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Greenback-Gold Returns and Expectations of Resumption, 1862-1879

Gregor W. Smith   R. Todd Smith
Queen's University   University of Alberta

Department of Economics
Queen's University
94 University Avenue
Kingston, Ontario, Canada
K7L 3N6

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Abstract

We propose a unified framework for studying the greenback-gold price during the U.S. suspension of convertibility from 1862 to 1879. The gold price is viewed as a floating exchange rate, with a fixed destination given by gold standard parity because of the prospect of resumption. We test this perspective using daily data for the entire period, and measure the effect of news during and after the Civil War. New evidence of a decline in the volatility of gold returns after the Resumption Act of 1875 provides statistical support for the importance of expectations of resumption.

Keywords: greenbacks, gold standard, regime switching

JEL Classification Code: N21

This study examines the price of gold, denominated in greenbacks, during the period of the U.S. suspension of convertibility from 1862 to 1879. We propose a new framework for studying the gold-greenback price and provide tests of this framework in daily data from the entire period. Our approach provides a unified perspective on previous studies, and suggests several new tests. For example, we re-examine the effects of war-time news in this framework, and also use it to assess the effects of the Resumption Act.

The approach begins from the observation that the gold price was approximately the floating exchange rate, because European countries remained on the gold standard. However, it was widely anticipated that gold standard parity would be restored. Unlike most floating exchange rates, then, the gold price had a fixed destination: when specie payments were resumed in 1879 the gold dollar was worth one greenback. Both contemporary obervers and later historians argued that expectations of resumption influenced the price of gold. For example, Wesley Mitchell suggested that the price reflected war news and financial developments during the Civil War because those events informed gold traders about the probability of resumption.[1] More directly, Irving Fisher described the price after the Resumption Act of 1875 as being determined by the terminal condition.[2] Our framework thus is a regime-switching model, in which the exchange rate regime switches from a float to a fix. We allow for the fact that the time of the switch or resumption was uncertain until at least 1875.

The gold price rose rapidly (the greenback depreciated) during the Civil War, and so a resumption of parity would have brought large capital gains to holders of greenbacks and capital losses to holders of gold. Therefore news which was likely to delay (hasten) resumption should have raised (lowered) the price of gold. This paper confirms the results of previous event studies for the Civil War period, by examining the gold price at the time of military and financial news events catalogued by Mitchell. A new contribution is to measure the cumulative effect of these news events. We find that the net effect of news was a fall in the price of gold, whereas the price actually rose by more that 30 percent during the War. Thus other influences on the greenback-gold price more than offset the effects of news during the War.

We also test for the importance of news in the post-war period, using a variety of

events. Here we find no evidence that discrete events were important, which suggests that the causes of greenback appreciation were gradual and perhaps anticipated.

Although a number of researchers have studied the response of the gold price to news events, especially during the Civil War, none has studied the implications of expected resumption for the statistical properties of gold prices. We derive those properties in detail, and find that the path of the gold price is predicted to bend down, and returns to holding gold to become less volatile over time, as resumption nears. Tests for these properties for the period after the Resumption Act show that volatility did decline, which is consistent with the view that expectations of resumption did influence the U.S. exchange rate after 1875.

To test for the effects of expected resumption we use daily gold prices from November 1861 to January 1879, which are shown in Figure 1. Mitchell collected the cash price of gold (for same-day settlement) from *American Gold, 1862-1878*, published by J.C. Mersereau, an official of the gold exchange in New York, and from *The Commerical and Financial Chronicle*.[3] We use the highest daily gold dollar price of the greenback and invert it to give the price of gold. The daily data allow a precise timing of news events and the numerous observations allow statistical tests of the path for the exchange rate which the regime-switching model implies.

A MODEL OF EXCHANGE RATE REGIME SWITCHING

As we have noted, the gold price approximated the floating exchange rate, because the sterling price of gold was fixed throughout the period at $4.86 $\frac{21}{32}$. Multiplying the gold price by the gold-sterling parity then yields the lowest daily greenback price of sterling. Changes in the gold value of sterling, within the gold points, were very small relative to changes in the greenback price of gold and so many studies have treated the latter price as the exchange rate.[4]

However, most dollar/sterling exchange was conducted through bills of exchange, (even after the transatlantic cable was installed in 1866) at rates which could differ from parity by a sterling premium which briefly rose to 3 percent in 1863.[5] Thus most derivations of exchange rate series for this period use bill prices and, with an interest-rate series,

attempt to eliminate the interest factor in the bills leaving a measure of the spot exchange rate.[6] Estimates are then time averaged (as price quotations on bills of exchange are available only at irregular intervals) and reported at quarterly intervals. Our method has the advantage of yielding daily observations, but our study is most precisely thought of as describing the greenback price of gold in New York, though we also refer to it as the exchange rate.

To study the effect of resumption expectations on the greenback price of gold, we draw on recent research on regime-switching in exchange rates.[7] In models of regime-switching, policy-makers announce that the exchange-rate regime will change in the future, for example from a floating to fixed system. This approach is appropriate because the U.S. resumption was widely anticipated. In this section we derive the implications of regime-switching for the time series properties of the gold price so that we may then test the historical relevance of this perspective.

Denote the logarithm of the greenback price of gold (or sterling) by $e(t)$, which we model in continuous time. The price is affected by current fundamentals such as monetary conditions and, like any asset price, by the expectation of capital gains or losses. Combining these two influences gives:

$$e(t) = f(t) + \alpha E_t(\frac{de(t)}{dt}) \tag{1}$$

where $f(t)$ is a fundamental determinant of the relative price and E_t denotes the expectation conditional on information at time t. This model captures the idea that the current price of gold, $e(t)$, partly reflects the anticipated price change, $E_t(de(t)/dt)$, with coefficient α. Equation (1) also may be thought of as the reduced form of the monetary model of the exchange rate, in which case α represents the interest semi-elasticity of money demand.

