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PRICE AND EXCHANGE RATE DETERMINATION DURING THE GREENBACK SUSPENSION

By CHARLES W. CALOMIRIS*

I. Introduction

DURING the suspension of convertibility of greenbacks into gold from 1862 through 1878 the greenback price of the gold dollar ranged from par to 2.5 (see Fig. 1). The monetarist explanation for these exchange rate movements espoused by Friedman and Schwartz (1963) views the supply of greenbacks and the growing real demand for money as the sources of domestic price movements and, through them, the depreciation and subsequent appreciation of the currency. A different explanation provided by Mitchell (1903, 1908) and Studenski and Krooss (1963) argues that expectations regarding government fiscal policy and fiscal shocks (e.g., battle reports), which affected the probability and expected timing of resumption of specie convertibility, caused changes in current exchange rates and prices.

Recent theoretical contributions by Sargent and Wallace (1981), among others, have demonstrated the potential importance of fiscal expectations for determining the current level of prices and exchange rates. For example, an expectation of fiscal profligacy may imply future money supply growth and inflation which causes the current level of real money demanded to decline; thus for a given level of current money supplied, the price level rises and the currency depreciates. Assuming the market in which currencies are traded operates efficiently, movements in the exchange rate properly track news of changes in expected government policy.

Evidence from currency and securities markets (discussed below) indicates that mid-nineteenth-century American financial markets responded to expectations of government policy changes in a manner consistent with market efficiency. In applying the Sargent–Wallace approach to the history of greenback exchange rate determination, however, one must take account of institutional peculiarities of the period. First, for most of the period of suspension the supply of paper high-powered money was not held fixed by the government; national banks were authorized to supply a perfect substitute for greenbacks in the form of national bank notes. From mid-1870 on bank notes rather than greenbacks were the marginal component of the paper high-powered money supply. Second, the potential for a return to promised gold dollar parity meant that expectations of fiscal

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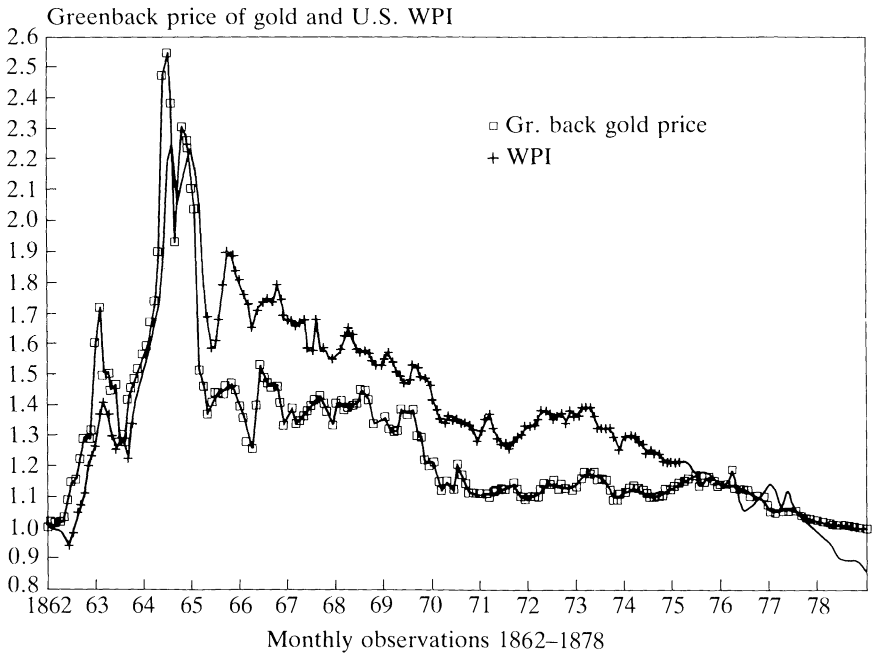

FIG. 1. Greenback price of gold and U.S. WPI

policy influenced exchange rates primarily through their effect on the perceived probability and timing of resumption.

Section II presents a model of financial markets for the post-Civil War years in which the institutional peculiarities of the money supply process and the potential for resumption play important roles in exchange rate determination. The results of the model lend support to the historical accounts of Mitchell and Studenski and Krooss. Current or expected marginal changes in the supply of greenbacks have no effect on prices or exchange rates, while resumption expectations play a central role in determining the current exchange rate and price level. Resumption expectations imply expected future values of the exchange rate and price level. Government money-supply policy effectively pegs the nominal rate of interest and the equilibrium rate of expected inflation. The nominal money stock adjusts endogenously to the level demanded (through the issue of national bank notes, the creation of bank deposits, and gold flows) given the predetermined nominal interest rate and price level.

Section III provides evidence to support the assumptions and conclusions of the model, including evidence of the importance of fiscal policy news in short- and long-run exchange rate and price determination for the period of greenback suspension.

II. A model of price determination

Defining the money stock

In order to discuss the role of money in price determination one must first define the relevant monetary aggregate. Defining the money stock is always a delicate task—all the more so for the Greenback Era. Potential candidates for inclusion are gold, greenbacks, national bank notes, and the deposits at state and national banks. The uses of these various components of money differed. National bank notes and greenbacks passed as currency; gold was used as a transacting medium primarily in California or, more generally, for foreign transactions; deposits became increasingly popular relative to currency during the period as urbanization and the development of clearing houses facilitated check clearing and consumer familiarity (see Cagan (1965)). Each component of money was introduced through a different supply process. Gold was produced in the U.S., and exported or imported to meet demand; deposits were issued by state and national banks; notes were issued by national banks under strict government regulations, and greenbacks were issued directly by the government.

Before proceeding to the issue of how the aggregate supply of notes and greenbacks was determined, it is important to discuss their substitutability. National bank notes and greenbacks traded at par even when their respective supplies varied independently. This indicates, *de facto,* that they were perfect substitutes. Furthermore, note issues were printed by the government and backed 111 percent by government bonds held on deposit at the Treasury. Thus notes were essentially indirect obligations of the government, no different—from the standpoint of the public—from greenbacks. There was one segment of the market, however, for whom greenbacks and notes were not perfect substitutes: the national banks. National banks were required to hold between 6 percent and 25 percent reserves in lawful money (gold or greenbacks)[1] on all note issues, until 1874 when this requirement was reduced to a uniform 5 percent. Because gold was trading at a premium relative to greenbacks throughout the suspension, greenbacks were a superior reserve asset for banks relative to gold. Banks were always inframarginal holders of greenbacks (the public always held both notes and greenbacks); therefore, banks' preference for holding greenbacks over bank notes did not influence the relative value of greenbacks and banknotes.

Consumers' money demand

The question of whether the nominal money supply was controlled by government policy is central to the discussion of exchange rate determination. In order to show that money—however defined—was not fixed by

[1] There were interest-bearing legal tender notes as well. Greenbacks were always the marginal reserve asset, as discussed in footnote 4 below.

TABLE 1
Selected Monetary Statistics

	Total Greenbacks G	Bank Holdings of Greenbacks G^P	Public Holdings of Greenbacks G^P	Public Holdings of National Bank Notes N^P	Total Bills $(G^P + N^P)$ B	Wholesale Prices P	Real Bills (B/P)	Real Income y	$\frac{B/P}{y}$	Commercial Paper Rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1868	328,572	100,166	228,406	294,369	522,775	158	3,308.7	7,927	0.417	6.69
1869	314,767	80,934	233,833	291,750	525,583	147	3,575.4	8,712	0.410	9.43
1870	324,963	94,573	230,390	288,648	519,038	135	3,844.7	9,627	0.399	6.52
1871	343,069	122,138	220,931	311,406	532,337	127	4,191.6	10,290	0.407	5.55
1872	346,169	122,994	223,225	329,037	552,262	137	4,031.1	11,000	0.366	7.17
1873	348,464	106,381	242,083	338,962	581,045	132	4,401.9	11,740	0.375	7.97
1874	371,421	103,108	268,313	340,266	608,579	124	4,907.9	11,970	0.410	5.70
1875	349,686	87,493	262,193	340,547	602,740	117	5,151.6	12,070	0.427	4.76
1876	331,447	90,837	240,610	316,121	556,731	106	5,252.2	12,470	0.421	4.54
1877	337,899	78,004	259,895	301,289	561,184	106	5,294.2	13,010	0.407	4.44
1878	320,906	71,643	249,263	311,724	560,987	88	6,374.9	14,770	0.432	4.22

Sources: Greenbacks and bank notes are expressed in thousands of nominal dollars. Data on total greenbacks, bank notes in the hands of the public and price are from *Historical Statistics of the United States*, first edition, series x433, x434, and app. 24, respectively. Data are for June. Real output is from Officer (1981) and commercial paper rates are from Macaulay (1938). Column (10) is a five-month average of commercial paper rates centered in June. Bank holdings of greenbacks are from the *Report of the Comptroller of the Currency*, 1879.

government policy, it is sufficient to establish that the narrowest monetary aggregate which includes the component supplied by the government was not fixed by government policy. Thus in order to demonstrate money supply endogeneity, *a fortiori,* I assume that the demand for real paper "bills" (greenbacks plus national bank notes) is separable from the demands for deposits and gold.[2] For simplicity I develop the model without deposit and gold demands initially and include them subsequently.

Consumers' demand for real paper bills takes the general form:

$$\left(\frac{B}{P}\right)^D = h(y, i_{pb}); \qquad h_1 > 0, \qquad h_2 < 0; \tag{1}$$

where B is nominal bills, P is the price level, y is real income, and i_{pb} is the nominal yield on private bonds.

By definition,

$$B \equiv N^p + G^p, \tag{2}$$

where N^p is public holdings of national bank notes and G^p is public holdings of greenbacks. The supply of total greenbacks is assumed fixed by the government.[3] By definition:

$$G \equiv G^p + G^b; \tag{3}$$

where G^b is the banking sector's holdings of greenback reserves.[4]

[2] Table 1 provides some empirical evidence for the stability of the demand for paper bills. The ratio of real bills to real income (shown in column (9)) is nearly constant, and its variation over time is negatively correlated with that of interest rates (column (10)).

