Understanding Greenback Inflation and Deflation:

An Asset-Pricing Approach

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I. Introduction

This paper challenges the monetarist explanation of exchange rate changes and corresponding price inflation and deflation offered by Friedman and Schwartz (1963) for the period of suspended gold convertibility, 1862-1879, and offers an alternative approach. Friedman and Schwartz view the supply of money as the determinant of domestic prices, which they argue in turn determined exchange rates. The alternative explanation offered in this paper views greenback exchange rates and prices as responsive to expectations of resumption and fiscal policy, and determined prior to the endogenous money supply.

Section II provides a critique of four basic components of the Friedman-Schwartz view. First, I argue that resumption expectations must have played a role in exchange rate determination independent of changes in the nominal supply of greenbacks. Second, I show that no economically meaningful monetary aggregate -- high-powered or low-powered -- can be treated as exogenous during the period. Third, rational expectations of future fiscal policy, given the government's budget constraint, should have played a role in exchange rate determination separate from resumption expectations. Finally, the elasticities approach to exchange rate determination used by Friedman and Schwartz ignores the role of speculators in an efficient exchange market.

Section III summarizes the alternative asset-pricing approach to exchange rate determination which differs with the Friedman-Schwartz approach by viewing resumption expectations and fiscal expectations as the determinants of exchange rates and prices, with nominal money adjusting endogenously to these changes in order to satisfy real money demand.

Section IV presents empirical evidence, using monthly data, which lend support to the alternative asset-pricing approach. These include tests of market efficiency, volatility comparisions, and Granger causality tests.

Section V summarizes the main results of the paper and connects these to the related issue of national bank note profitability.

II. Problems with the Friedman-Schwartz View

A. Myopia

An important weakness in the monetarist approach is the characterization of the pre-suspension, suspension, and post-suspension periods as three separate regimes -- that is, a gold standard, followed by an unbacked fiat-paper-money standard, followed by a gold standard. In contrast, the recent literature on rational expectations emphasizes the current effects of expectations of future regime changes. A simple heuristic model of paper money valuation during a suspension will serve to illustrate the sense in which the Friedman-Schwartz view depends on agents' myopia with respect to the future.[1]

Consider a small, open economy which uses gold as the exclusive medium of exchange. The total amount of gold used for transactions/portfolio purposes is X. Agents retain this gold rather than purchase other commodities from abroad in order to maintain an inventory of money. At t = 0, the government decides to issue paper claims on gold Y which it promises to exchange on demand for gold. Assume initially that Y < X. These paper certificates trade

[1] Friedman and Schwartz do recognize the role of greenback speculators in exchange rate determination after March of 1878 (see p. 83); but before that date they seem to view resumption expectation as influential only through its effect on the perceived real interest rate and hence international capital flows, which in turn determine the exchange rate (see p. 58). The elasticities and asset-pricing approaches to exchange rate determination are compared and contrasted in sections II.D and III below.

at par with gold as long as the government maintains that par at each instant by standing ready to accept the paper for gold at par. Agents will now hold less of their real balances X in actual gold. Gold holdings G will be the residual of the difference between total real money demand and real paper money supply P_gY, where P_g is the gold price of a unit of the paper certificate. That is

$$G = X - P_gY$$

X - G will be exported in return for commodities.[2]

Suppose that at t = 1 the government announces an unanticipated suspension of convertibility but promises to return to par at t = 2. Assume for simplicity that this promise is believed by all agents. First consider the case where paper and gold money identically satisfy transactions/portfolio demand. In other words, they are perfect substitutes. In this case, from t_1 to t_2 the gold price of paper will not change. If paper and gold both promise the same quantity of the same thing at t_2 and both are equally useful in the interim, then they will always trade at par. This first case is illustrated in Figure 1 by path A.

If gold is inferior for transactions/portfolio purposes -- perhaps it is heavier, prone to chipping, difficult to weigh and assay, more vulnerable to theft or more costly to transact in because goods are denominated in paper terms[3]-- then although it will still trade at par with paper at t_2, it must

[2]This assumes that the government's promise to redeem is believed by everyone, so that the government holds near-zero reserves of gold for redemption purposes.

[3]For a discussion of the factors affecting the choice and valuation of media of exchange see Calomiris and Cone (1984), Rolnick and Weber (1984) and Calomiris (1984b).

earn a capital gain in the interim relative to paper in equilibrium to encourage money holders to hold both gold and paper. Solving backward from the known future par value one arrives at time path B for the gold price of paper.

Finally, if paper is inferior to gold -- perhaps it is easy to counterfeit[4] -- then paper will have to earn a relative capital gain over the interim, and the time path of P_g will be C in Figure 1.

Along A, the amount of actual gold holdings G remains constant from t_1 to t_2 at $G = X - Y$. Along B, G rises over time as P_g falls in order to keep total demand X constant: $G = X - P_g Y$. Similarly, along C, G falls as P_g rises.

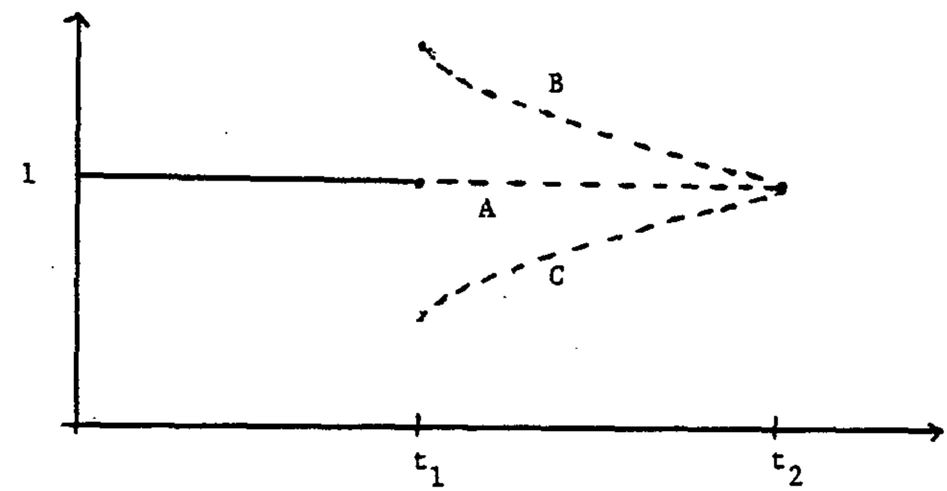
The main point of this exercise has been to show that in a model without myopic agents, expectations of resumption determine the gold price of paper independent of the nominal paper money supply.[5] Furthermore, it is important to point out that in a model with myopic agents, where gold is importable, the exchange rate between gold and paper is indeterminate if the two are perfect substitutes in real terms. Even if the two are not perfect subsitutes, it is

[4]In a model where redemption is uncertain, the time path of the gold price of paper may be upward sloping if agents are risk averse. Note that, unless information on redemption improves over the course of the suspension, the risk-neutral time path will be flat but at a lower P_g. For example if the probability of resumption at t_2 were 1/2, and probability of default were 1/2 P_g would be 1/2 uniformly between t_1 and t_2. Adding risk aversion to uncertain redemption, therefore, implies an upward sloping time path which lies below path C in Figure 1.

[5]Two caveats are in order here. First, for time paths B and C, one could construct demand specifications for which substitutability would be related to the relative equilibrium real supplies of paper and gold, in which case the position -- but not the shape -- of the time path would depend on Y. Second, if $Y > X$ the time path of P_g will resemble C even in the case where gold and paper are perfect substitutes. P_g will not be directly observable in this case, because no gold will actually circulate. But P_g may be inferred from commodity prices if the law of one price holds across international borders.

Figure 1

The Gold-Price of Paper During Suspension



hard to see why agents are willing to value government paper at all if they have no beliefs about a link between this paper and something real. These issues will occupy us in the subsequent two sections of this paper.

B. Price and Exchange Rate Indeterminancy with Money Endogeneity

The heuristic model of the previous section points out a weakness in the Friedman-Schwartz view — namely their need to assume myopia in order to argue that the money supply determined the gold price of greenbacks. In this section I show that, even assuming complete myopia, the Friedman-Schwartz view fails to explain the determination of the money stock itself.

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 Friedman and Schwartz definition of money includes all of the above. Money so defined could not have been exogenous since it included deposits and gold supplies over which the government had no control. Still, however, if there were a real demand for greenbacks or greenbacks and notes[6] which other forms of money could satisfy only imperfectly, then by fixing the supply of greenbacks and bank notes, Friedman and Schwartz might argue that the government was able to provide a nominal ground for the system. Of course, the strict proportionality of exogenous changes in greenback and note supply and price changes would only hold in the extreme case of zero substitutability between notes and greenbacks on the one hand and deposits and gold on the other hand.

Before proceeding to the issue of note and greenback aggregate exogeneity, it is important to discuss their substitutability. Notes and greenbacks always traded at par, even when their respective supplies were set independently as they were for the period 1867-1870. This indicates, de facto, that they were perfect substitutes. Furthermore, note issues were backed 111% by government bonds held on deposit at the Treasury. Thus notes were merely indirect obligations of the government, no different -- from the standpoint of the public -- from greenbacks. There was one segment of the population, however, for whom greenbacks and notes were not perfect substitutes: the national banks. National banks were required to hold between 6% and 25% reserves in lawful money (gold or greenbacks)[7] on all note issues, until 1874 when this requirement was reduced to a uniform 5%. Because gold was trading at a premium relative to greenbacks throughout the suspension, greenbacks were a superior reserve asset for banks relative to gold.

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[6]Friedman and Schwartz do not make this argument explicitly, but it seems the only possible way to interpret their view of money exogeneity, given that deposits and gold are clearly endogenous with respect to federal policy. Friedman and Schwartz lend support to this interpretation in their emphasis on paper high powered money as the exogenous controlling factor for money supply. See p. 51.

[7]There were interest-bearing legal tender notes as well. Their inclusion in the subsequent calculations would complicate the analysis without altering any of the fundamental arguments; therefore, they are omitted.

The Friedman-Schwartz view depends on assuming a given real demand function for notes and greenbacks, and an exogenous nominal supply of notes and greenbacks. Assume real demand is fixed at Z. Then we have

$$\left(\frac{G_p + N}{P}\right)^d = Z$$

where G_p is defined as the greenback holdings of the public, N is defined as the public's demand for bank notes, and P is the price of goods denominated in greenbacks (or notes). The total supply of greenbacks is given by $\bar{G}$ which can be held by the public or by banks as reserves (G_r).

Banks have zero "economic" demand for reserves on national bank notes, since these notes are fully-backed government obligations; they demand greenback reserves on notes only because they are required to by law.[8]

Different banks had different required reserve ratios, but none faced a requirement of over 25%.[9] Suppose, for simplicity, that all banks faced a requirement of 25%.[10]

$$G_r = .25\ N$$

8Note that if banks desired to hold reserve assets for voluntary portfolio purposes they could hold gold and bank notes instead of actual greenbacks.

9In fact only New York banks were required to keep the full 25% in greenbacks or gold; other city banks had a smaller effective reserve requirement, and country banks had an even smaller requirement. The 25% requirement used in this calculation is therefore an upper bound. Moreover, in June of 1874 reserve requirements on notes were sharply reduced for all banks, as noted above.

10The subsequent argument is bolstered if as was the case, the average reserve requirement was below 25%.

Given that banks wish to hold no excess reserves in greenbacks as backing for notes and given that greenbacks and notes are perfect substitutes for the public, the monetarist solution implies that banks would hold all the greenbacks in the economy as required reserves. This is the only way to treat N as base supply-determined, given that the public has no target ratio of notes to greenbacks.

There is no clear economic reason why in equilibrium banks would increase nominal notes to the maximum. A first approximation of the seignorage earned from note issue is $i_\ell(.75) - (.01)$, where i_ℓ is the relevant interest rate for the interest-free loan that banks receive from the public on the 75% of their notes which are not offset by reserve holdings, and (.01) was the annual tax rate on note issues.[11] In a competitive environment, which one would expect given that note circulation in any locale was not bank-specific, we have:

$$i_\ell(.75) - .01 = 0$$

with i_ℓ adjusting to bring real supply and demand into equilibrium. But the adjustment which brings this about is separate from the question of the level of <u>nominal</u> note issues and the price level in the monetarist model. The profit condition only describes the equilibrium ratio of notes to the price level given one or the other.

The supply-side view of the determination of the price level, therefore, offers no economic justification for any particular nominal note supply. The only equilibrium in which supply is binding would occur with the public

[11]The actual supply function for bank notes is additionally complicated by the possibility of banks holding premium reserves in gold for notes and by the portfolio cost of holding government bonds. These issues are treated, respectively in pages 9-11 and 49-55 below.

holding only bank notes and the banks holding all greenbacks as reserves. This would allow us to solve for the price level as follows. Given:

$$N = \frac{1}{.25}\bar{G} = 4\bar{G}$$

and

$$G_p = 0$$

we have that

$$\frac{N + G_p}{P} = \frac{\bar{G}/.25}{P}$$

which we know is equal to Z. Thus:

$$P = \frac{\bar{G}}{(.25)Z}$$

This view implies a close relationship between $\bar{G}$ and P through G's affect on N: dN/dG = 4.

Though this is a solution, it is arbitrary in the sense that it does not explain why in equilibrium banks would care to increase the nominal note supply to its maximum. Thus without further justification the fundamental exogenous variable in the monetarist explanation is itself indeterminate.

Leaving this important problem aside there are several other difficulties with the monetarist explanation. What determined note supply after 1874 when greenback reserve requirements were eliminated? Why is it that banks did not back notes with gold reserves as well? In this case the zero-profit condition would be rewritten as:

$$i_{\ell}\,[1-(.25)E] - .01 = 0$$

where E is the greenback price of gold. Assuming gold and other commodity prices are linked by international markets (say, for example, $P = E$) we then solve for E^* and N^* by combining the zero profit equation and the real demand for bank notes, given an exogenous i_{ℓ}. This additional complication only arises, of course, when the level of P, and hence E, given by the full use of greenback reserves $\bar{G}$ is less than the critical value above which it would never pay banks to use gold reserves.[12] That is, banks will never accumulate any gold if the exchange rate at the greenback reserve saturation point is greater than E^*. For example, if i_{ℓ} were .04 and E were 3.1, profits on the marginal gold-backed note would be slightly negative. However, if i_{ℓ} were above .04 and E at the greenback reserve saturation point were below 3, the maximum note supply profitable would exceed $4\bar{G}$. There was virtually no time during the suspension that such a mechanism could be precluded, given the actual values of E and i_{ℓ}, however proxied.

