

Why Keep a Good House? The Price of Exchange Rate Risk Between Gold Standard Regimes.

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Abstract

The United States faced a fiscal crisis at the onset of the civil war. Like emerging economies before and after, the United States responded to this crisis by abandoning a fixed rate of exchange and inflating their currency. How costly was the United States devaluation of 1862? Over 200,000 asset prices are employed to investigate the effects of exchange rate fluctuations on investor's intertemporal marginal rates of substitution and market risk premia.

Investors were able to escape most exchange rate risk by holding internationally diversified portfolios. As a result, exchange rate movements had little effect on investor's IMRS and exchange rate risk carried a near zero "price" on London and U.S. stock markets throughout most of the study.

“A foreigner wants payment in a medium which he can use in his own country, and he wants to be precisely sure how much of that medium he will receive. Since the civil war the United States has been excessively inconvenienced by the want of such a medium.

— Walter Bagehot *The Economist* November 1875

“Capital is fleeing Southeast Asia precisely because its currencies are still weakening and no guidance has been offered on future exchange rates. The reverse is also true. Stronger, less-volatile exchange rates attract capital inflows”

— *Wall Street Journal* October 1997

When confronted with a fiscal crisis, emerging economies face a dilemma. A currency devaluation will relieve a temporary crisis but may exclude the nation from future access to international capital if investors fear further devaluations. Alternatively, the exchange rate can be maintained, but this may require a default on debt (which often excludes future borrowing) or an austerity program with dire consequences to consumption. Many emerging economies face this dilemma at some point in their development. The United States was no exception. At the onset of the civil war the United States a developing economy borrowing heavily in the financial centers of Europe, found itself in a fiscal crisis. The United States responded by suspending convertibility, effectively allowing the dollar to float at a devalued level until 1879. How costly was the introduction of exchange rate risk? Did the devaluation of 1862 increase the cost of capital of U.S. firms or the consumption volatility of world investors? I propose we look to the stock exchanges of London and the United States to answer these questions.

1 The Devaluation of 1862

“Whatever benefit is possible from that compulsion [the use of irredeemable legal tender notes] to some individuals or to the government, is far more than outweighed by the losses of property, the derangement of business, the fluctuations of currency and values, and the increase of prices to the people and the government, and the long train of evils which flow from the use of irredeemable paper money.”

— Chief Justice Salmon P. Chase writing the majority opinion in *Hepburn V. Greswold* which declared the 1862 and 1863 issue of legal tender “greenbacks” unconstitutional¹.

In addition to a growing rebellion, the Lincoln administration inherited a looming fiscal deficit upon their inauguration in March of 1861. The treasury was virtually empty and daily expenditures outpaced revenues by approximately \$2 million a day.² To make matters worse, the eruption of hostilities in April of 1861 severely curtailed the collection of custom duties, which served as the main source of federal revenue in that era.³ Treasury Secretary Chase responded by taping the credit markets. By June of 1861, the treasury had already borrowed \$29 million of the \$41 million authorized under existing law and would soon be penniless without swift congressional action.

An emergency session of Congress was convened in July of 1861. This session increased authorized borrowing by \$200 million and approved the use of “demand notes” in lieu of gold as payments for government debts.⁴ Between August 1861 and February of 1862 the

¹One can only imagine the evils Justice Chase may have listed had he not been the Treasury Secretary that issued the greenbacks in 1862 and 1863 and not placed his own portrait on the first \$1 bill.

²Thompson (1985) pp. 22

³Thompson (1985) p. 23

⁴In addition to the borrowing provisions, Congress passed a direct tax of \$20 million on the states and a 3% income tax. Secretary Chase, however, did not agree with soft money or the tax provisions and made no effort to collect taxes and continued to pay government debts in gold for as long as possible. Thompson (1985) pp. 24-25

Treasury issued \$60 million demand notes. These notes could be redeemed for specie at the treasury and, if accepted by a bank as a deposit, gave the depositor the legal right to redeem the deposit in specie. To alleviate the immediate capital constraints the Treasury arranged to borrow gold from the New York, Boston, and Philadelphia Banks. Between July and November of 1861, the treasury was able to borrow \$145.8 million in specie from these banks in exchange for \$150 million worth of 7-year 3% bonds (the 7-3s).⁵ In essence, the banks underwrote the government bonds by purchasing them at a discount and then attempting to resell the bonds to the public at a profit. This left the banks in a precarious position with respect to specie reserves and totally reliant on their ability to resell their holdings of the government 7-3s to the public. On December 9, 1861 the Report of the Secretary of the Treasury indicated that the previous budget had underestimated the expected 1862 deficit by \$239 million. This, coupled with the December 16 arrival of the news of a belligerent English response to the Trent Affair, spooked the market for government bonds and further drained specie from the banks.⁶

Faced with a sudden drain of specie and no hope of selling their government bond holdings to the public, the New York banks suspended specie payments on December 30, 1861. Other cities and the Treasury soon followed and the United States abandoned the Gold Standard.

Congress responded to the suspension of specie convertibility by passing the Legal Tender Act of 1862. This Act authorized the issue of \$150 million "greenbacks" in February of 1862. This was soon followed by an additional issues of \$150 million greenbacks in July 1862 and March 1863. These "greenbacks" were legal tender for all private debts but could not be converted into gold or used to pay U.S. custom duties.

During the suspension of convertibility the United States had, for all intents and purposes, a free floating exchange rate with her major trading partners. If an American merchant wished to exchange greenbacks for foreign goods, he first had to convert greenbacks to gold and then use this gold to purchase a bill of exchange drawn on a bank in the country he wished to import from. Thus, the greenback exchange rate reflected the product of the rate

⁵Bolles (1886) pp. 21-31.

⁶Thompson p.26

of exchange between greenbacks and gold and gold dollars and foreign currency. Thus, as long as greenbacks were not convertible into gold at a fixed rate the United States currency was free to float with respect to the currency of other nations.

2 The Cost of Currency Devaluation

Developing economies often wish to access international capital markets but lack the fiscal or monetary credibility international investors crave. The problem lies in the time inconsistent nature of a government's optimal fiscal and monetary policies.⁷ Imagine a government which finances a given stream of expenditures through taxes and borrowing. The government can issue bonds or tax output directly (an income tax). Alternatively, the government can tax accumulated debt indirectly (through inflation) by printing high-powered money. The ability to issue debt is welfare enhancing because it allows the government to smooth tax rates over time.⁸ The use of debt is especially helpful during wars and depressions when the change in government expenditures are large.⁹ Without access to new borrowing "the required change in tax rates would severely reduce the incentives for economic activity at a time when the need for maintaining such activity is the greatest".¹⁰ Before the government can successfully issue debt it must convince would-be borrowers that it will not default on this debt through repudiation or inflation. The time inconsistent nature of the government's optimal fiscal policy can prevent the government from issuing debt, however. As Prescott and Kydland (1977) demonstrate, in the absence of a commitment mechanism the government will be unable to borrow. The problem lies in the fact that once the government has accumulated some debt its optimal response to an unexpected shortfall in revenues is to tax what is most inelastically supplied, in this case the accumulated debt. Of course borrowers realize this at the time of issue and are therefore unwilling to pay any price for government debt. The

⁷Bordo and Kydland (1995) provide an excellent essay on the gold standard as a commitment mechanism.

Much of what follows is drawn from their work.

⁸Barro (1979)

⁹Bordo and Kydland (1995) p. 427

¹⁰Bordo and Kydland p.427

resulting debt free equilibrium requires government expenditures to equal tax revenues each period. This is inferior to the socially optimal allocation with positive net borrowing and tax smoothing.

A government that wishes to issue debt needs a commitment mechanism to convince borrowers that the debt will be repaid. When the issuance of debt is a repeated game the government can credibly commit to honoring their bonds as long as taxing income or decreasing expenditures is less costly than the punishment future bond investors may extract by refusing to hold future debt offerings. If the government is a democracy, and its bonds are held by its citizens, the threat of an election defeat can further commit the government to honor its bonds provided the political cost of default (taxing bondholders) is greater than the political cost of direct taxation or fiscal austerity. This suggests that all things equal, governments should be more likely to default when the majority of their debt is held abroad or the current costs of austerity are high relative to the benefits of future borrowing (such as during wars or panics). Governments should be least likely to default when the benefits of future borrowing are high relative to the current costs of austerity.

In the repeated game environment, investors prevent nations from defaulting on outstanding debt by refusing to hold their debt in future periods, and nations only default on their past obligations when the present benefit of default is higher than the cost of losing access to future borrowing. In such an environment it is often sub-game perfect to not punish nations for deviations that are unlikely to be repeated. That is, if a nation has an unexpected emergency (like a war) both parties (government and bondholders) would be better off if the government is able to temporarily default on their debt obligations, without future retribution, provided the emergency was a one time event unlikely to be repeated.¹¹ This is due to the fact that, if the emergency is severe, the government is likely to default regardless of penalty. Given that the government has defaulted, however, it is seldom sub-game perfect for the future bondholders to punish the government if they think the emergency is unlikely to be repeated. Instead, investors will still hold the debt of the high risk nations but will

¹¹Grossman and Van Huyck (1988)

demand a risk premium proportional to the perceived probability that an unexpected fiscal crisis will result in future default.