[3] Our assumption of greenback supply exogeneity requires some qualification. Under the formula stipulated from January 1875 to May 1878 by Congress, total greenback supply responded to bank note supply such that greenbacks were reduced by \$0.8 for every \$1 of new bank notes. The supply of greenbacks, however, could not fall below \$300 million. Secretary Bristow interpreted this law to permit reductions in greenbacks as *gross*, rather than net, note issues rose. This regulation had no effect on the equilibrium supply of bills, since bank notes still could rise to adjust as needed. Thus this law does not affect the solution for equilibrium discussed below.

[4] State bank holdings of greenbacks or national bank notes as reserves against deposits are ignored in equations (2) and (3) because their inclusion would complicate, but not alter, any of our conclusions. State bank deposits were a small fraction of total deposits—\$143 million out of \$796 million total deposits in 1878 (see Studenski and Krooss (1963), p. 177). National bank holdings of bank notes or greenbacks as reserves against deposits are also excluded from equations (2) and (3) for simplicity; moreover, since national banks which issued notes as well as deposits enjoyed economies of scope in reserve holdings it is unclear what the true marginal reserve cost of deposit supply would be. Thus the deposit reserve cost was less for national than for state banks, and similarly, the effective required reserves on notes were less than the legal reserve requirement τ.

Greenbacks were not the only legal reserve for note issue; gold and interest-bearing legal tender notes were other options. From the standpoint of the model's solution, it is necessary to verify that greenbacks were the *marginal* reserve asset. To discover whether greenbacks were the marginal reservable asset one must check to see that: (1) required reserves for total notes issued exceeded the available supply of interest-bearing legal tender notes; and (2) required reserves for outstanding notes did not exceed the available supply of greenbacks plus interest-bearing legal tender. These are sufficient conditions because the order of opportunity

Banks' note supply

The supply of national bank notes depended on the expected profitability of bank note issues. Banks which devoted a unit of capital to purchasing bonds as backing for notes earned dividends from government bonds purchased, less the cost of holding zero-interest greenback reserves and paying a 1 percent tax on notes outstanding. The supply function for national bank notes, given free entry, takes the form of a zero-economic-profit condition. The profit condition, derived in the Appendix, may be written:

$$s = L(i_b - (0.9\tau)i_l - 0.009) - \pi^e, \qquad (4)$$

where s is the real expected marginal profit rate banks earn from devoting capital to purchasing bonds in order to issue zero-interest bank notes, π^e is expected inflation, τ is the proportion of greenback reserves required relative to notes issued, and i_l is the expected return to bank loans.[5] s is given exogeneously by alternative uses of bank capital. The profit rate reflects (the inverse of) the amount of capital one must devote to the purchase of bonds (L), the yield earned on government bonds (i_b), the opportunity cost of holding greenback reserves on bank notes [$(0.9\tau)i_l$], and the federal tax on bank note issues [0.009]. The coefficient 0.9 on the greenback reserve cost term reflects a 111 percent bond reserve requirement, and the 0.009 tax cost reflects a 1 percent federal tax on national bank notes, again multiplied by the note-to-bond reserve ratio.

Footnote 4 (*continued*)

cost from highest to lowest was gold, then greenbacks, then interest-bearing reserves. These conditions are verified easily. As shown in Table 1, the total supply of notes from 1868 to 1878 varied between \$300 million and \$340 million, while total outstanding greenbacks varied between \$314 million and \$348 million because they exclude issues not in circulation. During this period, interest-bearing legal tender notes were not sufficient to provide required reserves for all bank notes. Interest-bearing legal tender consisted of the one- and two-year notes of 1863 and the compound interest notes of 1863 and 1864. By 1867, only the compound-interest notes circulated. National bank holdings of these notes reached a peak of \$84 million in 1867. (*The Report of the Comptroller of the Currency,* 1879). The compound interest notes were exchanged for the 3 percent certificates of 1867. By the end of 1868, interest-bearing legal tender had practically disappeared from the economy. Even in 1867, bank holdings of legal tender currency always exceeded holdings of compound interest notes. This means that greenbacks were needed over and above interest-bearing reserves. The supply of greenbacks was sufficient to keep banks from resorting to gold. Therefore, greenbacks were clearly the relevant reservable asset for notes for 1868–1878.

[5] The relevant i_l is the lowest i_l among banks eligible to issue notes, since banks competed nationally in supplying notes. Legal requirements ranged between 5 percent and 25 percent depending on the date and location of the bank. Initially, only New York banks were required to keep the full 25 percent reserves; other cities' banks had a small effective reserve requirement of 12.5 percent; country banks had an even smaller requirement of 6 percent. In June 1874 reserve requirements were lowered for all banks to 5 percent. Presumably the true costs of holding greenback reserves were less than that indicated in equation (4), since superfluous reserves on bank notes would allow national banks to reduce reserves they would otherwise hold against deposits.

Steady-state equilibrium

We solve for the steady state where prices adjust fully and real output is predetermined in factor markets ($y = \bar{y}$).[6] Let the real rate of interest in the private bond market be determined exogeneously by international productive opportunities and time preference $r_{pb} = \bar{r}_{pb}$.[7]

For simplicity, assume that the real return on bank loans r_l equals the real rate on bonds, due to arbitrage between bank and bond finance. Abstracting from risk differentials, $r_l = \bar{r}_{pb}$.

Banks were not the sole holders of reservable bonds. As Cagan (1965) and Friedman and Schwartz (1963) point out, this holds throughout the period of greenback suspension. In this case, the real rate of return on bonds used as reserves for bank notes is governed by arbitrage across bond markets and is exogeneous to the supply and demand of bank notes. Thus, abstracting once again from risk differentials, $r_b = \bar{r}_{pb}$.

Rewrite equation (4) under our assumption of common real expected rates of return across financial markets ($r_{pb} = r_b = r_l$):

$$\pi^e = \frac{s - L(1 - 0.9\tau)r_{pb} + 0.009L}{L(1 - 0.9\tau) - 1}, \tag{5}$$

where $[L(1 - 0.9\tau) - 1]$ is positive (see the derivation in the Appendix). Equation (5) determines the equilibrium rate of expected inflation, and hence, the equilibrium nominal interest rate ($\bar{r}_{pb} + \pi^e$). Under the assumptions that banks earn a competitive return on capital devoted to note creation, and that the cost of a government "license" to issue currency is described in equation (4), equation (5) solves for the level of inflation (or deflation) which is consistent with zero economic profits to marginal note-issuing banks. Intuitively, the potential profitability of issuing national bank notes limits the equilibrium rate of seigniorage (or inflation tax). Note that for identical non-negative values of r_{pb} and s equation (5) implies a positive nominal interest rate, since $\pi^e > -r_{pb}$.

Even under such simplifying assumptions, with many variables determined exogenously to monetary policy, N and P remain indeterminate in equations (1) through (4) in the absence of a description of the process by which price *level* expectations are formed. Rewrite equation (1) substituting $\bar{r}_{pb}$, $\bar{y}$, and π^e from equation (5):[8]

$$\left(\frac{B}{P}\right)^* = h\{\bar{y}, \bar{r}_{pb} + \pi^e\}. \tag{6}$$

[6] For evidence to support the assumption of relatively short-run price flexibility for this period see Sachs (1980), Calomiris (1985), Calomiris and Hubbard (1986, 1987), and Delong and Summers (1984), as well as the discussion in Section III.

[7] Real interest rate parity equations which equate pound-dollar forward premia with the London–New York commerical paper rate differential (using monthly data) support this assumption. (See Calomiris and Hubbard (1987)).

[8] Note how different the solution would be under maintained specie parity. If a credible government return to fixed gold parity were accomplished, π^e would be exogenous. At the same time, the supply of greenbacks would be determined by redemption at the Treasury, in order to bring supply and demand into equilibrium.

Equation (6) solves for real bills $(B/P)^*$ but not for N, B, or P. From equations (2) and (3) we have:

$$\frac{G - G^b + N}{P} = \left(\frac{B}{P}\right)^*, \tag{7}$$

or

$$\frac{G + (1-\tau)N}{P} = \left(\frac{B}{P}\right)^*. \tag{8}$$

Given G and $(B/P)^*$ there is no unique solution for B^*, N^*, and P^*.

A unique solution for nominal bills, notes and the price level can be obtained if one adds to these equations an expectation of a particular greenback price of gold (ε) at some fixed point in the future due, say, to certain resumption at par at time x:

$$E\varepsilon_x = 1. \tag{9}$$

Assume the gold price of commodities (P^s) is given on world markets:

$$\bar{P}^s = \frac{\varepsilon}{P}. \tag{10}$$

This assumption is defended in Section III, below. Setting $\bar{P}^s = 1$ we have:

$$EP_x = 1. \tag{11}$$

This terminal condition for the price level, together with the equilibrium rate of inflation from (5), determines a unique price path P_t recursively. Given τ, G, $(B/P)^*$, and P_t we can solve for B_t and N_t as well.

Thus expectations are crucial for determining the levels of nominal variables. Note that *changes in G have no effect on the equilibrium time path of price or the exchange rate*. The time paths of the price level and the exchange rate instead depend crucially on the probability of parity resumption and its timing. As the likelihood of parity resumption rises or as events occur which lead people to anticipate that resumption will happen sooner than they had previously expected, the price level will fall. Political news of changes in resumption policy, or changes in fiscal policy which affect the ability or the costliness of the government's resuming would influence the current exchange rate and price level.[9]

[9] In order to verify that our equilibrium solution is appropriate we must make sure that the equilibrium values we derive do not lead to contradictions of our assumptions. The first condition to verify is the bondholder arbitrage condition. This is only relevant if the public is holding some of the bonds used by banks as reserves—that is, if banks are not holding all government bonds as required backing for bank notes. Implicitly we have assumed that:

$$RB^s > (1.1)N^*,$$

where RB^s is the exogenous supply of "reservable" bonds. If this condition were violated, equation (5) would no longer hold. In this equilibrium case, N^* would be directly constrained

The intuition for the result that the price level is independent of greenback supply is that so long as an endogenous perfect substitute (bank notes) exists for nominal greenbacks on the *margin*, the nominal supply of greenbacks will have no effect on the nominal equilibrium supply of total bills, and hence will have no effect on the time path of the price level. This is illustrated in Fig. 4. The current price level is given by world gold prices and resumption expectations. The real supply function for bills has two components: the exogenous (vertical) supply of greenbacks and the (horizontal) supply function for national bank notes. Marginal changes in the supply of greenbacks (shifts to the right or left in the supply function) are offset by changes in national bank note supply; real money, the price level, nominal bills, and expected inflation remain the same.[10]

Footnote 9 (*continued*)

by the scarcity of reservable bonds:

$$N^* = (0.9)RB^s.$$

Starting at time x we would solve recursively for the expected inflation rate using this path of N^* and the condition $EP_x = 1$, in order to satisfy the demand function for real bills. In this case, the time path of price would be influenced by the supply of greenbacks, because an increase in the supply of greenbacks would not be offset by a reduction in the supply of notes. Of course, this would only be true for a limited range of increases in G, since large increases in G would eventually cause a relaxation of the bond supply constraint. These ruminations are, from the standpoint of history, quite beside the point, since the assumed condition was never violated during the period of greenback suspension (see Friedman and Schwartz (1963), p. 23).