The upshot of all these considerations is that the most conservative prediction the monetarist view would imply for the ratio of notes to reserves would be 4. This prediction is not supported by the data. Table 1 shows the ratio of greenbacks to notes circulating in the economy from 1864 to 1878. If banks had been holding all the greenbacks for reserve purposes, this ratio would have been at (or below) .25 for the whole period. Given the larger

[12]Since the public is indifferent between greenbacks and notes, banks will always be able to purchase $\bar{G}$ before resorting to gold purchases.

Table 1

Greenbacks and Bank Notes in Circulation*

	(1) Greenbacks	(2) Bank Notes	(3) (1)/(2)	(4) Total "Bills" (1)+(2)	(5) Real "Bills" (1+2)/WPI**	(6) Real "Bills"/ Real Output (5)/Y***
1864	415,116	31,235	13.29	446,351	236.17	3.96
1865	378,917	146,138	2.59	525,055	330.22	5.24
1866	327,792	276,013	1.19	603,805	351.05	5.00
1867	319,438	286,764	1.11	606,202	381.26	5.10
1868	328,572	294,369	1.12	622,941	394.27	4.97
1869	314,767	291,750	1.08	606,517	412.60	4.74
1870	324,963	288,648	1.13	613,611	454.53	4.72
1871	343,069	311,406	1.10	654,475	515.34	5.01
1872	346,169	329,037	1.05	675,206	492.85	4.48
1873	348,464	338,962	1.03	687,426	520.78	4.40
1874	371,421	340,266	1.09	711.687	573.94	4.79
1875	349,686	340,547	1.03	690,233	589.94	4.89
1876	331,447	316,121	1.05	647,568	610.91	4.90
1877	337,899	301,289	1.12	639,188	603.01	4.63
1878	320,906	311,724	1.03	632,630	718.90	4.87

*Aggregates are in thousands of nominal dollars. Data are from _Historical Statistics of the U.S._, Series X433, X434. Data are for June 30.

**WPI (wholesale price index) is the Warren-Pearson index, from _Historical Statistics of the U.S._, First Edition, Series App. 24. Data are for June.

***Y (real output) is from L. Officer (1981).

ratio, it is clear that all the greenbacks were not being used as reserves. Though the nominal ceiling on bank note issues potentially might have constrained banks for the period before January 1875, when the ceiling was eliminated, it was not an effective constraint except for the years 1867-1870. Neither the capital of banks nor the available supply of reservable bonds could have acted as an upper bound during the period of suspension, though these too defined potential upper bounds.[13]

This conclusion is important for two reasons. First it implies that the zero-economic-profit equilibrium was not achieved by adjustment in per-unit reserve cost but by adjustment in other variables -- that is, banks never resorted to gold backing of notes.

Second, and most important for our immediate purposes, the fact that banks were not holding all greenbacks as reserves raises the question: how was the <u>nominal</u> note supply determined? Given a real demand for notes and greenbacks, the Friedman-Schwartz model posits that exogenous nominal supply determines the price level. Given the fractional reserve requirement on banks and the perfect substitutability for the public of notes and greenbacks, the limit on nominal supply would have been reached with banks holding all the greenbacks and the public holding only notes. But this approach fails to predict the actual ratio of greenbacks to notes. Moreover, for 1875-1879 it does not explain why the ratio of notes to greenbacks did not rise when the reserve requirement was all but eliminated.

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[13]The potential limits on nominal note supply other than the reserve requirement included: the supply of reservable bonds, and legislated limits on total note supply and its ratio to bank capital. None of these upper bounds was ever a binding constraint during suspension with the exception of the binding limit on note supply from 1867 to 1870. For more discussion see Friedman and Schwartz, p. 23 and Davis Dewey, <u>Financial History of the U.S.</u>, pp. 385-387.

The alternative to the Friedman-Schwartz view which I propose is to view the exchange rate, and through it the price level, as determined efficiently by agents' expectations, with the supply of notes adjusting endogenously to that price level given real demand. In this approach notes are viewed as the residual component of the public's demand for the sum of notes and greenbacks. To be explicit, as before we have:

$$\left(\frac{G_p + N}{P}\right)^d = Z$$

and

$$\bar{G} = G_r + G_p$$

$$G_r = (.25)N$$

Now, given P and Z we solve for N as follows:

$$N = \frac{1}{.25}\ \frac{((Z/P) - \bar{G})}{(\frac{1}{.25} - 1)}$$

Note that the significant differences between this and the previous approach are: (1) the ratio of greenbacks to notes need not be less than (.25); (2) the correlation between total notes and total greenbacks is negative.

Thus, one way to test the monetarist hypothesis that greenback supply fixed the supply of notes and greenbacks against the demand-determination view of notes is to see if the supply of notes is positively correlated with the stock of greenbacks. Again, according to Friedman and Schwartz, the two should be positively correlated since greenbacks are nominal high powered money and notes plus greenbacks are nominal lower powered money, while the view that the sum of notes and greenbacks is determined by real demand and a predetermined price level implies negative correlation — as nominal greenback supply varies notes should move in the opposite direction to maintain real balances for a given price level. The contemporaneous correlation is (-0.29) between notes and greenbacks. The correlation between lagged greenbacks and current notes is (-0.58).

The preceding section showed how expectations of future policy could determine the price level and how the nominal supply of residual money would adjust to this price level, given a fixed real demand function. In section III below I amend this model to make it more consistent with the suspension of 1862-1879 by giving fiscal policy a broader role in expectations formation. In this approach, as in the model of this section, the price level is exogenous with respect to note supply. Together with real demand, the price level determines nominal note supply. The constancy of the ratio of total real "bills" to real income, shown in Table 1, supports the assumed stable relationship between income and real "bills".

This approach is well-known from the literature on money flows under fixed exchange rates. For example, Friedman and Schwartz, in their discussion of the post-resumption era, write:

> under a gold standard with fixed exchange rates . . . the stock of money is ultimately a dependent factor controlled primarily by external influences — at least for a country which is an economically minor part of the gold-standard world. The major channel of influence is from the fixed rates of exchange with other currencies through the balance of payments to the stock of money, thence to the level of internal prices that is consistent with those exchange rates. (pp. 89-90)

Friedman and Schwartz mistakenly contrast this to their flexible exchange rate model for the Greenback Era. They fail to recognize that exchange rates may be fixed by expectations of future government policy as well as by contemporaneous policy.

The purpose of this section has been to show that the most sympathetic interpretation of the Friedman-Schwartz explanation of greenback inflation and deflation — that is, one which interprets them as claiming that the sum of greenbacks and notes fixed the price level — fails because note supply was not exogenously determined. In the absence of an exogenous nominal grounding for the system, the Friedman-Schwartz explanation cannot provide a rationale for price and exchange rate determination.[14]

C. Expectations and Fiscal Policy

An approach to valuing greenbacks which stresses resumption expectations must (1) posit some model of how those expectations are formed and (2) specify what an expected failure to resume implies for the value of the currency.

These questions are intimately related. The first depends in part on expectations about the government's ability to resume, which is a function of the expected present discounted value of net tax receipts. Expectations of resumption also depend on the government's perceived willingness to resume. In particular, during the suspension there came a point where the government

[14]As a matter of theoretical possibility, nominal greenback supply could have been set higher than gold-denominated money demand, in which case greenback-cum-note supply would have been exogenous, banks would have issued no notes and the price of greenbacks would have been determined as indicated in footnote 5 above (the case where $Y > X$). In this case, nominal greenback supply would have affected directly the value of greenbacks. This, of course, is not the mechanism Friedman and Schwartz imagine and it bears no resemblance to the history of the greenbacks.

had earned credibility for bond principal redemption in gold (after 1869),[15] but had not yet convinced currency holders that the resumption of greenback convertibility would occur. This may have been because: (a) people believed there was not enough present value of future taxes to redeem both, or (b) people believed the government wished to treat currency holders differently from bondholders. 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 government fiscal expectations and, hence, suspension may have constituted only a change in numeraire relative to government finance without suspension but with the same fiscal uncertainty. I take exception to this view because it fails to distinguish between government commitments to bond holders and fiduciary currency holders. History does distinguish between the two. For example, bond holders received full value for their assets after the Revolution, whereas money holders received one percent of the promised value of their paper assets.

Hammond (1961) suggests that some of the original motivation for issuing notes was to prevent losses to holders of outstanding bonds. The only way that such declines in real value could have been avoided was if the public perceived different redemption commitments to bonds and greenbacks. 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. Finally, the fact that the government always paid

[15]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.

interest on bonds in gold and redeemed bond principal in gold ten years before greenback resumption suggests strong preferential treatment for bond holders.

A reason for such willful discrimination by the government may be that the bond market is a more competitive forum for funding. That is, if bondholders consider different government bond issues close substitutes, governments with bad reputations will find they face high interest costs, and perhaps, as Stiglitz and Weiss (1981) and (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 even when it has the ability to do so.[16]

The second question -- the value of currency in the absence of a perceived commitment to resumption -- concerns the method for valuing purely fiduciary currency. Friedman and Schwartz, like many monetary economists, tend to think of the value of paper money which is not currently or potentially convertible (i.e. backed directly by gold or some other commodity) as solely a function of the current nominal supply of paper and the demand function for currency. Recent theoretical models which incorporate government budget constraints and rational expectations, however, demonstrate that there is no one to one mapping from contemporaneous money to prices [Sargent and Wallace (1981), McCallum (1982), and Aiyagari and Gertler (1983)]. These models stress the endogeneity of money in a world where future alternative means of financing and flows of government expenditure are taken as given.

[16]For more details, see a forthcoming paper by Veitch and Calomiris and Calomiris (1984b).

The central importance of fiscal policy in contributing to a currency's value through expectations is actually a very old notion. Adam Smith writes:

> A prince who should enact that a certain proportion of taxes should be paid in a paper money of a certain kind, might thereby give a certain value to this paper money, even though the time of its final discharge and redemption should depend altogether of the will of the prince. If the bank which issues this paper were careful to keep the quantity of it always somewhat below what could easily be employed in this manner, the demand for it might be such as to make it even bear a premium, or sell for somewhat more in the market than the quantity of gold and silver for which it was issued. (The Wealth of Nations, ed. Cannan, p. 311).

In recent studies of the colonial and revolutionary periods Smith (1983a, 1983b) and Calomiris (1983) find corroborating evidence for a link between the state of public finance and the acceptability of government liabilities. Sargent (1981a, 1981b) finds support for the importance of fiscal expectations in his examination of several high, inflationary episodes. He finds that a slowdown in inflation is contemporaneously associated with continuing growth in money aggregates, but drastic reform in fiscal policy leading to the reduction of current and anticipated government budget deficit through increased tax financing. Calomiris (1984a) presents evidence for the strong predictive power of bonds for prices in contemporary Brazil, and argues that the tax-based view is the interpretation most consistent with the observed results.

The importance of this debate for the Greenback Era derives from the uncertainty of a return to gold convertibility. The tax-based theory describes the only rational-expectations equilibrium with a definitely positive value of money in the absence of gold convertibility. As discussed in Section III below, this theory is important for greenback valuation to the extent that agents suspected that gold convertibility might never be re-established.

The important difference between the quantity theory and the tax-based theory of fiduciary money valuation is the result, in the tax-based approach, that current and expected future government deficits which imply monetization or debt default in the future may reduce the value of government liabilities today, and hence increase the current price level and exchange rate consistent with any current nominal stock of liabilities.

D. The Friedman-Schwartz Elasticities Approach to Exchange Rate Determination

Perhaps it would be expecting too much of Friedman and Schwartz -- or anyone else writing in 1963 -- to expect to find in their discussion of exchange rate determination all the basic elements which have become common only over the past twenty years. These basics include: speculative efficiency, the law of one price for traded goods, international portfolio diversification and interest rate parity across nations for assets which are perfect substitutes. Their framework, which this rational-expectations, asset-price approach has displaced, is the elasticities approach, which -- while it recognizes the importance of capital and commodity arbitrage -- sees exchange rates as determined primarily by the supply and demand functions for imports and exports of commodities and capital:

> The demand and supply of foreign exchange, which determined the exchange rate, reflected the U.S. demand for goods and services from abroad, the supply of goods and services in the United States for export, the demand abroad for U.S. goods and services, the supply abroad of goods and services for export to the United States, the desire of foreigners to transfer capital or make unilateral transfers to the United States, and of U.S. residents to transfer capital or make unilateral transfers abroad. . . . the relative movements of internal price levels in the United States and in gold-standard countries was, far and away, the most

> important factor affecting exchange rates with the currencies of such countries and hence the premium on gold. (p. 61-2)

The main weakness of the elasticities approach is that it fails to model the role of portfolio and speculative demand for foreign exchange. When these elements are combined with the balance of trade, prices and exchange rates are simultaneously determined (in a flexible price model) and exchange rate movements are smoothed by speculative demand. In a fixed-price model, exchange rates lead, rather than follow, price changes (see Dornbusch (1976)). For the purposes of greenback valuation, in a flexible-price world[17] exchange rates and prices are simultaneously and jointly determined. In the elasticities model price changes lead exchange rates, whereas divergence between changes in prices and exchange rates, in the asset-pricing approach, is best described with reference to changing real international demand and supply for gold relative to other commodities and assets.

Tests of the efficiency of the gold market and other evidence which support the asset-pricing approach are described in section IV below.

E. Summary

To sum up, the Friedman-Schwartz model (1) virtually ignores the role of resumption expectations and their implications for the intertemporal consistency of the exchange rate path, (2) fails to explain the determination of the nominal money supply, (3) does not consider the implications of the overall government balance sheet for inflation expectation and price

[17]The relative importance of homogeneous traded goods in the nineteenth century economy argues for a flexible price approach. Mitchell (1908) provides empirical support for this view, as do the empirical results of section IV below.

determination, and (4) fails to consider adequately the role of speculators in the exchange market.

III. An Alternative Asset-Pricing Approach to Greenback Valuation

The asset-pricing approach to greenback valuation views exchange rate changes as efficient responses to news which updates expectations about the possibility and timing of resumption, and expectations of current and future government liability issuance and taxation, which is relevant because in the absence of a return to convertibility the value of greenbacks would depend on expectations of government financing.

Exchange rate and commodity price determination are seen as essentially simultaneous. That is, domestic prices adjust rapidly to maintain given world gold prices. World commodity gold prices may change, but these changes are unrelated to the determination of the gold price of greenbacks.

Given the price level and exchange rate, the nominal supply of notes, net exports or imports of gold, and the nominal supply of deposits are determined by the real demands for these assets.

