THE REAL EXCHANGE RATE AND
FISCAL POLICY DURING THE
GOLD STANDARD PERIOD:
EVIDENCE FROM THE UNITED
STATES AND GREAT BRITAIN

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ABSTRACT

We study the determinants of the dollar/pound real exchange rate from 1879 to 1914 focusing on the role of fiscal policy. We present a simple dynamic model of the real exchange rate to frame our analysis. The econometric results are based upon the decomposition of the sources of the innovation of the real exchange rate drawn from a structural vector autoregression model. We find little evidence that changes in tariffs and government spending affected the real exchange rate. There is some stronger empirical evidence that shocks to deficits were associated with the fluctuations in the real exchange rate.

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I. Introduction

More than a century has passed since the widespread adoption of the gold standard in 1879 and almost eighty years stand between its demise at the beginning of the First World War and the present day. Economists look back to the gold standard period as a time when international markets in goods and capital operated efficiently and effectively. This view has served to make the gold standard period a benchmark for studying the experience of the interwar period or the post-World War II period with respect to issues such as international integration and international policy coordination.

The gold standard period has also come to serve as a benchmark for exchange-rate experience since it was largely characterized by stable nominal exchange rates. For example, the British pound was worth 4.86 United States dollars during the entire thirty-five years of the gold standard while the pound was devalued twice against the dollar during the shorter Bretton Woods era. There was also relative stability in the real exchange rate between the United States and Great Britain during the gold standard period as compared to other times. The bilateral dollar/pound real exchange rate fluctuated within a range of about twenty percent during the thirty-five years of the gold standard and its level a few years after the resumption of the gold standard by the United States was very close to its level at the outset of World War I. In contrast the Bretton Woods period saw an ongoing loss of competitiveness of the British pound with respect to the dollar. Britain's bilateral real exchange rate against the dollar appreciated by more than thirty percent between 1950 and 1973 despite the sixteen percent nominal pound devaluation in 1967.

In this paper we look back to the gold standard period to consider the link between fiscal variables and the real exchange rate between the United States and Great Britain during the period from the United States' resumption of the gold standard in 1879 to the outbreak of the First World War in 1914. Recent empirical studies of the determinants of the real exchange rate in the post-Bretton Woods era have focused on the role of fiscal variables under floating nominal parities (Feldstein (1986)) and under the semi-fixed parities of the European Monetary System (Froot and Rogoff (1991)). As with other topics in international economics, the gold standard era can serve as a type of benchmark for studying the real exchange rate since it was marked by relative stability.

A benchmark must not diverge too much from that to which it is compared, however, else the comparison is too riddled with differences to make it meaningful. There are manifold differences in the economic profiles of the United States and Great Britain between the gold standard period and more recent times and some of these are directly related to a study

of the real exchange rate and fiscal policy. One obvious difference is that governments had a much smaller role in economies in the late-nineteenth and early twentieth centuries as compared to today. Government expenditures in the United States and Great Britain were a much smaller proportion of national income during this period than in recent times but these low levels of expenditures were punctuated by wars in each country, increased public works spending in the United States in the early 1890s and a naval military buildup in the United States after the turn of the century. A major source of government revenue in the United States at that time, tariff revenues, represents an inconsequential part of today's budget. The modern period has been characterized by persistent inflation and has not had the steep deflations of the late 19th century. Finally, as mentioned above, there was a stable nominal parity during the gold standard period while the post-World War II period included devaluations and a switch from a fixed dollar/pound parity to a floating exchange rate.

While these differences between the classical gold standard period and the present day hardly need repeating, there are some striking similarities. The extent to which the United States and Great Britain were open to international trade in goods and assets during the period from 1879 to 1914 is more similar to the present day than to the intervening half-century. The steady growth in trade as a proportion of national income for the United States and Great Britain since World War II has served to return these proportions near levels that were observed in the late nineteenth century.[1] The high degree of international capital mobility during the gold standard period ended with the First World War and was not to be seen again until the present day.[2] Also, while the period from 1879 to 1914 did not see a change in the international monetary system similar to the switch from the Bretton Woods system to a float in 1973, the maintenance of the gold standard was not without dispute. The United States was riven by the debate over the maintenance of the gold standard in the 1890s and the presidential election of 1896 largely centered on this issue.

The list of similarities and differences between eras discussed above are wide-ranging since movements in the real exchange rate reflect a range of economic factors. The simple model of the real exchange rate presented in the next section helps frame the empirical discussion that follows by showing how different factors affect the real exchange rate. This model captures both the equilibrium real exchange rate and the dynamics of its adjustment. The third section provides a historical context for the subsequent empirical analysis by presenting a chronology of the evolution of the real bilateral dollar/pound exchange rate and the relevant

[1]   Paul Krugman (1990) pages 194-196.

[2]   See, for example, Maurice Obstfeld (1993).

economic and political events of the time. Section IV presents the empirical results. The analysis is based upon an econometric model which decomposes the movements in the real exchange rate into those associated with movements in fiscal variables, as well as those arising due to productivity shocks and shocks to the assets market. This model provides us with a variance decomposition of the real exchange rate, an impulse response relationship and a historical decomposition of its movements. Section V presents the conclusions.

II. A Simple Two-Country Model of the Real Exchange Rate

In this section we provide a framework for the empirical discussion that follows by sketching a simple stochastic flexible-price model of the real exchange rate for two countries with a fixed nominal parity. The model shows how factors such as government expenditures and supply shocks affect the equilibrium level of the real exchange rate. It also provides insight into the effect of an expected change in the nominal parity. This is important for our study since, as we will discuss in Section III below, there were several episodes when there was some likelihood that the United States would abandon the gold standard. We also discuss an extension of the model based upon the slow adjustment of relative prices.

The model, which describes the equilibrium conditions in the goods and money markets, is presented below:

$$(1) \qquad \overline{y}_t = f_t + \sigma(m_t - p_t)$$

$$(2) \qquad m_t = \lambda({}_ts_{t+1} - s_t) - s_t$$

where all variables represent United Kingdom variables relative to United States variables. All variables are in logarithms. For example, $\overline{y}_t = \overline{y}_t^{uk} - \overline{y}_t^{us}$ is the United Kingdom full-employment output relative to the United States full-employment output, s_t is the nominal exchange rate between the dollar and the pound (in dollars per pound), ${}_ts_{t+1}$ is the expected nominal exchange rate in period $t + 1$ conditional on information known in period t, $f_t = f_t^{uk} - f_t^{us}$ is the United Kingdom fiscal shock relative to the United States fiscal shock, which is interpreted as the United Kingdom government spending relative to the United States government spending, $p_t = p_t^{uk} - p_t^{us}$ is the United Kingdom price index relative to the United States price index, and $m_t = m_t^{uk} - m_t^{us}$ is the United Kingdom money supply relative to United States money supply. Later on, we will also refer to the real exchange rate, q_t, defined as $q_t = s_t + p_t$.

Equation (1) is the equilibrium condition in the goods market. Since it is assumed that prices and wages are fully flexible, output is always at the full employment level, $\bar{y}_t$. The left hand side of (1) reflects the demand for goods by the government sector, f_t, and the household sector, $\sigma(m_t - p_t)$. We think of government as just purchasing domestic goods; thus a change in United Kingdom government spending relative to United States government spending will equally change relative demand for United Kingdom goods.[3] We assume that households, as in the money-in-advance literature, must hold a stock of monetary balances to purchase goods. We further assume, as is traditional in international economics, that households need dollars to purchase U.S. goods and pounds to purchase U.K. goods (see, for example, Helpman (1981)). Thus, households demand for U.K. goods relative to U.S. goods will be proportional to relative real money balances, $m_t - p_t$.

Equation (2) is the condition for portfolio equilibrium. Investors are assumed to have available a choice between only two assets: U.S. money and U.K. money. Both currencies bear zero nominal interest.[4] To reflect that capital markets in the United States and the United Kingdom during the period studied were closely integrated, it is assumed that the holdings of pounds relative to dollars are proportional to the expected rate of depreciation of the dollar, $_ts_{t+1} - s_t$.

