Federal Reserve Bank of Chicago

The Crime of 1873: Back to the Scene

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Abstract

Milton Friedman's (1990) counterfactual analysis of what would have happened if the United States had not abandoned bimetallism in 1873 is revisited in a general equilibrium model of bimetallism. I find that bimetallism would have survived and the gold-silver ratio would have remained stable for another twenty years. If countries such as India that abandoned silver because of its depreciation are assumed not to, bimetallism survives to World War I. But the United States would have experienced a sharp bout of inflation in the early 20th century, although milder if India stays on silver.

Keywords: bimetallism, monometallism, commodity money, exchange rate indeterminacy (JEL E42, N10).

1 Introduction

A commodity money standard is a monetary system in which a given commodity can be turned into money at will. The most famous example is the gold standard, which prevailed in the world before 1914. A very few other countries at that time were on a silver standard, notably China. Yet another standard was bimetallism, a monetary system in which two commodities, gold and silver, could be turned into money, and coins made of either metal were perfect substitutes as money at a constant ratio. In 1914, bimetallism was extinct, but only recently so.

In February 1873, the United States Congress revised coinage laws; in doing so, it deliberately omitted to open the mints to the unlimited coinage of silver. This seemingly technical detail effectively placed the US on a gold standard, after 81 years of bimetallism. Within months, most of the other bimetallic countries in the world had also suspended free coinage of silver, and bimetallism had disappeared. This omission by Congress is called the "crime of 1873," the phrase a relic of late nineteenth-century American politics and the heated controversies to which the omission gave rise (after the fact). A good part of the controversies were fuelled by the long price deflation of the 1880s and 1890s, a deflation felt throughout the gold standard world. This deflation was followed by equally large inflation in the years leading to World War I.

In a recent paper, Milton Friedman (1990) revisited the crime of 1873. The question he sought to answer was the following: had the US retained its bimetallic system, what would the price level have been? In particular, would it have exhibited the alternation of deflation and inflation that actually took place? To do this, he constructed a counterfactual. He supposed the US had continued to freely mint the silver dollar after 1873 at the pre-Civil War silver content, and kept the silver dollar as unlimited legal tender. He found that the price level would have been more stable. This paper revisits the issue by using another model (Velde and Weber 2000).

2 Friedman revisits the Crime of 1873

I begin with a brief account of Friedman's counterfactual. The underlying assumptions are as follows:

1. production of both metals would not have changed;

2. the US would have effectively been on a silver standard;

3. monetary demand for silver outside the US would not have changed;

4. the US stock of monetary gold would have been absorbed by rest-of-world monetary uses and world nonmonetary uses proportionately;

5. the price of gold would have risen in proportion to the stock of monetary gold.

Friedman constructed a model embodying those assumptions, used data to estimate the model, and computed a hypothetical gold-silver ratio and price level.

To present the model, I use the following notation. For each metal i (where $i = g, s$ for gold and silver), the world supply of the metal is y^i, monetary demand for the metal outside the US is m^i_{-US}, monetary demand for the metal in the US is m^i_{US}, world nonmonetary demand for the metal is d^i, world income is I. A $\tilde{}$ over a variable indicates that it is counterfactual.

In Friedman's model, the price of silver p_s (in goods per ounce of silver) is determined by clearing the market for newly produced silver, in which the annual supply of new silver y^s is equated with the sum of the rest-of-world monetary demand m^s_{-US}, US monetary demand m^s_{US}, and world nonmonetary demand for new silver d^s (which includes the US). This last variable is a flow which may be positive or negative, depending on whether silver is added to or subtracted from the stock of monetary silver.

$$y^s = m^s_{-US} + \tilde{m}^s_{US} + \tilde{d^s}. \tag{1}$$

By assumptions 1 and 3, y^s and m^s_{-US} are unchanged. By assumption 2, the US would have used silver instead of gold as medium of exchange. But the real value of the stocks of commodity held for that purpose is the same in any commodity standard, thus $\tilde{m}^s_{US} = \tilde{p}_s m^g_{US}$. World nonmonetary demand for silver is assumed to be a linear function of the price of gold p^g, the price of silver p^s, and world income I, estimated by linear regression.