There is no presumption of perfect substitutability between gold on the one hand and greenbacks or notes on the other hand. Indeed the imperfect substitutability is seen as an important explanation of the role played in exchange rate determination by information updating with regard to the timing of resumption. Roll (1972) analyzes greenback- and gold-denominated yield differentials for 1863-1865 which indicate that greenbacks earned an expected capital gain relative to gold. This may be interpreted as a compensation for their greater riskiness. Thus the expected time path for the gold price of greenbacks will have the same shape as path C in Figure 1 of section II A above. Given this time path, changes in expectations about the timing of resumption cause changes in the expected time path of greenback prices. That is, if resumption is seen as more distant, ceteris paribus, P_g must fall in each period between the moment this information arrives and t_2.

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 great debate. Roll claims that his observed yield differentials provide evidence for a perceived difference in numeraire.[18] He recognizes, however, that there are alternative interpretations of his results and that, therefore, the interest rate differences may reflect other factors in addition to expectations of exchange rate changes (e.g. a maturity premium related to the relative riskiness of greenback-denominated securities).

In the appendix, I derive paper/gold yield differentials using monthly prices for government (gold) bonds and railroad (paper) bonds of similar maturities for 1869 through 1878, when government bond principal was clearly payable in gold but greenbacks were not. These results support Roll's view that yield differentials indicate expected changes in the greenback/gold exchange rate.

To sum up, the following derivation shows how exchange rates and prices respond to news. "News" is anything which updates expectations about the probability and timing of resumption or government financial policy. There are two possible ultimate states of the world — resumption or indefinite suspension. If agents are risk neutral they will value greenbacks according to the following equation:

[18]Section IIC above suggests reasons why bond and note redemption expectations may have differed.

$$P_g = \tilde{a}(1) + (1-\tilde{a})\ \tilde{F}$$

P_g is the gold price of greenbacks, $\tilde{a}$ is the probability of resumption, and F is the expected value of greenbacks in the fiduciary regime. For heuristic simplicity assume that resumption at a value less than par was not considered feasible. Now let agents be risk averse. Index the utility of one gold dollar as 1. That is:

$$U(1) = 1$$

First consider the case where the probability of resumption at some date is known, but the potential fiduciary value of the currency is not known, and bounded between 0 and 1.

$$P_g = a(1) + (1-a) \int_0^1 U(g(F))dF$$

where g(F) is the frequency distribution function for F. If a is unknown as well, and bounded between 0 and 1 we have:

$$P_g = \int_0^1 U(g(F))dF + \int_0^1 U(f(a))da - \int_0^1 \int_0^1 U(f(a))\ U(g(F))dFda$$

Note that the first two integrals are both strictly less than 1. This means that news which shifts the g or f distributions favorably throughout the unit interval will cause P_g to rise unambiguously. As previously remarked in section II, the expected timing of resumption will affect the price under risk aversion by lowering or raising the time path of P_g in path C of Figure 1 in section II A because the riskiness of greenbacks implies an upward sloping expected time path for P_g. This occurs in the above equation when extending the time horizon of expectations increases the dispersion of the f distribution in a mean-preserving way.

The following is an example of the way government financial policies would affect greenback prices according to this approach. When the government passes the National Banking Act, ceteris paribus, it creates a permanent real demand for greenbacks and bonds apart from the demand which depends on anticipated future taxation and the public's real demand for greenbacks. This would raise the value of greenbacks in the case where resumption never occurs and therefore increase the value of greenbacks today, as long as a is not equal to unity with certainty. Similarly an unanticipated increase in the deficit would reduce P_g, as long as a is not know to be unity.

It would be difficult to disentangle empirically the effects of any piece of news on the different components of this equation. For example, an expected improvement in the integral of budget surpluses might both bolster anticipation of resumption and reassure traders even to the extent that resumption was doubted, as a signal of less future greenback issues.

IV. Evidence in Support of the Asset-Pricing Approach

It is not possible to test directly the asset-pricing approach by quantifying news relevant for exchange rate determination, though there has been at least one attempt (Thompson (1972)) to do so. The evidence we will discuss is of three kinds: (1) impressionistic evidence about the gold market; (2) tests of efficiency for the gold/greenback exchange-rate, which is a necessary but not sufficient condition for the asset-pricing view; and (3) evidence on the time series properties of money, prices, interest rates and exchange rates, which, given exchange market efficiency, is consistent with the asset-pricing approach and not with the monetarist approach.

A. Impressionistic Evidence on the Gold Market

Wesley C. Mitchell's classic work on the greenback/gold exchange rate emphasizes the role of news in determining exchange rates through influences on expectations of resumption. In fact, Mitchell presents an astonishingly modern view of exchange rate determination. Mitchell claimed that a variety of items constituted news relevant for resumption expectations: information on battles, government fiscal policy, and Treasury reports. He rejected the quantity theory approach to prices and exchange rates citing the endogeneity of money and the lack of correspondence between money and prices. He challenged the elasticities approach and claimed that ". . . the supply and demand for gold, instead of controlling were themselves controlled by the premium."[19] He understood interest rate arbitrage and the consequent importance of London interest rates. Perhaps most important, Mitchell emphasized 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 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.[20]

[19]Mitchell, A History of the Greenbacks, p. 193.

[20]Ibid, p. 199.

To bolster his argument, Mitchell quotes exchange rates between the demand notes of 1861 and the greenbacks of 1862. The demand notes were identical to the greenbacks, except that they were acceptable for the payment of customs duties at part with gold. Mitchell notes that this tax-backing allowed the demand notes to trade at a premium, as shown in Table 2.

Though Mitchell rejects the quantity theory, he admits that the quantity of greenbacks may have influenced their value "by affecting the credit of the government [rather] than by altering the volume of the circulating medium."[21]

Secretary Chase agreed with this assessment when he reported to Congress in 1863:

> It is hardly too much, perhaps hardly enough to say that every dollar raised [by taxation] for extraordinary expenditures or reduction of the debt is worth two in the increased value of national securities.[22]

Much of Mitchell's work concerns itself with explaining the actual fluctuations in the specie value of greenbacks using his version of the asset-pricing approach, but Mitchell provides no real test of that approach. 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. Volatility is defined as daily fluctuations around a linear trend, and news is provided by dummy variables which indicate the presence or absence of certain less quantifiable events: resumption debates, war reports, legislative

[21]Ibid, p. 208.

[22]Ibid, p. 19.

Table 2

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

Date	Currency Value of: Gold	Currency Value of: Old Demand Notes	Gold Value of: Currency	Gold Value of: Old Demand Notes	Date	Currency Value of: Gold	Currency Value of: Old Demand Notes	Gold Value of: Currency	Gold Value of: Old Demand Notes
1862					1862				
Apr. 12	101 7/8	100	98.1	98.1	Oct. 4	122 3/4	119 1/2	81.5	97.3
19	101 9/16	100	98.4	98.4	11	128 1/8	123 3/4	78.1	96.6
26	101 9/16	100	98.4	98.4	18	130 1/8	129	76.8	99.1
May 3	102 5/8	100	97.4	97.4	25	130 5/8	127	76.6	97.2
10	103 5/16	100 1/4	96.8	97.0	Nov 1	130 7/16	126 1/2	76.7	97.0
17	103 1/16	100 5/8	97.0	97.6	8	132 1/4	126	75.6	95.3
24	103 1/2	100 5/8	96.6	97.2	15	131 7/8	126 1/2	75.8	95.9
31	103 9/16	100 5/8	96.6	97.2	22	130 5/8	124 1/4	76.6	95.1
June 7	104 1/16	101	96.1	97.1	29	129 1/8	124 1/2	77.5	96.4
14	105 11/16	103	94.6	97.5	Dec. 6	131 1/4	125	76.2	95.2
23	107 3/8	103	93.1	95.9	13	131 9/16	126 1/2	76.0	96.2
26	100 1/8	104 1/8	91.7	95.8	20	123 7/16	127 1/8	75.5	96.3
July 5	109 11/16	105 1/4	91.2	96.0	27	132 1/4	129	75.6	97.5
12	114 3/16	107 1/4	87.6	93.9	1863	—	—	—	—
19	118 3/8	108	84.5	91.2	Jan. 3	134 1/8	129	74.6	96.2
26	117 1/4	106 1/2	85.3	90.8	10	137 13/16	135	72.6	98.0
Aug. 2	115 1/8	105 1/4	86.9	91.4	17	147 1/4	143	67.9	97.1
9	112 11/16	105 1/2	88.7	93.6	24	149 3/16	144 3/4	67.0	97.0
16	114 9/16	107 1/2	87.3	93.8	31	159 7/8	153	62.5	95.7
23	115 1/2	108	86.6	93.5	Feb. 7	157 1/4	155	63.6	98.6
30	115 11/16	108 1/4	86.4	93.6	14	155 5/8	151	64.3	97.0
Sept. 6	119	108	84.0	90.8	21	162 3/4	162	61.5	99.5
13	118 1/8	108 3/4	84.7	92.1	28	172	171	58.1	99.4
20	116 15/16	112 1/2	85.5	96.2	Mar. 7	155 1/8	153	64.5	98.6
26	120 3/8	116 1/2	83.1	98.6	14	158 1/4	153	63.2	96.7

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

changes, changes in the international economy, institutional peculiarities (i.e., attempts to corner the gold market), elections, political appointments, and political controversies.

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. In 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.

If Thompson's model is correct, then speculators missed out on enormous predictable profits. If instead the exchange market was efficient, the measure of volatility relevant for comparison with news would be the variance of the residual error term in a martingale. A test of market efficiency would examine the errors from a martingale process to see if they exhibit serial correlation. Residuals from a martingale using monthly data appear to be white noise (see Section B below), and this lends support to the efficient-market hypothesis. But even if Thompson had used this alternative measure of volatility, the arbitrarily defined *ex post* news series he creates seems no more convincing than Mitchell's impressionistic arguments about the correlation between news and exchange rates.

Thompson's noble attempt to test formally the role of news fails because *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 able to explain all market events ex post with an R^2 of unity.

This is not to say that Mitchell and Thompson have not contributed to our understanding of greenback valuation; their explanations are useful given an accepted theoretical approach, but they provide neither objective tests nor convincing theoretical arguments for any one approach.

Moreover, impressionistic evidence does have some weight, especially when the impressions are shared -- as the authors show they were -- by market participants. In particular, the striking reduction of exchange rate volatility -- first after the end of the Civil War, then again after the Resumption Act -- indicates that exchange rate volatility cannot be explained by greenback supply or interest rate volatility. This, together with evidence in support of market efficiency, indicates that news coming from other sources must have been an important short- and long-run determinant of exchange rates. These propositions will be examined more formally below.

Finally, support for the Mitchell-Thompson view of news comes from Roll (1972) who points out that battle reports had similar effects on the yields of government securities. Indeed, Friedman and Schwartz recognize this influence on bond prices, as well. 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.[23] 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 vague comment that "the purchasers of government securities were a much more mixed and broader group than the

[23]Friedman and Schwartz, pp. 72-74.

speculators in foreign exchange were, so we are dealing with the expectations of two very different groups."[24]

B. Market Efficiency: Tests and Implications

The efficiency of the exchange market is a central feature of the asset-pricing approach. Of course, market efficiency is entirely separate from the issue of money exogeneity — that is, from what constitutes news; but if market efficiency can be shown, it may shed light on the question of whether the money stock is the predominant component of news. That is, if exchange rates can be shown to follow a martingale process, then innovations in exchange rates have a permanent effect. If this is true, then the "random" component of the martingale reflects "fundamentals" of exchange rate determination. If changes in the size of the variance of the random component of the exchange rate correspond to the extent of news predicted by the alternative "fiscal-news" view, rather than to changes in the variances of the variables Friedman and Schwartz view as determinants of exchange rate movements, this lends support to the alternative view. This argument motivates the results of Section C below.

In his analysis of yields on government bonds and implicit expected greenback depreciation, 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, following Fama (1970), I regress

[24]Friedman and Schwartz, p. 73, footnote 82. Roll (1972) and Russel (1976) note the logical inconsistency of the position taken here by Friedman and Schwartz.

-- using end-of-month data[25] -- the natural log of the exchange rate on its lagged value and test the residuals of the regression for white noise. If the market is efficient, no information from past innovations is useful for predicting current or future innovations, so the partial autocorrelations among residuals should be insignificantly different from zero. The random walk specification is more restrictive because it constrains the coefficient on the lagged term to be unity. As Table 3 shows, the estimated coefficients 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.[26] Results are reported for both specifications in Tables 3 and 4. The regression equations and significance levels for partial autocorrelation tests 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. Further evidence in support of market efficiency are the changes in sign and magnitude of the partial autocorrelation coefficients from sub-period to sub-period. This suggests that trading rules derived from previous observations would not have been profitable out of sample.

[25] Data are from Hunt's Merchants' Magazine and the Commercial and Financial Chronicle.

[26] If the exchange rate were covariance stationary in log levels, first differencing would lead to a first partial autocorrelation coefficient of -0.5.

Table 3

Martingale Equations

Sample	Lag Co-efficient*	Constant*	Standard Error	Q Statistic**	Q Sig. Level
1862,1-1865,4	0.904 (16.02)	0.0499 (1.78)	0.094	Q(18) = 10.7	0.91
1865,5-1875,1	0.964 (42.6	0.0058 (1.04)	0.027	Q(30) = 39.9	0.11
1875,2-1878,12	0.978 (25.05)	-0.0009 (-0.25)	0.015	Q(18) = 16.2	0.58
1862,1-1878,12	0.976 (53.7)	0.0075 (1.43)	0.047	Q(42) = 49.2	0.21

Random Walk Equations

Sample	Constant*	Standard Error	Q Statistic**	Q Sig. Level
1862,9-1865-4	0.010 (0.63)	0.0965	Q(18) = 10.1	0.93
1865,5-1875,1	-0.002 (-.89)	0.0268	Q(30) = 40.5	0.09
1875,2-1878,12	(-.003) (-1.25)	0.0144	Q(18) = 17.0	0.52
1862,1-1878,12	0.000 (0.00)	0.0473	Q(42) = 51.4	0.15

*t-statistics are in parentheses.