In order to examine the path of the real exchange rate over time, we have to postulate the processes followed by the fiscal shock and the output supply shock. As an example, we postulate the following relationships:

$$(3) \qquad \bar{y}_t = \bar{y}_{t-1} + \mu_t^{\bar{y}}$$

$$(4) \qquad f_t = f_{t-1} + \mu_t^{f}$$

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[3] In this section the fiscal shock, f_t, is assumed to capture just government spending. However, fiscal policy may affect demand for goods indirectly by affecting households' demand for goods. For example, the domestic currency may appreciate in real terms with the imposition of an import tariff that switches households expenditure from foreign to domestic goods. Similarly, domestic fiscal expansions —an increase in the deficit of the domestic government— may affect households net wealth, and thus modify households consumption behavior. In turn, this change in demand may affect relative prices of domestic and foreign goods. For example, Mundell's (1963) classical result is that expansionary fiscal policy "crowds out" foreign demand through an appreciation of the real exchange rate. More recently, Giovannini (1988) and Obstfeld (1989) also find, using an intertemporal optimizing model, that an increase in the government deficit in a large country will generate a real appreciation of the domestic currency. Thus, in the empirical estimation in Section IV we extend the model to allow for both tariffs and government deficits effects on the real exchange rate.

[4] In Section IV we allow for the possibility of bonds denominated in dollars and in pounds.

where the $\mu's$ are uncorrelated innovations. In equations (3) and (4) we assume that supply and fiscal shocks are of a permanent nature. This is just a useful simplification reflecting the highly persistent nature of the shocks.

The government foregoes control over the money supply when it pegs the exchange rate and faces highly-integrated world capital markets. For example, if the government issues more domestic money than the private sector is willing to hold, people will trade domestic money for foreign currency with the central bank. The central bank must accept the domestic money in exchange for the foreign currency to maintain the peg. The acceptance of this currency by the central bank, however, nullifies the initial expansionary monetary policy. Thus the equilibrium relative stock of money is determined by equation (2).

Equation (2) is general enough to allow for different likelihoods of the maintenance of the fixed exchange rate regime. If the private sector believes that the fixed exchange rate regime will be maintained then the expected depreciation term $(_t s_{t+1} - s_t)$ will be zero. The expected depreciation may not be zero, however, if events suggest to the market that there is a likelihood of a change in nominal parities. For example, when the government runs a persistent deficit financed by issuing money there will be a persistent loss of foreign reserves from the central bank. In time, a crisis will develop when people buy up the remaining reserves of the central bank in anticipation of a devaluation and thereby force the devaluation to occur.[5] In this section we allow expectations of a devaluation to be non-zero although we do not relate those expectations to a particular process followed by the government deficit. In particular, we assume that expectations of depreciation are described by:

$$(5) \qquad\qquad _t s_{t+1} - s_t = \mu_t'$$

where μ_t' is an uncorrelated shock. In equation (5) investors expect a permanent devaluation of the dollar of size μ_t'. Naturally, if, for example, expectations of depreciation are generated by a continuous government deficit, expectations of depreciation will in general be correlated over time. Thus, equation (5) only provides a useful benchmark to examine the effects of an expected depreciation on the real exchange rate.

The equilibrium real exchange rate in the flexible price model, $\overline{q}_t$, is given in (6).

$$(6) \qquad\qquad \overline{q}_t = \lambda \mu_t' + \frac{1}{\sigma}[f_t - \overline{y}_t]$$

An increase in the relative level of government spending by the United Kingdom increases the relative demand for British goods because we assume that governments concentrate

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[5] See, for example, Krugman (1979) for a complete model of the timing of a balance of payments crisis.

their spending on goods from their own countries. Therefore the real value of the pound appreciates with the increased relative demand for British goods generated by the increase in government purchases by the United Kingdom relative to the United States (i.e., an increase in f_t). Conversely, the pound depreciates with a supply shock that increases the supply of British goods relative to American goods (i.e., an increase in $\overline{y}_t$). The third determinant of the equilibrium real exchange rate is the expected devaluation of the dollar (μ_t^s). When investors expect the dollar to be devalued they sell dollars for pounds, lowering the level of the money supply in the United States relative to Great Britain (see equation (2)). The lower relative money supply in the United States lowers the relative demand for American goods (equation (1)). This results in a reduction of the relative price of United States goods and therefore a depreciation of the real dollar exchange rate. Thus an expected future nominal devaluation causes a real depreciation in the present.

For our empirical estimation, we allow also for the possibility of slow adjustment in prices. We assume the following price setting equation:

$$(7) \qquad p_t =_{t-1} \overline{p}_t + \theta(y_t - \overline{y}_t)$$

where $\overline{p}_t$ is the equilibrium relative price that will prevail in a flexible price model and y_t is the demand-determined level of output in the short run when price adjustment is sluggish. The pricing rule in this equation encompasses the outcomes of a broad set of models. On one extreme, it allows for fully flexible prices in a frictionless neoclassical model with output always at the full-employment level ($\theta = \infty$). On the other extreme, prices are set at the beginning of the period and do not adjust to supply or demand shocks ($\theta = 0$), but can be adjusted after a period.[6]

The equilibrium real exchange rate with slowly-adjusting prices is given below:

$$(8) \qquad q_t = \overline{q}_t + \frac{1}{(1+\theta\sigma)}[\frac{1}{\sigma}(\mu_t^{\overline{y}} - \mu_t^f) - \lambda\mu_t^s + (s_t - s_{t-1} - \mu_{t-1}^s)]$$

The real exchange rate in a slowly-adjusting-price model will increase in response to a fiscal shock, f_t, and to an expectation of a future dollar depreciation, μ_t^s, but by less than does the real exchange rate in the flexible price model. Conversely, the dollar will appreciate in real terms if there is a positive supply shock, $\overline{y}_t$, but by less than does $\overline{q}_t$.

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[6] We do not explicitly model the underlying source of stickiness here, although the rationale for the slow adjustment of prices in (7) can be provided by the small menu costs of price adjustment à la Akerlof and Yellen (1985) or Blanchard and Kiyotaki (1987).

Finally, when prices are not fully flexible, expectations of depreciation of the dollar at the moment in which prices are set, μ^s_{t-1}, will also affect the real exchange rate if these expectations turn out to be wrong ex-post (i.e., if $s_t - s_{t-1} - \mu^s_{t-1} \neq 0$). The intuition is straightforward. Prices are assumed to be set at $t-1$ so that they clear the market if expectations turn out to be correct. When prices are set in period $t-1$ prior to knowing the nominal exchange exchange rate, s_t, they will incorporate price setters' expectation of the nominal exchange rate. Thus, if individuals expect that a dollar devaluation will occur next period, prices in the United States will rise accordingly. If in period t the devaluation is not made effective, there will be an appreciation of the dollar real exchange rate and excess supply of goods in the United States.

III. The Real Exchange Rate and Fiscal Policy During the Gold Standard

As suggested by the model above, movements in the real exchange rate may reflect changes in a wide range of underlying fundamentals. A study of the bilateral real exchange rate between the United States and Great Britain during the gold standard period is particularly interesting since there were many economic and political events at that time which played a role in the determination of the real exchange rate. To put the econometric analysis presented below into historical context, we discuss in this section the time path of the dollar/pound real exchange rate between 1879 and 1914 as well as relevant economic and political events of the period. We first present the time series of the real exchange rate, fiscal variables in each country and the relative output, interest rates and money supplies. This is followed by a narrative of the chronology of the path of the real exchange rate and concurrent relevant economic and political events.[7]

Figure 1 presents the logarithm of the real exchange rate between Great Britain and the United States over the period from 1879 to 1914.[8] The range of the real exchange rate's movement during this period was about twenty percent. The most depreciated value of the dollar/pound real exchange rate was at the outset of the period and its most appreciated value was towards the end of the period. As shown in Figure 1, however, the fact that the extreme values of the real exchange rate were at the beginning and the end of this era does

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[7] This narrative draws from a number of sources including J. H. Clapham (1938), Davis R. Dewey (1939), Barry Eichengreen (1992), Milton Friedman and Anna Schwartz (1963), G.P. Jones and A. G. Pool (1940), W. W. Rostow (1948), and Paul Studenski and Herman E. Kroos (1963).

[8] The real exchange rate is defined as the ratio of British to the American producer price indices (times the dollar/pound exchange rate) so an increase in this number represents a real depreciation of the dollar. The sources for these and all other series used in the paper are presented in Data Appendix.

not imply a steady appreciation over the almost four decades covered by the sample. Instead, there were periods of sharp appreciation and sharp depreciation that saw near 10 percent movements in the real exchange rate over the course of a few years.

The time series of some of the factors that may have contributed to the path of the real exchange rate during this period are presented in Figures 2 and 3. Fiscal variables in the Great Britain and the United States are presented in the six panels in Figure 2. These six figures include government purchases relative to GNP, the average tariff rates and the real government deficits relative to GNP for each country.[9] The figures demonstrate the differences across countries in the range of these variables. Government purchases were on average much larger in Great Britain than in the United States. Likewise, the British real budget deficit rose at times to over four percent of national income while in the United States it never reached two percent.[10] Finally, average tariff rates in the United States were orders of magnitude greater than those in Great Britain.