Another counterfactual caveat to our equilibrium arises from the potentially binding constraint that the total supply of greenbacks poses for the supply of national bank notes. In other words, our solution implicitly requires that, at each point in time,

$$N^* < \frac{G}{\tau}.$$

Otherwise, the public holds no greenbacks and the requirement that banks redeem bank notes in greenbacks on request implies only a one-sided arbitrage condition: The price level denominated in greenbacks (P^g) must be greater than or equal to the price level denominated in bank notes (P^n):

$$P^g \geqslant P^n.$$

In this case,

$$B^* = \frac{G}{\tau}.$$

Now the equilibrium rate of expected inflation, the time path of B^* and the condition $EP^g = 1$ would be used to solve recursively for P^n in order to satisfy the real demand for bills. As before, this caveat is irrelevant to the history of greenback suspension, because the public always held greenbacks as well as bank notes (see Table 1).

A final counterfactual caveat involves the non-negativity constraint on national bank notes. If $N^* = 0$ then $B^* = G$. In this case, one would solve recursively for the time path of price and inflation given EP_x and the demand function for real bills.

[10] In principle, changes in the supply of greenbacks could influence expectations of government resumption policy (and hence, the current exchange rate) by altering the potential gain to the government from default. Empirical evidence reported below, however, does not support such a connection between greenback issues and exchange rates.

Adding the demands for gold and deposits to the model

In addition to bills, the public held deposits and used gold for foreign transactions, domestic transactions (especially in California), and potentially for portfolio diversification. Write the demand for gold as:

$$\left(\frac{C\varepsilon}{P}\right)^D = \gamma(y, i_{pb}, i_d, f); \qquad \gamma_1, \gamma_4 > 0, \qquad \gamma_2, \gamma_3 < 0, \tag{12}$$

where C is the gold holdings of the public, i_d is the interest rate earned on deposits, and f is the expected rate of greenback depreciation relative to gold. The demand functions for bills and deposits Q take the form:

$$\left(\frac{B}{P}\right)^D = h(y, i_{pb}, i_d, f); \qquad h_1 > 0, \qquad h_2, h_3, h_4 < 0, \tag{13}$$

and

$$\left(\frac{Q}{P}\right)^D = \delta(y, i_{pb}, i_d, f); \qquad \delta_1, \delta_3 > 0, \qquad \delta_2, \delta_4 < 0. \tag{14}$$

Given (10), expected inflation and currency depreciation are equal:

$$\pi^e = f. \tag{15}$$

Abstracting from the spread between bank loan and deposit rates of return, we may rewrite equations (12) through (14) to solve for equilibrium values of real bills, deposits, and gold:

$$\left(\frac{B}{P}\right)^* = h\{\bar{y}, \bar{r}_{pb} + \pi^e, (\bar{r}_{pb} + \pi^e), \pi^e\}, \tag{16}$$

$$\left(\frac{Q}{P}\right)^* = \delta\{\bar{y}, \bar{r}_{pb} + \pi^e, (\bar{r}_{pb} + \pi^e), \pi^e\}, \tag{17}$$

$$(C\bar{P}^s)^* = \gamma\{\bar{y}, \bar{r}_{pb} + \pi^e, (\bar{r}_{pb} + \pi^e), \pi^e\}. \tag{18}$$

As before, in order to solve for B^*, N^*, and P^* one must incorporate price expectations from equation (11). C^* and Q^* are derived solely from the demand equations and the assumption of perfectly elastic gold and deposit supplies (i.e., exogenous real interest rates).

Forming price expectations under uncertainty

When resumption is uncertain agents update their beliefs about the timing and likelihood of resumption as news emerges of changes in the government's ability or willingness to resume convertibility.

What would have determined the value of greenbacks if the government had announced a credible policy of never returning to any maintained parity? To the extent that this event had a positive probability, the potential purely fiduciary value of greenbacks was relevant for their current value. In the context of our model, without an expectation of a future price level, the current price level is indeterminate, because the total supply of bills is endogenous. Additional assumptions regarding the behavior of the government under a fiduciary regime are necessary to solve this indeterminacy problem.

A simple solution to this probelm is to posit a target price path under the potential fiduciary regime, to which all other government policy instruments would adjust. For simplicity, assume the fiduciary target path would be $P_t = \hat{P}$ for all time. As long as $\hat{P} > 1$, expectations of a quicker or more likely return to maintained parity would lead today to currency appreciation and price deflation. Assuming resumption is expected to occur, or not to occur, at time x, the expectation at time t of the price level at time x is the probability weighted sum of par value and the fiduciary price level:

$$E_t P_x = \tilde{a}_t(1) + (1 - \tilde{a}_t)\hat{P}, \tag{19}$$

where $\tilde{a}$ is the probability of resumption, and $\hat{P} > EP_x > 1$. Under risk neutrality, to arrive at the current price level P_0 one solves for the price path recursively from $E_0 P_x$ using the value of π^e derived from equation (5):

$$P_0 = (E_0 P_x) \exp(-\pi^e x). \tag{20}$$

"News" which implies quicker expected resumption (a reduction in x), a higher probability of resumption, or a lower expected fiduciary price level, all reduce the price level today:[11]

$$P_0 = Z(\tilde{a}, x, \hat{P}); \qquad Z_1 < 0,\ Z_2,\ Z_3 > 0. \tag{21}$$

III. Empirical evidence

My empirical efforts to verify the applicability of the model presented in Section II to the period of greenback suspension divide in two: first, to evaluate some of the assumptions which underlie the model; second, to provide evidence in support of the connection between expectations of appreciation and the perceived long-run backing of the currency.

Verifying the assumptions of the model

Among the important assumptions of the model in Section II are: (1) free entry in bank note supply (2) the efficiency of asset markets; and (3) the

[11] An extension of the model would be to consider the behavior of risk-averse agents, for whom higher moments of probability distributions would be relevant. If agents were risk-averse, for example, mean-preserving increases in the variance of density functions for the timing of resumption and the fiduciary equilibrium price would reduce the current value of greenbacks relative to gold (and commodities). Risk aversion is potentially important for understanding the portfolio demand for gold in an equilibrium with expected deflation. The findings of Roll (1972) and those discussed below suggest that deflation was expected, and we know gold was held by many agents, though one might argue that foreign transactions and California regulations, rather than risk-aversion, were at the heart of the demand for gold. Gold was required to pay interest on coin-paying bonds, to pay duties, for foreign trade, and for transactions in California (see Lester (1939)).

international determination of commodity gold prices. I discuss each in turn.

A free-entry caveat: the nominal ceiling on national bank notes, 1867–1870

Our model assumes an endogenous, competitively supplied level of national bank notes; yet national banks did not come into existence until 1863 and a nominal ceiling of $300 million was placed on bank note supply initially. Once that amount had been subscribed, no more notes could be issued. As Dewey (1903) shows, the aggregate note ceiling was a binding constraint through 1870, though legislated regional distribution guidelines were never enforced.[12] The raising of the note ceiling constraint in July 1870 to $354 million rendered the ceiling irrelevant until it was eliminated altogether in January 1875. Still, from 1867 until 1870 the $300 million ceiling on notes, together with the supply of greenbacks, fixed the supply of nominal bills (see Fig. 2). The effective ceiling on notes until July 1870 made greenbacks supply a binding constraint on total bills. Potentially, this could have exerted an important influence on nominal variables.

Analyzing the effect of the supply of greenbacks on the price level and exchange rate for the period 1862–1866 is difficult because the supply function for state bank notes and their substitutability with greenbacks would have to be specified, as well as the peculiarities of the initial period of adjustment in national bank note supply from 1864 to 1867. Instead I focus on the period from 1867 on.

How does the $300 million national bank note ceiling change the solution for the equilibrium time path of price for 1867 to 1870? The solution depends on whether agents anticipate the relaxation of the note supply constraint. Suppose first that they do. Then from the time the constraint is relaxed, t_1 to time x, the equilibrium is as before. From the initial moment to t_1, one solves for the time path of price recursively using the price level at t_1 as the starting point. π^e at t_1 is the (higher) rate of expected inflation consistent with $\bar{N}$ (the note ceiling), the price level at t_1, and the real bills demand function.

Note that equation (6) no longer determines π^e; in the presence of the note ceiling, competition among banks for providing notes does not occur. Instead equation (6) solves for the new higher level of equilibrium seigniorage rent, s, given the solution for π^e.[13] If prior to its removal the

[12] See Dewey (1903), pp. 385–387.

[13] The rate of seigniorage on note issues is difficult to measure directly. First, the calculation depends crucially on the measured opportunity cost to banks in the loan market, which James (1976) argues varied greatly across regions. Second, the extent of leveraging of bank capital in bond purchasing by banks is crucial and unclear. Third, there may be invisible costs or benefits to banks from issuing notes. Finally, effective reserve requirements varied depending on the location of the bank and its reserve-to-deposit ratio. These issues are discussed in the Appendix.