The differential equation (1) relates the current level of the gold price to its own rate of change. As usual with differential equations, then, there are many mathematical solutions. We therefore adopt the so-called no-bubbles condition, which gives a unique solution by ruling out self-fulfilling, speculative bubbles. When there is a bubble, expected appreciation sustains the price even if the asset has no fundamental value such as a dividend or use in exchange. The asset price grows exponentially because the rate of appreciation must exceed the interest or discount rate, which is the opportunity cost of holding the

asset. There is no historical evidence which would suggest that there was a speculative mania in gold, and so we use the no-bubbles condition which rules out gold prices which grow explosively and are unrelated to fundamentals. With this condition equation (1) gives:

$$e(t) = E_t \int_t^\infty exp(\frac{t-s}{\alpha})f(s)ds \tag{2}$$

so that the current price is the discounted value of future fundamentals. This present-value model is widely used in exchange-rate modelling.[8]

We next make an assumption about the time series properties of fundamentals, f, but not about their identity, for two reasons. First, we wish to exploit the daily data in testing for the effects of expected resumption, and macroeconomic fundamentals are not available at that frequency. Second, economists have had very little success in explaining fluctuations in floating exchange rates with macroeconomic variables. Fundamentals which have been suggested for the period from 1862 to 1878 include the greenback issue, federal government budget deficits, output growth, and the current account balance, but none of these variables has been found statistically significant.[9] The method here allows us to measure the resumption effect in a relatively general way with results not conditioned on a specific, complete theory of exchange-rate determination.

Assume that the fundamentals follow a Wiener process, which is a random walk (a time series with unpredictable changes) in continuous time:

$$df(t) = \mu dt + \sigma dz(t) \tag{3}$$

where dz is a standard Wiener process. This is simply a drifting random walk; over a unit interval, changes in f are independently and identically normally distributed with mean μ and standard deviation σ.

If this path for the fundamental were expected to determine the price indefinitely, then forecasts based on the statistical description in equation (3) combine with the present-value model in equation (2) to give

$$e(t) = f(t) + \alpha\mu \tag{4}$$

so that the price or exchange rate e inherits the random walk property of the fundamental. That is a resilient statistical model of a floating exchange rate.[10] The random walk is

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appropriate in this context because the float from 1862 to 1879 was marked by virtually no intervention by the Treasury in the foreign exchange market, with the exception of Secretary Chase's ill-fated attempts from April to July 1864 to limit the increase in the gold price and restrict transactions in the gold room, gold sales on Black Friday (24 September 1869), and the resumption effect under study here.

Next, this standard model of nominal exchange rates is combined with a model of resumption expectations to test the hypothesis that those expectations influenced the price of gold. Denoting 1 January 1879 as T gives a terminal condition

$$e(T) = 0. \tag{5}$$

When specie payments are resumed at prewar parity the price of a gold dollar is one greenback dollar, which has a logarithm of zero.

With the terminal condition in equation (5) and fundamentals following equation (3) until resumption, the solution to equation (2) becomes:[11]

$$e(t) = [f(t) + \alpha\mu] \cdot [1 - exp(\frac{t-T}{\alpha})] + [e(T) - \mu(T-t)] \cdot [exp(\frac{t-T}{\alpha})], \tag{6}$$

for $t \leq T$. Equation (6) has two terms. The first term is the pure float solution multiplied by a weight that declines over time as resumption is approached. The second term reflects the terminal condition, multiplied by a weight that rises over time.

To summarize the implications of the model, we examine the rate of change of the gold price, which is the return in greenbacks to holding gold. Gold returns in the presence of future resumption have four key properties, which are formally derived in the Appendix. The first property concerns the effect of news about the time of resumption. Although we have not treated T as a random variable, it is a straightforward implication of equation (6) that news which increases T will raise the price of gold, while news which reduces T will lower the price of gold. This is property 1 (*resumption news*).[12]

The second property is that the relative price behaves like a random walk (the first term in equation (6)) when t is far less than T so that resumption is far in the future. As t becomes larger the weights tilt towards the second term, which draws the price down to 1 (its logarithm to 0) when $t = T$. We call this property 2 (*declining gold returns*).

The value of α is important – large values give an important role to expectations of future resumption in influencing current returns.[13]

The Appendix also shows that in the regime-switching model the gold price declines at an increasing rate as T approaches. Thus the model also predicts that the most negative returns to holding gold should be observed immediately prior to resumption. This is property 3 (*hard landing*). Finally, the second term in equation (6) is not random and so, as the weight on that term rises over time, the variance of returns declines over time. This is property 4 (*declining volatility of returns*).

Properties 2, 3, and 4 are illustrated in the upper panel of Figure 2, which shows a simulated gold price series. The series contains 1201 observations, the same as the number of daily observations after the Resumption Act, and begins at a price of \$1.12, the actual price on 8 January 1875. The dashed line shows a simulation of the underlying random walk, $exp(f(t))$, with a daily drift of $\mu = -0.0000001$ and a variance of $\sigma^2 = 0.000002$. The solid line shows $exp(e(t))$, with $e(t)$ constructed from equation (6) and the simulated random walk, with $\alpha = 500$. By construction, the simulated price falls to parity in December 1878.

The lower panel of Figure 2 shows the actual gold price after the Resumption Act. The volatility of the gold price appears to fall over time, as suggested by the theory. Comparison of the two panels also seems to support the theory by showing that the simulated path matches the actual path in reaching parity at the end of 1878, whereas the random walk does not. But this simulation begs the question of whether drift in fundamentals, as opposed to the pull of expected resumption, brought about this outcome. We shall later estimate μ, σ^2, and α to test formally for the effects of expected resumption.

We next provide empirical evidence on each of the implications of the process-switching model. Unlike properties 1 and 2, properties 3 and 4 of the process-switching model have not been studied previously to our knowledge. T was not known prior to the passage of the Resumption Act, and so we test only property 1 in data from that period. Then with the data from the period from 1875 to 1879 we investigate properties 2, 3, and 4.