Figure 3 presents relative monetary bases, relative output, and interest rate differentials between Great Britain and the United States over the sample period. The figures demonstrate that the British real output relative to that of the United States fell by about thirty percent over the sample. Most of this change came in the second half of the sample. The monetary base of Great Britain relative to the United States likewise decreased over the sample. This was on the order of sixty percent and it included a substantial change at the beginning of the sample when gold flowed into the United States after resumption. The interest rate differential figure demonstrates that the British interest rate was consistently below that of the United States with the largest differential in the first half of the 1890s corresponding to the time of the greatest strength of the free silver movement in the United States.

The data presented here, along with other information on relevant economic and political events of the times, allows us to develop a chronology of the evolution of the real exchange rate and its probable proximate causes over our sample. This informal description provides a

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[9] Real government deficit is defined as total government deficit minus the inflationary erosion of the public debt (i.e., government expenditure includes only real interest payments).

[10] Although some of the government imbalances in the United Kingdom were triggered by tax cuts, such as the 1907 income tax cut, or by increases in government purchases during the Boer war, some of the deficits in the 1880s and the beginning or the 1890s were the result of the large seemingly "unanticipated" deflation from the early 1880s to 1897, which substantially increased the real burden of the debt. In contrast, the effects of the deflation on the U.S. real government deficit were quite small because of the relatively small size of the government debt.

historical context for the econometric analysis offered in the next section. The sample begins with an appreciation of the real value of the dollar of more than fifteen percent within two years after resumption. This likely reflects the effect of substantial gold inflows at that time. The United States gold stock rose from $210 million in mid-1879 to $439 million two years later. The concurrent movement in British gold holdings is reflected in the loss of forty percent of the Bank of England's reserves during this period. In response, the Bank of England raised the bank rate from 2.5 percent in 1879 to 6 percent by 1881. The subsequent real depreciation of the dollar from 1882-1886 reflects the twenty percent deflation in the United States and the smaller, twelve percent deflation in Great Britain. During this time there was a financial panic in the United States (in May 1884) and silver purchases weakened confidence in the maintenance of the gold standard.

The latter half of the 1880s saw a depreciation of the dollar real exchange rate. This may have been due to a relatively contractionary fiscal policy in the United States since other factors, like the revival of British lending to the United States, would have put pressure on the dollar to appreciate. The United States government surplus, equal to $64 million in 1885, rose over the next few years, reaching a peak of $111 million in 1888 before falling again at the close of the decade. In the late 1880s, the administration of Grover Cleveland favored reducing this surplus through tariff reductions rather than through increased spending. This led, however, to a political backlash and as a consequence the protectionist McKinley Tariff was passed in 1890. One of the most important fiscal implications of the McKinley Tariff was its provision which put sugar on the "free list." This reduced tariff revenues and shrunk the government's budget surplus. The surplus was further affected by Congressional authorization of increased government spending for pensions, rivers and harbors.[11]

The real exchange rate fluctuated within a fairly narrow range of less than five percent during the 1890s. This quiescence belies the economic and political turbulence of the decade and reflects forces working in opposite directions on the real exchange rate. The decade began with a financial crisis when the English banking house of Baring Brothers failed in 1890. The potential panic and economic consequences due to this event, however, were averted through timely gold purchases by the Bank of England. A variety of events created incipient pressure for dollar appreciation in the 1890s. As discussed above, the McKinley tariff and the Pension Act of 1890 had adverse fiscal implications. The McKinley tariff also may have contributed to the fall in British exports in the first half of the 1890s when they were ten percent lower than their average over the previous five years. At the end of the

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[11] For a discussion of the events of this period see Vittorio Grilli (1990).

decade the Dingley tariff in 1897 represented the highest tariffs in the United States up until that point. In Britain the Great Depression continued after a four year hiatus. British prices fell over the first part of the decade and reached a trough in 1896. Other events during the 1890s tended to cause an incipient dollar depreciation. In May 1893 there was a financial panic in the United States as gold reserves fell below $100 million, the level thought to be the minimum required for maintaining the parity. Reserves continued to fall and reached $66 million at the beginning of 1894 and, despite the efforts of the Morgan syndicate, $50 million by the beginning of 1896. The political events of this time also brought into question the maintenance of the gold standard by the United States. The free silver forces gained strength up until the election of 1896. None of these forces seemed to dominate the others, however, and the real exchange rate ended the century at a level close to that found over the full decade of the 1890s.

The steep dollar appreciation at the beginning of the new century foretold the higher real exchange rate volatility in the final years of the sample as compared to most of the earlier period. The dollar appreciated by about ten percent in the first years of the twentieth century. This may partially reflect increased confidence in the maintenance of the gold standard by the United States due to the second failure of the presidential aspirations of William Jennings Bryan as well as the passing of the Gold Standard Act of 1900 which made it the duty of the Secretary of the Treasury to maintain the gold parity. The period around the turn of the century also saw an increase in government expenditures associated with wars by each country. The United States fought the Spanish-American war in 1898 and this raised government expenditures by fifty percent. Great Britain was engaged in the more protracted Boer War from 1899 to 1902 and this was associated with a spike in British government expenditures. While an increase in taxes and the limited length of the Spanish-American War resulted in a small change in the American government's budget deficit, the British deficit rose dramatically after the turn of the century. This may have contributed to the depreciation of the dollar after 1902. The dollar appreciated again after 1905. Though the exact timing of this is difficult to conclusively link to fiscal causes, this period did see an end to British war spending and an increase in United States government expenditures to pay for a larger navy and to purchase the Panama Canal. The appreciation after 1905 may also have been fueled by the marked expansion in foreign investment by British investors with the United States one of the main recipients of these funds. The severe contraction in the United States in 1908 in the wake of the 1907 financial panic may also have contributed to the final stages of the appreciation of the dollar. The sample ends with a real dollar depreciation from 1909 to 1911 and then a stable real exchange rate in the final two years.

The contraction in the American business cycle from its peak in January 1910 to its trough in January 1912 occurred at a time when the British economy was in the midst of a five-year expansion that had begun in 1908.

While fiscal factors, supply and demand shocks, asset market shocks and political factors could all have played a part in the determination of the real exchange rate during the gold standard period, a narrative account is insufficient for decomposing the effects of the movements in the real exchange rate into parts attributable to each factor. For this reason we next turn to an econometric model in order to gauge the relative contribution of different factors to the time path of the real exchange rate under the gold standard.

IV. Empirical Evidence

The model developed above and the narrative provided in Section III suggest the effect of economic fundamentals such as supply shocks or government expenditures on the real exchange rate. In this section we empirically explore the links between economic fundamentals and the real exchange rate between Great Britain and the United States for the gold standard period from 1879 to 1914. We estimate a structural vector autoregression (VAR) model with variables that represent the differences between British macroeconomic variables and their American counterparts. We present estimates of the parameters of this structural VAR and then employ it to consider the variance decomposition of the shocks to the real exchange rate, the impulse responses of the real exchange rate to a variety of shocks, and a historical forecast-error decomposition of the real exchange rate.

The model estimated is based upon the model introduced in Section II with minor modifications. First, we allow three different fiscal shocks to possibly affect the real exchange rate: (1) government spending, (2) fiscal deficit, and (3) import tariffs. Second, we introduce bonds denominated in dollars and pounds, which bear positive nominal return. Third, we incorporate shocks to demand for money into the model to allow for the possibility of financial innovations, which according to Friedman and Schwartz (1982) were the main factor behind the increase in the demand for dollars during the gold standard period.[12] Finally, we also allow for shocks to preferences (which shift demand from U.S. goods in favor of U.K. goods).

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[12] Friedman and Schwartz (1982) conclude that "the doubling of real balances expressed in weeks of income in the United States in the course of the three decades from 1876 to 1906, during which United Kingdom balances fell by 7 percent, suggests that the change in relative financial sophistication of the United Kingdom and the United States from 1880 to 1906 was probably by all odds the single most important factor accounting for the divergent trends in real balances." [page 147].