The probability that an unexpected event will result in default depends upon the proportion of debt held abroad, the expected benefit of future borrowing, and the likelihood that the government will face a depression, war, or other unexpected event serious enough to justify future punishment. Developing nations, who often borrow large sums from abroad and are more likely to suffer severe economic downturns, need a credible commitment mechanism to escape high interest rates on their debt.

A developing nation may gain credibility by adopting a fixed exchange rate. If foreign investors believe that monetary and fiscal policy are ancillary to maintaining the exchange rate, the adoption of a credible fixed exchange rate may foster international investment by committing to monetary and fiscal policies that would be time inconsistent in the absence of an exchange rate peg¹². If credible, a fixed exchange rate may lower the cost of capital. On the other hand, the adoption of a fixed exchange rate often exacerbates international shocks and distorts price signals and capital allocations. Developing nations therefore face a choice between the more efficient allocation of capital, but a less credible commitment to price stability, of a flexible exchange rate or the credible commitment to price stability, but inability to accommodate shocks and smooth consumption, of a fixed exchange rate regime. A nation's optimal choice of exchange rate regime depends upon the credibility of the nations fiscal and monetary policies and dependence on international capital and trade¹³.

Recent experience suggests a credible fixed exchange rate is most beneficial to developing nations that rely on access to international capital and, in the absence of an exchange rate peg, lack fiscal or monetary credibility¹⁴. For these nations, exchange rate volatility is feared because it jeopardizes access to international credit markets. In this case, currency

¹²Calvo and Reinhart (2000) and Mendoza (2000) document the cost of exchange rate volatility on developing markets that rely on access to international credit.

¹³Bacchetta and van Wincoop (2000) and Neumeyer (1998)

¹⁴Ghosh, Ostry, Gulde and Wolf (1998), survey the mixed effects of exchange rate regimes on trade, inflation, and GDP growth since the 1960s.

devaluation is viewed as a signal of a pending fiscal crisis. This sort of debt crisis is often accompanied by large swings in international capital flows and trade distortions which result in sharp business cycle fluctuations¹⁵. This was clearly the fate of Asian nations in 1997

“Southeast Asia’s developing economies must learn that international capital markets are rigorous and discerning judges of any country’s economic policies....In addition, as illustrated by the Thai central bank’s recent failure to disclose its future currency commitments, the international capital markets will punish any lack of transparency.”

— *Wall Street Journal*. October 1997

Credible fixed exchange rates “impart (in theory) a higher degree of credibility to policy making” because the preservation of the exchange rate peg constrains monetary and fiscal policy.¹⁶ Thus, an emerging economy that can convince international capital markets that the risk of default through currency devaluation is low will enjoy a decline in the risk premium on foreign borrowing, stable capital flows, and high investment.¹⁷ Was the same true in the 19th century? If so, how costly was the United States’ default of 1862?

There is mixed evidence that adherence to the 19th century gold standard facilitated access to international (English) capital. Bordo and Kydland (1995) and Bordo and Rockoff (1996) argue that the fixed exchange rates of the gold standard acted as a signal of fiscal and monetary responsibility. They find that, in the cross section of nations, international capital markets rewarded those nations that maintained a peg to gold. This “good housekeeping seal of approval” resulted in a low cost of capital for nations that could maintain their exchange rates. Just as the theory predicts, it appears that international capital markets

¹⁵Berg and Borensztein (2000)

¹⁶Edwards and Savastano (1999)

¹⁷Edwards (2000) finds that the elimination of Panamanian currency risk during the 1990s has lowered the cost of capital in Panama. Calvo and Reinhart (2000) demonstrate that the credibility and access to international capital of emerging markets were adversely effected by currency devaluations in the 1990s.

did not punish currency devaluations that appeared to be temporary in nature. Devaluations during war or financial panics often did not result in long term harm to a nation's cost of capital as long as the nation returned to the gold standard at the original par. Nations that devalued and did not return to par, however, were subsequently punished by higher risk premia on their debt. This result was even true for nations that issued bonds payable in gold. This premium for exchange rate risk in gold denominated securities suggests that gold standard adherence served, as the authors claim, as a signal of fiscal responsibility, a "good housekeeping seal of approval". Eichengreen (1996) and Bordo and Swartz (1994) also find a positive correlation between capital flows from England to the United States and exchange rate regime. On the other hand, Clemens and Williamson (2000) find that in the cross section a nation's choice of exchange rate regime had an insignificant effect on the level of English capital flows to that nation once one controls for population, colonial status, immigration and education.

Clemens and Williamson (2000) find an insignificant link between exchange rate regime and capital *flows* while Bordo and Rockoff (1996) find a significant link between exchange rate regime and the *price* of capital. These findings are not mutually exclusive. Take the United States for example. The United States did not maintain a fixed exchange rate yet still attracted an abundance of English capital due to its appealing investment opportunities. The question is not whether the United States had access to international capital but whether the United States' choice of exchange rate regime effected its access to capital. The devaluation of 1862 may well have increased the cost and decreased the flow of capital to the United States. But even with exchange rate risk the United States may well have been the best place for English investors to send their funds. This would be consistent with the findings of both Clemens and Williamson (2000) and Bordo and Rockoff (1996). Rather than asking whether the United States attracted more capital than other nations, we should ask whether the United States attracted less capital and faced a higher cost of capital than would have been the case had they maintained the gold standard. In short, we wish to know if the United States' suspension of convertibility was costly in terms of an increased cost of capital? To

answer this question we need to ask if investors took exchange rate exposure into account when pricing financial assets. Let us look to the security markets of the 19th Century United States and London to find out.

2.1 The Link between Exchange Rate Fluctuations and Asset Prices

In the international capital asset pricing model of Adler and Dumas (1983), exchange rate risk is priced because investors from different nations convert their investment returns into consumption denominated in different currencies and exchange fluctuations can not be diversified away. If purchasing power parity (PPP) holds, then all investors face the same prices when they convert their investments into consumption and there is no risk premium associated with exchange rate fluctuations. On the other hand, if PPP violations exist, exchange rate fluctuations result in consumption risk. If this is the case, investors will demand a risk premium in order to hold assets whose payoff are correlated with exchange rate fluctuations.

In the signaling model of Bordo and Kydland (1995), currency devaluations are correlated with real business cycle fluctuations. In such a setting, exchange rate risk premia can exist even when PPP holds. This is due to the fact that assets that are correlated with exchange rates have low payoffs in exactly the states of the world that investors' consumption is low. Holding these assets creates consumption risk and investors expect compensation, in the form of higher expected returns, for the consumption volatility created by variations in the exchange rate.

Imagine an investor with preferences over consumption at time t and $t + 1$ represented by the following utility function:

$$U(c_t, c_{t+1}) = u(c_t) + \beta E_t[u(c_{t+1})]$$

The investor can purchase a financial asset at time t . Let P_t denote the price of this asset at time t and $X_{t+1} = (P_{t+1} + D_{t+1})$ denote this asset's stochastic price and dividend (if any) at time $t + 1$. Let w_t and w_{t+1} denote the investors wealth at time t and $t + 1$ if she does not invest in the financial asset. The investor's problem is to choose S , the amount of the

asset to buy at time t .

$$\begin{aligned} \max_S & u(c_t) + \beta E_t[u(c_{t+1})] \\ \text{subject to the constraints} \\ c_t &= w_t - P_t S \\ c_{t+1} &= w_{t+1} + X_{t+1} S \end{aligned}$$

Substituting the constraints into the objective function and setting the derivative with respect to S equal to zero yields the first order condition for the optimal level of investment.

$$\begin{aligned} P_t u'(c_t) &= E_t[\beta u'(c_{t+1}) X_{t+1}] \\ \text{or } P_t &= E_t\left[\frac{\beta u'(c_{t+1})}{u'(c_t)} X_{t+1}\right] \end{aligned} \quad (1)$$

Expand $E_t\left[\frac{\beta u'(c_{t+1})}{u'(c_t)} X_{t+1}\right]$ to express price in terms of expected return and a risk premium.

$$P_t = E_t\left[\frac{\beta u'(c_{t+1})}{u'(c_t)}\right] E_t[X_{t+1}] + \text{cov}_t\left(\frac{\beta u'(c_{t+1})}{u'(c_t)}, X_{t+1}\right) \quad (2)$$

The term $\frac{\beta u'(c_{t+1})}{u'(c_t)}$ is the intertemporal marginal rate of substitution (IMRS). We shall let m_{t+1} denote the IMRS.