Calomiris (1985) reports measures of nominal seigniorage. Though these estimates provide only a very rough indication of nominal profitability, perhaps with greater confidence one can discuss the estimated changes in note profitability through time. The removal of the nominal

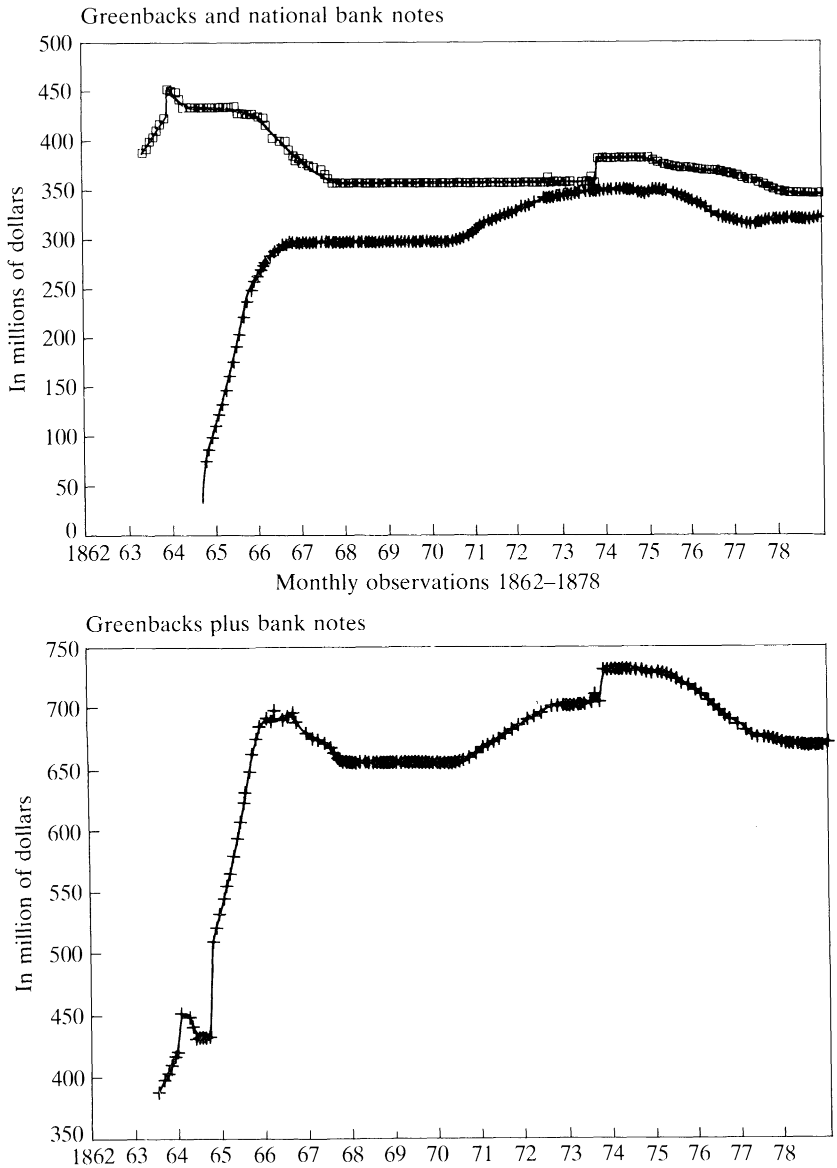

FIG. 2. Greenbacks and National Bank Notes

Footnote 13 (*continued*)

ceiling on notes does not seem to have had a large impact on nominal profits, though by all measures there is a slight decline in profit from the end of 1870 to the end of 1871. At the same time there was a 0.5 percent decrease in estimated long-run expected deflation, therefore, the small nominal decline in seigniorage may have been associated with a slightly greater real decline. For 1874–78, however, nominal and real profitability rise to higher levels. This confirms the view that profits from note issue were not significantly higher during the period the ceiling acted as an effective constraint, and that the ceiling offered little liquidity rent to note issuers.

ceiling were expected to persist, then one would solve in the same manner for the time path of price recursively from P_x rather than P_1.

Under the binding note ceiling expectations of resumption remain an essential component of the solution for the price level and exchange rate through their effect on ε_x and P_x, but the price and exchange rate paths from time zero to the time the ceiling is relaxed also will depend on the inital exogenous level of bills supplied. The level of nominal notes initially supplied, along with P_x, determine the equilibrium rate of seigniorage, and therefore, the rate of inflation.

One way to measure the importance of the ceiling's effect on the time path of price from 1867 to 1870 is to compare short-run expected rates of inflation before 1870 with those afterward. If the ceiling was important, expected rates of inflation should have been higher before 1870 than after.

No comparable short-term yields on gold- and greenback-denominated securities exist from which to derive inflation expectations. Actual annual inflation and greenback depreciation for 1867 through 1878 are provided in Table 2. Though *ex post* data may be poor indicators of the relevant *ex ante* series, to the extent that annual inflation and depreciation were foreseen, Table 2 suggests that expected inflation or greenback depreciation was not

TABLE 2
Annual Rates of Inflation and Greenback Depreciation

	Percent Inflation	*Percent Greenback Depreciation*
July 1867–July 1868	−2.47	2.43
July 1868–July 1869	−5.33	−4.18
July 1869–July 1870	−9.78	−15.21
July 1870–July 1871	−6.24	−3.26
July 1871–July 1872	7.68	1.06
July 1872–July 1873	−2.94	1.40
July 1873–July 1874	−5.83	−4.85
July 1874–July 1875	−5.63	4.37
July 1875–July 1876	−9.38	−2.88
July 1876–July 1877	−0.94	−5.83
July 1877–July 1878	−15.48	−4.19

Sources: Inflation is defined using the Warren-Pearson monthly wholesale price index, *Historical Statistics of the United States,* first edition, series app. 24, Greenback depreciation relative to gold is measured using end-of-month exchange rates reported in *Hunt's Merchants' Magazine* and *The Commercial and Finanical Chronicle*. Inflation and depreciation are measured as rates of change in the three-month averages of the price index and exchange rate, centered in July.

reduced after July 1870. If one compares the three years before July 1870 with the three following years, inflation and currency depreciation actually were greater on average in the later period.

These considerations suggest that from 1867 to 1870 the nominal ceiling on bank notes was not an important influence on the value of greenbacks. That is, the constrained and (counterfactual) unconstrained levels of nominal bank note supply were not very different from 1867 to 1870.

Market efficiency: tests and implications

Is it appropriate to assume that exchange rates and prices reflected informed expectations of fiscal policy and the long-run backing of the currency? What evidence can one muster to show that markets responded efficiently to news and that fiscal policy was an important component of news?

Market efficiency is separate from the issue of what constitutes news; but if gold market efficiency can be defended empirically, this may shed light on the question of what variables the market reacts to as news. For example, if exchange rates follow a random walk, then short-run innovations in exchange rates have a permanent effect. It follows that the "random" component of the exchange rate series reflects "fundamentals" of short- and long-run exchange rate determination. Variables which reflect important news of long-run interest should be correlated with these unpredictable short-run changes in exchange rates.

Roll (1972) shows that partial autocorrelations among innovations in weekly and monthly gold/greenback exchange rates provide evidence in favor of a random walk, and therefore, market efficiency. In order further to test market efficiency I regress—using end-of-month data—the natural log of the exchange rate on its lagged value and test the residuals of the regression for autocorrelation. The random walk specification is a more restrictive one, because it constrains the coefficient on the lagged term to be unity.

ARIMA identification procedures suggest either an AR(1) process or a random walk. As Table 3 shows, the estimated coefficients for the AR(1) specification are very close to unity. Furthermore, differencing does not produce strong negative first order serial correlation of errors. Together, these results indicate that the series is probably best described as a random walk. Results are reported for both specifications in Tables 3 and 4. The regression equations and significance levels for partial autocorrelation tests of the residuals are described in Table 3. These tests confirm the efficiency hypothesis. No significant seasonality or moving average process is evident in monthly exchange rate movements. Partial autocorrelations are given in Table 4, for the whole period and for three subperiods divided by the end of the Civil War and the Resumption Act of 1875. Furthermore, changes in sign and magnitude of the partial autocorrelation coefficients from

TABLE 3
Modeling Exchange Rate Movements

Sample	Lag Coefficient*	Constant*	Standard Error	Q Statistic†	Q Significance Level
		AR(1) Equations			
1862, 1–1865,4	0.904	0.0499	0.094	$Q(18) = 10.7$	0.91
	(16.02)	(1.78)			
1865,5–1875,1	0.964	0.0058	0.027	$Q(30) = 39.9$	0.11
	(42.6)	(1.04)			
1875,2–1878,12	0.978	−0.0009	0.015	$Q(18) = 16.2$	0.58
	(25.05)	(−0.25)			
1862,1–1878,12	0.976	0.0075	0.047	$Q(42) = 49.2$	0.21
	(53.7)	(1.43)			
		Random Walk Equations			
1862,1–1865,4	N/A	0.010	0.0965	$Q(18) = 10.1$	0.93
		(0.63)			
1865,5–1875,1	N/A	−0.002	0.0268	$Q(30) = 40.5$	0.09
		(−0.89)			
1875,2–1878,12	N/A	−0.003	0.0144	$Q(18) = 17.0$	0.52
		(−1.25)			
1862,1–1878,12	N/A	0.000	0.0473	$Q(42) = 51.4$	0.15
		(0.00)			

*t-statistics are in parentheses.

† The Q statistic measures the joint significance of the partial autocorrelation coefficients, adjusting for increases in the standard errors of estimated coefficients as the lag length increases. See Box and Jenkins (1976), p. 394.

subperiod to subperiod suggest that trading rules derived from previous observations would not have been profitable out of sample.[14]

International determination of commodity gold prices

For our steady-state model to be applied to short-run price movements two strong assumptions regarding commodity price determination must be satisfied: first, that prices adjust *quickly* to shocks which alter the equilibrium price level; and second, that world gold prices are homogenous

[14] Friedman and Schwartz recognize the influence of expectations on bond prices. Furthermore, they realize that given the high gold yields on bonds, there is evidence that bond dealers expected a rise in the gold value of greenbacks (pp. 72–74). Why then did they not include these expectations in their analysis of greenback valuation? On this point, Friedman and Schwartz are silent except for the comment that "the purchasers of government securities were a much more mixed and broader group than the speculators in foreign exchange were, so we are dealing with the expectations of two very different groups" (Friedman and Schwartz, p. 73, footnote 82). Roll (1972) and Russel (1976) note the inconsistency of the position taken here by Friedman and Schwartz.