The model is now rewritten as follows:[13]

$$(9a) \qquad p_t = a_{12}y_t + \sum_{j=1}^{r} A_j^p X_{t-j} - \eta_t^{\bar{y}}$$

$$(9b) \qquad y_t = -a_{24}i_t + a_{25}g_t + a_{26}\tau_t + a_{27}d_t + \sum_{j=1}^{r} A_j^y X_{t-j} + \eta_t^y$$

$$(9c) \qquad m_t = a_{31}p_t + a_{32}y_t - a_{34}i_t + \sum_{j=1}^{r} A_j^m X_{t-j} + \eta_t^m$$

$$(9d) \qquad i_t = \sum_{j=1}^{r} A_j^i X_{t-j} - \eta_t^i$$

$$(9e) \qquad g_t = \sum_{j=1}^{r} A_j^g X_{t-j} + \eta_t^g$$

$$(9f) \qquad \tau_t = \sum_{j=1}^{r} A_j^\tau X_{t-j} + \eta_t^\tau$$

$$(9g) \qquad d_t = -a_{71}p_t + a_{74}i_t + a_{75}g_t + a_{76}\tau_t + \sum_{j=1}^{r} A_j^d X_{t-j} + \eta_t^d$$

We have already defined most of the variables in Section II. The new variables introduced in this section are defined as follows: $i_t = i_t^{uk} - i_t^{us}$ is the interest rate differential, $g_t = g_t^{uk} - g_t^{us}$ is the United Kingdom government spending relative to the United States government spending (as a share of GNP), $d_t = d_t^{uk} - d_t^{us}$ is the United Kingdom real government deficit relative to the United States real government deficit (as a share of GNP), and $\tau_t = \tau_t^{uk} - \tau_t^{us}$ is the United Kingdom average import tariff relative to the United States average import tariff. In the above equations we define X_t as follows: $X_t = [p_t, y_t, m_t, i_t, g_t, \tau_t, d_t]'$. Finally, the $\eta_t's$

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[13] Since during the gold standard the nominal exchange rate between the dollar and the pound remained constant, in what follows, and by the choice of the numeraire, p_t will refer both to the real exchange rate and to relative prices indistinctly.

are the policy or "structural" innovations, which buffet the system and cause fluctuations. We have already described some of these shocks in Section II. The new shocks introduced in the above equations are: the shock to preferences or "aggregate demand" shock, η_t^y, the shock to money demand, η_t^m, the shock to government expenditure η_t^g, the shock to tariff policy, η_t^τ, and the shock to deficit policy, η_t^d.

We capture the dynamics in the model introduced in Section II by allowing each variable in the system to depend on past realizations of all the variables in the system. The A_j^x's for $j > 0$ capture the propagation mechanism of the economy over time. We impose no restrictions on these matrices (except by specifying the maximum lag length). We concentrate on modelling the contemporaneous relationships based basically on the model described in Section II. The matrix A_0, whose non-zero elements are denoted by a_{ij} in equations (9a)-(9g), captures these contemporaneous relations. We now describe more thoroughly these within-the-period responses. Equation (9a) is the price-setting equation. As in Section II, a demand-determined increase in output generates a within-the-year hike in prices. On the contrary, a supply shock, $\eta_t^{\bar{y}}$, will push prices downward.[14] The aggregate demand equation in (9b) replicates with minor modifications equation (1). First, the cash-in-advance constraint is introduced by allowing the nominal interest rate differential to reduce the relative demand for U.K. goods.[15] Second, the fiscal shock, f_t, is decomposed into a government spending shock, a tariff shock, and a government deficit shock. Equation (9b) postulates that demand for U.K. goods will increase with increases in U.K. relative government spending, g_t, with increases in U.K. tariffs relative to U.S. tariffs, τ_t, and with increases in U.K. relative real government deficit, d_t.[16] Equation (9c) is the typical money demand equation. As postulated

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[14]   The influence of the expected flexible price on the mark-up equation, $_{t-1}\bar{p}_t$ is captured by $\sum_{j=1}^{r} A_j^p X_{t-j}$.

[15]   Expectations of devaluation of the dollar create a negative wedge between U.K. interest rates and U.S. interest rates. Money demand in the United States decreases, pushing the demand for U.S. goods downward.

[16]   Although, there is basically general agreement that increases in domestic government spending generate increases in demand for domestic goods since most of government purchases are concentrated on domestic goods, there is less agreement concerning the effects of tariffs and government deficits. For example, the effect of tariffs depends, among other factors, on whether the tariff revenue is redistributed. When the tariff revenue is not redistributed, the tariff is a combination of an expenditure-switching policy and an expenditure-reducing policy. While the expenditure-switching element increases demand for domestic goods, the income effect tends to reduce demand for domestic goods. In this case the effect of the tariff is ambiguous (See, for example, Ostroy and Rose (1992)). Similarly, the debate over whether government deficit matters is still unsettled. Some models rule out this connection by assuming an economy inhabitated by an unchanged cohort of households. In this case, a budget deficit arising from a current tax cut requiring a corresponding rise in future taxes will not affect present consumption and demand for domestic goods. In contrast, some other models (see, for example, Obstfeld (1989)) allow for changing cohorts of households, with the new born cohort unconnected with the existing households. A budget deficit in this case transfers income from

in equation (2), expectations of devaluation of the pound, captured through the interest rate differential, reduce relative demand for U.K. money. In (9c), we also allow output to affect money demand. Equation (9d) defines the interest rate differential as a function of the shock to expectations of devaluation of the dollar. Equations (9e)-(9f) model the behavior of the fiscal variables as a function of policy shocks $-\eta_t^g$, η_t^τ. Finally, equation (9g) postulates that the government deficit decreases with unexpected inflation shocks, which reduce the costs of borrowing, and with increases in tariff revenues; and it increases with increases in government expenditures –purchases and interest payments. Note that in (9g) we allow for the possibility of a deficit policy shock, η_t^d. Fiscal policy innovations in equations (9e)-(9g) $-\eta_t^g$, η_t^τ, η_t^d- are designed to capture shocks to policy variables unrelated to other fundamental macroeconomic influences, such as military spending shocks due to the country engaging in a war or increases in tariffs due to a protectionist sentiment surge such as the adoption of the McKinley Tariff Act of 1890.[17]

We can write the model using matrix notation as follows:

$$(10) \qquad X_t = \sum_{j=0}^{r} A_j X_{t-j} + \eta_t$$

To summarize, the real exchange rate movements in the above model are explained by a supply and aggregate demand shocks $-\eta_t^{\bar{y}}$, η_t^y- a money demand shock and a shock to expectations of devaluation of the dollar $-\eta_t^m$, η_t^s-, and three fiscal shocks $-\eta_t^g$, η_t^τ, η_t^d-. These "structural" disturbances are uncorrelated over time and have a variance-covariance matrix $E(\eta_t \eta_t') = \Sigma$, which is assumed to be diagonal. The matrix A_0 captures the contemporaneous interaction of the variables. Their dynamic relationship is given by the matrices A_j (for $j > 0$). The theoretical source of the dynamic propagation mechanism of the economy is the slow adjustment in prices discussed in Section II.

Following Bernanke (1986) and Blanchard (1989), we estimate the system in (10) in two steps: First, we estimate a reduced form relating X_t to its lagged values:

$$(11) \qquad X_t = \sum_{j=1}^{r} B_j X_{t-j} + \epsilon_t$$

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future generations (whose propensity to consume present goods is zero) to the current generation (whose propensity to consume is positive) creating more demand for present goods. To sum up, tariffs and deficits do not have clear-cut effects on output and the real exchange rate. Thus, we should turn to the data for empirical evidence.

[17] Fiscal policy in (9e)-(9g) also reacts to fluctuations in other variables in the economy, such as the level of economic activity, but only with lags. Although the specification of fiscal policy in equations (9e)-(9g) is ad hoc, it is nonetheless quite general. For example, the tariff reaction function in (9f) is consistent with a variety of views on how tariffs are determined, such as countercyclical tariff policy, smoothing government deficits, or responding to imbalances in the foreign sector.

where $B_j = (I - A_0)^{-1}A_j$ and ϵ_t is a serially uncorrelated vector of residuals, which is observed by the econometrician. Second, we estimate the parameters of A_0 using the reduced vector of residuals and the method of moments. The estimation of A_0 will allow us to recover the "structural shocks," η_t, since the following condition holds:

$$(12) \qquad\qquad \epsilon_t = A_0\epsilon_t + \eta_t$$

We estimate the model in equations (11) and (12) with the variables in levels using annual data for the period 1879-1913. The order of the lag is two, a value based upon the results of likelihood tests. We first report the estimates of the contemporaneous relationships between the variables in the system. Afterwards we examine the dynamic transmission of the shocks throughout the system.

