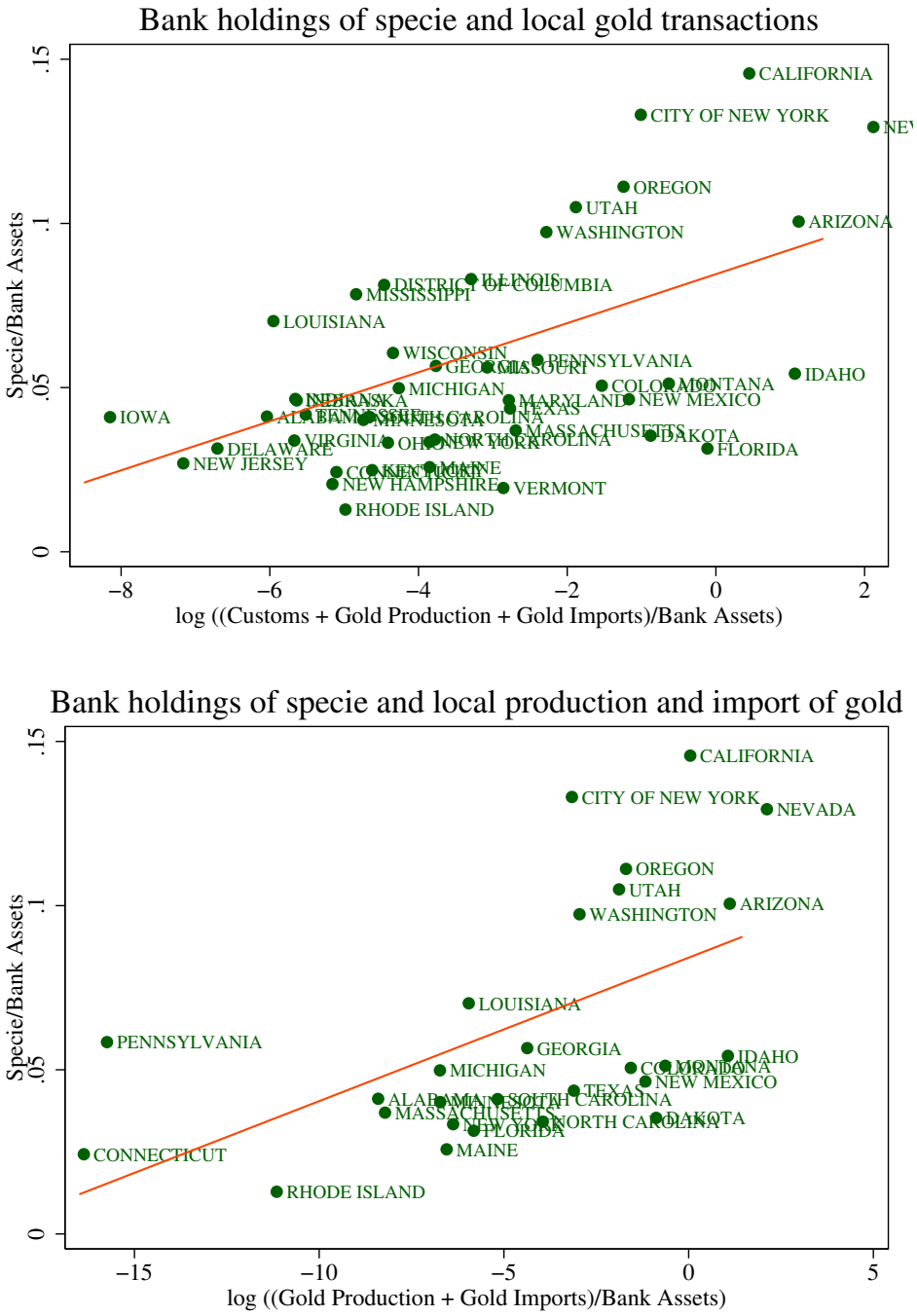
Source: Weber (2000) from the Annual Reports of the Comptroller of the Currency and author calculations.