The daily return to holding gold (expressed in greenbacks) is denoted $r_t = (e_t - e_{t-1}) \cdot 100$. Under the random walk model the average return to holding gold is simply μ, in the absence of resumption news. According to property 1, news which suggests that T will be delayed (advanced) raises (lowers) the return on gold, r_t. To test for this effect, we estimate by least-squares the equation:

$$r_t = \mu + \gamma_0 d_t + \gamma_1 d_{t-1} + \epsilon_t, \tag{7}$$

where d_t is a set of dummy variables attached to news events. The lag of the dummy variables allows for the diffusion of information. An example of this diffusion is provided by the rumors concerning the battle of Chancellorsville, which was fought on 3 May 1863. Reports favorable to the Union cause reached New York the next day. But over the following several days it became clear that a disastrous defeat had occurred, and the net effect was a large rise in the price of gold.

Mitchell listed events which influenced the price of gold.[14] He did not seek to make his lists comprehensive, but rather to cite examples of events which led to gold price movements. Thus our aim is not to show that these events were correlated with price movements, for they were selected on this basis. Instead, we hope to learn whether they accounted for an appreciable part of the variation in gold prices, and to measure the scale of a typical movement.

We construct two dummy variables, aligned with his daily quotations on gold prices, in order to study the role of these events. The first, denoted dw, measures news of war or diplomacy during the Civil War. It takes a value $+1$ on trading days on which there was bad news for Union finances (for example, 13 December 1862, when news of the defeat at Fredricksburg affected the gold market). These events increased the price of gold. The battles of Cedar Mountain (in the Peninsula campaign) and Gettysburg occurred on days when the gold exchange was closed. For such events we use the first subsequent trading day. The variable dw takes a value -1 with news of Union victories, which reduced the price of gold in greenbacks. It takes a value of 0 in other time periods. The events are listed in Table 1.

The second dummy variable is based on financial news, described by Mitchell as influencing gold prices, "since the first condition of redeeming the paper currency was financial strength."[15] It is denoted df. It takes the value $+1$ at the dates of events which expanded the greenback issue and raised the gold price (for example, 12 June 1862, when the second Legal Tender Act was announced). It takes the value -1 at the dates of successful loan issues or gold sales (for example, 25 March 1863, when news of Jay Cooke's bond sales on behalf of the Treasury reached the gold room). The associated events are listed in Table 2.

To measure the news effect we use the sample period from 1 May 1862 (by which time greenbacks were in circulation) to 30 June 1865, which includes 962 observations. Table 3 lists the results. In this period the mean daily return to holding gold was 0.0321 percent, with a standard error of 1.55. This same volatility is reflected in the least-squares regression of equation (7), which has an R^2 of only 0.079.

The coefficient on dw (with t-statistic in brackets) is 1.94 (4.83) for the current value and 0.86 (1.93) at one lag. For df the corresponding values are 1.43 (3.24) and 0.78 (2.95). This significance is not surprising, for we have included all events listed by Mitchell and presumably selected by him for their coincidence with changes in the price of gold. However, the estimates can be used to quantify his idea. The estimated average effect, after two days, of each item of wartime news (dw) is 2.80 (6.09) and of each item of financial news (df) is 2.22 (4.57). Including further lags shows some tendency for these positive effects to be reversed (suggesting that markets overreacted), but the sum remains positive and significant. Thus investors would have earned average, two-day returns of 2.80 percent by holding gold at the time of Confederate victories and greenbacks when the Union won.

The cumulative effects of these events over the entire war are revealing. In the case of military news, the cumulative effect of the Union losses listed on the left side of Table 1 was a 25.72 percent rise in the price of gold. Counting a further day of reaction to each event reduces this value to 20.20 percent. The cumulative effect of Union victories was a 30.89 percent fall in the price of gold, or a 51.19 percent fall if returns are measured over two days. Comparing one-day and two-day returns suggests that the gold room may have over-reacted to Union defeats and under-reacted to Union victories. In the case of

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financial news, the cumulative, two-day effect of good news (20.67 percent) was almost exactly offset by bad news (20.84 percent).

Thus the net effect of all the events highlighted by Mitchell was a fall in the price of gold, of about 30 percent. The price actually rose by more than 30 percent during the War, however, so other fundamentals must have driven up the gold price before 1865. Moreover, while returns at Mitchell's dates were large relative to mean returns, these factors account for only 8 percent of the variation of returns during the period, when we constrain them to have a common coefficient. If, instead, we attach a separate dummy variable to each event, then they explain 17 percent of the variation in returns. These findings are consistent with property 1, but they do not allow us to separate the influence of these news events on expectations about T from their potential effect on the gold price through fundamentals. In the next section we discuss a more direct test of property 1 for the postwar period.

Mitchell's daily data have been examined also for the Civil War period by Kristen Willard, Timothy Guinnane, and Harvey Rosen.[16] Rather than measuring and testing for changes at a given set of dates, they statistically identified dates at which jumps in the gold price of greenbacks occurred and also carefully measured the duration of these effects. They found seven dates at which the intercept shifts in a time series model of the price. Of these, the four dates which saw the largest percentage changes in the price also were highlighted by Mitchell and are included in (dw_t, df_t): 8 January 1863 when the House Ways and Means Committee recommended a third Legal Tender Act; 6 July 1863, the first trading day after the battle of Gettysburg; 12 July 1864 when Jubal Early's army was near Washington; 8 March 1865 when Hugh McCulloch was nominated as Treasury Secretary. Thus our measurements of the importance and scale of news effects are unlikely to be altered significantly by focusing on the events identified statistically by Willard, Guinnane, and Rosen as opposed to those listed by Mitchell.

It is possible that some of the military events listed in Table 1 did not affect the gold price, but simply happened to occur on days on which large price changes occurred for some other reasons. One way to shed light on this possibility involves the price of Confederate notes. If a piece of military news coincided with a fall in the gold value of the greenback, say, and also coincided with a rise in the value of Confederate notes, then one

is unlikely to attribute the change in the gold price to some other cause such as foreign trade.