TABLE 4
Partial Autocorrelation Functions of Residuals

	Log Levels AR(1)				*Random Walk*			
Lag	1862,1–1865,4	1865,5–1875,1	1875,2–1878,12	1862,1–1878,12	1862,1–1865,4	1865,5–1875,1	1875,2–1878,12	1862–1878,12
1	0.186	0.105	−0.165	0.176	0.171	0.088	−0.180	0.162
2	−0.112	−0.172	−0.212	−0.065	−0.121	−0.187	−0.235	−0.077
3	−0.066	−0.024	−0.221	−0.062	−0.067	−0.043	−0.255	−0.075
4	0.170	−0.077	0.032	0.164	0.180	0.096	−0.011	0.152
5	−0.177	−0.129	−0.015	−0.124	−0.166	−0.154	−0.055	−0.135
6	0.112	−0.124	0.210	0.084	0.125	−0.155	0.177	0.072
7	0.038	−0.129	0.120	0.031	0.059	−0.170	0.100	0.022
8	−0.121	0.021	−0.047	0.013	−0.105	−0.027	−0.064	0.002
9	−0.147	−0.015	0.313	0.090	−0.135	−0.066	0.307	−0.101
11	−0.203	0.001	−0.064	−0.100	−0.187	−0.053	−0.060	−0.113
10	−0.168	0.283	−0.126	−0.022	−0.158	0.237	−0.129	−0.037
12	−0.109	0.055	−0.164	−0.003	−0.118	0.023	−0.174	−0.022
13	−0.022	0.025	0.114	0.051	0.020	0.000	0.105	0.033
14	0.012	0.146	0.056	−0.018	0.028	0.132	0.056	−0.034
15	−0.160	0.040	−0.147	−0.153	−0.153	0.031	−0.148	−0.173
16	0.219	0.091	0.029	0.179	0.252	0.088	0.026	0.162
17	0.065	−0.125	0.012	0.032	0.097	−0.126	0.015	0.018
18	−0.085	0.034	−0.083	0.050	−0.036	0.031	−0.084	0.039
19	−0.098	−0.055	−0.130	0.000	−0.035	−0.057	−0.135	−0.008
20	−0.098	0.003	−0.034	−0.015	−0.066	0.000	−0.042	−0.027

across countries within narrow bandwidths of autonomous domestic variation which result from information and transaction costs. The bandwidths must be narrow in the sense that most price variation—especially persistent large price changes—is governed by common international factors.

Before summarizing the evidence which supports these assumptions it is worth emphasizing that neither short-run price flexibility nor common international commodity gold prices is a crucial assumption for the main conclusion of our model—that long-run price level movements are determined by policy expectations rather than by exogenous money supply innovations. If we relax these two assumptions—allow prices to adjust sluggishly and assume an exogenously-determined domestic supply of gold, instead of international price arbitrage to which the supply of gold is endogenous—our long-run equilibrium would be different only in the role played by the fixed supply of gold. Fiscal news still would fix exchange rates, while the price level would be influenced by exchange rate changes as well as the level of gold supply.

In support of the assumption of rapid price adjustment, one can appeal to the relative homogeneity of commodities in the nineteenth century and the relative absence of labor market contracting. Using monthly data for 1879 through 1914, Calomiris and Hubbard (1986) find evidence of rapid adjustment of prices, relative to output, to shocks which affect both price and output over the course of the business cycle—the reverse of the standard result for post-World War II data. These results confirm those in Sachs (1980) and DeLong and Summers (1984).

Calomiris and Hubbard (1987) present evidence of two kinds in favor of elastic gold flows and common short-run international determination of commodity gold prices for the period 1879 to 1914. ARIMA models and event studies indicate that perturbations in the demand for gold are resolved within approximately three months. Tariff-adjusted price ratios for sugar, wheat and cotton yield estimated transaction-cost bandwidths of approximately 10 percent of traded goods prices in both the short and long runs. These results indicate that short-run variations in commodity prices mainly reflect rapid, common international adjustment and that full adjustment occurs rapidly.[15]

[15] For convenience, the model of Section II carries the assumption of common international gold prices a step farther to the assumption of common gold-price levels, or "purchasing power parity (PPP)." In the real world, of course, changes in the composition of consumption and investment goods will alter the price deflator relevant for asset demand equations even when individual commodity prices are constant. Moreover, nontraded goods may not bear as close a relation to one another across countries as traded goods, though McCloskey and Zecker (1985) argue nontraded goods prices should be linked by common factor costs. The upshot of these considerations is that in empirical work one would expect to find persistent deviations, or drift over time, in a PPP index, which reflects the changing composition of goods, and the bandwidths of autonomous domestic variation. This qualification of the model in Section II implicitly is included in the empirical model reported below. The domestic price equation is estimated in log first-differences with foreign price terms on the right-hand side. In addition, several lagged domestic price terms which appear on the right-hand side could approximate an MA(1) process in domestic price change, which would allow drift over time in the PPP index.

Evidence from reduced-form vector autoregressive (VAR) models confirms that unpredictable changes in price indexes are highly correlated between the U.S. and Britain, and that full adjustment of U.S. or British price levels to simulated shocks originating in the other country's prices essentially takes place within six months. Calomiris (1985, chapter 3) finds, for the period 1867 through 1878, that the correlation between monthly unpredictable wholesale price inflation in Britian and the U.S. ranges from 0.3 to 0.4 depending on the variables included in the forecasting equations.

Testing the predictions of the model

The model of Section II implies that news relevant for movements in exchange rates and prices primarily involves expectations of future government policy. Here I present evidence of three kinds in support of the importance of fiscal news: first, evidence from securities markets that changing perceptions of the long-run specie value of greenbacks were linked to expectations of resumption; second, exchange rate data on the value of greenbacks relative to government money with different backing (the old demand notes); third, evidence from a vector autoregressive model which shows that government bond "funding" policy was an important element of news in exchange rate determination.

Expected appreciation: evidence from bond-market yields

According to equation (4), the equilibrium expected rate of deflation and currency appreciation is given by expected real rates of return in financial markets, marginal reserve requirements, the tax on bank note issues, and the degree of capital leveraging in note issuing. This suggests that the long-run pattern of exchange-rate appreciation and price deflation should have been largely anticipated, and that forecast errors in long-run expected inflation should be related to news about the timing and likelihood of resumption, since actual appreciation is the sum of predictable smooth changes in the exchange rate and unpredictable leaps related to news.

Evidence in support of deflationary expectations comes from comparisons of yields on greenback- and gold-denominated securities. Interest differentials between bonds which paid in greenbacks and those which paid in gold were negative, which implies an expected capital gain on greenback-denominated principal. Roll (1972) reports this result for the Civil War years, using government securities of similar maturity denominated in greenbacks and coin for comparison.[16]

[16] There is some question regarding the extent to which Roll is able to attribute differences in interest rates to differences in the numeraire of the securities. Whether before 1869 government bonds were seen as gold-denominated *ex ante* is a subject of debate. Roll claims that his observed yield differentials provide evidence for a perceived difference in numeraire. He recognizes, however, that there are alternative interpretations of his results and that, therefore, interest rate differences may reflect other factors in addition to expectations of exchange rate changes (e.g., a premium related to the relative riskiness of greenback-denominated securities).

TABLE 5
Bond Yield Differentials and Long-Run Appreciation

	(1) *Average Differential Between Gold and Greenbacks Yield**	(2) *Expected Appreciation (Current Differential Less Differential for July-December* 1878)	(3) *Average Actual Rate of Greenbacks Appreciation to* 1881†	(4) *Appreciation Forecast Error* (2)–(3)
January–June 1869	1.33	3.53	2.00	1.53
July–December 1869	0.49	2.69	1.85	0.84
January–June 1870	−0.52	1.68	0.93	0.75
July–December 1870	−0.42	1.78	0.93	0.85
January–June 1871	−1.01	1.19	1.09	0.10
July–December 1871	−0.95	1.25	1.10	0.15
January–June 1872	−0.02	2.18	1.26	0.92
July–December 1872	0.01	2.21	1.40	0.81
January–June 1873	−0.09	2.11	1.90	0.21
July–December 1873	−0.26	1.94	1.39	0.55
January–June 1874	−0.65	1.55	1.60	−0.05
July–December 1874	−0.45	1.75	1.50	0.25
January–June 1875	0.07	2.27	2.36	−0.09
July–December 1875	0.09	2.29	2.30	−0.01
January–June 1876	−1.19	1.01	2.50	−1.49
July–December 1876	−1.07	1.13	1.76	−0.63
January–June 1877	−1.22	0.98	1.36	−0.38
July–December 1877	−1.21	0.99	0.84	0.15
January–June 1878	−1.32	0.88	0.40	0.48
July–December 1878	−2.20	0.00	0.10	0.10

* $\frac{1}{6}\sum_{j=1}^{6}[i_{sp}(j) - i_{gr}(j)] = d.$

† The average of monthly exchange rate closings for the period was used to measure the current gold price of greenbacks. The 6s of 1881 were redeemable June 1, 1881.

Source: Calomiris (1985).

For the later period, no comparable greenback-denominated government bonds exist for comparison. Yields on low-risk, greenback-denominated railroad bonds and coin-denominated government bonds are available, however, though time varying default risk differentials and splicing of different railroads' yields introduce potential errors into the measurement of expected deflation. Calomiris (1985, chapter 3) constructs a measure of expected appreciation, under the assumption of constant default risk differentials among government bonds and highest-quality railroad bonds of similar maturity, for the period from 1869 to 1878, when the redemption of government bond principal in gold was a virtual certainty.[17]

The risk-adjusted yield differential thus calculated (reported in Table 5)

[17] Government credibility was established by the actual redemption of bond principal in gold, as well as by the Act of March 18, 1869 guaranteeing payment in gold, and the Supreme Court decision in Veazie Bank v. Fenno which supported the constitutionality of gold clauses.

indicates a consistent expectation of appreciation throughout the period. Expected and actual greenback appreciation are close for much of the period. Of course, whenever imputed expected appreciation is greater than actual, this reflects either time-varying default risk or measurement error, since no one would have expected appreciation beyond the parity level.