Imagine a risk-free real asset granting its holder 1 real time t dollar of consumption at time $t+1$. If such an asset existed, its price would be equal the conditional expectation $E_t[m_{t+1}]$. Thus, $E_t[m_{t+1}]$ is equal to the reciprocal of the real gross risk-free rate.

$$E_t[m_{t+1}] = \frac{1}{R_{f,t+1}}$$

Substituting the definition of the risk free rate into (2) yields

$$\begin{aligned} P_t &= \frac{E_t[X_{t+1}]}{R_{f,t+1}} + \text{risk adjustment} \\ \text{risk adjustment} &= \text{cov}_t[m_{t+1}, X_{t+1}] \end{aligned}$$

Assume the investor is risk averse, i.e. $u(\cdot)$ is increasing and concave. Stocks whose time $t+1$ payoffs have positive correlation with consumption will have low prices (relative to there

expected price in the future) and thus have high expected returns. This suggests a natural test of the effect of exchange rate fluctuations on investor's consumption and the cost of capital. If exchange rate movements are positively correlated with consumption, investors will receive a premium for holding assets with exchange rate exposure. On the other hand, if exchange rate movements are uncorrelated with consumption, there will be no link between an asset's exchange rate exposure and expected return.

2.2 Using the Cross Section of Asset Returns to Measure the Cost of Exchange Rate Volatility

The international Capital Asset Pricing model predicts that the expected gross return of a security can be expressed as a linear function of its exposure to non-diversifiable market and exchange rate risks¹⁸

$$E_t(R_{t+1}) = 1 + \gamma_{0,t+1} + b_m \gamma_{m,t+1} + b_{fx} \gamma_{fx,t+1} \quad (3)$$

Where b_m is the asset's beta with respect to the market portfolio and b_{fx} is the asset's beta with respect to the exchange rate in the following projection

$$R_t = a + b_m R_{m,t} + b_{fx} f_{x,t} + \varepsilon_t \quad (4)$$

$R_{m,t}$ is the return on the market portfolio at time t . $f_{x,t}$ is the return on a currency investment time t . $1 + \gamma_{0,t+1}$ is the gross risk free rate and $\Gamma = [\gamma_{m,t+1}, \gamma_{fx,t+1}]'$ is the vector of risk premia. $\gamma_{m,t+1}$ is the "price of risk" investors receive for holding undiversifiable market risk. $\gamma_{fx,t+1}$ is the "price of risk" investors receive for holding exchange rate risk associated with fluctuations in the currency.

¹⁸There can be more than one exchange rate in the ICAPM. In principle every exchange rate that results in undiversifiable consumption risk should be included in (3). In practice one can usually capture exchange rate fluctuations with a single basket of currencies or a single currency that represents the majority of trade exposure. In this paper, we only include the U.S. dollar/English pound exchange rate. Of course the fact that the English pound was convertible into gold assures that this exchange rate captures all exchange fluctuations between the U.S. dollar and any nation on the gold standard.

The specification in (3) and (4) has been employed by Korajczyk and Viallet (1989), Jorion (1991), Dumas and Solnik (1995) and De Santis and Gerard (1998) to investigate the modern linkages between exchange rate fluctuations and asset returns.

The plan of attack is now clear. If exchange rate movements are correlated with consumption volatility, assets with exchange rate exposure will carry a risk premium. We can investigate the effect of the devaluation of 1862 by sorting assets into test portfolios based on their exchange rate exposure. If the exchange rate mattered, the returns of the test portfolios will vary across assets according to their respective levels of exchange rate exposure.

19th Century Security Markets

To identify the effect of exchange rate fluctuation on investor's IMRS and the cost of capital, I have collected the prices of 2,023 stocks and bonds which traded in London, New York, Baltimore, Boston, Cincinnati, Charleston, Louisville, Philadelphia, St. Louis, and San Francisco. The prices consist of the closing bid and ask, or daily high and low for actively traded securities. In addition to prices I have collected all coupon and dividend payments. The prices are sampled every 28-days between January 1866 and December 1878. The sum of all observations amounts to 221,920 separate prices and dividends. The sample is extremely representative. The observed assets account for over 95% of the market value of all securities traded on United States' exchanges.

The data was collected from the following sources:

Quotations for gold, foreign exchange, all stocks and bonds listed on the NYSE, as well as over the counter quotations for many unlisted New York securities were collected from *The Commercial and Financial Chronicle*.¹⁹ In addition to New York quotations, *The Chronicle* also provided closing bid and ask quotations for securities listed in Boston, Baltimore,

¹⁹It was common for members of the stock exchange to make markets in unlisted securities by publishing bid and ask prices in the financial papers. These lists typically announced that a given broker would buy or sell, at the listed price, at his New York office on the day of the announcement. I ignore all price lists of this kind. I only include over the counter quotations that appear under "brokers quotations" on the official quotation pages of *The Chronicle*. To appear on the official pages the brokers quotation had to be deemed

Charleston, Cincinnati, Louisville, Philadelphia, and St. Louis, as well as dividend histories and the terms of each merger or bankruptcy for all firms trading in the United States.²⁰ I use the price, merger, bankruptcy, and dividend data to compute the 28-day holding period return for each asset.

Between 1866 and 1878 *The Commercial and Financial Chronicle* changed its format many times. With each change some cities were dropped and others added to the coverage. As a result, continuous quotations are only available for New York, Boston, Philadelphia, and Baltimore. The other cities appear for a subset of the sample.

The daily closing prices and a dividend history of every mining security traded on the San Francisco stock exchange between 1877-1878 were collected from *The Mining Record*.

The Money Market Review listed the official closing quotations of each security listed on the London Stock Exchange. Due to the size of the London market I have limited my sample to railroad, financial, and U.S. securities listed in London. This subset of securities accounted for over 75% of the market value of the London Stock Exchange and reflected the mix of securities in the United States.

Dividend histories of securities listed on the London Stock Exchange were found in the *The Investor's Monthly Manual*.

The hand written daily ledgers of the Boston Stock Exchange can be found in *Records of Stock Brokers and Stock Exchanges* at Harvard's Baker Library (historical collections # Mss: 785 1790-1917). Each day, the members of the Boston Stock Exchange recorded the daily high and low of every security. The closing bid and ask are preferred to high and low prices. I therefore only used this source to fill in missing bid and ask observations. If *The* "accurate and reliable" by the editors of *The Chronicle*. Quotation lists from other pages or sources carry no such guarantee.

²⁰The southern securities appear on the official quotation page under their own heading. The heading identifies the broker that provides the quotes and lists his offices in New York and Charleston. Apparently these securities are listed in Charleston and sold over the counter in New York. It is unclear whether the prices in *the Chronicle* represent official stock exchange prices from Charleston or over the counter prices in New York.

Commercial and Financial Chronicle did not list a bid and ask for a Boston security, the daily high and low was used in place of the missing observations.

Data Limitations

The use of historical data presents some unique challenges to the estimation of investors' IMRSs. Missing observations are endemic to the samples. The quotes are not "missing" in the sense that they exist and are unobservable to the econometrician. Often there is no quote because no market was made in the security that day. Most 19th Century stock exchanges did not publish official prices or require their members to make markets and post prices. As a result, some securities have no closing bid and ask quotations²¹. Moreover, many securities are "missing" because they do not exist. A railroad that incorporates in 1870 will be "missing" from the first 5 years of the sample. If prices are missing at random the estimation can be easily altered to accommodate missing observations. If the probability of observing a given return, however, is correlated with the value of that return, the missing values will bias our estimates.

To test the hypothesis that the returns are missing at random, I apply Little's (1988) test of the null hypothesis that the missing data is missing completely at random (MCAR). Data is said to be MCAR if the probability that a given observation is missing is independent of the values of other variables both observed and missing. The application of Little's test requires the estimation of the data covariance matrix in the presence of missing data via an EM algorithm. As a result, I am unable to simultaneously test the null that all 2000 assets are jointly MCAR. Instead, for each asset I evaluate the null that the asset is MCAR with respect to the exchange rate, instruments, and that asset's market index (the factors we shall use to estimate the ICAPM). This results in a separate p-value for the test that each asset is

²¹The quotes from London and San Francisco are complete. In London the committee of the stock exchange published an official list every Tuesday and Friday. This list contained a bid and ask for every security. The members of the San Francisco exchange created the Stock Exchange Publishing Company. This company printed daily official price lists in San Francisco. Unfortunately, these are the only exchanges that had reporting requirements.

MCAR. With individual p-values in hand, I employ Simes (1986) Bonferroni test to evaluate the null hypothesis that the data is jointly MCAR. The joint null has a p-value of .0109 and is thus rejected at conventional significance levels. Following Simes procedure for identifying which assets are not MCAR, I find that the MCAR assumption is rejected due to 8 bonds trading in New York. The market maker for these bonds did not post prices for October 1873, the month immediately after the panic of 1873. A search of the data results in 4 more bonds that exhibit this pattern but nonetheless survive the MCAR test. I exclude all 12 bonds from the analysis that follows. The remaining data easily passes the MCAR criteria. Thus, I am confident that the missing prices are not correlated with return or instruments.