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

Table 4

Partial Autocorrelation Functions

	Log Levels Martingale				Random Walk			
	1862,1-1865,4	1865,5-1875,1	1875,5-1878,12	1875,1-1878,12	1862,1-1865,4	1865,5 1875,1	1875,2 1878,12	1862-1878,12
Lag								
1	.186	.105	-.165	.176	.171	.088	-.180	.162
2	-.112	-.172	-.212	-.065	-.121	-.187	-.235	-.077
3	-.066	-.024	-.221	-.062	-.067	-.043	-.255	-.075
4	.170	-.077	.032	.164	.180	.096	-.011	.152
5	-.177	-.129	-.015	-.124	-.166	-.154	-.055	-.135
6	.112	-.124	.210	.084	.125	-.155	.177	.072
7	.038	-.129	.120	.031	.059	-.170	.100	.022
8	-.121	.021	-.047	.013	-.105	-.027	-.064	.002
9	-.147	-.015	.313	.090	-.135	-.066	.307	-.101
10	-.203	.001	-.064	-.100	-.187	-.053	-.060	-.113
11	-.168	.283	-.126	-.022	-.158	.237	-.129	-.037
12	-.109	.055	-.164	-.003	-.118	.023	-.174	-.022
13	-.022	.025	.114	.051	.020	.000	.105	.033
14	.012	.146	.056	-.018	.028	.132	.056	-.034
15	-.160	.040	-.147	-.153	-.153	.031	-.148	-.173
16	.219	.091	.029	.179	.252	.088	.026	.162
17	.065	-.125	.012	.032	.097	-.126	.015	.018
18	-.085	.034	-.083	.050	-.036	.031	-.084	.039
19	-.098	-.055	-.130	.000	-.035	-.057	-.135	-.008
20	-.098	.003	-.034	-.015	-.066	.000	-.042	-.027

C. Volatility Comparisons and Granger-Causality Tests

It is clear from inter-period differences in the variance of the residuals from Table 3 that the sub-periods are different. The efficiency of the exchange market indicates that these differences reflect economic fundamentals. Though there is no way to "prove" that battle reports and fiscal news were responsible for specific "shocks" to the exchange rate, it seems that these variables, rather than variation in the supply of greenbacks must have been responsible for such high and changing exchange rate volatility. (See Figure 2).[27]

Table 5 describes the standard deviations and standard deviations from quadratic trend for various monthly time series. The growth rate of greenbacks is far too smooth to explain the extreme volatility of prices, exchange rates, and deposits or their changes through time. Commercial paper rates show highest volatility during the middle sample period, unlike any of the other series. The change in the volatility of bank notes from the middle to late sample periods is much larger than the comparable changes for exchange rates, deposits, and prices, though total bills volatility is closer to those of prices, exchange rates, and deposits for the middle period -- a result consistent with either viewing notes as exogenous or endogenous.

Though the results presented in Table 5 are far from conclusive, they cast doubt on the monetarist view that the quantity of greenbacks was the single most important determinant of other nominal variables. The asset-pricing approach is consistent with this evidence since it views greenbacks as only one component of news.

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[27]Complaints frequently were made that currency was unable to respond quickly to changes in demand because of fixed government greenback supply and bureaucratic delays in the production of bank notes. See Unger (1964), pp. 99 ff; Friedman and Schwartz, p. 169. footnote 55; Hunt's Merchants' Magazine 1868, p. 138.

Figure 2

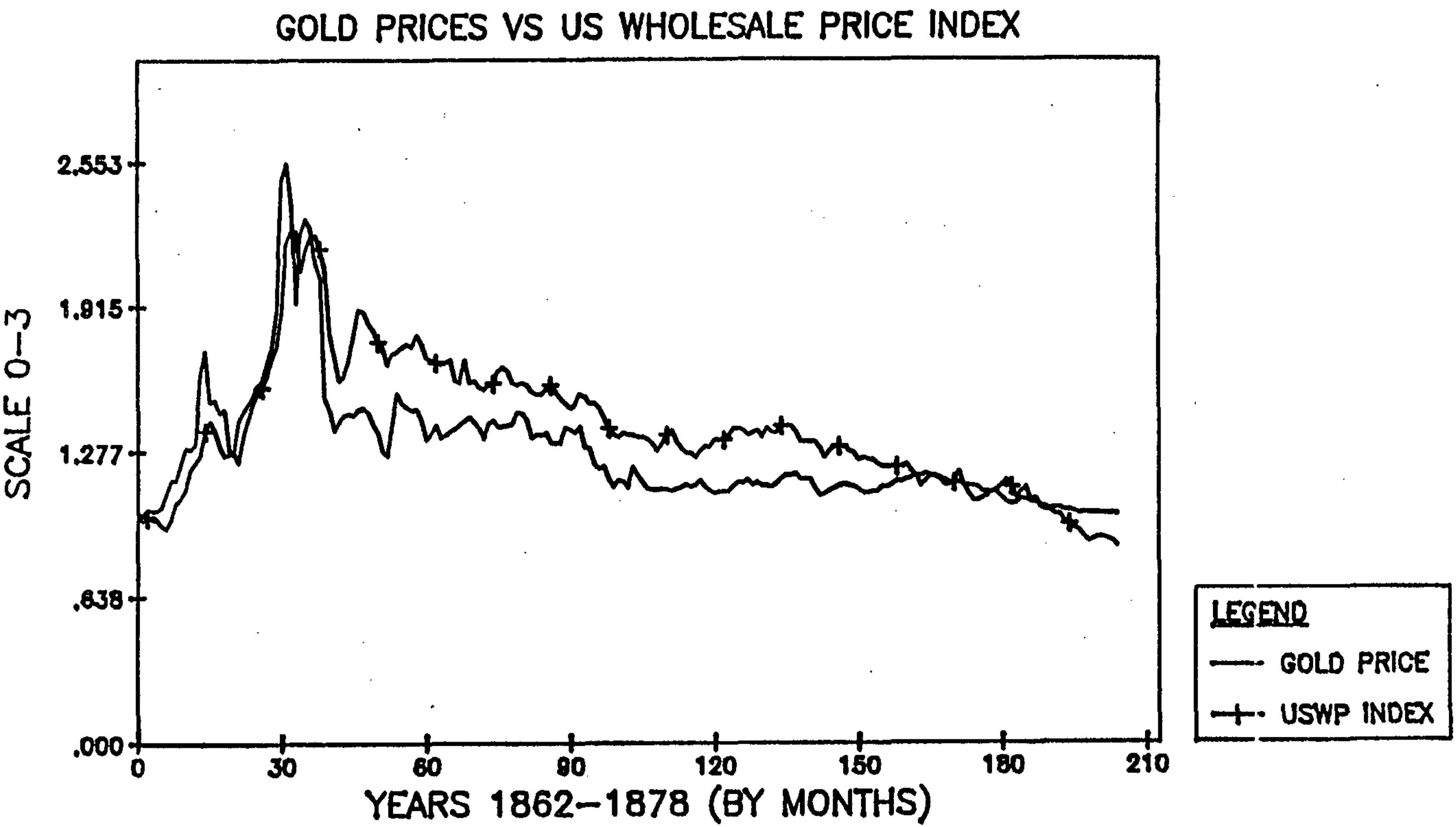

GOLD PRICES VS US WHOLESALE PRICE INDEX
2.553
1.915
1.277
.638
.000
SCALE 0–3
0
30
60
90
120
150
180
210
YEARS 1862–1878 (BY MONTHS)
LEGEND
GOLD PRICE
USWP INDEX

Figure 2 (cont'd).

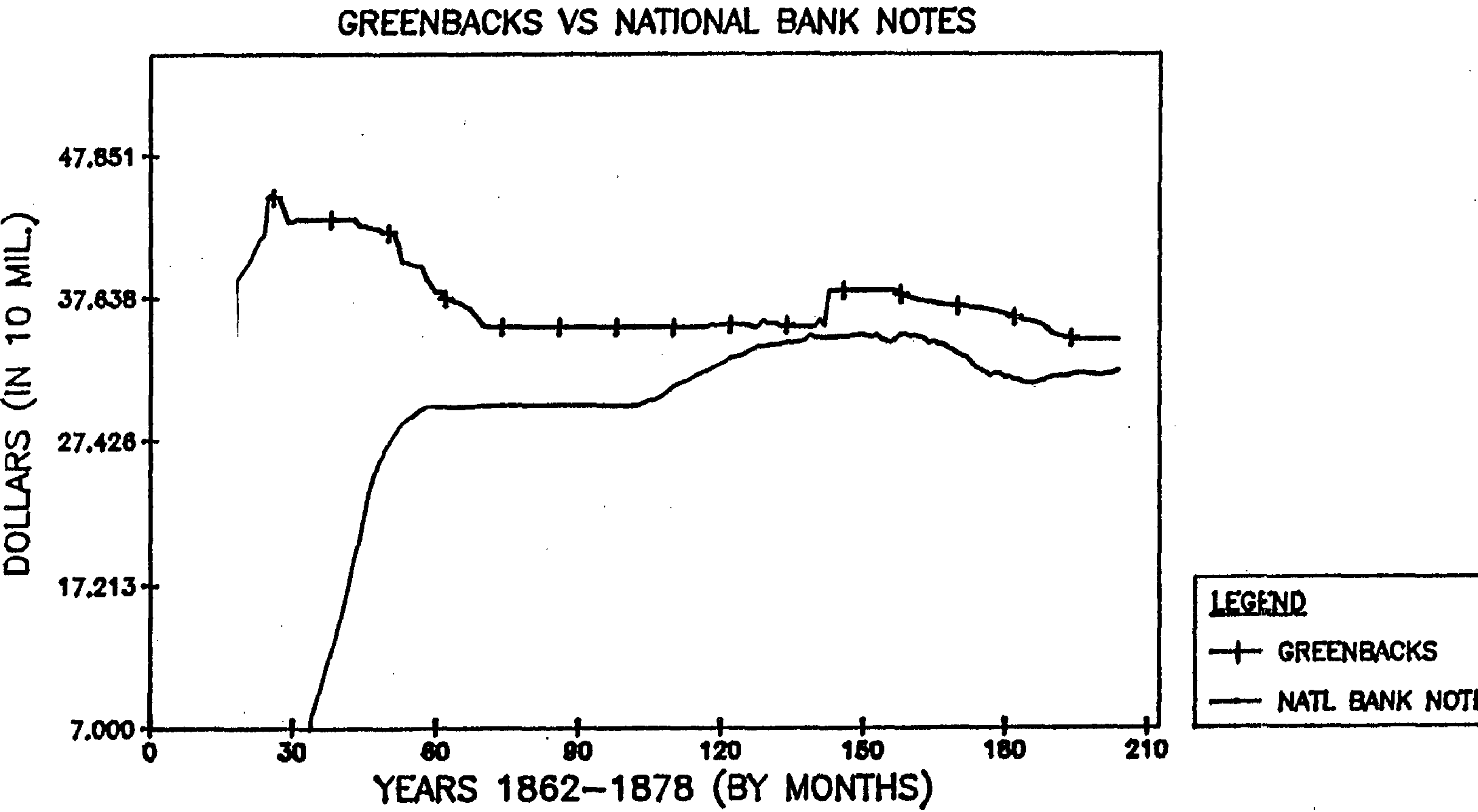


Figure 2 (cont'd).

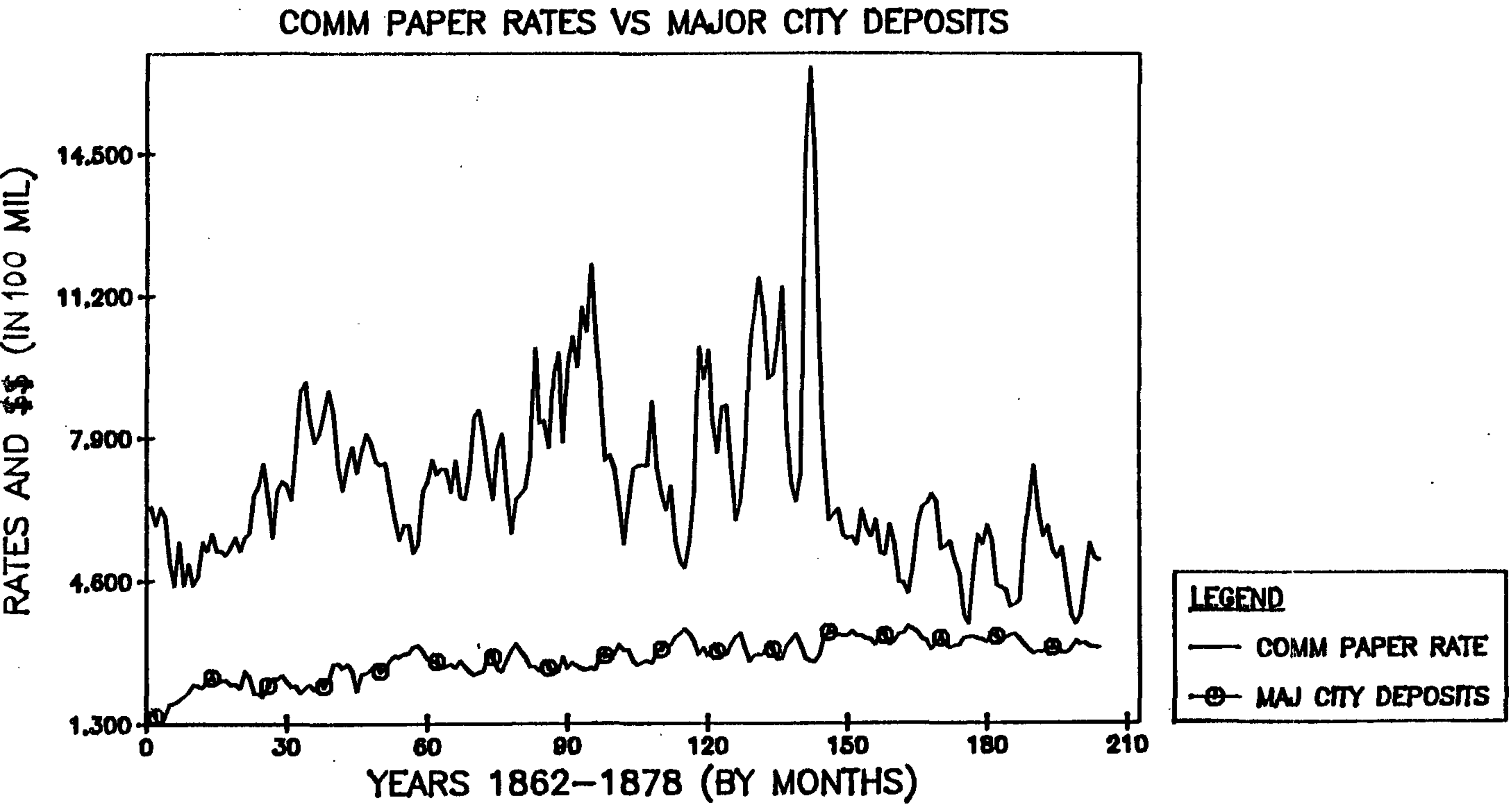


Table 5

Monthly Volatility Measures

	1862,2-1865,4		1863,7-1865,1		1865,5-1875,1		1875,2-1878,12		1862,1-1878,12		1863,7-1878,12	
	σ_1*	σ_2**	σ_1*	σ_2**	σ_1*	σ_2**	σ_1*	σ_2**	σ_1*	σ_2**	σ_1*	σ_2**
Growth Rate of Exchange Rate	9.38	9.65	10.31	11.54	2.70	2.68	1.44	1.44	4.71	4.73	4.51	4.49
Growth Rate of Wholesale Price Index	4.82	5.15	4.52	5.99	2.24	2.22	1.84	1.83	2.96	3.04	2.86	2.91
First Dif. of the Comm. Paper Rate	0.62	0.62	0.67	0.64	1.33	1.32	0.63	0.62	1.08	1.08	1.12	1.11
Growth Rate of Greenbacks			1.60	1.69	0.79	0.83	0.19	0.19			0.90	0.90
Growth Rate of National Bank Notes					2.91	3.16	0.43	0.48			2.75+	3.29+
Growth Rate of "Bills"					1.10	1.12	0.17	0.21			0.96+	1.03+
Growth Rate of Deposits	7.65	7.58	8.01	7.97	6.06	6.01	3.19	3.12	5.85	5.84	5.72	5.69

Sources: All data except commercial paper rates and wholesale prices are from the Commercial and Financial Chronicle and Hunt's Merchant's Magazine. Commercial paper rates are macaulay's (1938). Wholesale prices are the Warren-Pearson index, from the Historical Statistics of the U.S., First Edition, Series App. 24.