a. The Estimated Contemporaneous Relations

The estimate of the matrix A_0 is reported in Table 1. These estimates show how shocks contemporaneously affect the economy. The estimated price-setting equation is relatively flat (equation $(9a)$). This implies little relation between innovations to p_t and innovations to y_t suggesting that fluctuations in demand have a small contemporaneous effect on relative prices and the real exchange rate and a large effect on output. The aggregate demand function, equation $(9b)$, suggests that aggregate demand within the year strongly increases with positive shocks to deficit but is little affected by changes in interest rates and tariff policy. Surprisingly, aggregate demand depends negatively on shocks to government purchases suggesting that government spending during the gold-standard period might not have been biased towards purchases of domestic goods. The money demand function, equation [9c], is basically unresponsive to interest rates but increases in proportion to prices. The government deficit equation, [9g], shows the deficit increasing with government spending and decreasing with increases in import tariffs. Unexpected shocks to inflation reduce the cost of borrowing of the government and hence negatively affect the government deficit.

b. Dynamic Effects of Structural Shocks

While we estimate the VAR for the entire set of variables, the focus of our work is the determinants of the real exchange rate. Therefore we only examine the dynamic effect of the structural shocks on the real exchange rate. The main source of the fluctuations of the real exchange rate over time and the dynamic effects of shocks can be examined in a variety of ways. We first examine the variance decomposition which demonstrates the contribution

of each source of innovations to the variance of the n-year ahead forecast error for the real exchange rate. Afterwards, we report impulse responses and a historical forecast-error decomposition.

b.1 Variance Decomposition

Variance Decompositions are reported in Table 2. Three main findings here are:

1. Innovations to aggregate supply, $\eta_t^{\bar{y}}$, account for most of the variance of the real exchange rate at short horizons, reflecting that relative prices do not respond immediately to aggregate demand shocks.

2. At longer horizons, shocks to expectations of devaluation and deficit innovations account for a larger fraction of the variance of the real exchange rate. These two innovations jointly account for 23 percent of the variance at a 4-year horizon and for 37 percent at an 8-year horizon.

3. The proportion of the variance explained by the supply shock decreases monotonically over the years suggesting that this shock may be capturing transitory phenomena such as the effect of bumper crops.

b.2 Impulse Responses

The impulse responses of the real exchange rate to innovations in each of the seven structural shocks are presented in Figure 4. The results of the variance decomposition above suggest the importance of the responses to $\eta_t^{\bar{y}}$, η_t^s, and η_t^d and accordingly we focus on these results though we also briefly discuss responses to the other innovations.

The panel representing the impulse response of the real exchange rate to a positive supply shock (a positive supply shock in the United Kingdom relative to a supply shock in the United States) in Figure 4 demonstrates an appreciation in the real dollar exchange rate for about three years. Thereafter, its effect on the real exchange rate is basically zero. Since supply shocks have mainly transitory effects on output too (not reported), these shocks may capture the large transitory fluctuations in agricultural output that occurred in this period, such as the unusually large crops in the United States in 1880-1881 and 1891-1892. In these years, American production was the largest on record and so were exports of crude foodstuffs. This generated a large gold inflow which, in turn, caused over time a spurt in the U.S. money stock and a subsequent rise in U.S. wholesale prices, reverting the initial dollar real depreciation due to the positive supply shock.

It is interesting to examine in detail the response of the real exchange rate to a decrease in the interest rate differential. As postulated in Section II, the expectation of a dollar-depreciation, which is manifested in an increase in the U.S. interest rates relative to those in the U.K. (i.e., a negative shock to the interest differential) leads to an depreciation in real terms of the dollar. The estimate suggests that an eighty basis points negative shock to interest rate differential has basically no effect on the real exchange rate on impact but leads to a 1 percent depreciation of the real exchange rate for the dollar in the medium run. Since interest rate differentials were larger in absolute values in the disturbed decade of the 1890s, this impulse response reflects in large part the response of the real exchange rate to the agitation over silver. As it is discussed in Section III, during the 1890s there was a general distrust of the maintenance of the gold standard originating with the passing of the Sherman Silver Purchase Act in mid-1890. This distrust was manifested in a on-average large outflow of gold in 1892. The Senate's approval in July 1892 of a free silver coinage bill, which never became a law, reinforced such fears. Moreover, the run on the banks in the financial crisis of 1893 reinforced those fears further increasing capital outflows. These capital outflows reduced the money supply and prices and led to a dollar depreciation.

The estimated dynamic effect of a shock to deficit policy is consistent with the traditional Mundell-Fleming model over the medium and long run. An increase in Great Britain's deficit relative to the one in the United States leads to an appreciation in real terms of the pound. A one-standard deviation innovation in the deficit, which increases the relative deficit by 0.1 percent permanently, appreciates the pound by up to 0.5 percent in the medium and long run. Surprisingly, we find that in the short run an increase in the deficit in Great Britain has a deflationary impact and thus depreciates the pound by about 1 percent.

Finally, we discuss very briefly the four other impulse responses. Positive money demand innovations –in Great Britain relative to the United States–, which stand for such factors as financial innovations, generate an appreciation of the pound in the short and medium run, which is what the conventional wisdom would lead one to expect. In the long run the effect is basically zero. Similarly, a one-standard positive aggregate demand shock in Great Britain relative to the United States leads to a 0.4 percent real appreciation of the pound. An increase in relative tariffs generates a positive shock to demand for goods in Great Britain leading to price increases in this country relatively to the United States. A positive one-standard deviation shock to tariffs, which increases tariffs on impact in about 1.5 percent leads to a depreciation of the dollar in real terms in at most 0.3 percent after five years. Surprisingly, a positive shock to government purchases in Great Britain relatively to the United States generates an appreciation of the dollar. While the impact response of

the real exchange rate is difficult to reconcile with any model, the medium and long run depreciation of the pound may capture the movements in relative prices needed to offset the U.K. current account deficit brought about by the increase in U.K. government spending relative to U.S. government spending (see, for example, Giovannini (1988)).

b.3 Historical Decomposition

The seven panels in Figure 5 illustrate the roles played by the different shocks over different historical episodes. Each panel plots the forecast error of the real exchange rate at the four-year horizon and the portion of this forecast error attributable to each of the respective structural shocks. A closer tracking of the particular "structural" innovation (represented by the dashed line) to the overall real exchange rate innovation (represented by the solid line) suggests a larger role for that innovation as a source of the innovation of the real exchange rate.

Of the three fiscal shocks, the government deficit shock seems to track the real exchange rate innovation the most closely. At the end of the 1880s there were government surpluses in the United States. At this time, the total forecast error of the real exchange rate showing the unexpected real dollar depreciation is closely tracked by the error attributable to the relative fiscal constraint in the United States. These United States fiscal surpluses were feared to be contractionary. Policy reversed this fiscal stance by 1894 with the revenue effects of the McKinley tariff (which put sugar on the free list) as well as increased spending on pensions, rivers, and harbors. Our decomposition picks up the unexpected appreciation of the dollar at this time. After 1895 the deficits of the United States and the United Kingdom began to diverge to a greater extent than in the earlier part of our sample. The deficit in the United States changed relatively little from 1895 to World War I but the deficit in the United Kingdom shifted dramatically, first falling with the end of the Boer War (1899-1902) and then rising with the income tax cut in 1907. Our decomposition shows that the effects of the relative deficit tracks the real exchange rate after 1905. The pound first depreciates after 1905 with the fiscal contraction in the United Kingdom and then appreciates in the subsequent fiscal reversal after 1907.

The contribution of the innovations of the other two fiscal factors to the total innovation of the real exchange rate appear relatively slight. Innovations to government purchases are only mildly associated with the overall innovation to the real exchange rate. The tariff shock makes the smallest contribution to the total real exchange rate innovation of any of the seven innovations. Neither of the two changes in tariffs in the period studied, the McKinley

Tariff Act of 1890 nor the Dingley Tariff of 1897, show up in the estimates as important explanations of the real exchange rate innovation in those years.

The innovation that accounts for the preponderance of the innovation in the real exchange rate is the output supply shock. This shock seems to explain relatively well the fluctuations in the real exchange rate around the turn of the century. One possible explanation can be traced to the favorable agricultural shock in the United States and unfavorable agricultural shock in Europe in 1897 and 1898. While initially these shocks exerted downward pressure on U.S. commodity prices relative to U.K. prices (a depreciation of the dollar in real terms), over time this trend was reversed. The reversion of the trend was brought about by the subsequent major shift in the recorded balance of merchandise trade in the United States, which was promptly reflected in gold movements –about 200 million during the 1897-1899 period. After some delay, in the 1899-1903 period, this shock was reflected in prices, which started to increase relative to those in England leading to a real dollar appreciation. After 1903 the real appreciation of the dollar was reversed with the dollar depreciating about 8 percent in real terms in the 1903-1906 period. Interestingly, these years were characterized by strong industrial growth in the United States, of which the most obvious signs were the rapid growth of the output of coal and iron and of the volume of railroad traffic.