Test Portfolios and Exchange Rate Exposure

Over 2000 securities appear in the data set. In order to estimate the ICAPM and conduct inference with respect to exchange rate risk, these securities must be combined into test portfolios. The assets should not be randomly assigned to portfolios, however. If securities are assigned at random, the mean variance frontier will become degenerate as the number of assets increase. Moreover, the means, variances, and covariances of individual securities will likely change over time. Any sorting procedure should attempt to minimize the time variation in the portfolio's covariances.

I follow the long tradition of sorting securities into portfolios based on their betas. As our goal is to identify the effect of exchange rate risk on the price of assets, I sort the assets into portfolios according to their exchange rate exposure.

The Securities are sorted into test portfolios via the following procedure. For each time period between July 1867 and December 1878, the exchange rate beta of each security with at least 20 observations over the past 60 time periods, is estimated via an OLS regression of the security's trailing 60 period returns on a constant and the returns of the value weighted index and greenback-sterling exchange. With beta estimates in hand, the securities are assigned, period by period, to one of 10 portfolios based on the magnitude of their trailing beta estimate. This sorting procedure results in 10 test portfolios with relatively constant

exchange rate exposure. Details of the portfolios can be found in table I.

The exchange rate exposure of a given asset was fairly constant over time. The portfolios formed from the assets with the largest trailing betas also had the largest exposure to future movements in exchange rates. This means that an investor who wanted to make a bullish bet on the future direction of the greenback could do so by buying assets with the largest trailing b_{fx} estimates while an investor who was bearish about the future prospects of the greenback could buy the assets with the smallest trailing b_{fx} estimates.

The distribution of exchange rate exposure can be seen in Chart I. The vast majority of assets have b_{fx} between -1 and 1 and the total distribution of exchange rate exposures is centered near zero. For every security that suffered during greenback devaluations there was another security they benefited. This suggests that investors who did not wish to hold exchange rate exposure could diversify away the vast majority of exchange rate risk simply by holding a well diversified portfolio. In fact the average exchange rate exposure of the value-weighted portfolio of all assets is .09.²²

As long as investors were able to hold all assets, exchange rate movements had little effect on aggregate wealth. Exchange rate fluctuations mattered, however, if investors were unable to hold assets listed on foreign exchanges. The average exchange rate exposure of the value-weighted portfolio comprised of only U.S assets was .39 while its English counterpart's exposure was -.17. It appears that 19th century investors could have escaped most of their exchange rate exposure by holding each others assets. Perhaps it is not surprising that European investors held \$1.39 billion worth of U.S. securities in 1869.²³

The IMRS and Risk Premia

Recall that the random variable m_{t+1} is a valid IMRS if m_{t+1} discounts future payoffs such that the time t price of a time $t + 1$ payoff, X_{t+1} , is $P_t = E_t[m_{t+1}X_{t+1}]$. An IMRS

²²This is computed by forming a time series of exchange rate exposure by taking the value weighted average of the exchange rate exposure of each asset available at time t and then averaging over time.

²³Wilkins (1989) Table 4.5

is guaranteed to exist (by the Riesz representation theorem)²⁴. Furthermore, if markets are complete and arbitrage free, the IMRS will be unique and positive in all states of the world. Even in the absence of complete markets, the moment condition $P_t = E_t(m_{t+1}X_{t+1})$ can be used to estimate a valid IMRS. We will estimate the IMRS implied by a conditional version of the international asset pricing models of Solnik (1974) and Adler and Dumas (1983) and use this estimate to investigate the link between exchange rate risk and risk premia.

When risk premia are allowed to vary, (3) and (4) imply the following IMRS

$$m_{t+1} = c_{0,t+1} + c_{1,t+1}R_{m,t+1} + c_{2,t+1}fx_{t+1} \quad (5)$$

$E_t[R_{t+1}]$, the expected return of an asset can now be written as a function of the risk free rate and that asset's covariance with the market portfolio and exchange rate.

$$1 = E_t[m_{t+1}]E_t[R_{t+1}] + c_{1,t+1}cov_t(R_{m,t+1}, R_{t+1}) + c_{2,t+1}cov_t(fx_{t+1}, R_{t+1}) \quad (6)$$

The specification in (5) makes it possible to directly test the effect of exchange rate movements on investors' IMRSs. A test of the null hypothesis that exchange rate fluctuations had no effect on aggregate consumption amounts to a test of the null hypothesis that $c_{2,t+1} = 0$.

Even if $c_{2,t+1} = 0$, $\gamma_{fx,t+1} \neq 0$ if fx_{t+1} is correlated with aggregate consumption. Within the framework of the IMRS implied by the ICAPM, this amounts to the insight that $\gamma_{fx,t+1}$ will not equal 0 if the exchange rate is correlated with the market portfolio. To see this let $\tilde{\Psi}_{t+1} = [\tilde{R}_{t+1} \tilde{fx}_{t+1}]'$ denote a vector of the de-measured return on the market index and exchange rate. Then

$$\Gamma_{t+1} = -\gamma_{0,t+1}cov_t(\tilde{\Psi}_{t+1} \tilde{\Psi}_{t+1})[c_{1,t+1} \ c_{2,t+1}]'$$

If R_{t+1} and fx_{t+1} are independent, $cov_t(\tilde{\Psi}_{t+1} \tilde{\Psi}_{t+1})$ is a diagonal matrix and $\gamma_{fx,t+1} \neq 0$ if and only if $c_{2,t+1} \neq 0$. If R_{t+1} and fx_{t+1} are not independent, however, exchange rate movements

²⁴This assumes that the first 2 moments of X_{t+1} exist.

may have no effect on investor's IMRS and nonetheless carry a "price" in the cross section of assets. This is the case because exchange rate movements are correlated with other factors that effect investor's IMRSs. We, therefore, must be very careful when forming our null hypothesis. A test of the null hypothesis that $c_{k,t+1} = 0$ is a test of the hypothesis that given the market return the exchange rate has no effect on an investor's IMRS. A test of the null hypothesis that $\gamma_{fx,t+1} = 0$ is a test of the null hypothesis that exchange rate risk carries no price in the cross section of assets. The two hypothesis are not equivalent when exchange rate changes are correlated with (but do not help explain) consumption changes.

In the language of the ICAPM, R_{t+1} and fx_{t+1} are non-diversifiable factors. An evaluation of the null hypothesis that $c_{2,t+1} = 0$ is a test of the hypothesis that exchange rate movements constitute a diversifiable risk. If investors could diversify exchange rate risk away, then fx_{t+1} is a spurious factor and the true IMRS is $m_{t+1} = c_{0,t+1} + c_{1,t+1}R_{m,t+1}$. Whether fx_{t+1} belongs in our IMRS specification as a true non-diversifiable risk is an empirical question to be answered in the next section.

We have seen that investors could eliminate the vast majority of exchange rate risk by holding an internationally diversified portfolio. An evaluation of the null hypothesis that $c_{2,t+1} = 0$ can therefore be interpreted as a test of the extent of international risk sharing. If 19th Century investors were able to adequately share risks, the IMRS estimated without the exchange rate as a factor ($c_{2,t+1} = 0$) should price assets as well as an IMRS estimated with the exchange rate as a factor.

If exchange rate risk can be diversified away, movements in exchange rates will have no effect on aggregate consumption and $c_{2,t+1} = 0$. Even if exchange rate risk could be diversified away, however, the "price" of exchange rate risk, $\gamma_{fx,t+1}$, will not be zero as long as exchange rate movements are correlated with consumption.

The inclusion of a spurious factor (fx_{t+1}) in our IMRS specification will add no information about the true IMRS. The sign of $\gamma_{fx,t+1}$, however, contains considerable information about investors' expectations with regard to the future covariance between consumption and exchange rates. This is true even when fx_{t+1} is a diversifiable risk.

Imagine a set of N assets such that the return of the n -th asset is

$$R_{n,t+1} = R_{f,t+1} + b_{n,m}R_{m,t+1} + b_{n,fx}fx_{t+1} + e_{t+1}.$$

Let w_n be the amount of money an investor invests in each asset. This investor could bet on exchange rates by choosing w_n such that

$$\sum^n w_n = 1$$

$$\sum^n b_{n,m}w_n = 0$$

$$\sum^n b_{fx,n}w_n = 1$$

If the number of assets is sufficiently large, the investor can diversify away all idiosyncratic risk $\sum^n w_n e_{n,t+1} = 0$. The result is a “factor mimicking portfolio”. This portfolio is perfectly correlated with the exchange rate, has a price of 1, and an expected return of

$$E_t(R_{t+1}^{Port}) = (1 + \gamma_{0,t+1}) + \gamma_{fx,t+1}$$

Investors can use this portfolio to insure against aggregate consumption volatility. If exchange rates are positively correlated with aggregate consumption, the investor would short the factor mimicking portfolio and invest the proceeds in a risk free bond. The result would be a zero cost portfolio that has positive returns in the states of the world where exchange rates (and aggregate consumption) are low and negative returns in the states of the world where exchange rates (and aggregate consumption) are high. Holding such a portfolio will insure the investor against aggregate consumption volatility.