*Standard deviation of deviations from quadratic trend.
**Standard deviation.
+Sample period is from 1864,11-1878,12.

National bank note data for the period prior to December 1864 are not available on a consistent monthly basis, so they could not be included in the first-period calculations. Their inclusion no doubt would add to the volatility of the total bills series for 1863-1865, but this period is hardly one which a monetarist would want to point to for supporting evidence — the stock of total bills increased 68% from $312.50 million at the end of June 1863 to $525.06 million at the end of June 1865, while prices rose by 26%, the level of exchange rates was nearly identical, and real output fell 4% (see Table 1).

A more formal test can be performed using a VAR (Vector Autroreggressive) model. Reduced-form estimation equations are derived using monthly data which trace intertemporal Granger causality among economic time series from the beginning of 1867 to the end of 1878. Two sets of models are estimated and simulated. The endogenous variables in the first version of the VAR model are U.S. and British price indexes, the U.S. commercial paper rate, U.S. bills — defined as the sum of greenbacks and national bank notes — and major city deposits. Monthly U.S. prices are the Warren-Pearson wholesale price index. Total greenbacks, national bank notes, 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). Monthly dummy variables, time, time squared, and a constant term comprise the deterministic portion of the model.[28]

[28]All data, except the Warren-Pearson index, are end-of-month. British interest rates are excluded from the VAR system because, with the exception of the panic of 1866, they are virtually constant throughout the period; see Jevons (1884), Appended Diagram II.

In the second verions of the VAR model, government debt net of gold in the treasury, and the ratio of debt bearing interest in coin to total net debt are included as proxies for fiscal news. These data are from Hunts Merchants' Magazine and the Commercial and Financial Chronicle.

The ratio of gold-coupon debt to total net debt is included because — given the preferential treatment which bond holders received — it may have indicated government intentions regarding redemption policy. That is converting lawful-money-paying obligations into gold-paying obligations makes fiscal sense if the government expects greenbacks to appreciate relative to gold. The market might therefore pay attention to the ratio of gold-paying to total debt as an indicator of greenback appreciation.

In the first version of the VAR model, two reduced-form models were estimated. Model I divides money into bills and deposits; Model II also distinguishes greenbacks from national bank notes. The lag length for both versions is four months, which allows for different rates of adjustment among variables without sacrificing necessary degrees of freedom. In the second version of the VAR model — inclusive of government debt aggregates — Model III divides money into bills and deposits, while Model IV distinguishes greenbacks from national banks notes.

The structural neutrality of the VAR approach is both its strength and weakness. The inclusion of all variables of uniform lag length in each reduced form allows one to test the predictive power of the various series, but often the estimation results are open to various structural interpretations. Still, the VAR model is useful for distinguishing among competing descriptions of intertemporal correspondence among variables. The monetarist and asset-pricing approaches to exchange rates and prices offer different views which imply somewhat different predictive relationships among the variables in the VAR models. Friedman and Schwartz would expect nominal bills to predict significantly deposits, prices, interest rates and exchange rates, with deposit adjustment preceding price adjustment and price adjustment preceding exchange rate adjustment. The asset-pricing approach predicts that exchange rates follow a random walk, with the price level and monetary aggregates adjusting to changes in exchange rates and interest rates as news becomes available. The asset-pricing approach would distinguish greenbacks from notes, since greenbacks supply innovations probably contain policy "news," while note supply for much of the period is a function of the residual demand for bills. Both models predict predictive significance running in both directions for U.S. and British prices, holding exchange rates constant. The asset-pricing approach would expect changes in government debt to predict exchange rates, interest rates, prices, and money while the monetarist view assigns no importance to non-monetized debt.

Estimation Results

The Granger causality tests reported in Tables 6a-6d are more consistent with the asset-pricing approach.

Exchange rates are not significantly predicted by other varibles, with the possible exception of national bank notes. Though this would seem to contradict market efficiency, a better explanation of this result is that truncation of the lag structure at four is responsible for spurious correlation. This is a more plausible explanation because: (1) the coefficients on lagged terms in a random walk follow a smoothly declining autocorrelation function; and (2) national bank notes are themselves significantly predicted by exchange rates in Model II. Moreover, none of the monetary aggregates is significant in predicting prices. Though one might argue that lag truncation is responsible for this as well, given that notes predict exchange rates and exchange rates predict prices, we shall see below that simulation tests which allow money to affect prices through exchange rates are not consistent with this view. In other words, shocks originating in money are not important for the time path of prices, even allowing for feedback on prices through exchange rates.

In order to test the hypothesis that the predictive power of notes for exchange rates is the result of lag truncation, I ran the VAR model using only national bank notes and exchange rates with a twenty month lag structure. In this test neither is significant in predicting the other (notes predict exchange rates at a 0.24 significance level while exchange rates predict notes at a 0.22 significance level). In simulations, however, shocks to notes accounted for 12.5% of the forecast variance of exchange rates, while exchange rates accounted for 47.2% of the forecast variance of notes. The contemporaneous correlation of residuals is 0.000. These results seem to support the truncated-lag explanation of the importance of notes for exchange rates.

The supply of greenbacks is a significant predictor of deposits. The significance of greenbacks for predicting commercial paper rates and deposits may reflect, among other things, a loan supply effect in which increases in greenbacks temporarily increase the sum of greenbacks and specie in the economy. The high correlation of contemporaneous shocks to commercial paper rates and deposits: -0.54, -0.56, and -0.53, and -0.55 in Models I, II, III, and IV, respectively, supports the loan-supply-shock interpretation.[29] This interpretation is also consistent with the fact that, in the simulations which follow, shocks to high-powered money or its components are generally not very important for deposits or interest rates in the long run.

[29] See Judd and Scadding (1982a) and (1982b) for a discussion of this approach

Table 6a

VAR Version I: Model I*

Significance Levels of F-Tests

Lagged Endogenous Variables \ Contemporaneous Variables	LEX	CPR	LDEP	LWP	LB	LUK
LEX	0.000	0.576	0.277	0.062	0.740	0.619
CPR	0.572	0.000	0.404	0.977	0.000	0.797
LDEP	0.726	0.093	0.000	0.195	0.023	0.960
LWP	0.965	0.424	0.692	0.000	0.492	0.593
LB	0.044	0.041	0.029	0.726	0.000	0.990
LUK	0.957	0.345	0.270	0.735	0.582	0.000

*Equations are estimated with 102 degrees of freedom.

LEX = ℓn (greenback price of gold)
CPR = commercial paper rate
LDEP = ℓn (deposits)
LWP = ℓn(U.S. price index)
LB = ℓn(greenbacks and national bank notes)
LUK = ℓn(British price index)

Table 6b

VAR Version I: Model II*
Significance Levels of F-Tests

Lagged Endogenous Variables \ Contemporaneous Variables	LG	LEX	CPR	LDEP	LWP	LN	LUK
LG	0.000	0.598	0.004	0.048	0.726	0.799	0.932
LEX	0.173	0.000	0.593	0.359	0.077	0.024	0.808
CPR	0.000	0.302	0.000	0.445	0.991	0.839	0.869
LDEP	0.023	0.613	0.080	0.000	0.219	0.781	0.935
LWP	0.440	0.799	0.414	0.787	0.000	0.932	0.518
LN	0.035	0.120	0.055	0.847	0.998	0.000	0.664
LUK	0.389	0.879	0.205	0.125	0.721	0.809	0.000

*Equations are estimated with 98 degrees of freedom.

LG = ℓn (in greenbacks)
LEX = ℓn (greenback price of gold)
CPR = commercial paper rate
LDEP = ℓN (deposits)
LWP = ℓn (U.S. price index)
LN = ℓn (national bank notes)
LUK = ℓn (British price index)

Table 6c

VAR Version II Model III*
Significance Levels of F-Tests

Lagged Endogenous Variables	Contemporaneous Variables							
	LNET	RING	LEX	CPR	LDEP	LWP	LB	LUK
LNET	0.000	0.193	0.432	0.058	0.387	0.181	0.477	0.007
RING	0.497	0.000	0.767	0.008	0.542	0.063	0.184	0.116
LEX	0.470	0.889	0.000	0.500	0.164	0.117	0.235	0.594
CPR	0.464	0.620	0.537	0.000	0.323	0.887	0.000	0.842
LDEP	0.333	0.238	0.995	0.035	0.000	0.150	0.096	0.929
LWP	0.407	0.357	0.985	0.619	0.690	0.000	0.303	0.782
LB	0.618	0.412	0.298	0.009	0.058	0.332	0.000	0.066
LUK	0.492	0.832	0.953	0.083	0.229	0.681	0.111	0.000

*Equations are estimated with 94 degrees of freedom.

LNET = ℓn (net government debt)
RING = ratio of debt bearing interest in gold to total net debt.
LEX = ℓn (greenback price of gold)
CPR = commercial paper rate
LDEP = ℓn (deposits)
LWP = ℓn (U.S. price index)
LB = ℓn (greenbacks and national bank notes)
LUK = ℓn (British price index)

Table 6d

VAR Version II: Model IV*
Significance Levels of F-Tests

Lagged Endogenous Variables \ Contemporaneous Variables	LG	LNET	RING	LEX	CPR	LDEP	LWP	LN	LUK
LG	0.000	0.498	0.672	0.244	0.029	0.104	0.113	0.968	0.259
LNET	0.159	0.000	0.556	0.421	0.129	0.581	0.056	0.257	0.008
RING	0.084	0.612	0.000	0.765	0.144	0.785	0.007	0.355	0.149
LEX	0.277	0.829	0.907	0.000	0.427	0.156	0.076	0.006	0.751
CPR	0.000	0.593	0.849	0.316	0.000	0.244	0.985	0.827	0.844
LDEP	0.084	0.376	0.351	0.912	0.036	0.000	0.155	0.724	0.847
LWP	0.744	0.225	0.059	0.885	0.864	0.754	0.000	0.914	0.727
LN	0.005	0.804	0.062	0.845	0.080	0.759	0.243	0.000	0.196
LUK	0.298	0.606	0.918	0.954	0.102	0.155	0.621	0.309	0.000

*Equations are estimated with 90 degrees of freedom.

LG = ℓn (greenbacks)
LNET = ℓn (net government debt)
RING = (ratio of debt bearing interest in gold to total net debt.
LEX = ℓn (greenback price of gold)
CPR = commercial paper rate
LDEP = ℓn (deposits)
LWP = ℓn (U.S. price index)
LN = ℓn (national bank notes)
LUK = ℓn (British price index)

An interesting result from Models II and IV is the significant predictive power of past commercial paper rates and bank notes for the supply of greenbacks. The effect from bank notes may reflect the legislative response of greenback supply to bank note supply for 1875-1878. The Resumption Act of 1875 provided that for every $100 of bank notes created, $80 of greenbacks would be retired. This was repealed in May of 1878.[30] The significance of commercial paper rates and deposits for predicting the supply of greenbacks may reflect the endogeneity of policy to the cost of the bond-financing alternative or to "tightness" in the money market.

The inclusion of net government debt and the ratio of gold-paying to total debt has important consequences in Version II estimations. These variables are not significantly predicted by most others in the system, but they do have predictive power for commercial paper rates and for prices, both in the U.S., and surprisingly so, in Britain. The marginal significance of bank notes for predicting the proportion of gold-bearing debt is something of a puzzle. The slow adjustment of bank notes combined with the truncated lag structure of the model, once again, seems the best explanation. As the efficient market hypothesis would imply, the government debt variables do not predict exchange rates; but shocks in exchange rates are significantly correlated with shocks in the government debt variables (see tables 7c and 7d).

The generally low significance of the pasts of prices in Britain and the U.S. for predicting each other may be interpreted several ways. First, the contemporaneous correlation between shocks to the two indexes is significant: 0.33, 0.33, and 0.32, and 0.31 in Models I, II, III, and IV respectively.

[30] Note that only if $100 in greenbacks had been retired for every $100 in notes invested would the total supply of bills have been exogenous.

Thus rapid price adjustment may account in part for the insignificance of lagged terms. Second, commodity arbitrage — the mechanism by which uniform world gold prices are maintained — is costly; therefore, the law of one price holds imperfectly. That is, there exists a band within which gold prices may deviate from one another. Small changes in one series, therefore, would not affect the other. Finally, the law of one price may hold even when "purchasing power parity" does not. That is, arbitrage conditions for individual commodities do not translate into parity conditions for indexes of commodities.

Figure 3 plots a purchasing power parity measure for the ratio of British to American gold prices, assuming that the parity condition is satisfied perfectly in November 1870. In order to accept the PPP hypothesis one must be able to interpret persistent deviations from unity as within the band of arbitrage cost. If one assumes transportation, insurance and speculative costs equal to 10% of value transported, there is no persistent violation of the PPP hypothesis. Thus it seems reasonable to assume similar world commodity gold prices.