Two studies have found that the military news events in Table 1 did significantly influence the value of Confederate notes. Richard Burdekin and Farrokh Langdana studied fluctuations in the commodity price of Confederate notes, at monthly frequency.[17] They concluded that war events accounted for much of the variations in that price. George McCandless used a time series model, at bi-weekly frequency, and showed that the gold values of greenbacks and of Confederate notes responded symmetrically to war news.[18] These studies use dummy variables for wartime events, though the variables are not based on Mitchell's list. They perhaps could be augmented with df, to see whether Union fiscal news also affected the value of Confederate notes.

POSTWAR NEWS

Mitchell's list of events ends in 1865; he had hoped to extend his study to 1879 but did not. However, a list of postwar news events likely to influence expectations of resumption and based strictly on primary sources is available. Richard Thompson constructed a set of 0/1 monthly dummy variables for the period from 1866 to 1878, basing his classification on news reported in *The Commercial and Financial Chronicle*, *The New York Times*, and *The New York Herald-Tribune*.[19] His five dummy variables capture news events pertaining to resumption, threats of foreign wars, crop and other real-sector news, gold corners, and political changes respectively. The first of these dummy variables is of particular interest here, as its significance should shed light on property 1 of the regime-switching model. Indeed, this test should be more powerful than the test applied to the wartime period, since Mitchell did not narrowly define events which affected expectations about T.

We estimated equation (7), including Thompson's 'resumption-news' dummy variable, in postwar monthly returns. The dummy variable is insignificant at the 5 percent level. One mild disadvantage of the dummy-variable test is that it restricts the size of response to be the same for all events. However, if the events were genuinely significant then the average response, measured in this way, would be too. Thus there is no evidence from this specification that news about the timing of resumption was reflected in the price of

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gold. Possibly many of the post-war legislative and political events which influenced the price of gold were anticipated and hence discounted in advance. In contrast, the war news described by Mitchell by its very nature might have been less easily anticipated.

Although the focus of this study is on resumption news, it is worth briefly noting that attempts to use dummy variables to answer other questions about the postwar gold price also are unsuccessful. For example, in Thompson's set of dummy variables only the variable which measures news of foreign wars is individually significant at the 5 percent level. Moreover, the five dummy variables are jointly insignificant at the 5 percent level.

Bruce Phelps catalogued news which he suggested could be used to discriminate between two competing theories of greenback valuation.[20] In one theory, the price can be described by a monetary model of the exchange rate, as argued by Friedman and Schwartz and Kindahl. In the other, the greenback's value fluctuates with information concerning fiscal policy and expected future convertibility. Phelps argued that at certain news events the price of gold should rise according to one theory and fall according to the other.

Phelps listed fourteen such news events in the period from 1864 to 1878.[21] His list includes the Public Credit Act, Grant's veto in 1874 of a bill authorizing further greenback issues, the Resumption Act, and Hayes's inauguration. His dates also include March 1865, a month which saw McCulloch nominated as Treasury Secretary. As noted earlier, Mitchell attributed a large fall in the price of gold on 8 March 1865 to the nomination, Willard, Guinnane, and Rosen found a break in the time series on that day, and it is included in our wartime df. Phelps described how the price of gold should rise or fall with each event under each theory. Based on his description, we created two $+1/-1$ dummy variables. Each of these dummy variables is insignificant at even the 10 percent level in equation (7) for the period from 1864 to 1878.

In seeking patterns in gold returns after 1865 we have so far tested only for a shift in the return at specific dates, as suggested by property 1. More gradual effects linked to potential fundamentals were investigated by Charles Calomiris, who fitted a vector autoregression to monthly data for the period from March 1867 to December 1878. In his equation for the greenback-gold return, current and lagged values of the supply of greenbacks, the ratio of coin-denominated to greenback-denominated debt, an index of economic acitivity, net

federal government debt, the commercial paper rate, and the wholesale price index were each insignificant at even the 30 percent confidence level.[22] Calomiris concluded that the greenback-gold price was best described as a random walk.

Thus, existing research has found no patterns in the gold price after 1865 which would help economic historians discriminate among theories of its variation. We next develop our own test for gradual effects of expected resumption and apply it to the period during which T was known.

AFTER THE RESUMPTION ACT

With the passage of the Resumption Act in January 1875, T was set at January 1879. As a number of commentators have argued, gold returns prior to 1875 may have been influenced by resumption expectations, in turn affected by fiscal developments. However, market participants had no reason to focus on the beginning of 1879 until the Resumption Act. Our statistical model is based on that terminal date.

For the period from 1875 to 1879 we thus investigate whether the gold price departed from a random walk in the way predicted by the process-switching model. That model predicts that gold returns should decline over time (property 2), that they should decline at an increasing rate (property 3), and that they should become less volatile (property 4).

To test whether returns had these properties, we study two samples. The first begins 8 January 1875, the day after the House passed the Resumption Act. Grant's approval on 14 January was expected and the Senate had passed the Act on 22 December 1874. This sample ends 17 December 1878, when parity was permanently restored and the gold room closed. It contains 1201 daily returns.

However, the survival and implementation of the legislation was by no means certain, as Mitchell, for example, observed.[23] Thus we also study a second sample which begins 5 March 1877, the day on which Hayes was inaugurated (4 March was a Sunday), naming John Sherman as Secretary of the Treasury. This sub-sample contains 545 returns. Paul Studenski and Herman Krooss described how Sherman added to the Treasury's gold stock to allow resumption, but emphasized other events which ensured that resumption occurred on schedule.[24] First, greenbackers failed to repeal the Resumption Act even though the

retirement of greenbacks ceased. Second, large surpluses in agricultural trade with Europe contributed to gold reserves. In fact, when the Treasury resumed gold payments on 2 January 1879 citizens presented more gold for conversion to paper money than the reverse.