What is the cost of this insurance? The portfolio costs nothing at the time of purchase and has an expected payoff of $-\gamma_{fx,t+1}$. If $\gamma_{fx,t+1} = 0$, this portfolio is costless (zero price and zero expected return). Every risk averse investor will want to hold this portfolio. In the aggregate, however, we can not all insure against consumption risk. Someone must consume less in the states of the world where aggregate consumption is low. $\gamma_{fx,t+1} = 0$ can not, therefore, be an equilibrium. Instead, if exchange rates are positively correlated with

aggregate consumption, the price of consumption insurance, $\gamma_{fx,t+1}$, must be greater than zero. Thus, $\gamma_{fx,t+1} > 0$ if and only if investors expect the exchange rate to be positively correlated with consumption. The reverse is also true. If investors expect the exchange rate to be negatively correlated with aggregate consumption, $\gamma_{fx,t+1} < 0$.

Investors' IMRS During the Greenback Era 1866-1879

\$450 million greenbacks were in circulation at the end of the Civil War. The greenbacks had been introduced as an emergency war measure and with the rebellion quelled, congress began to retire them with the funding act of 1866. The resulting deflation gave voice to the populist movement for inflation rather than a return to the gold standard. A compromise bill, signed into law in 1869, assured the payment of government coupons in gold and set the circulation of greenbacks at roughly \$350 million but failed to address the issue of eventual resumption.

For the next 3 years, there was great uncertainty as the Congress and the Supreme Court debated the fate of the nations return to the gold standard. In September 1869, speculators Jay Gould and James Fisk attempted to corner the gold market. In what was to be popularly known as Black Friday, Gould and Fisk drove the price of greenbacks to a new low before the Treasury intervened by selling their gold reserves. The Supreme Court ruled the Legal Tender Acts unconstitutional in *Hepburn v. Griswold* (1870) and then reversed itself in *Knox v. Lee* (1871) and *Parker v. Davis* (1871) after President Grant appointed two Republicans to the court. The Panic of 1873 and resulting depression gave birth to the Greenback party, who championed the expansion of the money supply and rejected the deflationary policies necessary to return to the gold standard. At there prime the Greenback party would poll over 1 million votes and send 14 members to Congress. An inflation bill passed Congress in 1874 but was vetoed by President Grant.

Finally, Congress placed the credibility of the United States behind the return to the gold standard with the passage of the Resumption Act in January 1875. This act called for the resumption of specie redemption on Jan 1, 1879. Between 1875 and Jan 1879 the price

of the greenback slowly returned to par and the United States returned to the gold standard on Jan 1 1879.

The greenback/pound exchange rate can be found in Figure II. Throughout the greenback era the price of the greenback ebbed and flowed with each legislative turn. The United States did, however, eventually return to the gold standard. This is consistent with the optimal behavior of a nation playing the signaling game of Bordo and Kydland (1995). The devaluation of 1862, therefore, appears to be a textbook case of a “forgivable” default. A nation devalues its currency due to a pressing emergency. Once the emergency has passed, however, the nation wishes to return to the gold standard to signal its credibility to international investors. Investors, meanwhile, view the devaluation as a one-shot deviation and find it is sub-game perfect to not punish the deviation as long as they feel it is unlikely to be repeated. In fact, Calomiris (1988) has convincingly demonstrated that investors did expect the United States to the gold standard at the original par.

Did the exchange rate volatility of the greenback era cause consumption volatility in the United States and abroad? How costly would it have been had the United States not returned to the gold standard? We can use the cross section of asset returns to estimate investors’ IMRSs and answer these questions. If exchange rate fluctuations caused consumption volatility, $c_{2,t+1} \neq 0$ and movements in the exchange rate should help us price assets. Likewise, if investors expected their consumption to be low in the states of the world that the exchange rate depreciated the price of exchange rate risk, $\gamma_{fx,t+1}$ will be positive.

Conditional Information

There is considerable evidence that exchange rate risk is priced conditionally in modern financial markets.²⁵ That is, equation (6) is valid when the expectations and covariances are conditioned on time t information and invalid unconditionally. $E_t[.]$ denotes the conditional expectation operator on some information set Ω_t . In reality the conditional expectations in (6) are functions of all information available to investors at time t. In practice, we the

²⁵Dumas and Solnik (1995) and De Santis and Gerard (1998).

economist must limit our estimation to the small number of conditioning variables available to historians. I model the dependence of $c_{0,t+1}$, $c_{1,t+1}$ and $c_{2,t+1}$ as a function of two time t instruments \mathbf{z}_t .

Potential instruments can be anything available at time t . Good instruments, however, should be good predictors of changes in exchange rates and conditional asset returns. I therefore employ the difference between the 60-day commercial paper rate in New York and London and the difference between the yield on long term U.S. railroad bonds and New York commercial paper as instruments. Changes in the yield curve have proven to be excellent forecasters of business cycle variation in modern times and the spread between U.S. and London interest rates has obvious ramifications for exchange rate movements.

I follow Cochran (1996) and Lettau and Ludvigson (1999) and model the conditional expectations by expanding the IMRS to include linear combinations of portfolios scaled by time t instruments \mathbf{z}_t . Replace $E_t[m_{t+1}|\mathbf{z}_t] = c_{0,t+1} + c_{1,t+1}R_{m,t+1} + c_{2,t+1}f_{t+1}$ with

$$m_{t+1} = \{[1 \ \Psi_{t+1}] \otimes [1 \ \mathbf{z}'_t]\} \boldsymbol{\delta} \quad (7)$$

where \otimes denotes the kronecker product and $\boldsymbol{\delta}$ denotes a vector of time-invariant weights. In principal setting $c_{k,t+1} = [\delta_k + \delta_{1k}z_{1,t} + \delta_{2k}z_{2,t}]$ will account for the conditional information in \mathbf{z}_t .

In addition to the moment conditions $P_t = E_t[m_{t+1}X_{t+1}]$ the observation that the IMRS should reflect all information available at time t implies that the IMRS should price all managed portfolios $z_t P_t$. The managed portfolio $z_t P_t$ is a portfolio scaled by conditioning information variable z_t . For instance, if z_t is the slope of the yield curve at time t . Then $z_t P_t$ is a portfolio whose manager invests more when z_t is high and less when z_t is low. If the candidate IMRS reflects information contained in z_t the pricing equation will remain valid.

$$z_t P_t = E_t[m_{t+1} z_t X_{t+1}]$$

C Estimation

Given $R_{n,t+1}$, the time $t+1$ gross return on asset n , one can estimate (7) via GMM and

the moment conditions $1 = E_t[m_{t+1}R_{n,t+1}]$. Define the following error model:

$$\begin{aligned} u(\boldsymbol{\theta})_{n,t+1} &= m(\boldsymbol{\theta})_{t+1}R_{nt+1} - 1 \\ \boldsymbol{\theta} &= [\delta_0 \dots \delta_{2,2}] \end{aligned} \tag{8}$$

My goal is to pick the free parameters $\boldsymbol{\theta} = [\delta_0 \dots \delta_{2,2}]$ to make the model fit the observable data. Let T be the number of observations for asset n . Then $g(\boldsymbol{\theta})_n$ is the average pricing error of asset n :

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

To estimate $\boldsymbol{\theta}$, form the N -vector of average pricing errors $\mathbf{g}(\boldsymbol{\theta}) = [g(\boldsymbol{\theta})_1 \dots g(\boldsymbol{\theta})_n \dots g(\boldsymbol{\theta})_N]'$. Then Hansen's (1982) GMM estimates of $\boldsymbol{\theta}$ are the parameter values which minimize $J = \mathbf{g}(\boldsymbol{\theta})' \mathbf{W} \mathbf{g}(\boldsymbol{\theta})$ for a positive definite weighting matrix \mathbf{W} .

There are two ways to evaluate a candidate IMRS. Typically, one estimates the model and evaluates the moment conditions by setting $\mathbf{W} = \mathbf{S}^{-1}$, the inverse of the $N \times N$ sample moment covariance matrix. When $\mathbf{W} = \mathbf{S}^{-1}$ under the null that $m(\hat{\boldsymbol{\theta}})$ is a valid IMRS, Hansen (1982) demonstrates that

$$TJ(\hat{\boldsymbol{\theta}}) \sim \chi^2_{(N-h)} \tag{9}$$

Where N is the number of moment conditions and h is the number of parameters. The $TJ(\hat{\boldsymbol{\theta}})$ statistic answers a simple question: if $m(\hat{\boldsymbol{\theta}})$ is a valid IMRS, what is the probability of observing the given mispricing $\mathbf{g}(\hat{\boldsymbol{\theta}})$. While this is an interesting question that provides valuable insight with respect to the validity of $m(\hat{\boldsymbol{\theta}})$, purely *statistical* measures of asset pricing can be lacking. This is especially true in the presence of highly correlated scaled portfolios. A candidate IMRS can survive the over-identifying test by doing an excellent job of pricing assets. Alternatively, the candidate IMRS may do a poor job of pricing the assets, yet survive the test if the variance of the sample moments is high. One should always ask, is the $TJ(\hat{\boldsymbol{\theta}})$ statistic small because the candidate IMRS does a phenomenal job of pricing assets, or is the variance of early asset markets so great that we can not reject? To answer this question, Hansen and Jagannathan (1997) suggest a weighting matrix that does not reward excess volatility.