World income is assumed to be unchanged: $\tilde{I} = I$. The price of gold $\tilde{p}_g$ (in goods per ounce of gold) is determined in the following way. By assumption 5, its inverse (the price

level in the gold bloc) is proportional to the hypothetical stock of monetary gold, which can be computed under assumption 4:

$$\frac{p_g}{\tilde{p}_g} \propto \frac{\tilde{m}^g_{-US}}{m^g_{-US}} = 1 + \frac{m^g_{US} + d^g}{m^g_{-US} + d^g} \tag{2}$$

so that

$$\tilde{p}_g = p_g \frac{m^g_{-US} + m^g_{US} + d^g}{m^g_{-US} + d^g}. \tag{3}$$

Finally, the price of silver $\tilde{p}_s$, which is the inverse of the hypothetical price level in the US, is computed by solving equation (1):

$$y^s = m^s_{-US} + \tilde{p}_s m^g_{US} + [\tilde{p}_s \ \tilde{p}_g \ I]\beta \tag{4}$$

where β is a 3×1 vector estimated by linear regression as noted above.

Friedman found that the US adoption of silver would have kept the price of silver relative to gold low enough that the (silver-based) price level in the US would have been higher, but not excessively so. The price level would have been more stable, that is, the deflation from 1873 to 1896 (-1.7% per year) and subsequent inflation from 1896 to 1913 (+2.0%) would have been replaced by stable prices throughout, except for some inflation in the 1890s (see Figure 5).

The result is a little surprising. After 1873, the value of silver fell by 55%. The silver bloc's price levels were fixed in terms of units of silver, hence prices must have gone up significantly in those countries, relative to gold standard countries. In Friedman's counterfactual, the US changes sides from the gold to the silver bloc. Friedman's result is that the resulting increase in demand for silver is enough to push up the price of silver relative to gold, and avoid large-scale inflation in the silver-based US. This is evidenced by Friedman's hypothetical gold-silver ratio in Figure 4, whose path is much lower than the actual path.

Some aspects of Friedman's analysis are unsatisfactory. The model of the silver market embodied in 1 assumes that the metal is nondurable in nonmonetary uses, since existing stocks have no bearing on the current price of silver. The gold market is not modelled explicitly (in the appendix, he explains why his attempts to do so failed). Assumption 3 is not consistent with the principle that real balances do not depend on the metal in which they are held. Assumption 2 is an assumption about prices (that the gold-silver ratio would have been above the legal ratio of 16) which is actually violated for a few years in his counterfactual results.

I bring to bear a recent model of bimetallism, namely Velde and Weber (2000). The exercise differs from Friedman's from the points of view of theory and data. From the theoretical point of view, the model obviates most of Friedman's assumptions, keeping only 1. That is, I do not model the production of gold and silver, and retain the assumption that the production of gold and silver would not have changed, irrespective of price changes. I model the market for gold and silver, and endogenously determine the split between monetary and nonmonetary stocks for both metals in response to price changes. I also determine in the context of the model whether the US would have been effectively on a bimetallic standard (with both gold and silver circulating) or only silver. The model also allows changing the monetary systems in the other countries. These advantages come at the cost of specifying a particular form for preferences.

3 A general equilibrium model of bimetallism

3.1 The model

Time is infinite and discrete. The model is intended to represent the world economy. There are three types of goods in the model: a nonstorable general consumption good ξ_t, and nondepreciating stocks of gold and silver metal $Q_{1,t}$ and $Q_{2,t}$. In each period, there is a given amount of consumption good, and given increases (or decreases) in the stocks of gold and silver. Total quantities of all goods are thus stochastic and exogenous to the model; the model is a pure exchange economy.