To examine property 2, we regressed returns on a time trend to see if the conditional mean return to holding gold declined over time. We found no significant trend. As a test of property 4, we regressed squared returns (approximately the variance plus a constant, if there is no trend in the mean) on a time trend and found a significant negative coefficient (with a t-ratio below -5 in both samples), as the theory would predict. Thompson also documented this trend, using various measures of volatility.[25] Thus there is some evidence in favour of the theory. However, this trend in variance implies that errors in the mean regression are not homoskedastic; thus our preliminary test of property 2 may be problematic. We next allow for a trend in variance, and jointly test for properties 2-4 of returns.

We have remained agnostic about the identity of the fundamental f and so we cannot directly estimate the parameters in equations (3) and (6). As a simpler alternative, we consider a discrete-time model which embodies the exponential paths in the mean and variance which the theory predicts:

$$r_t = \mu - \omega exp(\frac{t - T}{\alpha}) + [1 - exp(\frac{t - T}{\alpha})]\epsilon_t, \tag{8}$$

where ϵ_t is an independent, normally-distributed error term with mean zero and variance σ^2, and μ, α, and ω are parameters to be estimated. When t is much less than T, equation (8) gives $r_t = \mu + \epsilon_t$, so that the gold price follows a random walk with drift. As t approaches T the mean return declines at an increasing rate if ω is positive (properties 2 and 3). Finally, the error term in equation (8) has a variance

$$[1 - exp(\frac{t - T}{\alpha})]^2\sigma^2, \tag{9}$$

which declines over time (property 4).

To find an equation which can be estimated by standard statistical methods, we divide by $1 - exp(\frac{t-T}{\alpha})$ to give:

$$r_t [1 - exp(\frac{t - T}{\alpha})]^{-1} = [\mu - \omega exp(\frac{t - T}{\alpha})] [1 - exp(\frac{t - T}{\alpha})]^{-1} + \epsilon_t. \tag{10}$$

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This can be thought of as an example of weighted least squares. According to the theory, later observations on returns are less variable; thus they receive higher weights in the estimation of the trend in returns. We estimate equation (10) by maximum likelihood, though, because the value of α is unknown and it appears on the left-hand side of the equation.[26] Although the sample ends at 17 December 1878, T is 1 January 1879, to ensure that the divisor in equation (10) remains non-zero for all observations. We did not include the news dummy variable because it was found to be insignificant for this period.

Table 4 gives the parameter estimates and t-ratios. There is no evidence that gold returns declined more rapidly as resumption neared between 1875 and 1879, for $\hat{\omega}$ is not significant at conventional levels. In contrast, $\hat{\alpha}$ is positive and significant, so that the volatility of returns did decline, as predicted by property 4 of the regime-switching model. This decline was significant economically, as well as statistically. The estimates from the full sample imply that the variance of returns fell by 10 percent in the second half of 1877 and by 36 percent in the first half of 1878.

Our findings illustrate Robert Merton's demonstration that fine observation intervals, as in the daily data here, enhance precision in detecting patterns in the variance of returns rather than in their mean.[27] To provide more information on expected returns prior to resumption, the regime-switching model here perhaps could be combined with evidence on bond returns. Fisher noted that returns were higher on bonds denominated in gold than on those denominated in greenbacks due to 'the hope of resumption.'[28] Richard Roll and Calomiris have each estimated expected rates of change of the price of gold using this differential.[29] Calomiris found that the implied, expected appreciation of the greenback was fastest during the second half of 1878, which is consistent with the hard landing property.

CONCLUSION

We have argued that the regime-switching model provides a unified framework for examining war-time events as well as the transition to resumption. Our findings confirm previous event studies of the greenback's value during the Civil War, in the sense that military and financial news events had statistically significant effects of the signs predicted by the theory. However, the economic significance of these events should not be exaggerated,

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for they explain very little of the variation of gold returns, and their cumulative effect cannot explain the depreciation of the greenback during the War. It also is unclear whether these news events influenced the gold price through expectations of the resumption date or through fundamentals.

We also showed that discrete news events cannot explain the postwar movements in the gold price. This negative finding applies whether news events were selected from the contemporary press (by Thompson) or on the basis of theoretical models (by Phelps). Possibly, these events were discounted in advance in the gold market. For example, there may have been little uncertainty about the timing of resumption after the passage of the Resumption Act in 1875.

Our tests of two properties of the regime-switching model for the period after the Resumption Act yielded mixed results. There is no evidence of a decline in gold returns (the hard landing property) as resumption neared, but there is some evidence of a decline in the volatility of returns. This provides the first statistical evidence, from the time series of the exchange rate, in support of the widely held view that resumption expectations influenced the value of the greenback.

The transition to some certainty of resumption between 1865 and 1875 remains an historical puzzle. No study has identified news events or fundamentals which are statistically significant for gold returns during this period. However, the regime-switching model also provides a framework for future investigation of this transition.

APPENDIX

Under a pure float the average return is simply μ because the log price is a linear function of fundamentals. Under equation (6) the drift in $e(t)$ is found by applying Itô's lemma, a rule for differentiation with respect to a continuous-time stochastic process. If equation (6) gives e as a function denoted $g(f, t)$, then

$$de = g_f \, df + g_t \, dt + \frac{g_{ff}}{2} \, \sigma^2 dt, \qquad (A1)$$

where subscripts denote partial derivatives. This gives

$$de = \mu_e(f,t)dt + \sigma_e(f,t)dz,$$

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where the function μ_e is the expected return. Applying the Itô differential operator in (A1) to equation (6) gives

$$\mu_e = \mu - exp(\frac{t-T}{\alpha}) \cdot [\frac{f}{\alpha} + \mu + \frac{\mu}{\alpha}(T-t)]. \qquad (A2)$$

The drift term μ_e gives the conditional mean return to holding gold.

Property 1 Resumption news. Although we have not treated T as a random variable, the effect of news about T is simple to see. From equation (A2), $d\mu_e/dT > 0$. Thus when T is uncertain news which is believed to delay T will raise gold returns or lower the value of the greenback.