The over-identifying test is derived under the null hypothesis that the candidate IMRS under consideration is valid. That is, the candidate IMRS assigns the correct prices to all assets. An alternative strategy is to recognize that all models are abstractions and strictly speaking mis-specified. Rather than assume the candidate IMRS assigns the correct prices, Hansen and Jagannathan assume the IMRS assigns incorrect prices and measures how far the candidate IMRS is from the space of valid IMRSs.

Define $\mathbf{X} \equiv \{x \in L^2 : x = \mathbf{R} \cdot \mathbf{w} : \mathbf{w} \in \mathfrak{R}^N\}$ as the space of possible returns spanned by the test portfolios. w_n is the n -th element of the vector \mathbf{w} . Define a pricing functional on \mathbf{X} as

$$\pi(x) \equiv \left\{ \sum_{n=1}^N w_n : w_n \in \mathfrak{R} \text{ and } \mathbf{R} \cdot \mathbf{w} = x \right\} \forall x \in \mathbf{X} \quad (10)$$

Under assumptions outlined in Hansen and Jagannathan (1997) there exists a valid IMRS $m \in L^2$ such that²⁶

$$\pi(x) = E[mx] \quad \forall x \in \mathbf{X}$$

Let μ denote the set of all valid IMRS. Given a candidate IMRS, y , which implies prices $\pi_y(x) = E[yx]$ Hansen and Jagannathan (1997) suggest the following measure of mis-specification

$$\Phi \equiv \min_{m \in \mu} \|y - m\| \quad (11)$$

Φ is the least squares distance of the candidate IMRS from the space of all valid IMRS's. Hansen and Jagannathan (1997) demonstrate that Φ is the following mini-max bound on the mispricing of all hypothetical derivative claims with a unit norm²⁷:

$$\Phi \equiv \min_{m \in \mu} \max_{x \in L^2, \|x\|=1} | \pi(x) - \pi_y(x) | \quad (12)$$

²⁶The assumptions are \mathbf{X} is a closed linear subspace of L^2 . The functional $\pi(x)$ is continuous and linear on \mathbf{X} and there exists a payoff $x \in \mathbf{X}$ such that $\pi(x) = 1$.

Given these assumptions the existence of a valid stochastic discount factor is a direct application of the Riesz representation theorem.

²⁷This is Hansen and Jagannathan (1997) proposition 2.2. The proof requires the additional assumption that a valid discount factor exists in μ^+

Thus, Φ is the maximum mispricing, of all possible portfolios with a unit second moment, that results when one uses the candidate IMRS y to assign prices instead of a valid IMRS. Φ provides an upper bound on the mispricing that would result if one used the candidate IMRS y to price assets. By focusing on expected mispricing instead of expected mispricing scaled by variance, the Hansen-Jagannathan measure can be meaningfully applied to compare candidate IMRSs.

Φ can be estimated by setting $W = E[\mathbf{R}\mathbf{R}']^{-1}$

$$\hat{\Phi} = \min_{\theta} \mathbf{g}(\hat{\theta})' E[\mathbf{R}\mathbf{R}']^{-1} \mathbf{g}(\hat{\theta}) \quad (13)$$

That is, by setting $W = E[\mathbf{R}\mathbf{R}']^{-1}$ and minimizing $J = \mathbf{g}(\theta)' \mathbf{W} \mathbf{g}(\theta)$ we can choose a candidate IMRS that does the best job of pricing assets.

With IMRS estimates in hand, we can evaluate the effect of exchange rate fluctuations on investors IMRS and the cost of capital.

3 Results

We wish to employ a cross section of assets to estimate the IMRSs of 19th century investors. Four candidate IMRSs are estimated using U.S. stocks, U.S. bonds, London stocks, and London bonds respectively. If markets are integrated (risks are shared), $c_{2,t+1}$ should equal zero and the price of exchange rate risk should be the same in every market. If markets are segmented, however, investors will be unable to hold well diversified portfolios and the effect of exchange rate risks on IMRS may vary across markets.

For each set of test assets, I estimate the following candidate IMRS via GMM

$$m_{t+1} = c_{0,t+1} + c_{1,t+1} R_{m,t+1} + c_{2,t+1} f x_{t+1} \quad (14)$$

where $R_{m,t+1}$ is the return on the value weighted market index and $f x_{t+1}$ is the return, on an investment in greenbacks relative to sterling. Conditioning information is reflected by allowing the coefficients in (14) to vary linearly with the conditional information variables

such that $c_{k,t+1} = \delta_{k0} + \delta_{k1}z_{1t} + \delta_{k2}z_{2t}$. The null hypothesis that exchange rate risk has no effect on IMRS amounts to a test of the null hypothesis that $\delta_{20} = \delta_{21} = \delta_{22} = 0$. m_{t+1} is estimated with the respective 10 test portfolios and four managed portfolios. The return on the market index and the greenback portfolio are scaled by \mathbf{z}_t to form the managed portfolios.

To evaluate this hypothesis we shall estimate the unrestricted IMRS $m_{t+1} = c_{0,t+1} + c_{1,t+1}R_{m,t+1} + c_{2,t+1}fx_{t+1}$ and an IMRS restricted such that $m_{t+1} = c_{0,t+1} + c_{1,t+1}R_{m,t+1}$. If the exchange rate has no effect on investors IMRS the restricted estimate should have the same asset pricing implications as the unrestricted estimate.

Hansen's (1982) Lemma 4.1 provides us with a formula for the variance of the moment conditions $E[\mathbf{g}(\boldsymbol{\theta})] = 0$ for any weighting matrix. We can test the over-identifying restrictions that $E[\mathbf{g}(\boldsymbol{\theta})] = 0$ for both the restricted and unrestricted models by evaluating the chi-squared statistic

$$TJ = \mathbf{g}(\boldsymbol{\theta})'var[\mathbf{g}(\boldsymbol{\theta})]^{-1}\mathbf{g}(\boldsymbol{\theta}) \sim \chi_{(N-h)}^2$$

To formally test the null hypothesis that $c_{2,t+1} = 0$, I estimate the unrestricted model and employ Hansen's lemma to estimate the moment covariance matrix. I then impose the constraint that $\delta_{20} = \delta_{21} = \delta_{22} = 0$ and estimate the constrained model and evaluate the moment conditions with the unconstrained covariance matrix. The criteria function $\mathbf{g}(\boldsymbol{\theta})'var[\mathbf{g}(\boldsymbol{\theta})]^{-1}\mathbf{g}(\boldsymbol{\theta})$ must increase as a result of the constraints. If the null is true, however, and $c_{2,t+1}$ is in fact zero the criteria function should not rise by much. Newey and West (1987) demonstrate that under the null that the restrictions are true the expected increase in the criteria function will be equal to the number of restrictions. Thus, under the null, if I impose the 3 restrictions that $\delta_{20} = \delta_{21} = \delta_{22} = 0$ and let $\mathbf{g}^R(\boldsymbol{\theta})$ denote the restricted models moment conditions

$$LR = \mathbf{g}^R(\boldsymbol{\theta})'var[\mathbf{g}(\boldsymbol{\theta})]^{-1}\mathbf{g}^R(\boldsymbol{\theta}) - \mathbf{g}(\boldsymbol{\theta})'var[\mathbf{g}(\boldsymbol{\theta})]^{-1}\mathbf{g}(\boldsymbol{\theta}) \sim \chi_{(3)}^2$$

This is very similar to a likelihood ratio test.

Candidate IMRSs are estimated with $W = E[\mathbf{RR}']^{-1}$ and do an excellent job of pricing assets. Table II reports the TJ over-identifying test statistic, the LR test statistic of the null hypothesis that $\delta_{20} = \delta_{21} = \delta_{22} = 0$ and the value of Φ for each candidate IMRS.

We can not reject the null that $\delta_{20} = \delta_{21} = \delta_{22} = 0$ in any model. That is, IMRS estimates formed with and without exchange rate movements are statistically indistinguishable with respect to their asset pricing implications.

The constrained IMRS estimates do an excellent job of pricing the test portfolios. The addition of the exchange rate does not help us explain asset prices. This implies that investors IMRSs were unaffected by changes in the greenback-sterling exchange rate. Foreign investors were able to escape exchange rate fluctuations by holding internationally diversified portfolios.