The expectations of devaluation and money demand shocks seem to track the innovations to the real exchange rate over selected periods. The innovation due to the credibility shock –expectations of devaluation of the dollar– closely tracks the innovation in the real exchange rate from 1892 to 1898. This corresponds to the period of the rise and subsequent fall in the political strength of the free silver movement. During the time when the free silver movement was strongest the likelihood of the United States abandoning the gold standard was greatest. The innovation due to money demand tracks the overall real exchange rate innovation most closely at the beginning of the sample. At this time, in the wake of resumption, there was an increased in demand for money in the United States. Thus at this time we see a decrease in the money demand shock and a corresponding appreciation of the dollar.

V. Conclusion

There are three possible channels through which fiscal policy could have affected the bilateral dollar/pound real exchange rate during the gold standard. The first is through the standard effect of government expenditures shifting the consumption pattern of the economy and affecting the relative price of domestic versus foreign goods. The second effect of fiscal policy is through tariffs which were an important source of revenues for the United States

during this period. Changes in government deficit are the third source of fiscal effects on the real exchange rate. Government deficits, as it was discussed in Section IV, may alter the behavior of households and therefore the equilibrium relative price of domestic goods. Although not modelled explicitly, persistent U.S. government deficits may have affected the public's faith in the maintenance of the gold standard by the United States. We find that there is almost no empirical evidence that tariffs and government spending affected the real exchange rate. There is some stronger evidence that innovations in government budget deficits were associated with innovations to the real exchange rate. This is specially true with the large increases in deficits in the United Kingdom with the Boer war and the income tax cut in 1907.

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Data Appendix

I. Definitions

Government Purchases = G.Expenditure − G.Interest Payments − G.Transfer Payments

Government Deficit = Government Expenditure − Government Revenue

$$g_t^j = \frac{\text{G.Purchases}_t^j}{\text{GNP}_t^j} \times 100$$

$$\tau_t^j = \frac{\text{Custom Duties}_t^j}{\text{GNP}_t^j} \times 100$$

$$d_t^j = \left[\frac{\text{Deficit}_t^j}{\text{GNP}_t^j} + \frac{\text{Debt}_{t-1}^j}{\text{GNP}_t^j} \times [1 - \frac{p_t^j}{p_{t-1}^j}] \right] \times 100$$

p_t^j = Country j Producer Price Index in period t (in logs)

s_t = dollar/pound nominal exchange rate in period t (in logs)

m_t^j = Country j Monetary Base in period t (in logs)

y_t^j = Country j real GNP in period t (in logs)

i_t^j = Country j short term nominal interest rate in period t

II. Sources

Nominal Exchange Rate

1879-1884: Edwin Perkins (1978).

1885-1889: *Commercial and Financial Chronicle*, various issues.

1890-1910: National Monetary Commission (1910).

1911-1913: F.A. Pearson and G.F. Warren (1935), Table 6, page 158.

Producer Price Index

a. United States

1879-1913: F.A. Pearson and G.F. Warren (1935), Table I, pages 6-10.

b. United Kingdom

1879-1884: B.R. Mitchell (1988), Table Prices 4, page 725.

1885-1913: *Journal of the Royal Statistical Society*, various issues.

Real GNP, in 1929 prices

a. United States

1879-1888: Christina Romer (1986).

1889-1908: *Historical Statistics of the United States* (1975), Series F3.

1909-1913: *The National Income and Product Accounts of the United States* (1981).

b. United Kingdom

1879-1913: Calculated as the ratio of Nominal GNP to the GNP Deflator.

Nominal GNP

a. United States

1879-1888: Estimated as real GNP × GNP Deflator.

1889-1908: *Historical Statistics of the United States* (1975), Series F1.

1909-1913: *The National Income and Product Accounts of the United States* (1981).

b. United Kingdom

1879-1913: Capie and Webber (1985), Table III.12.

GNP Deflator

a. United States

1879-1913: Ratio of Nominal to Real income from Friedman and Schwartz (1982), Table 4.8.

b. United Kingdom

1879-1913: Capie and Webber (1985), Table III.12.

Monetary Base

a. United States

1879-1913: Friedman and Schwartz (1963), Table B-3.

b. United Kingdom

1879-1913: Capie and Webber (1985).

Nominal Interest Rates

a. United States

1879-1890:

1890-1909: National Monetary Commission (1910), Table 29. 4/6-month rates.

1909-1913:

b. United Kingdom

1879-1913; Capie and Webber (1985). Table III.10, column V. 3-month bank bills.

Government Expenditure

a. United States

1879-1913: *Historical Statistics of the United States* (1975). chart Y457-469.

b. United Kingdom

1879-1913: Mitchell and Deane (1962), pages 397-399.

Government Interest Payments

a. United States

1879-1913: Mitchell and Deane (1962), pages 397-399.

b. United Kingdom

1879-1913: Mitchell and Deane (1962), pages 397-399.

Government Transfer Payments

a. United States

1879-1913: *Historical Statistics of the United States* (1975), Charts Y457-465, Y466-471.

b. United Kingdom

1879-1913: Mitchell and Deane (1962), Social Security Payments, page 400.

Government Revenue

a. United States

1879-1913: *Historical Statistics of the United States* 1975, Chart Y258-263.

b. United Kingdom

1879-1913: Mitchell and Deane (1962), T3, Public Finance. Page 393.

Government Debt

a. United States

1879-1913: *Historical Statistics of the United States* (1975) , Chart Y368-Y369.

b. United Kingdom

1879-1913:   Mitchell and Deane (1962), T5, page 403.

Customs Duties

a. United States

1879-1913:   *Historical Statistics of the United States* (1975).

b. United Kingdom

1879-1913:   Mitchell and Deane (1962), pages 393-395.

Imports

a. United States

1879-1913:   *Historical Statistics of the United States* (1975), Dutiable Imports.

b. United Kingdom

1879-1913:   Mitchell and Deane (1962), pages 283-284.

Table 1

Estimated Contemporaneous Effects

$$\varepsilon_t = A_0 \varepsilon_t + \eta_t$$

ε^p	$= 0.138\varepsilon^y$ (0.100)	$- \eta^{\bar{y}}$			
ε^y	$= -0.007\varepsilon^i$ (0.010)	$- 0.046\varepsilon^g$ (0.018)	$+ 0.369\varepsilon^\tau$ (0.495)	$+ 0.012\varepsilon^d$ (0.006)	$+ \eta^y$
ε^m	$= 0.654\varepsilon^p$ (0.285)	$+ 0.015\varepsilon^y$ (0.137)	$- 0.001\varepsilon^i$ (0.007)	$+ \eta^m$	
ε^i	$= -\eta^s$				
ε^g	$= \eta^g$				
ε^τ	$= \eta^\tau$				
ε^d	$= -33.90\varepsilon^p$ (12.00)	$+ 1.141\varepsilon^g$ (0.505)	$- 10.137\varepsilon^\tau$ (15.905)	$- 0.162\varepsilon^i$ (0.309)	$+ \eta^d$

Note: Standard errors are in parentheses.

Table 2

Variance Decomposition of the Real Exchange Rate						
Years Ahead	$\bar{\eta^y}$	η^y	η^m	η^s	η^g	η^τ	η^d
1	91.85	6.04	0.00	0.19	0.93	0.05	0.94
2	60.96	5.49	12.99	5.04	3.81	0.10	11.61
3	52.83	4.61	14.42	8.32	5.43	0.09	14.31
4	47.14	5.86	13.34	15.03	5.27	0.48	12.87
5	42.34	6.75	13.39	19.23	4.78	1.10	12.39
6	40.02	7.57	12.82	20.91	4.69	1.22	12.78
7	38.89	7.69	12.53	21.65	4.51	1.15	13.59
8	37.75	7.78	12.52	22.45	4.30	1.22	13.98
9	36.71	8.01	12.58	23.38	4.19	1.25	13.88
10	35.79	8.53	12.46	24.18	4.14	1.22	13.68
11	35.01	9.09	12.19	24.70	4.09	1.35	13.56
12	34.32	9.41	11.85	25.10	4.05	1.61	13.71