Property 2 Declining gold returns. When resumption is not imminent returns fluctuate around μ. If $\mu \geq 0$ and $f > 0$ then as resumption nears the drift is negative and lower than that under a free float.

Property 3 Hard landing. The negative drift in gold returns would be a property of any model of resumption. A more striking property can be shown by differentiating (A2) with respect to t: the returns fall at an increasing rate as resumption nears, so that the largest negative returns occur just prior to resumption.

What if there is negative drift in fundamentals f? That possibility is worth considering because of the fitful retirement of greenbacks, described by Richard Timberlake, and trends in debt-management policy, which might lead to $\mu < 0$.[30] In fact equation $(A2)$ shows that gold returns will be lower, and fall over time, with resumption expected even in this case provided μ is not too negative. Large negative values for μ would make $\mu_e > \mu$ and imply that resumption propped up the price of gold which otherwise would have fallen even more rapidly. That possibility seems unlikely.

Property 4 Declining volatility of returns. Resumption expectations also influence the variability of returns, in this model. Under a pure float the variance of returns over unit intervals is simply σ^2. Along the path influenced by expected future resumption the variance is:

$$\sigma_e^2 = [1 - exp(\frac{t-T}{\alpha})]^2 \sigma^2 \qquad (A3)$$

which declines over time.

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NOTES

1. See Mitchell, <u>History</u>.
2. See Fisher, <u>Purchasing Power</u>.
3. The data are taken from Mitchell, <u>Gold</u>, appendix, Table 1.
4. Wimmer, "Gold Crisis," pp. 106-7; Kindahl, "Economic Factors," p. 33; Friedman and Schwartz, <u>Monetary History</u>, pp. 58-9; and Thompson, <u>Expectations</u>, pp. 5-7.
5. Officer, "Integration."
6. See Davis and Hughes, "Dollar-Sterling Exchange;" Perkins, "Foreign Interest Rates;" Officer, "Dollar-Sterling Mint Parity;" and Officer, "Integration."
7. For applications of this research to historical episodes see Flood and Garber, <u>Speculative Bubbles</u>; Oppers, "Model;" and Smith and Smith, "Stochastic Process Switching."
8. For some conflicting evidence on the present-value model see Smith, "Exchange-Rate Discounting."
9. Calomiris, "Price and Exchange Rate Determination", Table 7, p. 745, gives p-values for the significance of a wide range of potential fundamentals in a vector autoregression estimated with monthly data. None of the fundamentals is significant (even contemporaneously) in explaining changes in the exchange rate.
10. See Meese and Rogoff, "Empirical Exchange Rate Models."
11. The solution was derived by Obstfeld and Stockman, "Exchange-Rate Dynamics," and Miller and Sutherland, "Britain's Return."
12. Property 1 often is associated with Wesley Mitchell, who argued that the value of the greenback depended on the prospect of resumption, and hence on miliary and financial news affecting Union public finances; see Mitchell, <u>History</u>, p. 199. For similar views, see Fisher, <u>Purchasing Power</u>, pp. 262-3; Calomiris, "Price and Exchange Rate Determination;" and Calomiris, "Greenback Resumption."
13. For an early statement of property 2, which describes the present-value model with a terminal condition at 1 January 1879, see Fisher, <u>Purchasing Power</u>, pp. 261-2. For similar views, see Barrett, <u>Greenbacks</u>, p. 100; Roll, "Interest Rates," p. 482, p. 497; and Officer, "Floating Dollar," fn 3.
14. Mitchell, <u>History</u>, part II, chapter III; and Mitchell, <u>Gold</u>.
15. Mitchell, <u>History</u>, p. 201.
16. Willard, Guinnane, and Rosen, "Turning Points."
17. Burdekin and Langdana, "War Finance."

18. McCandless, "Money."
19. Thompson, <u>Expectations</u>, Appendix B.
20. See Phelps, "Finance Approach."
21. Phelps, "Finance Approach," p. 177.
22. Calomiris, "Price and Exchange Rate Determination," Table 7.
23. Mitchell, <u>Gold</u>, p. 14.
24. Studenski and Krooss, <u>Financial History</u>, p. 185.
25. Thompson, <u>Expectations</u>, chapter 4.
26. The likelihood function was maximized numerically using routines in RATS ™.
27. Merton, "Estimating," Appendix A.
28. Fisher, <u>Theory</u>, p. 401.
29. Roll, "Interest Rates," and Calomiris, "Price and Exchange Rate Determination."
30. Timberlake, "Resumption Act."