Simulation Results

Given an ordering for contemporaneous correlation among shocks to the different series, one can simulate the effects of a random disturbance to any one variable and the percentage contribution which any variable's random component makes to the forecast variance of each variable in the system. The ordering of contemporaneous shocks should reflect priors regarding exogeneity/endogeneity and speed of adjustment. I allow for two orderings of contemporaneous shocks: one places greenbacks first, followed by U.S. debt aggregates, exchange rates, interest rates, deposits, prices, bank notes, and

Figure 3

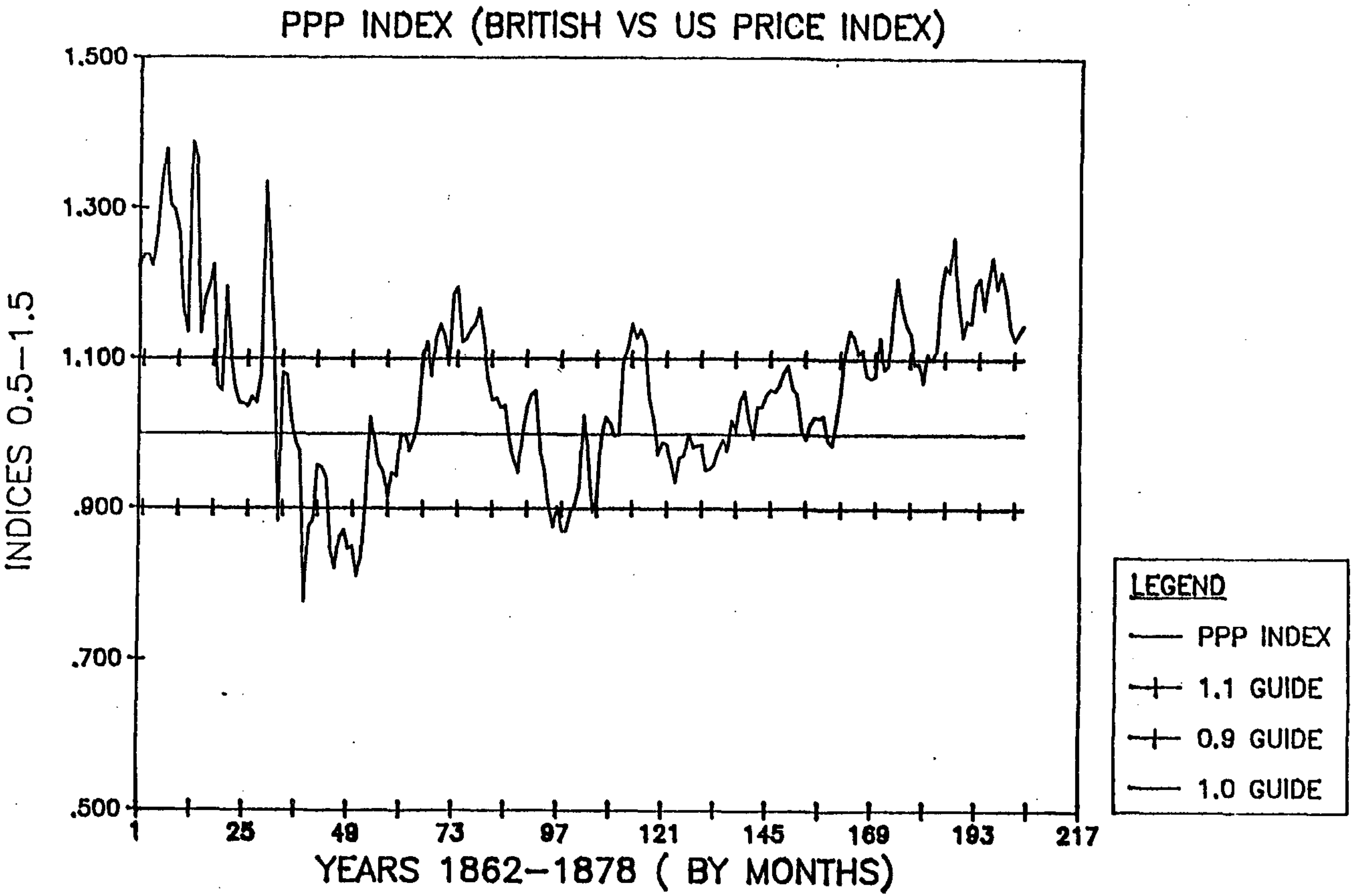
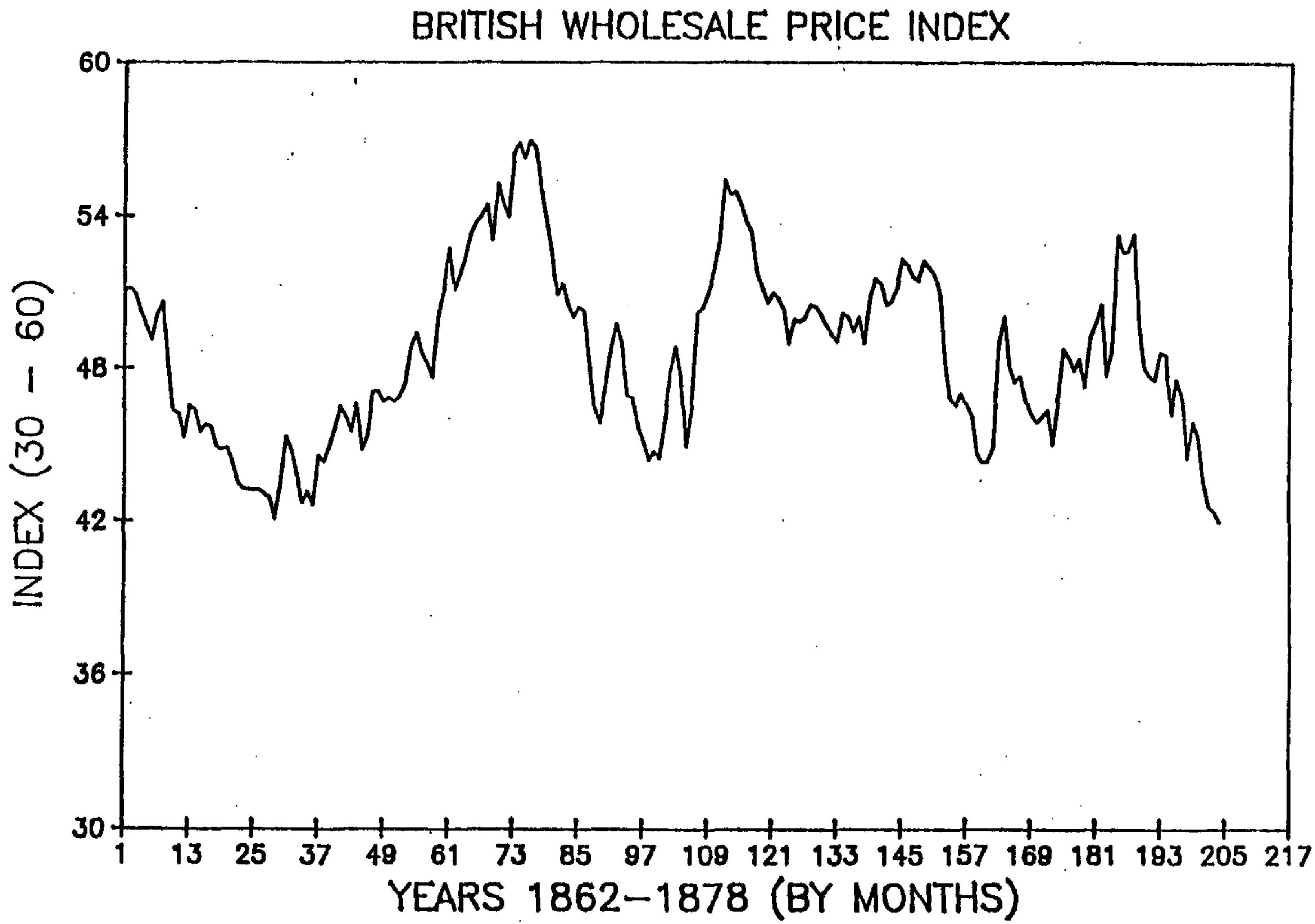

PPP INDEX (BRITISH VS US PRICE INDEX)
INDICES 0.5—1.5
1.500
1.300
1.100
.900
.700
.500
1
25
49
73
97
121
145
169
193
217
YEARS 1862—1878 (BY MONTHS)
LEGEND
PPP INDEX
1.1 GUIDE
0.9 GUIDE
1.0 GUIDE

Figure 3 (cont'd).



British prices; the other ordering places greenbacks first, followed by notes, deposits, interest rates, prices, exchange rates, debt aggregates and British prices. The first ordering is more consistent with the asset-pricing approach, while the second is constructed to be the "best-case" monetarist ordering.

Tables 7a-7d present the contemporaneous correlation matrices among residuals and summarize the decompositions of forecast variance for each series in Model I-IV, for both orderings. The decomposition of forecast variance is a measure of the "importance" of shocks to one variable in the future of another. Variables may be significant in the Granger sense without being important in simulation. Also some variables which are highly correlated contemporaneously may not be correlated as highly intertemporally.

The relative importance of each variable's influence on the others is somewhat sensitive to the ordering used, since there is significant contemporaneous correlation among residuals. Some conclusions however, are robust to changes in ordering. Shocks to monetary aggregates are not important contributors to the forecast variance of prices in any model under either ordering. Shocks to commercial paper rates constitute an important factor in the forecast variance of greenbacks in all models for both orderings. Shocks to exchange rates are important for notes under both orderings, and for prices in the first ordering where exchange rates adjust before prices. The first ordering seems the more plausible, since asset markets probably adjust to changes faster than commodity markets.

Table 7a
VAR Version I: Model I
Simulation Results
Correlation Matrix of Residuals*

	LEX	CPR	LDEP	LWP	LB	LUK
LEX	1					
CPR	-0.12	1				
LDEP	0.17	-0.54	1			
LWP	0.15	0.15	-0.04	1		
LB	-0.09	0.06	-0.19	-0.09	1	
LUK	-0.07	0.12	-0.06	0.33	0.04	1

*Residuals are from Model I; variables are defined in Table 6a.

Table 7a (cont'd.)
VAR Version I: Model I
Simulation Results
Correlation Matrix of Residuals
Decomposition of Forecast Variance*

Residuals Percent Contribution to Long-Run Forecast Variance \ Endogenous Variables	LEX	CPR	LDEP	LWP	LB	LUK
LEX (I)	62.1	6.4	8.5	14.5	18.1	2.2
LEX (II)	59.6	4.7	8.6	7.9	10.7	4.7
CPR (I)	5.8	76.8	30.9	5.0	23.4	2.5
CPR (II)	3.4	49.0	4.0	4.1	20.1	1.6
LDEP (I)	1.7	1.8	42.7	0.7	0.2	0.5
LDEP (II)	3.1	28.4	68.1	1.0	4.3	1.0
LWP (I)	0.3	11.7	4.9	58.7	0.8	15.1
LWP (II)	3.4	14.4	6.1	67.6	0.5	12.9
LB (I)	21.7	0.9	2.4	9.3	45.9	0.5
LB (II)	22.1	1.1	2.6	7.6	52.8	0.7
LUK (I)	8.4	2.4	10.5	11.8	11.7	79.1
LUK (II)	8.4	2.4	10.5	11.8	11.7	79.1

*Residuals are from Model I; variables are defined in Table 6a; (I) indicates ordering: LEX, CPR, LDEP, LWP, LB, LUK; (II) indicates ordering: LB, LDEP, CPR, LWP, LEX, LUK. The forecast horizon is two years.

Table 7b

VAR Version I: Model II

Simulation Results

Correlation Matrix of Residuals*

	LG	LEX	CPR	LDEP	LWP	LN	LUK
LG	1						
LEX	-0.12	1					
CPR	0.03	-0.12	1				
LDEP	-0.21	0.17	-0.56	1			
LWP	-0.07	0.15	0.16	-0.05	1		
LN	-0.06	-0.06	0.03	0.03	-0.04	1	
LUK	0.17	-0.06	0.08	-0.07	0.33	-0.14	1

*Residuals are from Model II; variables are defined in Table 6b.

Table 7b (cont'd.)
VAR Version I: Model II
Decomposition of Forecast Variance*

Residuals Percent Contribution to Long-Run Forecast Variance \ Endogenous Variables		LG	LEX	CPR	LDEP	LWP	LB	LUK
LG	(I)	58.4	4.1	11.9	10.4	2.2	4.8	2.7
LG	(II)	58.4	4.1	11.9	10.4	2.2	4.8	2.7
LEX	(I)	9.3	68.0	8.3	7.1	14.3	25.6	1.0
LEX	(II)	6.6	61.5	5.8	7.7	6.7	24.6	2.6
CPR	(I)	9.1	1.5	49.3	23.5	1.7	0.4	1.8
CPR	(II)	11.8	3.6	31.2	1.0	1.6	0.5	1.1
LDEP	(I)	2.4	1.9	2.5	38.3	0.7	0.8	0.9
LDEP	(II)	1.2	1.6	20.9	59.2	0.8	0.1	1.8
LWP	(I)	3.8	2.1	14.1	4.9	67.7	3.5	14.7
LWP	(II)	5.0	5.7	17.8	6.8	74.8	2.0	12.8
LN	(I)	13.3	12.6	9.3	2.4	3.1	59.3	3.7
LN	(II)	13.3	13.7	7.7	1.7	3.5	62.3	4.0
LUK	(I)	3.6	9.8	4.6	13.3	10.3	5.7	75.1
LUK	(II)	3.6	9.8	4.6	13.3	10.3	5.7	75.1

*Residuals are from Model II; variables are defined in Table 6b; (I) indicates ordering: LG, LEX, CPR, LDEP, LWP, LN, LUK; (II) indicates ordering: LG, LN LDEP, CPR, LWP, LEX, LUK. The forecast horizon is two years.

Table 7c
VAR Version II: Model III
Simulation Results
Correlation Matrix of Residuals*

Lagged Endogenous Variables	Contemporeanous Variables LNET	RING	LEX	CPR	LDEP	LWP	LB	LUK
LNET	1							
RING	-0.85	1						
LEX	-0.26	0.22	1					
CPR	0.07	-.01	-0.23	1				
LDEP	-0.27	0.15	0.18	-0.53	1			
LWP	0.02	-0.00	0.11	0.14	-0.05	1		
LB	-0.05	0.11	-0.02	0.09	-0.19	-0.02	1	
LUK	0.16	-0.08	-0.13	0.15	-0.11	0.32	0.11	1

*Residuals are from Model III; variables are defined in Table 6c.