There is a slight negative trend in the imputed forecast error series (column (4) of Table 5) which may reflect peculiarities in the splicing of the series, or an unpredictable trend in policy.[18] The large value of 1.53 in column (4) for the first half of 1869 is consistent with the fact that 1869 was a turning point in the government's commitment to the redemption of bond principal in gold. Most of the subsequent entries in column (4) are relatively close to zero, which indicates that deflationary expectations were generally accurate, and the risk premium differential was fairly constant.

The large negative value of −1.49 for early 1876 is consistent with Unger's (1964) description of the political controversy and consequent forecast error regarding the future of resumption policy prior to the election of 1876. The first half of 1876 was the time of greatest challenge to the timely resumption of specie convertibility stipulated by the Resumption Act of 1875. The Democrats were divided between "hard"- and "soft"-money advocates. The desire to maintain party unity and to attract soft-money independents led to a tolerance of the soft-money minority in the Democrat-controlled Congress. Repeated attempts by soft-money Democrats to force consideration of the repeal of the Resumption Act prior to the election were thwarted by procedural rules and then finally by the nomination of the hard-money candidate Tilden. The repeal movement failed to force the issue prior to the election in an attempt to extract a price for party unity. Tilden's empty promises to postpone resumption and a party platform pledging the same were not viewed as credible commitments. The nomination of Tilden in July had effectively put to rest any true threat of a postponement of resumption. Even the house bill calling for postponement which passed August 5, 1876 was nothing more than a political ploy; it was kept vague deliberately and passed with a vote of 106 to 86, with 93 abstentions.

The old demand notes

Further evidence that the current specie value of greenbacks and other assets reflected expectations of resumption policy and long-run backing comes from Mitchell (1903). To bolster his argument that exchange rates were governed by fiscal news, Mitchell cites exchange rates between the demand notes of 1861 and the greenbacks of 1862. The demand notes were identical to the greenbacks in every respect, except that they were

[18] One thing this trend in errors does not support is Fels' (1959) conjecture that railroad defaults in 1873, which were important in the failure of Jay Cooke & Co., led to a general distrust of railroad securities. If Fels were right, one would expect, *ceteris paribus*, a positive trend in column (4).

acceptable for the payment of customs duties at par with gold, while greenbacks were not. Mitchell notes that this special tariff-backing allowed the demand notes to trade at a premium relative to greenbacks, as shown in Table 6. It is important to note that tariff backing was not immediate; until all demand notes had been paid in, agents had to value demand notes based on *expectations* of par valuation with gold, since not all demand notes could be redeemed immediately in payment of duties. Thus it was *expected* backing that distinguished demand notes from greenbacks.[19]

Debt funding policy as news

The conversion in the late 1860s of short-term paper-denominated government debt into long-term funded securities denominated in coin substantially reduced the potential benefit to the government of depreciating the currency. In mid-1865 government debt was split roughly evenly between obligations payable in lawful money and those payable only in coin. By mid-1867 coin-denominated securities out-numbered paper securities more than three to one, and by mid-1869 interest-bearing debt denominated in legal tender was less than 3 percent of total debt. There was some initial doubt regarding the government's intention to repay the principal of its coin-denominated debt in specie, but this was resolved in early 1869 when a combination of actual principal payments in specie, legislation mandating payment in specie, and a Supreme Court ruling made

TABLE 6
Relative Depreciation of United States Notes and Old Demand Notes At Various Dates in 1862 and 1863

Date	*Currency Value*		*Gold Value*	
	Gold	*Old Demand Notes*	*Currency*	*Old Demand Notes*
		1862		
April 12	$101\frac{7}{8}$	100	98·1	98.1
19	$101\frac{9}{16}$	100	98.4	98.4
26	$101\frac{9}{16}$	100	98.4	98.4
May 3	$102\frac{5}{8}$	100	97.4	97.4
10	$103\frac{5}{16}$	$100\frac{1}{4}$	96.8	97.0
17	$103\frac{1}{16}$	$100\frac{5}{8}$	97.0	97.6
24	$103\frac{1}{2}$	$100\frac{5}{8}$	96.6	97.2
31	$103\frac{9}{16}$	$100\frac{5}{8}$	96.6	97.2

[19] Because demand note supply was less than the sum of future tariff payments, the parity of gold and demand notes in payment of duties created a market parity between the two through arbitrage. The discounting of demand notes probably reflects the possibility of a future change in tariff payment parity. This discount explains why the demand notes were used instead of gold in payment of duties until their supply was exhausted. For more discussion of tax arbitrage constraints see Adam Smith (1776), p. 311; and Calomiris (1985).

TABLE 6 (*continued*)

Date	*Currency Value* Gold	*Currency Value* Old Demand Notes	*Gold Value* Currency	*Gold Value* Old Demand Notes
		1862		
June 7	$104\frac{1}{16}$	101	96.1	97.1
14	$105\frac{11}{16}$	103	94.6	97.5
23	$107\frac{3}{8}$	103	93.1	95.9
26	$100\frac{1}{8}$	$104\frac{1}{8}$	91.7	95.8
July 5	$109\frac{11}{16}$	$105\frac{1}{4}$	91.2	96.0
12	$114\frac{3}{16}$	$107\frac{1}{4}$	87.6	93.9
19	$118\frac{3}{8}$	108	84.5	91.2
26	$117\frac{1}{4}$	$106\frac{1}{2}$	85.3	90.8
August 2	$115\frac{1}{8}$	$105\frac{1}{4}$	86.9	91.4
9	$112\frac{11}{16}$	$105\frac{1}{2}$	88.7	93.6
16	$114\frac{9}{16}$	$107\frac{1}{2}$	87.3	93.8
23	$115\frac{1}{2}$	108	86.6	93.5
30	$115\frac{11}{16}$	$108\frac{1}{4}$	86.4	93.6
September 6	119	108	84.0	90.8
13	$118\frac{1}{8}$	$108\frac{3}{4}$	84.7	92.1
20	$116\frac{15}{16}$	$112\frac{1}{2}$	85.5	96.2
26	$120\frac{3}{8}$	$116\frac{1}{2}$	83.1	98.6
October 4	$122\frac{3}{4}$	$119\frac{1}{2}$	81.5	97.3
11	$128\frac{1}{8}$	$128\frac{3}{4}$	78.1	96.6
18	$130\frac{1}{8}$	129	76.8	99.1
25	$130\frac{5}{8}$	127	76.6	97.2
November 1	$130\frac{7}{16}$	$126\frac{1}{2}$	76.7	97.0
8	$132\frac{1}{4}$	126	75.6	95.3
15	$131\frac{7}{8}$	$126\frac{1}{2}$	75.8	95.9
22	$130\frac{5}{8}$	$124\frac{1}{4}$	76.6	95.1
29	$129\frac{1}{8}$	$124\frac{1}{2}$	77.5	96.4
December 6	$131\frac{1}{4}$	125	76.2	95.2
13	$131\frac{9}{16}$	$126\frac{1}{2}$	76.0	96.2
20	$123\frac{7}{16}$	$127\frac{1}{8}$	75.5	96.3
27	$132\frac{1}{4}$	129	75.6	97.5
		1863		
January 3	$134\frac{1}{8}$	129	74.6	96.2
10	$137\frac{13}{16}$	135	72.6	98.0
17	$147\frac{1}{4}$	143	67.9	97.1
24	$149\frac{3}{16}$	$144\frac{3}{4}$	67.0	97.0
February 7	$157\frac{1}{4}$	155	63.6	98.6
14	$155\frac{5}{8}$	151	64.3	97.0
21	$162\frac{3}{4}$	162	61.5	99.5
28	172	171	58.1	99.4
March 7	$155\frac{1}{8}$	153	64.5	98.6
14	$158\frac{1}{4}$	153	63.2	96.7

Sources: Data are from Mitchell (1903), p. 196, based on reported series in *Hunt's Merchants' Magazine*.

it clear that the principal of coin-denominated debt would not be paid with depreciated paper.[20]

Given the credibility of government debt repayment in coin and the reduction in the incentive to depreciate the currency which came from the changing debt composition, it follows that unanticipated changes in the composition of government debt may have been perceived as a component of news regarding the likelihood and timing of resumption. By reducing the amount of greenback-denominated debt, and consequently its incentive to depreciate the currency, the government may have signaled its intentions to redeem greenbacks in gold.

In order to investigate this proposition, I construct a vector autoregressive (VAR) model to measure the contributions of unpredictable changes in government debt composition and other variables in explaining movements in exchange rates, prices, and monetary aggregates.[21]

[20] The fact that the government always paid interest on bonds in gold and redeemed bond principal in gold ten years before greenback resumption indicates strong preferential treatment for bondholders. A reason for discrimination by the government in favour of bondholders over currencyholders may be that the bond market is a more competitive forum for funding. That is, if bondholders have access to many government bond issues, governments with poor reputations will find they face high interest costs, and perhaps, as Stiglitz and Weiss (1981, 1983) would suggest, increasing quantity constraints in bond markets. Thus there are strong incentives for a government to maintain its reputation among bondholders. If the elasticities of substitution between a government's currency issues and other media of exchange are smaller, the government may wish to ensure bond redemption first, and in some instances may even choose not to redeem currency when it has the ability to do so.

In their recent paper, "Suspension and the Financing of the Civil War: A Critique of Newcomb and Mitchell" (1984), Rolnick and Wallace conjecture that resumption expectations may have depended only on overall government fiscal expectations and, hence, suspension may have constituted only a change in numeraire relative to government finance without suspension but with the same overall fiscal uncertainty. I take exception to this view because it fails to distinguish between government commitments to bondholders and fiduciary currencyholders during and after the War. History often distinguished between the two. For example, bondholders received full value for their assets after the Revolution, whereas moneyholders received 1 percent of the promised value of their paper assets.