Figure 1 contains $\hat{\gamma}_{fx,t}$, the time series estimated exchange rate risk premium in each market. The remarkable co-movement in $\hat{\gamma}_{fx,t}$ further demonstrates the level of risk sharing in U.S and London asset markets. Recall that if investor's can share risks, the risk premium on any random asset will be determined by its covariance with aggregate consumption. Risk sharing also implies that shocks to aggregate consumption have the same effect in each market. If this is the case, the risk premium should be the same in every market. The $\hat{\gamma}_{fx,t}$ series estimated with London and U.S. stocks are virtually identical across stock markets. The magnitude of the risk premia estimates do vary, however, between stocks and bonds markets. This is evidence of less than perfect risk sharing between stock and bond investors²⁸. Nonetheless, failure to reject $c_{2,t+1} = 0$ and the common shape of the risk premia series suggests there was a high degree of cross Atlantic risk sharing and exchange rate fluctuations did not represent beggar-thy-neighbor transfers between English creditors and US borrowers.

In the stock markets, the exchange rate risk premium fluctuates around zero with some notable exceptions. Around the financial panic of 1869 (black Friday) and following the panic of 1873 the risk premia are negative in both markets. Both of these panics were preceded by tight money and high interest rates. Recall that negative risk premia imply that investors expect their consumption to be negatively correlated with the exchange rate. It is perhaps

²⁸The apparent segmentation between stock and bond markets is consistent with arbitrage pricing theorem based tests applied to these markets (Chabot 2000) and the modern equity premium puzzle literature.

no coincidence then, that negative risk premia coincided with two of the most prominent examples of popular agitation for inflationary policies.

The other notable pattern is a positive risk premia after 1874. Recall that Congress committed the full faith and credit of the United States to a fixed exchange rate with the enactment of the resumption act of January 14, 1875. This act called for the U.S. to resume convertibility at the pre-war rate on January 1, 1879. After the passage of the resumption act, the risk premium on greenback exchange increases dramatically in each market. The positive risk premium after 1874 suggests investors expected their consumption to be positively correlated with a strong greenback. During this period, the greenback gained value versus sterling until reaching par on Dec 18, 1878. In retrospect, the high risk premium during the 1875-1878 period makes perfect sense. A failure of the US to return to convertibility after announcing the intention to would have most likely occurred in states of the world where the U.S. suffered a fiscal crisis. These are the same states of the world where consumption tends to be low. The high risk premia after 1874 suggests that a devaluation after the U.S. had committed her credibility to a strong greenback would have only occurred after some unexpected emergency with dire consequences for consumption in both the US and London.

As a whole, the evidence from financial markets suggests the United States was able to finance her war effort without losing credibility on international capital markets. The co-movement in risk premia combined with IMRS estimates that do not benefit from the inclusion of the exchange rate as a factor, suggests that the United States' suspension of convertibility had little effect on consumption, both at home and abroad. Foreign investors were willing to hold American assets to such an extent that they were able to diversify away the vast majority of exchange rate fluctuations. In fact, exchange rate fluctuations had little effect on U.S. and English consumption and therefore little effect on the cost of capital in international financial markets.

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TABLE I

28-day gross returns, Betas

Beta(fx) sorted, Value Weighted portfolios

Beta1=smallest beta, Beta10=Largest beta

| Portfolio | beta fx | | | |
|-----------|---------------------|---------|--------------|-------------|
| | US Stock | US Bond | London Stock | London Bond |
| Beta1 | -0.9083 | -0.7791 | -0.9727 | -1.0759 |
| Beta2 | -0.3593 | -0.3237 | -0.752 | -0.8476 |
| Beta3 | -0.3115 | -0.1563 | -0.7876 | -0.7767 |
| Beta4 | -0.3946 | -0.0207 | -0.6318 | -0.6332 |
| Beta5 | -0.2265 | 0.0734 | -0.3661 | -0.3572 |
| Beta6 | 0.0544 | 0.0226 | -0.2972 | -0.3611 |
| Beta7 | 0.117 | 0.1553 | -0.0849 | -0.1284 |
| Beta8 | 0.2678 | 0.2491 | 0.0758 | -0.0119 |
| Beta9 | 0.4243 | 0.5067 | 0.8238 | 0.8982 |
| Beta10 | 1.0433 | 0.6061 | 1.8349 | 2.1914 |
| | beta market index | | | |
| Beta1 | 0.1835 | 0.4774 | 0.1602 | -0.0737 |
| Beta2 | 0.3527 | 0.2887 | 0.321 | 0.1906 |
| Beta3 | 0.4518 | 0.3494 | 0.4065 | 0.3373 |
| Beta4 | 0.5614 | 0.6159 | 0.454 | 0.4384 |
| Beta5 | 0.8118 | 0.8401 | 0.6026 | 0.7582 |
| Beta6 | 1.1512 | 0.8722 | 0.6197 | 0.6742 |
| Beta7 | 1.3341 | 0.8738 | 0.8609 | 0.8481 |
| Beta8 | 1.5882 | 1.0388 | 0.929 | 0.5406 |
| Beta9 | 1.7058 | 1.6361 | 1.4398 | 2.0993 |
| Beta10 | 1.9366 | 2.0043 | 2.8261 | 2.9514 |
| | Mean 28-Day Returns | | | |
| Beta1 | 1.002 | 1.002 | 1.0062 | 1.0037 |
| Beta2 | 1.0054 | 1.0054 | 1.0025 | 1.0024 |
| Beta3 | 1.006 | 1.006 | 1.0031 | 1.0022 |
| Beta4 | 1.006 | 1.006 | 1.0032 | 1.0026 |
| Beta5 | 1.0054 | 1.0054 | 1.0018 | 1.0024 |
| Beta6 | 1.0063 | 1.0063 | 1.0012 | 1.0028 |
| Beta7 | 1.0049 | 1.0049 | 0.9995 | 1.0023 |
| Beta8 | 1.0067 | 1.0067 | 1.0018 | 1.0045 |
| Beta9 | 1.0053 | 1.0053 | 1.0079 | 1.0049 |
| Beta10 | 1.0047 | 1.0047 | 1.005 | 0.997 |

TABLE II
GMM Estimates

28-day Returns

$T^*J_T \sim \chi^2_{(5)}$ if exchange rate included as factor $T^*J_T \sim \chi^2_{(8)}$ if exchange not rate included as factor

$W = E[RR]^T^{-1}$

| Assets Used in Estimation | US Stock | | US Bond | | London Stock | | London Bond | |
|-------------------------------------|----------------|----------------|----------------|-----------------|-----------------|-----------------|-----------------|------------------|
| | Yes | No | Yes | No | Yes | No | Yes | No |
| Includes Exchange Rate as Factor | | | | | | | | |
| T^*J_T (p-value) | 2.79 0.7326 | 6.19 0.5782 | 3.06 0.6897 | 15.07 0.0577 | 10.81 0.0551 | 24.08 0.0022 | 3.015 0.6976 | 9.7339 0.2842 |
| Φ | 0.0203 | 0.0472 | 0.0706 | 0.1045 | 0.1147 | 0.1232 | 0.0491 | 0.0635 |

LR test of the null hypothesis that $\delta_{20} = \delta_{21} = \delta_{22} = 0$

$LR \sim \chi^2_{(3)}$

| | | | | |
|------------------------|--------|--------|--------|--------|
| $LR \sim \chi^2_{(3)}$ | 3.003 | 1.01 | 2.4983 | 1.4935 |
| p-value | 0.3911 | 0.7988 | 0.4756 | 0.6838 |

Average Mispricing 28-day returns

| Portfolio | Beta1 | Beta2 | Beta3 | Beta4 | Beta5 | Beta6 | Beta7 | Beta8 | Beta9 | Beta10 | Z ₁ R _m | Z ₂ R _m | Z ₁ fx | Z ₂ fx |
|-------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|-------|--------|-------------------------------|-------------------------------|-------------------|-------------------|
| Beta1 | -0.0055 | -0.0082 | -0.0017 | -0.0024 | 0.0033 | 0.0034 | 0.0006 | 0.0010 | | | | | | |
| Beta2 | 0.0000 | -0.0021 | 0.0005 | 0.0000 | 0.0001 | -0.0003 | -0.0004 | 0.0000 | | | | | | |
| Beta3 | -0.0003 | -0.0023 | 0.0010 | 0.0016 | 0.0004 | 0.0003 | -0.0007 | -0.0005 | | | | | | |
| Beta4 | 0.0004 | 0.0014 | 0.0011 | 0.0010 | 0.0004 | 0.0004 | 0.0001 | 0.0001 | | | | | | |
| Beta5 | 0.0006 | 0.0011 | -0.0010 | 0.0001 | -0.0016 | -0.0010 | -0.0006 | 0.0000 | | | | | | |
| Beta6 | 0.0020 | 0.0015 | 0.0000 | 0.0006 | -0.0004 | -0.0017 | 0.0004 | 0.0004 | | | | | | |
| Beta7 | 0.0007 | 0.0005 | 0.0001 | -0.0004 | -0.0027 | -0.0033 | -0.0006 | -0.0004 | | | | | | |
| Beta8 | -0.0005 | -0.0007 | 0.0014 | 0.0014 | -0.0003 | -0.0010 | 0.0015 | 0.0013 | | | | | | |
| Beta9 | -0.0011 | -0.0011 | -0.0002 | -0.0007 | 0.0053 | 0.0051 | 0.0015 | 0.0025 | | | | | | |
| Beta10 | -0.0024 | 0.0015 | -0.0012 | -0.0024 | 0.0007 | 0.0026 | -0.0037 | -0.0054 | | | | | | |
| Z ₁ R _m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | | | | | |
| Z ₂ R _m | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | | | | | |
| Z ₁ fx | 0.0000 | 0.0032 | 0.0000 | 0.0008 | 0.0000 | 0.0009 | 0.0000 | -0.0008 | | | | | | |
| Z ₂ fx | 0.0000 | 0.0011 | 0.0000 | -0.0005 | 0.0000 | 0.0003 | 0.0000 | 0.0002 | | | | | | |