Figure 1: Greenback Price of Gold
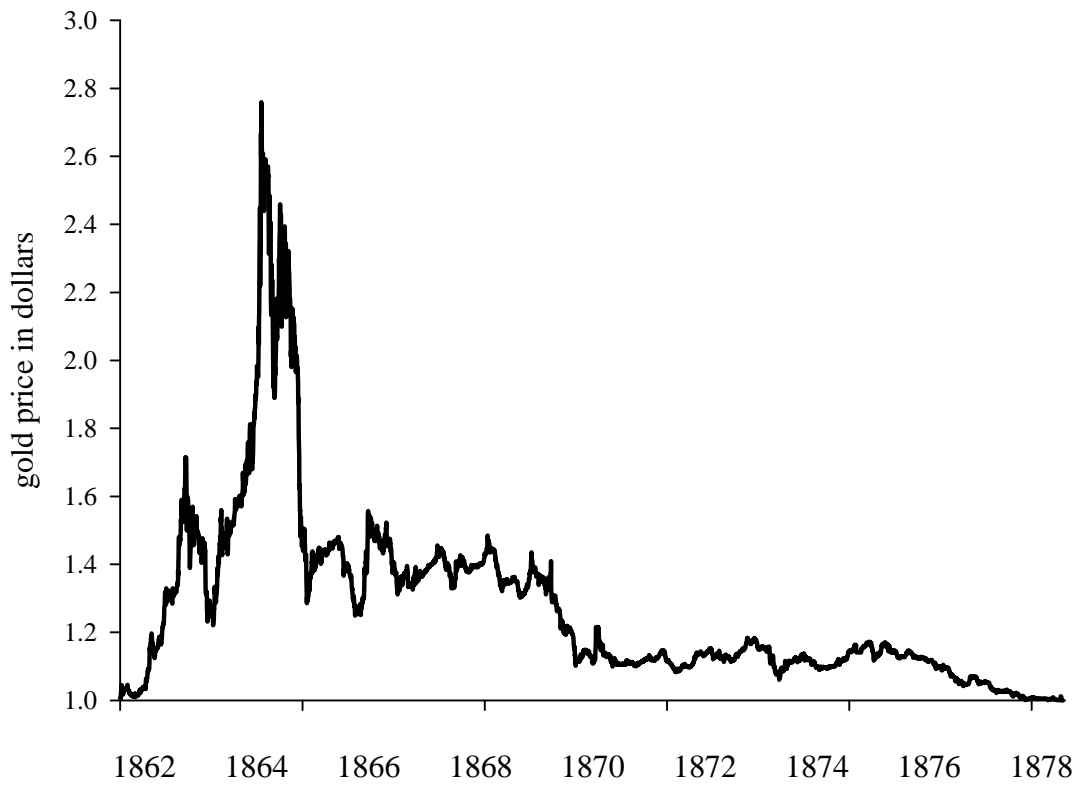
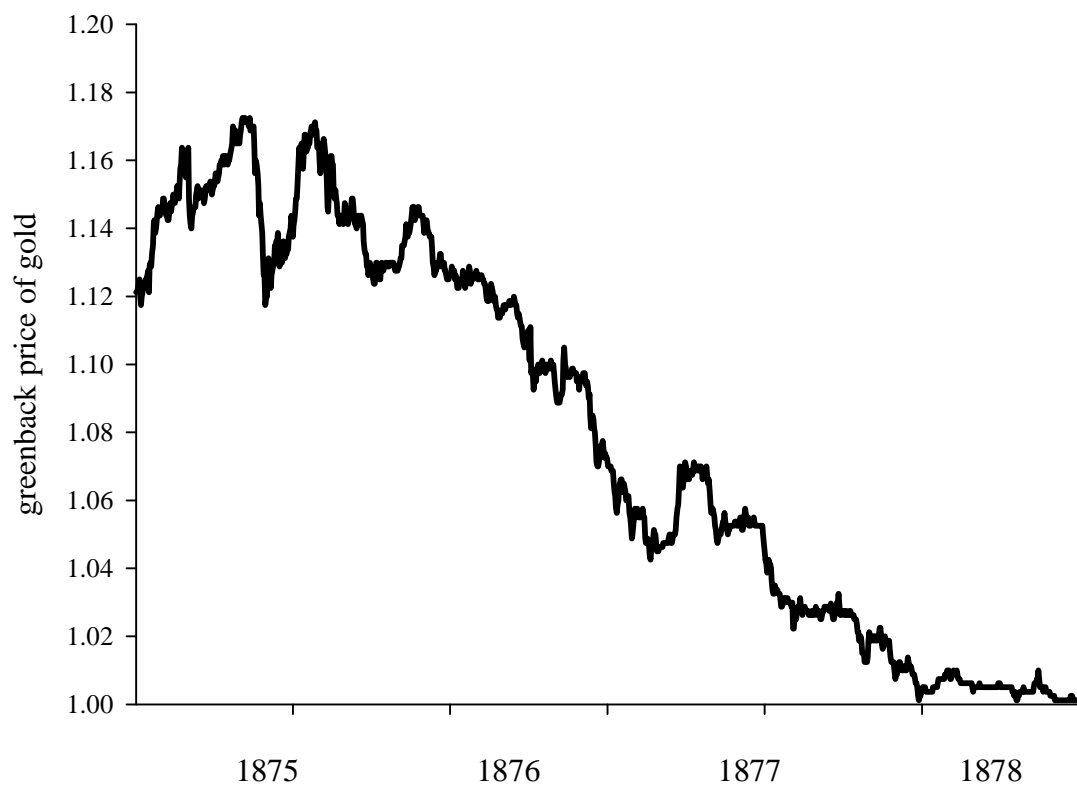Source: Daily prices are from Mitchell, *Gold*, appendix table 1.