Hammond (1961) suggests that some of the original motivation for issuing notes to finance the Civil War was to prevent losses to holders of outstanding bonds. Bankers on the whole supported the issuing of greenbacks, though it is not clear whether they did so as a means to enhance liquidity or to protect the value of their bond holdings.

[21] Mitchell (1903, 1908) and Thompson (1972) compare actual fluctuations in the specie value of greenbacks with events they define as news. Mitchell claims that a variety of items constituted news relevant for resumption expectations: information on battles, government fiscal policy, and Treasury reports. He rejects the quantity theory approach to prices and exchange rates citing the endogeneity of money and the lack of correspondence between money and prices. He challenges what would now be called the elasticities approach to exchange rates and claims that "... the supply and demand for gold, instead of controlling were themselves controlled by the premium." He understands interest rate arbitrage and the consequent importance of London interest rates. Perhaps most important, Mitchell emphasizes that greenbacks were the liability of the government and that their value was determined as that of any private liability—by the credibility of the issuer.

> Greenbacks were notes of the government of the U.S., and as such their value—like the value of the notes of a private person—depended on the credit of the issuer. If confidence in the government's ability ultimately to redeem its notes had been entirely destroyed, the

I include the following monthly data series in the reduced-form model: the exchange rate; the U.S. wholesale price index; the British wholesale price index; Frickey's (1947) production index for communication and transportation; total government debt net of gold in the Treasury; the ratio of coin- to greenback-denominated debt; deposits of banks in New York, Boston, and Philadelphia; the interest rate on double-name choice commercial paper; the outstanding stock of greenbacks; and the outstanding stock of national bank notes.[22] Given the random-walk character of nominal variables, the model is estimated in first-differences. All variables enter as first-differences of logarithms except the commerical paper rate and the ratio of coin- to greenback-denominated debt which enter as simple differences.

The estimation equations derive series of predicted values and shocks for each variable using six lags of each endogenous variable and monthly dummies for the period 1867 through 1878. In simulation, the system of equations is solved simultaneously to derive the percentage contribution of shocks from each variable to the forecast variance of the others and the responses of all variables to shocks which originate in each series. Both the

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Footnote 21 (*continued*)

> paper money would have depreciated to the level finally reached by the confederate currency. On the other hand, if the credit of the government had suffered no diminution, its notes would have depreciated little, if at all. Fluctuations between these two limits—par and zero—followed the varying estimates which the community was all the time making of the government's present and prospective ability to meet its obligations. [Mitchell (1903), p. 199]

Thompson (1972) extends Mitchell's discussion of resumption expectations and adds to it more formal statistical tests. Thompson finds a positive correspondence between exchange rate volatility and the extent of news. Thompson's results, however, are of limited usefulness because they are based on arbitrarily defined events seen with the benefit of hindsight, and because the definition of volatility employed implies inefficiency in the exchange market. *Ex ante,* news is virtually impossible to identify. In deciding what constitutes news the informed researcher and the contemporaneous press on which he draws will look for news where there is much to be explained, much the same way *The Wall Street Journal* seems to explain all market events *ex post* with an R^2 of unity.

A further weakness in Thompson's analysis derives from his attempt to reconcile the Friedman–Schwartz approach to exchange rates with Mitchell's asset-pricing approach. Thompson distinguishes between long- and short-run effects. He views the evidence of correspondence in prices and exchange rates as support for the Friedman–Schwartz approach to exchange rate determination, in which money is the "fundamental," long-run determinant of exchange rates and prices. News explains only departures from the "correct" path. In other words, Thompson's definition of volatility implicitly equates volatility with irrationality.

[22] Monthly U.S. prices are the Warren–Pearson wholesale price index. Greenbacks, national bank notes, government debt statistics, and deposits (for New York, Boston, and Philadelphia banks) are from *Hunt's Merchants' Magazine* and the *Commercial and Financial Chronicle*. A monthly price index for Britain was computed using eleven individual commodity prices from *The Economist* and price weights from Gayer, Rostow, and Schwartz (1953). All data, except the Frickey index and the Warren–Pearson index, are end-of-the-month. While measurement error no doubt enters in each of the series due to their partial coverage of relevant data, estimates using first-differences should eliminate "drift" caused by errors in the measurement of levels.

decomposition of forecast variance and the response patterns to shocks depend on assigning the estimated residuals—which are correlated across variables—to particular variables in the system. The orthogonalization of contemporaneous shocks that one chooses may alter, for example, the relative percentage contribution of one variable's disturbances to another's forecast variance.

I assign the following order of priority among residuals: greenbacks (DLG), outstanding net debt (DLNET), the ratio of coin- to greenback-denominated debt (DRINC), the exchange rate (DLEX), the commercial paper rate (DCPR), the U.S. wholesale price index (DLWP), deposits (DLDEP), national bank notes (DLN), production (DLPROD), and the British price index (DLUK). This ordering reflects the fact that initial note supply adjustment took longer than a month (due to bond purchase and note delivery lags), as well as the view that asset prices respond to common shocks before commodity prices, and the desire to place greenbacks supply and fiscal news prior to the exchange rate in order to measure the impact of innovations in these series on the exchange rate.[23] Varying the relative order of monetary aggregates, price indexes, the interest rate, and the exchange rate has little effect on the simulation results discussed below.

Table 7 reports F-tests of the inclusion of a variable's lagged values in each predicting equation, the correlation matrix of residuals, and the forecast variance decomposition for each variable. Only the long-run (forty-month) forecast variance decomposition is reported, but typically six-month decompositions are close to the forty-month figures because convergence to long-run responses occurs rapidly.

The high marginal significance levels for F-tests in the exchange rate equation supports the random-walk hypothesis of exchange rate movements. The government debt ratio proves to be one of the most important determinants of exchange rate movements; unpredictable innovations in this series lead to reductions in the exchange rate and price level; they explain 8.56 percent of the forecast variance of the exchange rate, and 8.03 percent of the forecast variance of the price level. Another important influence on the exchange rate is unpredictable changes in the production index. One way to explain their importance is as an indicator of prosperity, and hence, increased government budget surpluses.

Exchange rate disturbances prove a relatively significant and important determinant of wholesale prices, deposits and bank notes, which is consistent with the theoretical view of the exchange rate as the nominal anchor of the system. In contrast, shocks to money are unimportant for the determination of the exchange rate or price level. The high correlation (0.39) between disturbances in U.S. and British wholesale prices and the

[23] In order to issue notes banks had first to purchase and deposit bonds and await the delivery of the government-printed bank notes. Complaints frequently were made of bureaucratic delays. See Unger (1964), pp. 99 ff; Friedman and Schwartz (1963), p. 169, footnote 55; *Hunt's Merchants' Magazine*, 1868, p. 138.

TABLE 7
VAR Results

Lagged Endogenous Variables	*F-Tests Contemporaneous Variables*									
	DLG	*DLNET*	*DRINC*	*DLEX*	*DCPR*	*DLWP*	*DLDEP*	*DLN*	*DLPROD*	*DLUK*
DLG	0.002	0.691	0.761	0.357	0.027	0.531	0.087	0.712	0.384	0.935
DLNET	0.279	0.055	0.005	0.883	0.297	0.976	0.141	0.973	0.659	0.436
DRINC	0.287	0.979	0.687	0.937	0.153	0.952	0.217	0.980	0.643	0.467
DLEX	0.297	0.126	0.472	0.970	0.288	0.129	0.140	0.031	0.795	0.930
DCPR	0.000	0.923	0.802	0.440	0.096	0.912	0.042	0.693	0.310	0.902
DLWP	0.981	0.043	0.118	0.813	0.243	0.529	0.678	0.726	0.924	0.648
DLDEP	0.358	0.915	0.644	0.653	0.003	0.690	0.004	0.391	0.775	0.758
DLN	0.208	0.743	0.670	0.985	0.756	0.196	0.346	0.000	0.731	0.833
DLPROD	0.247	0.398	0.214	0.390	0.126	0.272	0.315	0.036	0.047	0.988
DLUK	0.265	0.092	0.180	0.558	0.824	0.467	0.118	0.109	0.395	0.655

Correlation Matrix

	DLG	*DLNET*	*DRINC*	*DLEX*	*DCPR*	*DLWP*	*DLDEP*	*DLN*	*DLPROD*	*DLUX*
DLG	1.00									
DLNET	−0.04	1.00								
DRINC	0.09	−0.92	1.00							
DLEX	0.00	−0.14	0.02	1.00						
DCPR	0.09	0.19	−0.15	−0.12	1.00					
DLWP	0.02	0.07	−0.10	0.10	0.19	1.00				
DLDED	−0.21	−0.16	0.18	0.19	−0.49	−0.06	1.00			
DLN	−0.04	0.02	0.04	−0.10	0.13	0.02	−0.07	1.00		
DLPROD	−0.13	−0.09	0.02	−0.11	−0.03	−0.09	0.13	−0.03	1.00	
DLUK	0.25	−0.18	0.16	−0.11	0.05	0.39	0.02	−0.09	0.05	1.00

Decomposition of Forecast Variance (40 *month*)
(*Columns sum to* 100 *percent*)

	DLG	*DLNET*	*DRINC*	*DLEX*	*DCPR*	*DLWP*	*DLDEP*	*DLN*	*DLPROD*	*DLUK*
DLG	45.85	1.84	3.05	3.32	10.20	1.62	6.40	2.41	5.05	6.40
DLNET	3.59	62.96	53.55	3.01	5.60	3.50	8.33	1.25	6.92	4.31
DRINC	8.94	3.23	9.73	8.56	10.99	8.03	7.34	3.06	7.74	7.56
DLEX	6.94	5.82	6.13	62.99	5.42	9.67	7.27	8.77	3.87	2.56
DCPR	11.97	1.35	2.44	4.49	44.54	4.16	16.62	3.78	6.46	2.64
DLWP	1.60	5.33	4.00	1.24	2.73	54.46	2.32	1.47	4.60	15.66
DLDEP	2.72	2.48	3.25	2.94	7.34	3.16	37.74	2.54	4.33	4.23
DLN	9.38	4.07	4.17	1.64	4.19	8.56	3.23	66.13	3.62	4.35
DLPROD	3.87	5.90	6.30	8.93	4.37	3.25	5.00	5.18	51.74	2.01
DLUK	5.52	7.01	7.39	2.88	4.62	3.57	5.74	5.41	5.68	50.29

Data are monthly from March 1867 to December 1878.