Table 7c (cont'd.)
VAR Version II: Model III
Simulation Results
Decomposition of Forecast Variance*

Residuals Percent Contribution to Long-Run Forecast Variance \ Endogenous Variables	LNET	RING	LEX	CPR	LDEP	LWP	LB	LUK
LNET (I)	48.2	10.0	12.9	4.0	6.3	5.3	0.7	28.7
LNET (II)	40.1	9.6	3.2	5.2	3.1	3.4	2.3	23.8
RING (I)	15.9	48.5	4.5	28.4	12.9	17.3	22.9	4.6
RING (II)	11.0	37.2	2.2	23.8	9.5	14.2	18.2	7.2
LEX (I)	9.0	0.2	57.7	4.6	4.9	10.1	20.8	0.4
LEX (II)	15.3	1.5	61.3	2.7	9.0	6.5	11.3	5.6
CPR (I)	6.4	9.7	1.6	47.7	25.4	0.8	10.9	5.5
CPR (II)	3.4	7.2	1.9	33.9	3.0	0.6	11.8	2.8
LDEP (I)	2.1	0.5	1.7	2.7	36.7	1.2	0.6	3.0
LDEP (II)	2.9	3.0	4.4	17.0	61.1	2.3	4.4	1.1
LWP (I)	8.7	13.1	1.5	7.0	4.5	54.5	5.0	8.0
LWP (II)	12.2	14.5	3.7	8.6	5.1	60.9	5.5	7.5
LB (I)	6.4	13.1	16.5	3.3	3.8	8.1	26.2	11.3
LB (II)	12.0	22.2	19.9	6.6	3.9	9.4	33.6	13.6
LUK (I)	3.2	4.9	3.5	2.3	5.4	2.7	12.9	38.5
LUK (II)	3.2	4.9	3.5	2.3	5.4	2.7	12.9	38.5

*Residuals are from Model III; variables are defined in Table 6c; (I) indication ordering: LNET, RING, LEX, CPR, LDEP, LWP, LB, LUK; (II) indicates ordering: LB, LDEP, CPR, LWP, LEX, LNET, RING, LUK. The forecast horizon is two years.

Table 7d
VAR Version II: Model IV
Simulation Results

Correlation Matrix of Residuals*

	LG	LNET	RING	LEX	CPR	LDEP	LWP	LN	LUK
LG	1								
LNET	0.03	1							
RING	-0.06	-0.84	1						
LEX	-0.03	0.25	0.21	1					
CPR	0.07	0.07	-0.03	-0.19	1				
LDEP	-0.22	-0.27	0.15	0.16	-0.55	1			
LWP	0.07	-0.00	0.04	0.11	0.18	-0.07	1		
LN	-0.11	-0.02	0.10	-0.02	0.08	0.02	0.03	1	
LUK	0.24	0.16	-0.09	-0.11	0.12	-0.12	0.31	-0.08	1

*Residuals are from Model IV; variables are defined in Table 6d.

Table 7d (cont'd)
VAR Version II: Model IV
Simulation Results
Decomposition of Forecast*

Residuals Percent Contribution to Long-Run Forecast Variance \ Endogenous Variables	LG	LNET	RING	LEX	CPR	LDEP	LWP	LN	LUK
LG (I)	31.3	0.7	0.2	4.6	3.0	4.0	7.0	2.4	4.7
LG (II)	31.3	0.7	0.2	4.6	3.0	4.0	7.0	2.4	4.7
LNET (I)	3.1	50.6	9.1	12.0	4.0	5.0	7.5	1.8	24.0
LNET (II)	3.6	44.1	8.1	5.7	4.8	2.5	6.8	0.0	21.4
RING (I)	19.3	5.3	25.1	1.4	14.3	10.0	15.7	2.0	13.1
RING (II)	12.5	2.7	16.6	2.2	10.1	6.0	13.6	1.2	16.6
LEX (I)	5.2	11.6	2.9	59.0	4.5	5.6	8.3	23.0	0.5
LEX (II)	2.4	13.6	5.4	57.8	3.3	8.7	4.5	25.9	4.3
CPR (I)	9.6	3.7	1.5	1.9	45.7	25.2	1.6	0.2	4.1
CPR (II)	11.6	4.4	0.9	5.2	31.2	1.9	1.9	0.7	3.1
LDEP (I)	2.0	2.1	0.4	1.4	3.4	34.7	1.9	0.3	3.2
LDEP (II)	3.5	3.1	1.1	2.5	17.7	59.9	1.0	0.5	1.9
LWP (I)	15.2	19.5	34.1	2.1	13.1	6.9	53.4	5.7	5.3
LWP (II)	17.2	24.7	36.1	6.0	15.4	7.6	61.3	2.7	5.6
LN (I)	12.2	3.1	21.7	12.5	8.8	2.6	2.8	52.0	7.3
LN (II)	15.9	3.4	26.6	10.8	11.3	3.4	2.3	54.2	4.7
LUK (I)	2.1	3.3	5.0	5.1	3.1	6.1	1.7	12.4	37.8
LUK (II)	2.1	3.3	5.0	5.1	3.1	6.1	1.7	12.4	37.8

*Residuals are from Model IV; variables are defined in Table 6d; (I) indicates ordering: LG, LNET, RING, LEX, CPR, LDEP, LWP, LN, LUK; (II) indicates ordering: LG, LN, LDEP, CPR, LWP, LEX, LNET, RING, LUK. The forecast horizon is two years.

The government debt variables are the most "important", as well as the most significant, varibles for future prices, though these variables play a smaller and less significant role in exchange rate prediction. Once, again, lag truncation may be responsible for this divergence, if news about trends in government policy precedes changes in debt aggregates and if prices adjust to news slower than exchange rates.

VAR Models and the Lucas Critique in Historical Perspective

Though VAR models are useful for describing broad patterns in data, an historically cognizant adherent to the endogenous-money/asset-pricing view would not puzzle too long over every F-test result or forecast variance component. As Lucas (1976) points out, econometric modelling is a perilous business when policy changes influence structural relationships. Thus, for example, the constrained constancy of nominal bank notes from 1867 to 1870 and their subsequent endogeneity lead one to interpret the VAR results for that series as an averaging of two very different sets of interactions. Similarly, the legislated response of greenbacks to changes in note supply for 1875-1878 and periodic long stretches of constancy in the series make any uniform characterization of this series dubious.

If one attempted to take account of all such important historical changes it would be impossible to perform almost any formal statistical tests on the relevant time series. Fortunately, for our purposes it is not necessary to infer stable structural relations among the variables in the models, only to discredit the mechanistic exogenous-money approach to exchange rate and price change which fails precisely because it ignores important institutional features of the financial history of the period. In other words, the VAR model is a sufficient tool to reject the proposition that monetary aggregates are the single most important determinants of prices and exchange rates throughout the Greenback Period. The VAR approach also may be useful for describing the links among prices, interest rates and exchange rates and for further testing the efficiency of the exchange market, to the extent these relationships are robust to changes in the way money is introduced into the economy.

V. Concluding Remarks

Summary of Results

This paper argues in favor of the basic approach taken by Mitchell and others[31] who concentrate on expectations of government fiscal and resumption policies during the Greenback Period as the main determinants of exchange rates and prices, and through them, money. The arguments used in favor of this approach, and against that of Friedman and Schwartz, include theoretical propositions regarding the exchange market and the role of greenback supply in determining the money stock, and empirical studies of exchange market efficiency, volatility comparisons, and an analysis of the predictive relationships among money, prices, interest rates and exchange rates.

The picture which emerges from these arguments and facts is roughly as follows: during the Greenback Period the United States was an open economy with a freely floating exchange rate which responded efficiently to changing perceptions of the 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 statisfy real money demand.

[31]See Paul Studenski and Herman E. Krooss, Financial History of the United States, second edition, pp. 147-8.

Greenback Valuation and Rents from Note Issues

If prices were determined independent of the supply of national bank notes — as the above analysis suggests — then the period during which the nominal supply of bank notes was constrained (1867–1870) potentially was a time when banks which had the privilege of note issue could earn rents from their notes outstanding. That is, the zero profit condition should not apply for 1867 to 1870. The extent of rents, of course, depends on how binding was the nominal constraint. Nominal note supply did not skyrocket upon the removal of the $300 million constraint (see Figure 2), and column 6 of Table 1 shows a remarkably constant ratio of real notes and greenbacks relative to output. Thus casual empiricism suggests rents were small. Still it would be interesting to measure changes in rents from note issue directly.

In his 1873 Annual Report, the Comptroller of the Currency, John Jay Knox, published calculations of the profitability to national banks from issuing notes during the suspension. Knox finds that the zero-profit condition is approximately satisifed. He finds profits to be between 1 and 2 1/2 percent, depending on the region in which the bank is located.[32] An algebraic version of Knox's calculation of the yearly profit rate would be written (in paper terms):

$$\text{Rate of Profit} = \frac{(c)(e)}{p} - (0.9)\ ri_{\ell} - 0.009$$

where p is the cost of the bond required to be purchased, e is the paper value of gold, i_{ℓ} is the paper rate of interest earned on alternative assets, r is

[32]James (1976) finds regional differences in opportunity cost to be important predictors of bank note issues for the period 1888–1911. He uses this fact to argue that the marginal profitability on bank notes was less than the average, and hence to explain the excess profit "conundrum" posed by Cagan (1965).

the cash reserve requirement and 0.009 is the cost incurred due to the 1% tax on note issues. Knox adds that the bank will also suffer (p - 100,000), the difference between the market and face values of the bond at the date of maturity, but he does not include this in his calculation. To include this in a calculation of the average annual profit rate to the date of maturity requires an ex ante estimate of the time path of the exchange rate. In paper terms, the ex ante profit rate is given by:

$$\text{Rate of Profit} = Y - (0.9)\ r\tilde{i}_{\ell} - 0.009$$

where $\tilde{i}_{\ell}$ is the average expected paper rate on alternative assets and Y is the average paper yield to maturity from bonds. Since reservable (registered) bonds were not being held only by banks, arbitrage kept the yield on registered bonds close to that of coupon bonds. This means that, abstracting from risk differences, we could use the railroad bond yields from the appendix (Table A1 column 5) as a proxy for ex ante paper yields on reservable bonds. In order to proxy for risk differentials I use the average ex post rate of deflation to measure the portion of the yield differential not attributable to risk differences. For example, in late 1865 the actual rate of deflation to 1881 is roughly 2.3%, while the average yield differntial is .09%. Thus, if expectations were correct, the risk differential was 2.21% in favor of government securities. Thus the paper yield on government securities would be the railroad yield less 2.21%. This procedure assumes, of course, that banks did not benefit from the lower portfolio risk which government bonds provided; thus such profit calculations should be taken as strictly true only for risk neutral banks. Profit calculations without risk adjustment are performed, as well, for purposes of comparison. The rates of profit implied by these calculations for the years 1869 through 1878 are shown in Table 8.[33] The six-month averages of commercial paper rates and bond yields are used as proxies for $\tilde{i}_{\ell}$ and Y, respectively[34].

Cagan (1965) uses a different method to calculate the profitability of note issue. As Cagan points out, if banks can buy bonds rather than make loans with the notes they receive, and issue further notes on these bonds, then the rate of return on note issuing should be taken as a ratio of bank funds diverted, not as a ratio of the total amount invested in bonds. Instead of $\frac{(c)(e)}{p}$ and Y in the equation above, Cagan would substitute

$\frac{(c)(e)}{L}$ and $\frac{Y}{L}$ where $L \equiv \frac{p}{p-90}$. L represents the leverage banks enjoy by using

bond-backed notes to purchase further bonds. This implies a revised version of the long run profit rate calculation:

$$\text{Rate of Profit} = YL - (0.9)\, r\tilde{i}_{\ell} - 0.009$$

These figures are reported in Table 8, using the six-month average of P to compute L.

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

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[33]For 1869 through 1874, r is .25; for 1875 through 1878, r is .05.

[34]Under the strong assumption of risk neutrality, banks only care about expected profit. For the period excluding the latter half of 1873 and early 1874, seasonally adjusted commercial paper rates follow a random walk -- that is partial autocorrelation tests fail to show any significant patterns. If commercial paper rates follow a random walk it is reasonable to use current rates as a proxy for future rates. Partial autocorrelation tests are positive when the panic period is included. In other words, commercial paper rates during the panic of 1873 were not unbiased predictors of rates in 1875. Thus profit calculations for the latter half of 1873 are slightly biased downward.

Table 8

Long-Run Nominal Excess Profitability of Note Issue

	P	Y^a	Y^u	$\tilde{i}_\ell$	L	π_k^a	π_k^u	π_c^u	π_c^a
Jan.-June 1869	117.71	5.59	6.26	8.79	4.25	2.59	3.26	20.76	23.61
July-Dec. 1869	119.84	5.05	6.41	10.54	4.02	1.65	3.01	16.91	22.37
Jan.-June 1870	116.82	4.86	6.31	7.15	4.36	2.24	3.69	18.56	24.89
July-Dec. 1870	113.71	5.10	6.45	7.35	4.80	2.43	3.78	21.81	28.29
Jan.-June 1871	116.09	4.32	6.42	6.24	4.45	1.90	4.00	16.81	26.15
July-Dec. 1871	117.46	4.21	6.26	7.72	4.28	1.46	3.51	15.26	24.04
Jan.-June 1872	111.00	4.84	6.12	7.72	5.29	2.09	3.37	22.85	29.62
July-Dec. 1872	111.46	4.84	6.23	9.54	5.19	1.67	3.06	21.95	29.17
Jan.-June 1873	115.09	4.26	6.25	9.19	4.59	1.17	3.16	16.46	25.60
July-Dec. 1873	111.61	4.79	6.44	11.43	5.16	1.19	2.84	21.12	29.63
Jan.-June 1874	114.98	3.98	6.23	6.18	4.60	1.58	3.83	15.90	26.25
July-Dec. 1874	112.86	4.12	6.07	5.79	4.94	1.80	3.75	18.04	27.70
Jan.-June 1875	116.52	3.41	5.70	5.15	4.39	2.18	4.47	13.74	23.79
July-Dec. 1875	117.19	3.25	5.46	5.74	4.31	1.99	4.20	12.75	22.27
Jan.-June 1876	123.00	1.51	5.20	5.41	3.73	0.26	3.95	4.39	18.15
July-Dec. 1876	118.21	2.34	5.17	4.86	4.19	1.12	3.95	8.58	20.44
Jan.-June 1877	113.57	2.57	5.15	4.49	4.82	1.37	3.95	11.18	23.62
July-Dec. 1877	110.88	2.90	4.95	5.87	5.31	1.63	3.68	14.13	25.02
Jan.-June 1878	107.71	3.30	5.02	5.00	6.08	2.07	3.79	18.84	29.29
July-Dec. 1878	108.36	2.55	4.85	4.61	5.90	1.34	3.64	13.84	27.41

π^a, Y^a are adjusted for imputed risk differentials.