Figure 2: Simulated Gold Prices after the Resumption Act
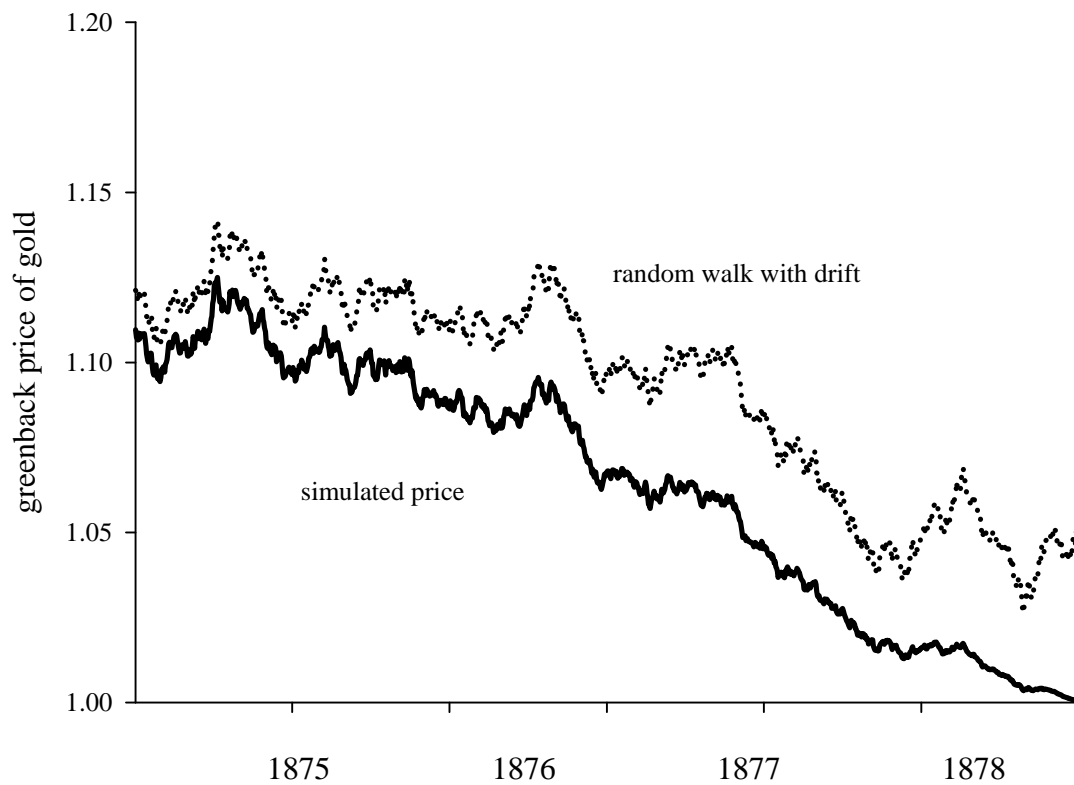
Note: The dashed line shows 1202 observations on levels of a simulated random walk with a daily drift of -0.0000001 and a variance of 0.000002. The solid line shows 1201 observations on levels of a simulated gold price, beginning at the actual price on 8 Januaru 1875 and constructed from equation (6) using the simulated random walk and a = 500.

Figure 3: Actual Gold Prices after the Resumption Act

Note: The figure shows 1201 daily gold prices from 8 January 1875 to 17 December 1878.
Source: Actual daily prices are from Mitchell, *Gold*, appendix table 1.

TABLE 1

WAR NEWS (dw)

+1 (Gold price up)		−1 (Gold price down)	
11 Aug 1862	Cedar Mountain	30 July 1862	British non-intervention news
30 Aug 1862	Second Bull Run	10 Feb 1863	peace rumour
3 Sept 1862	Jackson in Baltimore rumour	6 July 1863	Gettysburg
13 Dec 1862	Fredericksburg	7 July 1863	Vicksburg surrender
1 Apr 1863	Yazoo expedition	15 July 1863	Port Hudson
5-7 May 1863	Chancellorsville	23-25 Nov 1863	Chattanooga
20 Sept 1863	Chickamauga	3 Sept 1864	Atlanta
3 May 1864	French troops in Mexico	19 Jan 1865	peace rumour
11 July 1864	Early near Washington	14 March 1865	Sherman news
28 Dec 1864	Fort Fisher	16 March 1865	Richmond rumour
		19 June 1865	British non-recognition

Notes: The dummy variable dw takes the value +1 at news of Union defeats or adverse rumors, listed in the left column. It takes the value −1 at Union victories (or favorable political news), listed in the right column.

Source: Mitchell, <u>History</u>, part II, chapter III.

TABLE 2

WARTIME FINANCIAL NEWS (*df*)

+1 (Gold price up)		−1 (Gold price down)	
12 June 1862	second legal tender act announced	17 Mar 1863	Treasury gold sales approved
8 July 1862	final vote on second act	25 Mar 1863	Cooke bond sales success
8 Jan 1863	WM recommends third act	15-21 Apr 1863	Chase gold sales
14 Jan 1863	House resolution on third act	20 May 1863	Chase gold sales
17 Jan 1863	army pay crisis	22 Oct 1863	foreign loan rumour
26 Jan 1863	House passes third legal tender act	10 Sept 1864	successful loan issue
16 Apr 1863	Senate passes gold bill	8 Mar 1865	McCulloch's nomination
14 June 1863	House passes gold bill		

Notes: The dummy variable *df* takes the value +1 at news of difficulties in Union finances, such as further issues of greenbacks, listed in the left column. It takes the value −1 at news of favorable developments in Union public finance, listed in the right column.

Source: Mitchell, History, part II, chapter III.

TABLE 3

WARTIME NEWS AND GOLD RETURNS

(May 1862–June 1865)

$$r_t = \mu + \gamma_{w0}dw_t + \gamma_{w1}dw_{t-1} + \gamma_{f0}df_t + \gamma_{f1}df_{t-1}$$

Parameter	Estimate	t-statistic
γ_{w0}	1.94	4.83
γ_{w1}	0.86	1.93
γ_{f0}	1.43	3.24
γ_{f1}	0.78	2.95
R^2	0.079	
N	962	

Notes: r is the daily percentage change in the greenback price of gold. The constant term is insignificant. There is no significant residual autocorrelation. Standard errors are robust to heteroskedasticity and autocorrelation, and are constructed by the Newey-West method with two lags and damping parameter 1 so as to ensure a positive definite variance-covariance matrix.

Source: Daily prices are from Mitchell, Gold, appendix, Table 1; dummy variables are from Tables 1 and 2.

TABLE 4

THE RESUMPTION ACT AND GOLD RETURNS

$$r_t = \mu - \omega exp(\frac{t-T}{\alpha}) + [1 - exp(\frac{t-T}{\alpha})]\epsilon_t$$

Parameter	Resumption Act 8 January 1875 – 17 December 1878 (N=1201)		Hayes-Sherman 5 March 1877 – 17 December 1878 (N=545)	
	Estimate	t-statistic	Estimate	t-statistic
α	110.86	11.97	280.45	0.01
μ	-0.01	-1.89	-0.00012	-0.01
ω	-0.01	-1.72	0.806	0.03
σ	0.202	41.58	0.202	2.66

Notes: r is the daily percentage change in the greenback price of gold. Estimation is by maximum likelihood.

Source: Daily prices are from Mitchell, <u>Gold</u>, appendix, Table 1.