Equations are estimated with 69 degrees of freedom. All variables except DRINC and DCPR are first-differences of logs. Six lags are used in estimation. Definitions follow:

DLG = greenbacks
DLNET = government debt net of Treasury gold
DRINC = ratio of gold- to greenback- denominated debt (differenced)
DLEX = exchange rate
DCPR = commercial paper rate
DLWP = U.S. wholesale price index
DLDEP = bank deposits at New York, Philadelphia, and Boston
DLN = national bank notes
DLPROD = U.S. production index
DLUK = constructed British wholesale price index

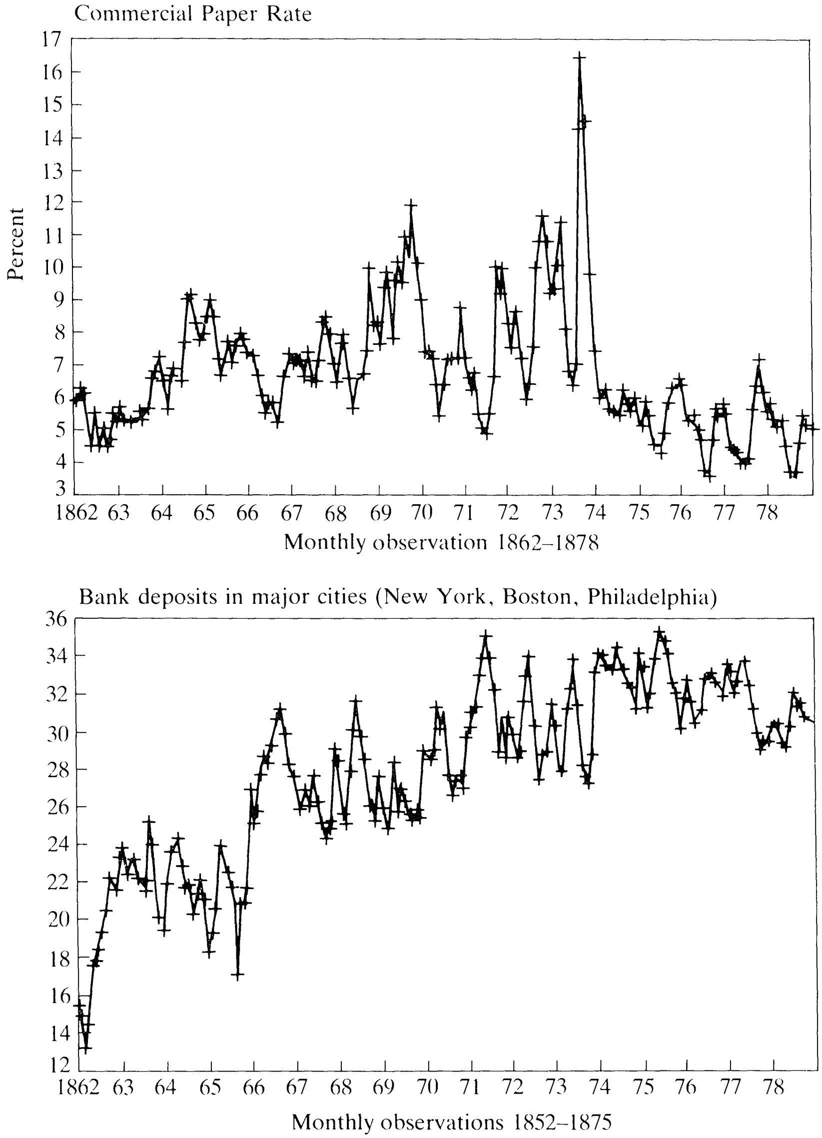

FIG. 3. Commercial paper rate and bank deposits

importance of U.S. shocks for British prices (or vice versa, when the orthogonalization reverses the ordering of price shocks) is supportive of close short-run price linkages across countries.[24]

[24] The significance and importance of commercial paper rate changes for greenbacks reflects the one-time increase in greenbacks supply in response to the Panic of 1873.

The market for real paper money

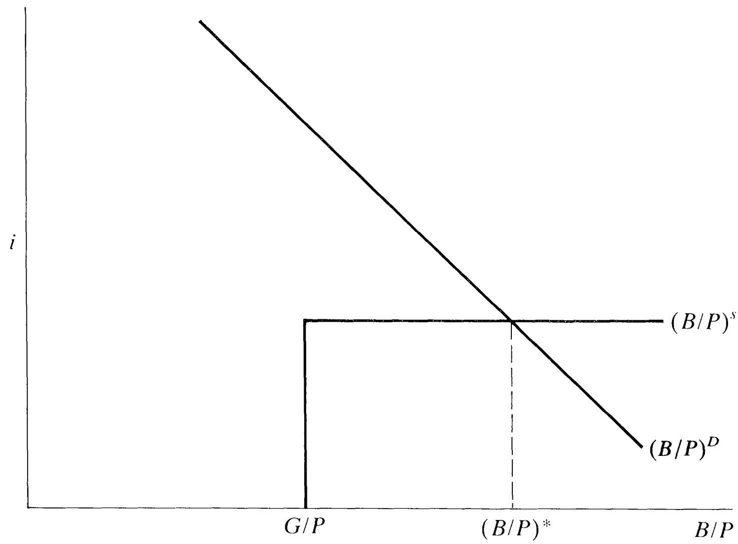

FIG. 4. The market for real paper money

IV. Concluding remarks

This paper argues in favor of the basic approach taken by Mitchell and others who concentrate on expectations of government fiscal and resumption policies during the Greenback Era as the main determinants of exchange rates and prices, and through them, money. The arguments used in favor of this approach include theoretical propositions regarding exchange rate determination and the infra-marginal role of greenbacks supply in determining the money stock, as well as empirical analysis of the importance of fiscal news for exchange rates.

The picture which emerges from these arguments and facts is roughly as follows: During the Greenback Era the United States was an open economy with a freely floating exchange rate that responded efficiently to changing perceptions of the future gold value of government paper. All classes of money—specie, bills, and deposits—adjusted to these changes in the price of gold, and hence those of other commodities, in order to satisfy real money demand. Thus the descriptive historical accounts of Mitchell, Studenski and Krooss, and Thompson are preferable to that of Friedman and Schwartz.

Aside from explaining variations in nominal variables from 1862 through 1878, this asset-pricing approach, with its emphasis on fiscal news, is useful for understanding both the onset of suspension in December 1861 and the successful resumption of parity at the beginning of 1879. In the first instance, the threat of British entry in the War due to the Trent Affair, the bad fiscal news of Chase's Report of December 1861, Chase's proposal to remedy the fiscal crisis by regulating the banking system, and the fact that the bad fiscal news came at a time when banks held large inventories of government loans, together led to the need for banks—and then the government—to suspend specie parity.[25] Similarly, it was the sound fiscal footing on which the government had placed itself by 1878 that made attempted resumption credible and successful.[26]

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APPENDIX: MEASURING RENTS FROM NOTE ISSUES

In his 1873 *Annual Report,* the Comptroller of the Currency, John Jay Knox, published calculations of the profitability to national banks from buying bonds and issuing notes during the suspension. Knox estimated profits at between 1 and $2\frac{1}{2}$ percent, depending on which region the bank was located. Knox noted that banks suffer an additional loss due to the difference between the market and face values of the bond at the date of maturity, but he did not include this in his calculation. In paper terms, one can write the *ex ante* profit rate to maturity per unit of bond purchase as:

$$s + \pi^e = Y - (0.9)\tau i_l - 0.009, \qquad (1)^*$$

where Y is the nominal annual yield to maturity on government bonds, i_l is the long-run yield on alternative uses of capital, and τ is the proportional greenback reserve requirement on notes. The 0.9 coefficient reflects the 111 percent ratio of bond reserves to notes, while the -0.009 intercept reflects the 1 percent federal tax per year on notes outstanding.

Government bonds were payable in coin rather than paper, but given that government bonds were not being held only by banks, arbitrage kept the real yield on government bonds close to that of other bonds, adjusting for default risk. Thus one can use paper railroad bond yields, adjusted for default risk, to derive *ex ante* paper yields on government bonds (see Calomiris, 1985).

Cagan (1965) modifies this approach to calculating the profitability of note issue. As Cagan points out, if banks can buy more bonds rather than make loans with the notes they receive initially, and issue further notes on these bonds, then the rate of return on note issuing should be taken as a ratio of bank capital diverted, not as a ratio of the total amount invested in bonds. Cagan (1965, p. 87) shows that leverage L is bounded by $BP/(BP-90)$, where BP is the purchase price of government bonds per \$100 in face value, and 90 reflects the number of notes which can be issued per \$100 in face value. This implies a revised version of the long-run nominal profit rate calculation:

$$s + \pi^e = L[Y - (0.9)\tau i_l - 0.009]. \qquad (2)^*$$

Some authors object to Cagan's assumption that banks could use notes to purchase bonds. Such objections are based on the claim that bond brokers or their banks would return notes to the bank of issue (see James (1976), p. 362). This is tantamount to challenging a bank's ability to determine its circulation. Of course, in the *aggregate,* given the independently determined

[25] See Studenski and Krooss (1963), pp. 142–43; Mitchell (1903), pp. 19–43.

[26] Consistent with their view that the money supply, rather than government credibility, determined the price level and exchange rate, Friedman and Schwartz (1963) consider resumption an "accomplishment of omission, as it were, not of commission" (p. 82).

price level and real demand, the nominal supply of notes would be demand determined, but individual banks would act as price takers in determining their own note supply. Interest rates would adjust to keep the sum of individual supplies equal to the desired aggregate and the Cagan form of the profit condition should hold in equilibrium. It is difficult to see why individual banks would not be able to increase their circulation by purchasing bonds as easily as they would by making loans.

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