π^u, Y^u are not adjusted for risk differences.

π_k measures excess profits using Knox's formulation.

π_c measures excess profits using Cagan's formulation.

All other variables are defined in the text.

their banks would return notes to the bank of issue.[35] This is tantamount to challenging a bank's ability to determine its circulation. Of course, in the aggregate, given the independently determined price level and real demand, the nominal aggregate 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 zero-excess 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.

Not surprisingly, the Cagan formula produces much higher profit rates for both the risk-adjusted and unadjusted series. None of the four profit series comes close to the measured profit rate of banks, defined as the average ratio

[35] See James (1976), p. 362.

Table 9

End of Period	Annual Rate of Profit for Six Month Periods*
Sept. 1869	12.44
March 1870	11.87
Sept. 1870	10.65
March 1871	10.69
Sept. 1871	10.29
March 1872	10.25
Sept. 1872	11.01
March 1873	11.11
Sept. 1873	11.22
March 1874	9.87
Sept. 1874	9.96
March 1875	9.54
Sept. 1875	9.33
March 1876	7.37
Sept. 1876	6.61
March 1877	6.34
Sept. 1877	5.06
March 1878	5.74
Sept. 1878	4.67
March 1879	5.12

*The annual rate of profit is calculated using the ratio of earnings to capital and surplus for six-month periods given in the Annual Report of the Comptroller of the Currency for 1879.

of net earnings to capital.[36] The Comptroller's Report of 1879 shows overall profits so defined for 1869 through 1878. Table 9 reproduces these figures. By this criterion "of reasonable profit" one might judge therefore that banks were able to leverage bond purchases, but by less than the amount Cagan suggests.

Perhaps with greater confidence one can discuss the changes in note profitability through time. The removal of the nominal ceiling on notes does not seem to have had a large impact on profits, though by all measures there is a decline in profit from the end of 1870 to the end of 1871. This confirms the view that profits from note issue were not significantly higher during the period the ceiling acted as an effective constraint.

The extremely low estimate of *ex ante* profits in the first half of 1876 indicates that expected deflation was much less than actual for 1876. This is because the risk premium was calculated as the residual of the *ex post* real interest rate differential.

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[36] The reserve requirements and commercial paper rates used in the note profit calculations are most applicable to New York banks. If, as James (1976) suggests, New York banks had lower than average profits than the relevant comparison for overall bank profits may be below those in Table 9.

Appendix

Interest Rate Differentials and Deflationary Expectations

The appendix presents calculations of interest rate differentials between paper-denominated railroad bonds and the gold-denominated U.S. bonds of 1818, for the period 1869-1878 when gold-denominated bonds were clearly redeemable in gold, but greenbacks traded at below par with gold.

Table A1, columns (1) through (4), are railroad bond yields from Macaulay. Column (5) splices these series together, according to the procedure described in Table A1, to produce a single low-yield railroad bond series for the period 1869-1878. Column (6) is calculated from end-of-month price quotations for the U.S. 6's of 1881 in Hunt's Merchant's Magazine and the Commercial and Financial Chronicle.

Table A2 calculates six-month averages of yield differentials computed from columns (5) and (6) of Table A1. Six-month averages are used to eliminate the effect of the coupon payment schedules on the interest differential.

Column (2) of Table A2 subtracts the interest differential from late 1878 — when gold and greenbacks were trading at par — from the differentials for each year. If the relative riskiness of railroad bonds and government securities were constant from 1869 to 1878, then column (2) would measure accurately the expected rate of greenback appreciation.

Column (4) measures the difference between the column (2) *ex ante* deflation estimate and the *ex post* rate of deflation. Thus derivations from zero in column (4) are due to some combination of variation in the risk premium, deflation forecast error, and measurement error.

The value 1.53 in column (4) for the first half of 1869 is consistent with the view that 1869 was a turning point in the government's commitment to the redemption of bond principal in gold. Most of the other values in column (4) seem to be quite close to zero, indicating that deflationary expectations were generally accurate, and the risk premium differential was fairly constant. The large negative value of -1.49 for early 1876 may reflect political controversy over the future of resumption policy. From this perspective, one would judge that market agents were not confident of the government's commitment to resume on January 1, 1879.

The results of our exercise lend support to Roll (1972)'s interpretation of yield differentials as measures of expected greenback appreciation, which is consistent with viewing greenbacks as risky relative to gold.

Table A1

Yields to Maturity on Low-Yield Railroad Bonds and U.S. Government 6's of 1881

	(1) Penn. RR 7s 1880	(2) Hudson River RR 7s 1885	(3) N.Y. Central 6s 1887	(4) Camden & Amboy 6s 1889	(5) Combined and Adjusted RR Bonds	(6) U.S. 6s 1881
1867, 1	6.07	6.77	6.63		6.07	8.57
2	6.10	6.87	6.66		6.10	8.57
3	6.17	6.91	6.64		6.17	8.26
4	6.27	6.99	6.88		6.27	8.21
5	6.32	6.87	6.68		6.32	8.08
6	6.38	6.86	6.52		6.38	8.19
7	6.25	6.76	6.68		6.25	8.67
8	6.17	6.68	6.89		6.17	8.69
9	6.17	6.62	6.73		6.17	8.94
10	6.25	6.79	6.69		6.25	8.55
11	6.31	6.89	6.84		6.31	8.24
12	6.23	6.93	6.87		6.23	7.92
1868, 1	6.15	6.86	6.83		6.15	8.68
2	6.08	6.83	6.73		6.08	8.86
3	6.02	6.73	6.74		6.02	8.56
4	6.03	6.68	6.74		6.03	8.39
5	5.95	6.75	6.69		5.95	8.17
6	5.95	6.98	6.60		5.95	8.01
7	6.02	6.77	6.59		6.02	8.73
8	6.08	6.62	6.46		6.08	8.80
9	6.12	6.75	6.56		6.12	8.65
10	6.12	6.75	6.75		6.12	7.88
11	6.14	6.69	6.82		6.14	7.88
12	6.24	6.68	6.95		6.24	7.81
1869, 1	6.22	6.61	7.00	7.04	6.22	8.34
2	6.32	7.00	7.06	6.99	6.32	7.48
3	6.28	6.94	7.06	7.02	6.28	7.57
4	6.34	6.99	7.14	7.09	6.34	7.22
5	6.17	6.93	6.94	7.06	6.17	7.52
6	6.23	7.08	6.88	6.91	6.23	7.43
7	6.31	7.03	6.99	7.05	6.31	7.17
8	6.25	6.86	6.89	7.07	6.25	7.41
9	6.32	6.95	7.08	7.15	6.32	7.04
10	6.51	6.94	7.13	7.12	6.51	6.97
11	6.61	7.00	7.24	6.57	6.61	6.74
12	6.61	7.19	7.70	6.68	6.61	6.20
1870, 1	6.39	6.80	7.37	6.78	6.39	6.29
2		6.65	7.20	6.77	6.25	5.93
3		6.64	7.09	6.76	6.24	5.76
4		6.72	7.04	6.60	6.32	5.85
5		6.75	7.02	6.62	6.35	5.64
6		6.71	7.00	6.58	6.31	5.27
7		7.06	7.02	6.57	6.66	6.79
8		6.97	7.15	6.58	6.57	6.32

Table A1 (continued)

Yields to Maturity on Low-Yield Railroad Bonds and U.S. Government 6's of 1881

	(1) Penn. RR 7s 1880	(2) Hudson River RR 7s 1885	(3) N.Y. Central 6s 1887	(4) Camden & Amboy 6s 1889	(5) Combined and Adjusted RR Bonds	(6) U.S. 6s 1881
9		6.76	7.21	6.65	6.36	6.00
10		6.75	7.25	6.58	6.35	5.71
11		6.75	7.29	6.58	6.35	5.68
12		6.82	7.56	6.58	6.42	5.71
1871, 1		6.76	7.29	6.57	6.36	5.71
2		6.80	7.07	6.55	6.40	5.55
3		6.95	7.04	6.61	6.55	5.31
4		6.88	7.01	6.62	6.48	5.28
5		6.80	6.87	6.53	6.40	5.37
6		6.75	6.86	6.50	6.35	5.42
7		6.73	6.87	6.53	6.33	5.52
8		6.66	7.02	6.57	6.26	5.38
9		6.68	6.94	6.52	6.28	5.56
10		6.78	6.93	6.67	6.38	5.43
11		6.66	7.09	6.60	6.26	5.11
12		6.47	7.01	6.66	6.07	4.89
1872, 1		6.43	6.83	6.56	6.03	6.00
2		6.39	6.72	6.52	6.00	6.20
3		6.57	6.88	6.56	6.17	6.02
4		6.49	6.88	6.58	6.09	5.95
5		6.59	6.90	6.58	6.19	6.24
6		6.61	6.79	6.51	6.21	6.18
7		6.57	6.64	6.36	6.17	6.27
8		6.55	7.08	6.34	6.15	6.07
9		6.39	6.96	6.41	6.00	6.50
10		6.57	7.02	6.42	6.17	6.17
11		6.88	7.50	6.50	6.48	6.34
12		6.79	7.30	6.67	6.39	6.08
1873, 1		6.74	7.00	6.53	6.34	5.76
2		6.66	7.02	6.53	6.26	6.26
3		6.74	7.01	6.57	6.34	6.35
4		6.74	7.13	6.64	6.34	6.17
5		6.59	7.17	6.56	6.19	6.26
6		6.43	7.21	6.56	6.03	6.16
7		6.52	6.94	6.47	6.12	5.96
8		6.65	7.00	6.41	6.25	6.09
9		6.73	7.01	6.74	6.33	6.00
10		6.95	7.83	6.94	6.55	6.23
11		7.10	7.78	6.81	6.70	5.92
12		7.10	7.41	6.92	6.70	5.89
1874, 1		6.85	7.25	6.47	6.45	5.65
2		6.51	6.84	6.40	6.11	5.71
3		6.62	6.71	6.33	6.22	5.73

Table A1 (continued)

Yields to Maturity on Low-Yield Railroad Bonds and U.S. Government 6's of 1881

	(1) Penn. RR 7s 1880	(2) Hudson River RR 7s 1885	(3) N.Y. Central 6s 1887	(4) Camden & Amboy 6s 1889	(5) Combined and Adjusted RR Bonds	(6) U.S. 6s 1881
4		6.53	6.91	6.33	6.13	5.36
5		6.68	6.94	6.18	6.28	5.51
6		6.58	6.64	6.13	6.18	5.53
7		6.46	6.90	6.08	6.06	5.35
8		6.48	6.87	6.12	6.08	5.45
9		6.54	6.87	6.09	6.14	5.66
10		6.46	6.57	6.02	6.06	5.62
11		6.29	6.29	6.03	5.89	5.88
12		6.57	6.29	5.96	6.17	5.75
1875, 1		6.22	6.24	5.89	5.82	5.52
2			6.20	5.86	5.78	5.96
3			6.21	5.90	5.79	5.87
4			6.12	5.86	5.70	5.66
5			5.99	5.76	5.57	5.85
6			5.94	5.71	5.52	5.72
7			5.89	5.73	5.47	5.36
8			5.86	5.74	5.44	5.51
9			5.78	5.64	5.36	5.79
10			5.99	5.61	5.57	5.77
11			5.86	5.57	5.44	5.63
12			5.91	5.59	5.49	5.25
1876, 1			5.74	5.58	5.32	4.10
2			5.62	5.58	5.20	4.18
3			5.52	5.63	5.10	5.27
4			5.65	5.73	5.23	4.04
5			5.59	5.67	5.17	4.00
6			5.61	5.54	5.19	3.71
7			5.44	5.52	5.02	4.13
8			5.37	5.44	4.95	4.20
9			5.70	5.44	5.28	4.15
10			5.55	5.46	5.13	4.12
11			5.65	5.32	5.23	4.28
12			5.80	5.13	5.38	3.67
1877, 1			5.54	5.08	5.12	3.96
2				5.12	4.99	4.13
3				5.27	5.14	4.08
4				5.47	5.34	4.17
5				5.36	5.23	3.76
6				5.23	5.10	3.49
7				5.21	5.08	4.06
8				5.05	4.92	3.85
9				5.01	4.88	3.79
10				5.10	4.97	3.46
11				5.20	5.07	3.61
12				5.13	5.00	3.89

Table A1 (continued)

Yields to Maturity on Low-Yield Railroad Bonds and U.S. Government 6's of 1881

	(1) Penn. RR 7s 1880	(2) Hudson River RR 7s 1885	(3) N.Y. Central 6s 1887	(4) Camden & Amboy 6s 1889	(5) Combined and Adjusted RR Bonds	(6) U.S. 6s 1881
1878, 1				5.08	4.95	4.28
2				5.13	5.00	4.63
3				5.19	5.06	3.93
4				5.24	5.11	3.53
5				5.19	5.06	3.38
6				5.09	4.96	2.49
7				5.01	4.88	3.08
8				5.07	4.94	2.78
9				4.99	4.86	2.93
10				5.01	4.88	2.73
11				4.98	4.85	2.44
12				5.04	4.91	2.13

Columns (1) through (4) are from Macaulay (1938).

Column (5) splices together columns (1) through (4) in the following fashion: (5) is identical with (1) through 1870,1; (5) is identical with (2), less the difference between (2) and (1) in 1870,1, for 1870,2 through 1875,1; (5) is identical with (3), less the difference between (3) and (5) in 1872,1, for 1875,2 through 1877,1; (5) is identical with (4), less the average difference between (4) and (5) for 1876,7-1871,1, for 1877,2 through 1878,12. The six-month average differential is used in the splicing of (4) and (5) to eliminate the bias due to different coupon payment schedules.

Column (6) is calculated from end-of-month prices quoted in Hunt's Merchants' Magazine and the Commercial and Financial Chronicle.

Coupon payments occur in January and July for all but series (4), which paid in May and November.

Table A2

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

*$\frac{1}{6} \sum_{j=1}^{6} [i_{sp}(j) - i_{gr}(j)] = d$ where i_{sp} and i_{gt} are given by columns (6) and (5) of Table A1, respectively.

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

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