Figure 3: National Bank Leverage



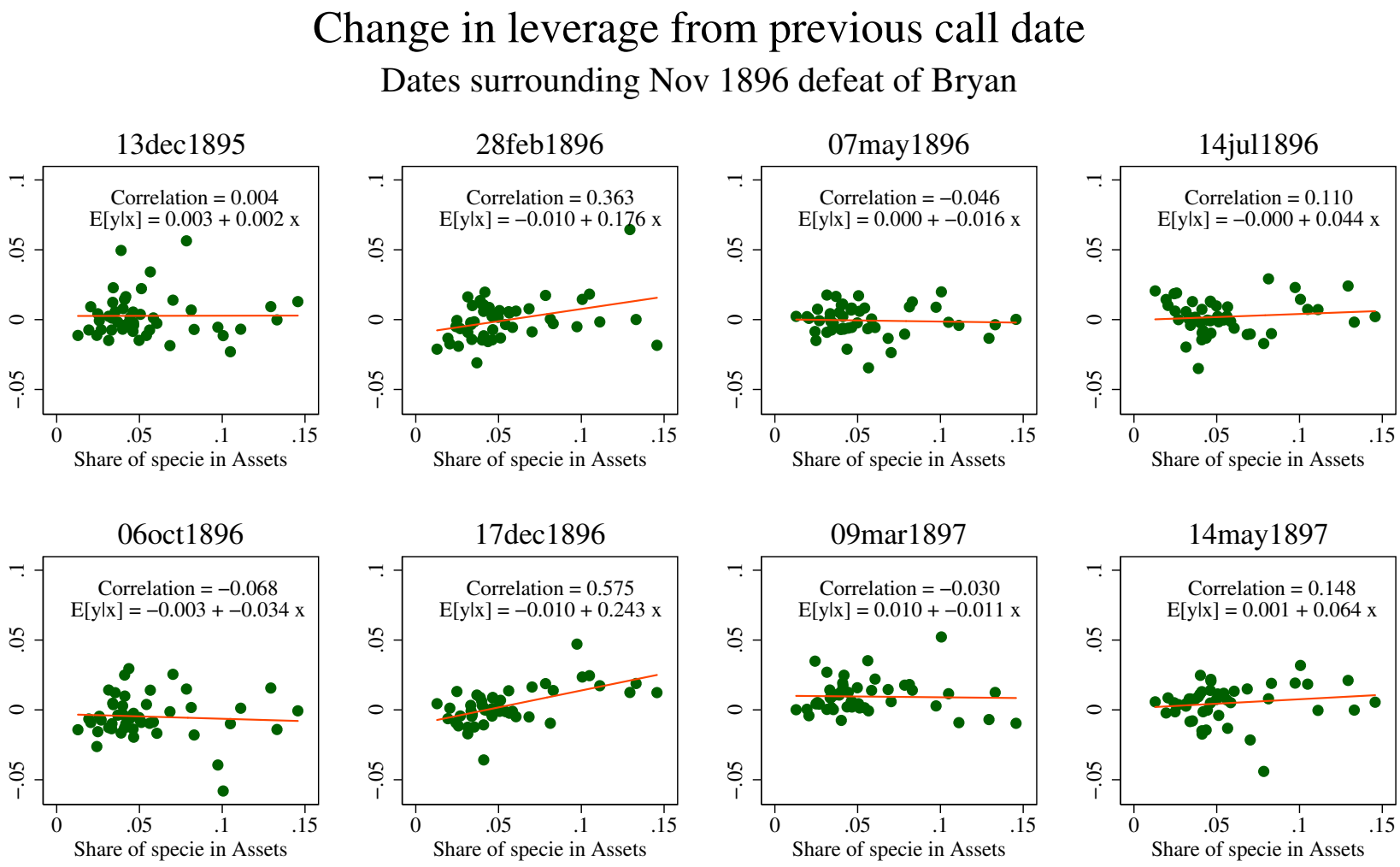
Source: Weber (2000) from the Annual Reports of the Comptroller of the Currency and author calculations.