Figure 1

Dollar/Pound Real Exchange Rate

Figure 2

Fiscal Factors

Great Britain
Government Purchases / GNP

United States
Government Purchases / GNP

Average Tariff

Average Tariff

Real Government Deficit / GNP

Real Government Deficit / GNP
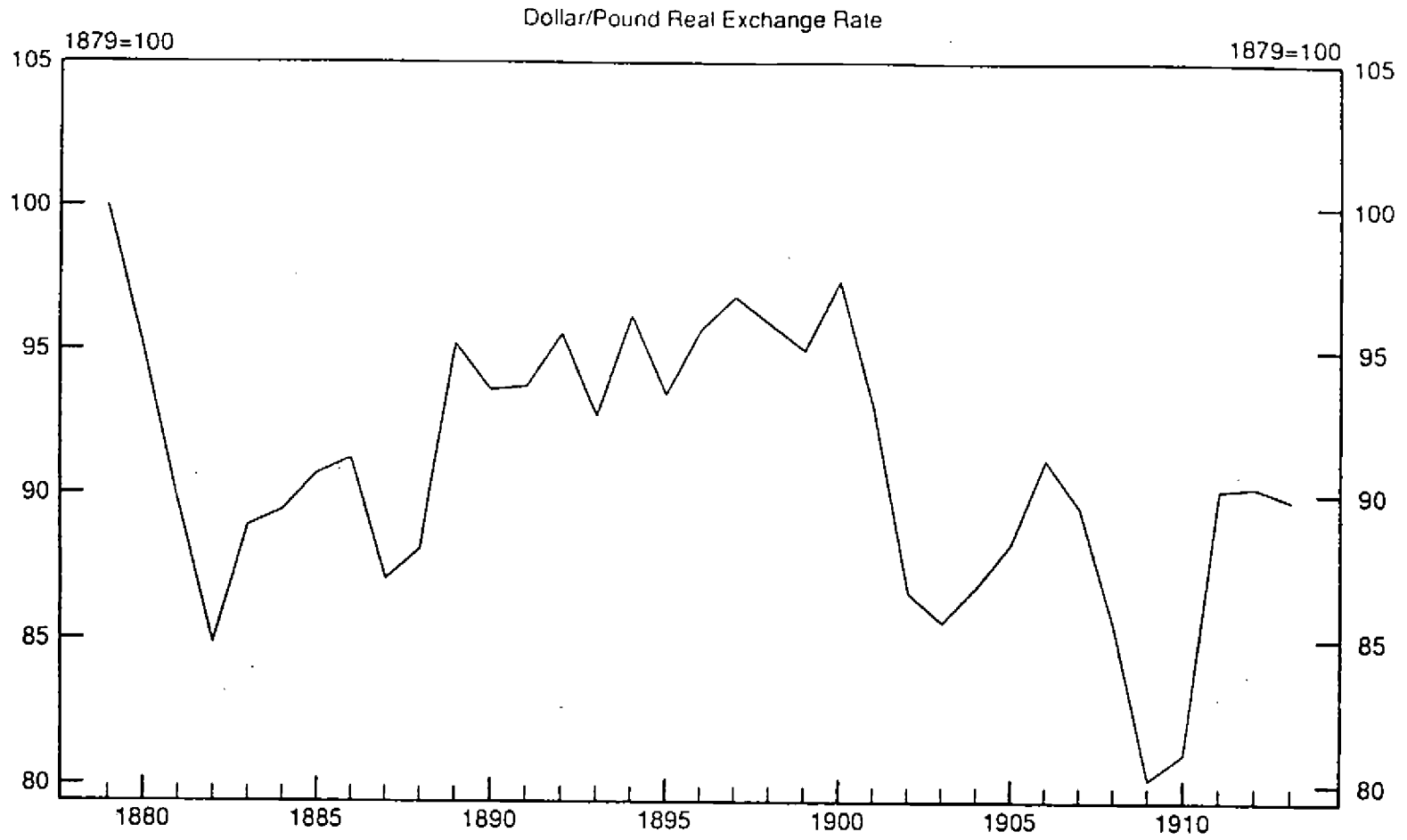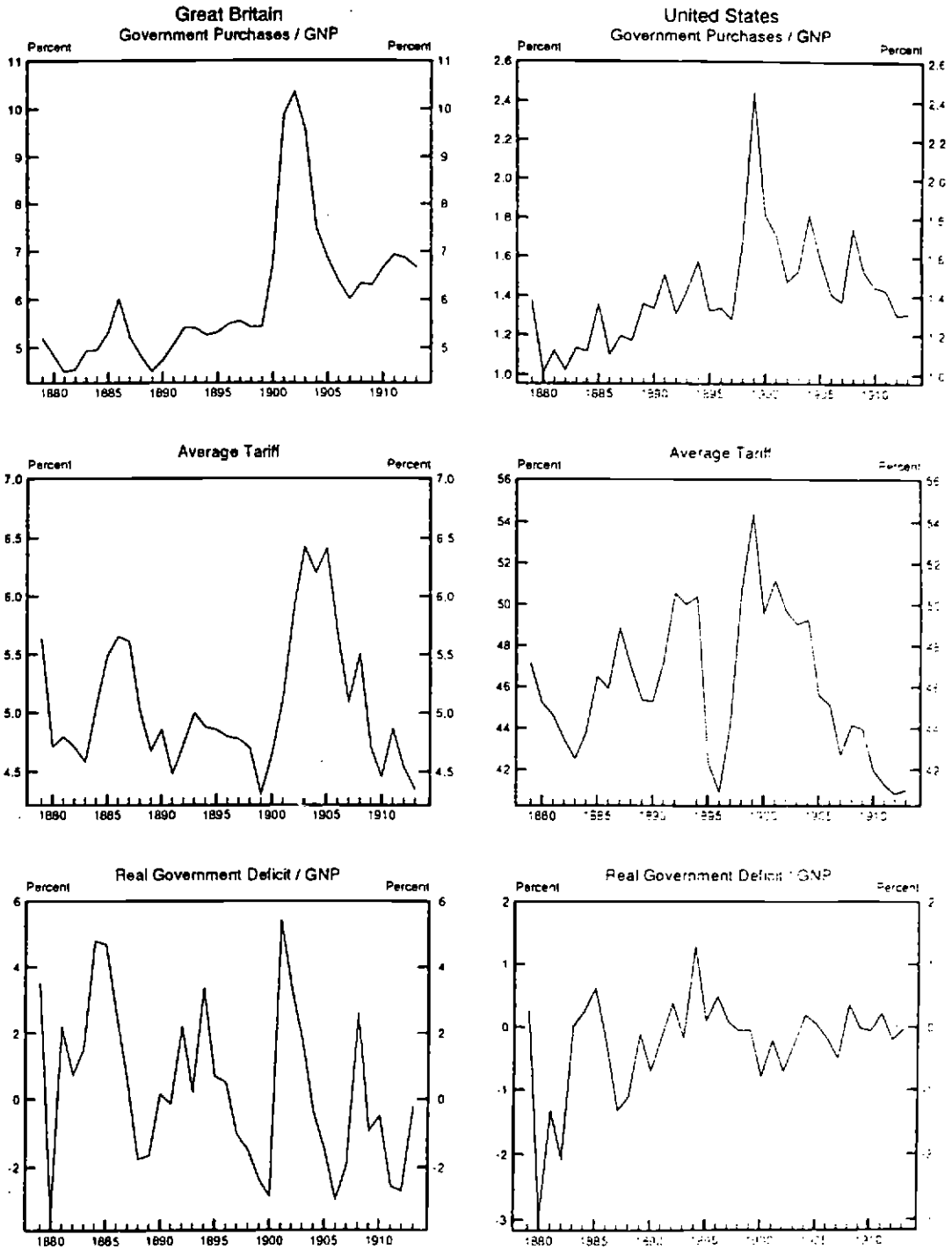
Figure 3

Other Market Factors

Relative Money

Relative Money = ln(Great Britain money base / United States money base)

Relative Output

Relative Output = ln(Great Britain GNP / United States GNP) taken at constant prices.