Chart I

Exchange Rate Exposure

Distribution of b_{fx}

$$R_{n,t} = a + b_{fx} R_{m,t} + b_{fx} fx_t + e_{n,t}$$

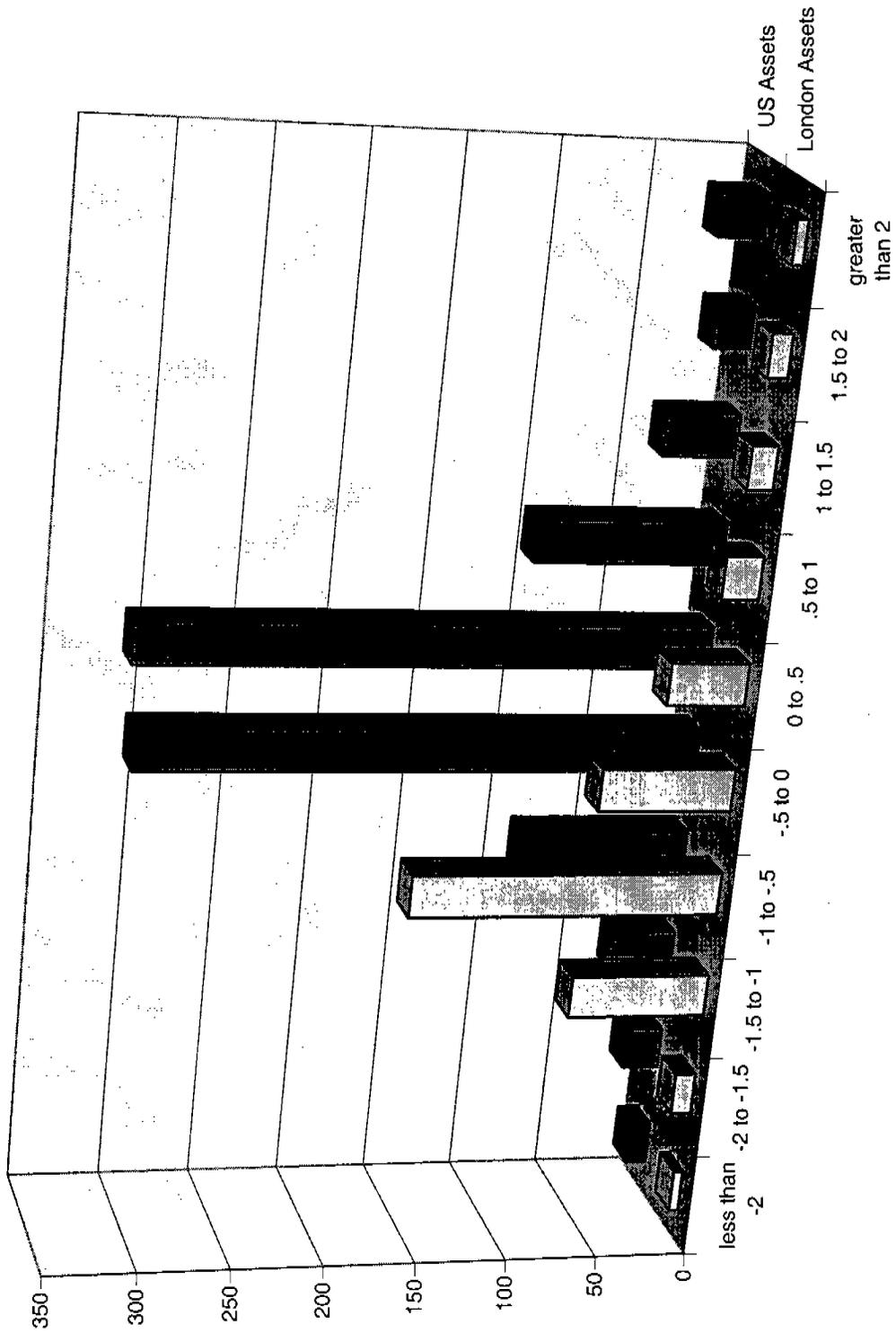


Figure 1: Exchange Rate Risk Premia

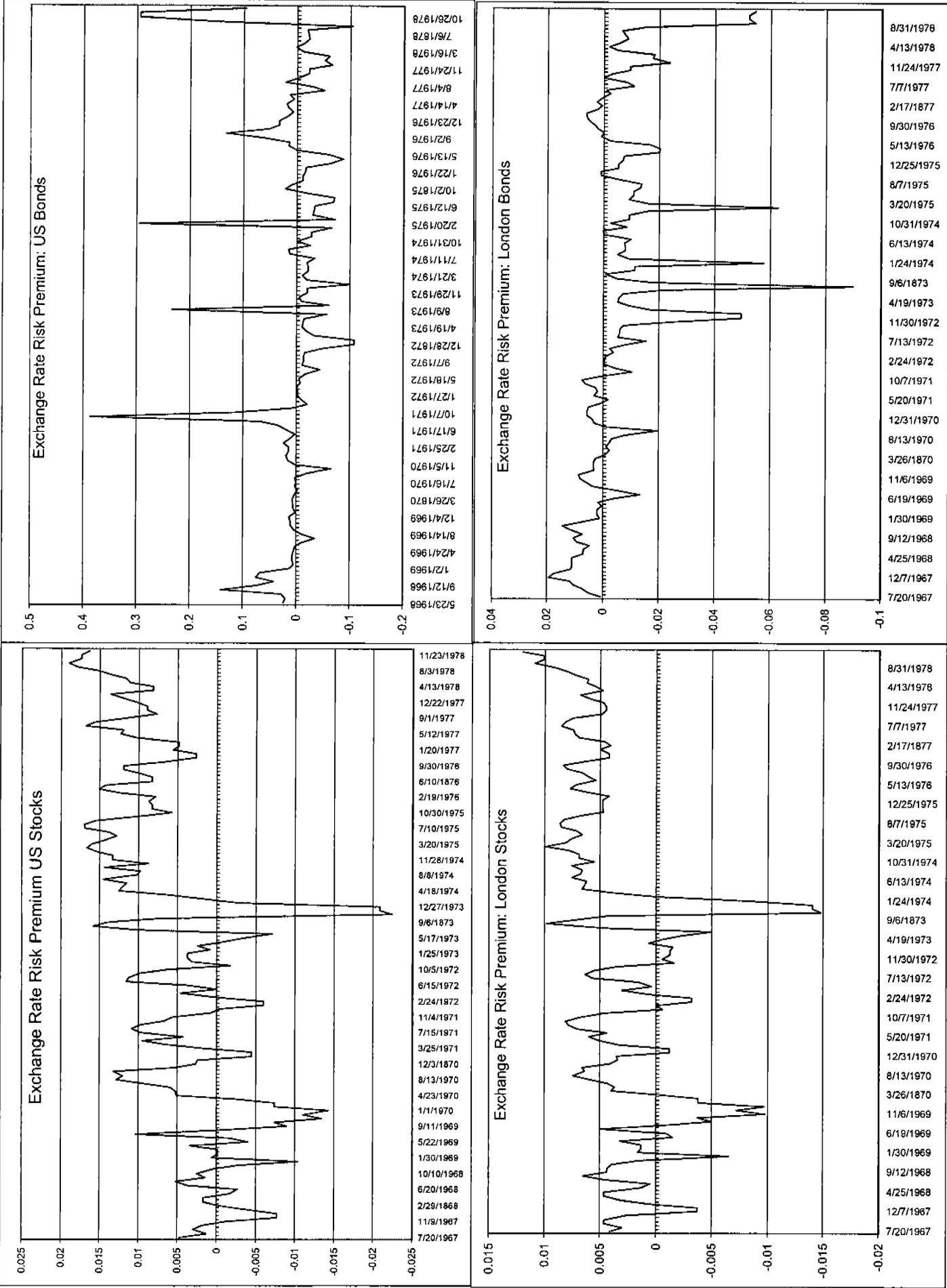


Figure II
Greenbacks/Pound
1867-1878