Figure 4: Gold use and national bank specie holding



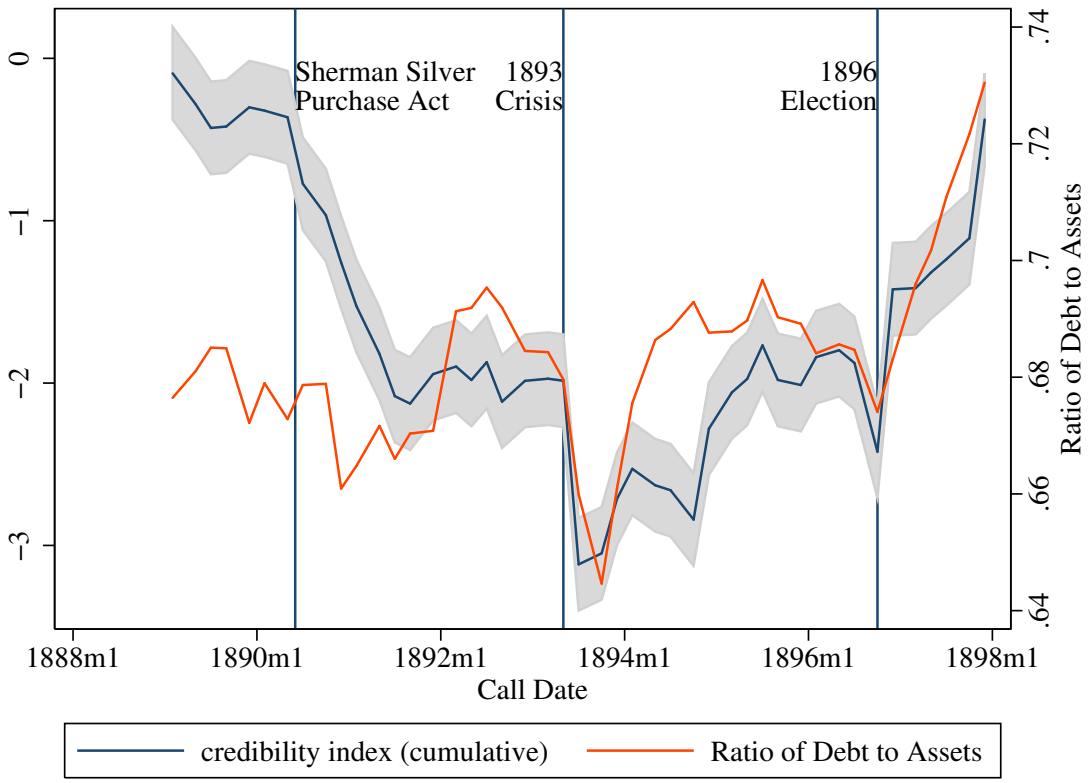
Source: National bank assets are from Weber (2000) and the Annual Reports of the Comptroller of the Currency. Gold imports and production from the Statistical Abstract of the United States 1895. Customs receipts the Annual Report of the Secretary of the Treasury 1890. See text.

Figure 5: Leverage and specie holding around 1896



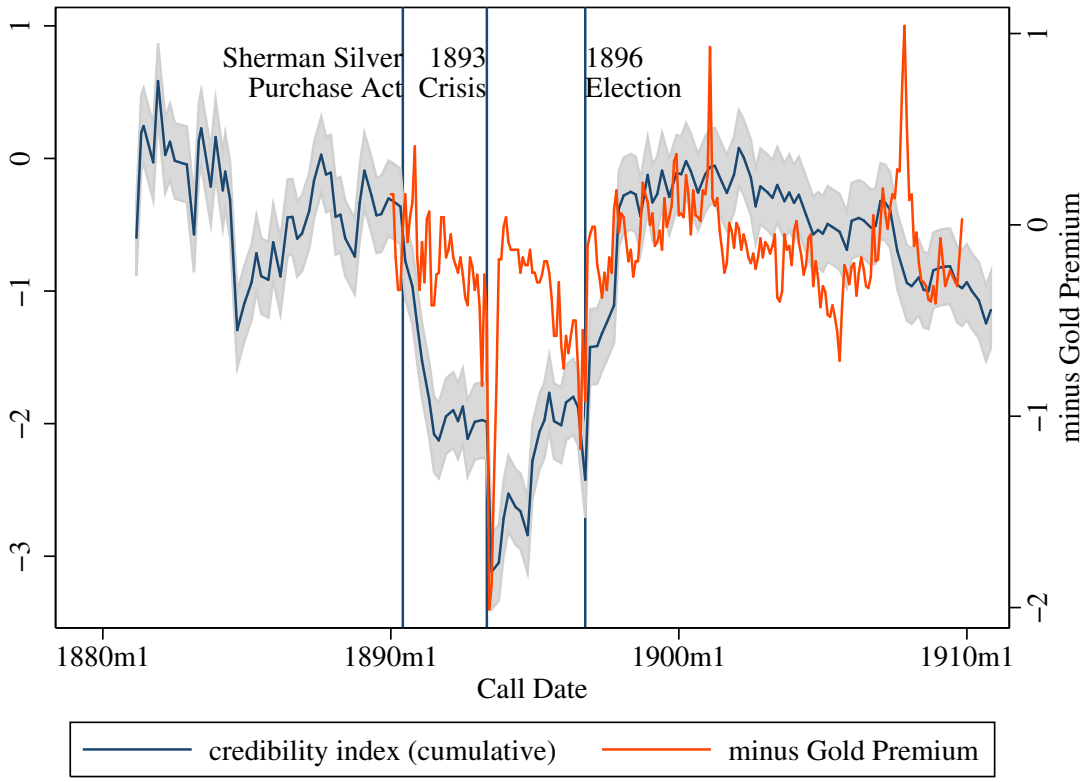
National bank assets are based on Weber (2000) and author calculations.