Interest Rate Differential

Interest Rate Differential = nominal interest rate of Great Britain - nominal interest rate of the United States.
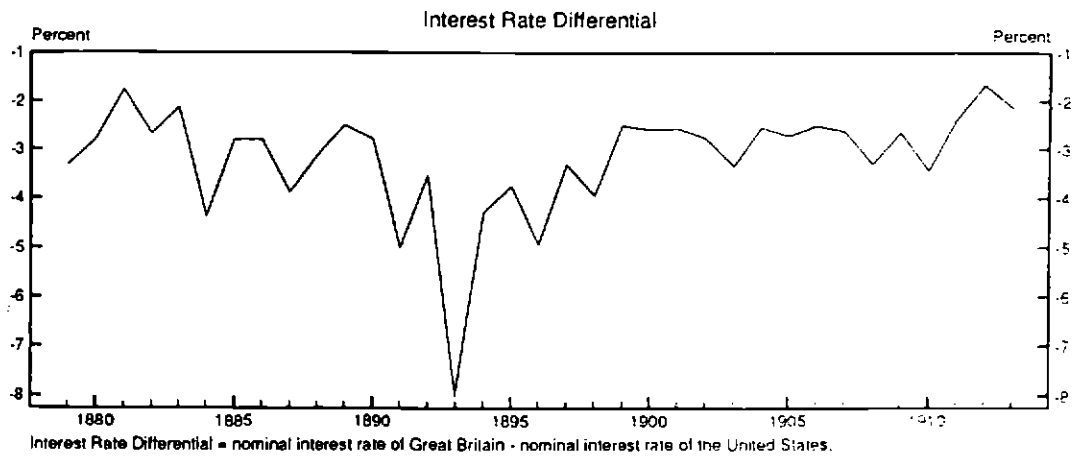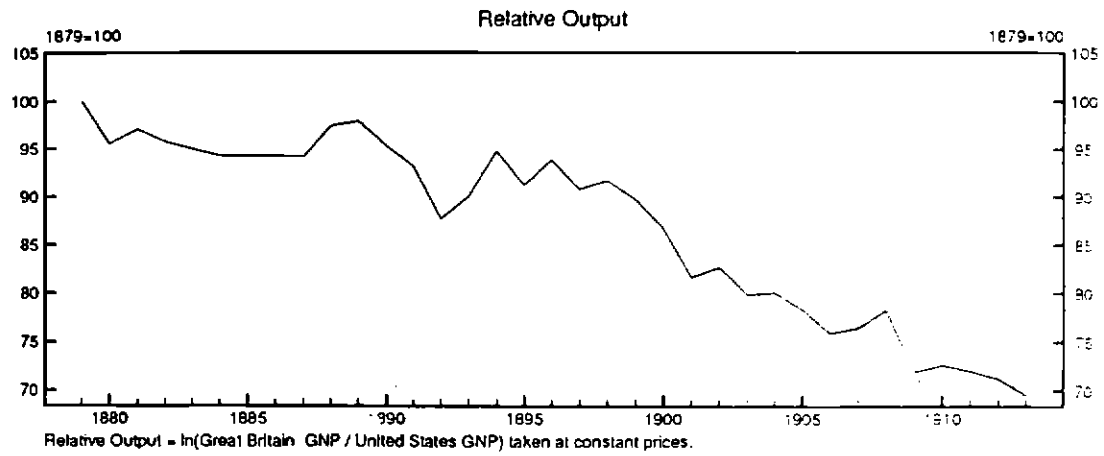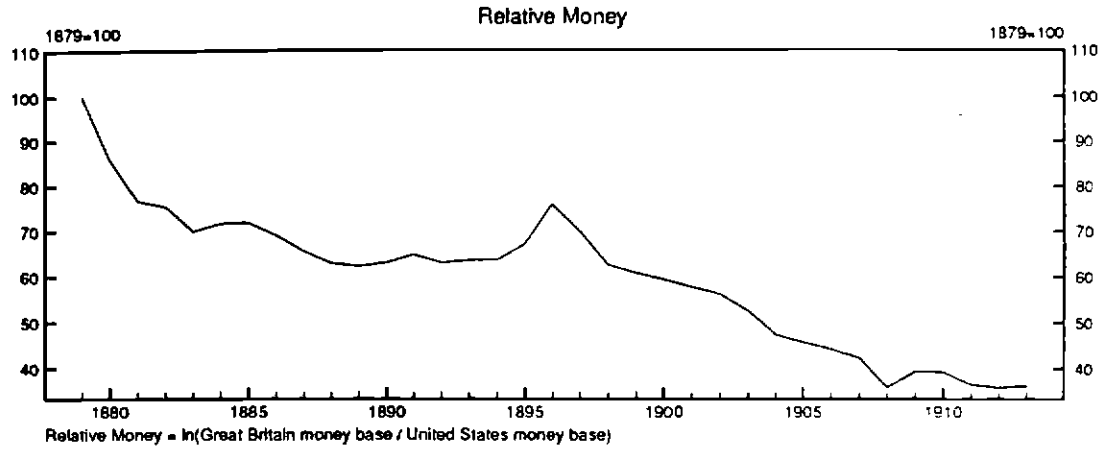
Figure 4

Response of the Real Exchange Rate
to a one-standard-deviation shock in the structural innovations

Aggregate Supply Shock

Government Purchases Shock

Aggregate Demand Shock

Tariff Shock

Money Demand Shock

Government Deficit Shock
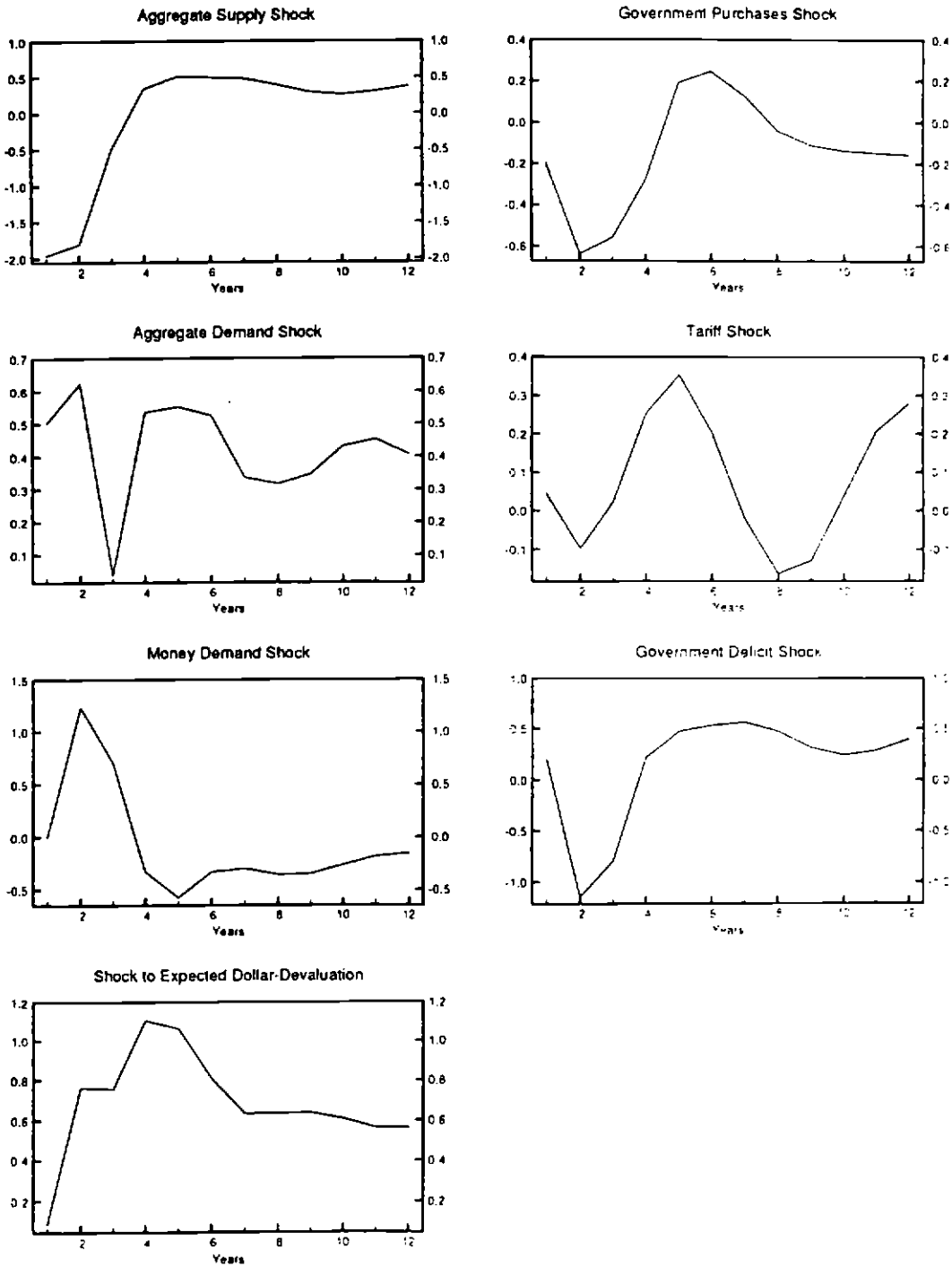
Shock to Expected Dollar-Devaluation

Figure 5

Historical Forecast-Error Decomposition
of the Real Exchange Rate (4-year Horizon)

Aggregate Supply Shock

Government Purchases Shock

Aggregate Demand Shock

Tariff Shock

Money Demand Shock

Government Deficit Shock

Shocks to Expected Dollar-Appreciation

NOTE:

———— Total Forecast Error

············ Structural Shock Portion

Forecast errors are shown as percentages.