Figure 6: The credibility index and Bank leverage



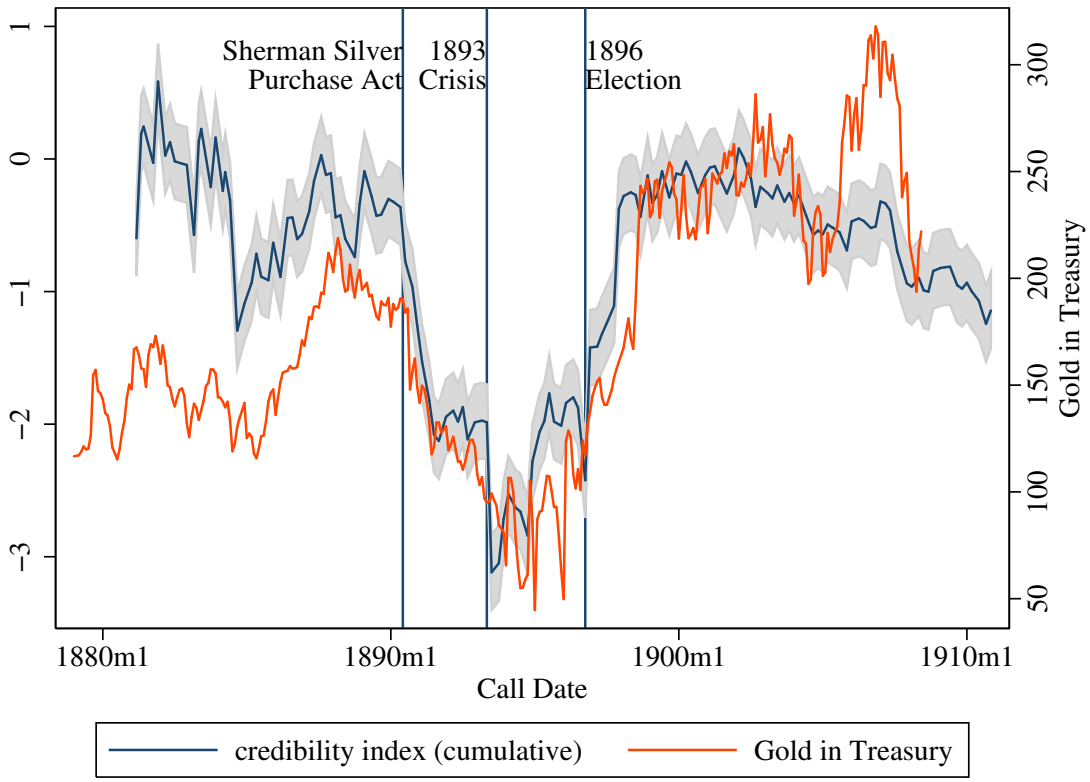
National bank assets are based on Weber (2000) and author calculations. Shaded area shows two standard deviations of the changes in the credibility index.

Figure 7: The Credibility index and (-) the premium on gold vs. dollar denominated assets.



Source: The gold premium is from Calomiris (1992) extended using the 1910 National Monetary Commission (pp. 122 and 192) (available: http://fraser.stlouisfed.org/docs/historical/nmc/nmc_570_1910.pdf). For the rates of exchange we take the high value on the last trading day of each month, construct the rate as (R60/Rsight-1)*6/5 . Shaded area shows two standard deviations of the changes in the credibility index.

Figure 8: The Credibility index and net holdings of gold in the Treasury



Source: Gold in Treasury is from the Annual Report of the Secretary of the Treasury in 1900 and 1908. Shaded area shows two standard deviations of the changes in the credibility index.