What is determined within the model is the distribution of gold and silver stocks between monetary and nonmonetary uses. Gold and silver can each be in either of two forms: coined or uncoined. All gold (respectively silver) coins are of the same size and are called dollars.[1] Let $m_{i,t}$ $(i = 1, 2)$ be the number of existing coins, and d_i the quantity of either metal in uncoined form. There is an adding-up condition:

$$Q_i = m_{i,t} + d_{i,t}$$

I assume that it is costless to convert metal from one form to the other. Metal is coined

[1] I normalize measurement units by using US monetary standards, so that gold stocks are measured in gold dollars (1 gold dollar = 1/20.69 tr oz) and silver dollars (1 silver dollar = 1/1.2929 tr oz).

because money is needed for purchases of the consumption good to meet a cash-in-advance constraint described shortly. Converting from coined to uncoined is melting, and converting from uncoined to coined. A key feature of a commodity money standard is that both operations be unimpeded.

A representative household's preferences are defined over the consumption good and over the stocks of uncoined metal. That is, the household derives direct utility from the uncoined metal only, which I call jewelry. Preferences are described by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) + v(d_{t+1}) \right] \tag{5}$$

where d_{t+1} stands for $(d_{1,t+1}, d_{2,t+1})$, the end-of-period stocks of jewelry.

The timing is as follows. At the beginning of period t, the household holds stocks of coins and jewelry $m_{i,t}$ and $d_{i,t}$. Exogenous increases or decreases in the stocks of metal $Q_{i,t+1} - Q_{i,t}$ accrue directly to the stocks of jewelry held by the household. The household also received the period's endowment of consumption good ξ_t which it cannot consume directly, but must purchase from the firm. The household sells its endowment to the firm in exchange for end-of-period profits. The firm sells to the household the consumption good at a price p_t , and increases in jewelry holdings $h_{i,t}$ at prices $q_{i,t}$ (all prices are denominated in gold coins). These transactions are subject to a cash-in-advance constraint in which both coins are perfect substitutes, but silver coins are valued at an *endogenous* price e_t (in gold coins per silver coin).[2]

A minor complication needs to be introduced at this point. The model in Velde and Weber (2000) was intended to formalize the idea of worldwide bimetallism. Here, I will estimate the model using data from the period after 1873, when bimetallism had disappeared. To make use of the data, the model has to be modified to include two features. One is the existence of "limping standards", monetary systems where the currency is pegged to gold but consists in large part of (overvalued) silver coins.[3] The other is the existence of separate gold and silver blocs, regions of the world where only one or the other metal was legal tender and

[2]The correspondence with Friedman's model is: $e = p_s/p_g$, $p = 1/p_g$.

[3]Such was the case in the United States and France. In fact, many countries that abandoned silver or bimetallism kept their existing stocks of silver coinage, rather than retire them and replace them with gold; thus placing themselves on a limping standard.

freely minted.

The first feature is represented by having part of the money stock consist of overvalued silver coins: the number of coins is $\bar{m}_{2,t+1}$ and the legal tender value of each coin is $\bar{e}_t > e_t$. The numbers $\bar{m}$ and $\bar{e}$ are allowed to change over time as the number of countries adopting the limping standard changed, and the degree to which their coins were overvalued varied. These numbers are thus taken as exogenous and given by the household.

The second feature is represented by two separate cash-in-advance constraints, requiring that a certain fraction $\alpha_{1,t} > 0$ of (world) consumption, corresponding to the share of the gold bloc in world monetary transactions, be paid for with gold or overvalued silver, the other $\alpha_{2,t} > 0$ in silver:

$$m_{1,t} + \bar{e}_t \bar{m}_{2,t+1} \geq p_t \alpha_{1,t} \xi_t \tag{6}$$

$$e_t m_{2,t} \geq p_t \alpha_{2,t} \xi_t. \tag{7}$$

Again, the numbers $\alpha_{i,t}$ are taken as given and exogenous by the household, and satisfy $0 < \alpha_{1,t} + \alpha_{1,t} \leq 1$. In the period 1873–1913, I consider that $\alpha_{1,t} + \alpha_{2,t} = 1$. The counterfactual will consist in removing the United States from the gold bloc, that is, subtracting $\alpha_{US,t}$ from $\alpha_{1,t}$), where $\alpha_{US,t}$ represents the share of the US in world consumption.[4]

The cash-in-advance constraint is:

$$p_t c_t + q_{1,t} h_{1,t} + q_{2,t} h_{2,t} \leq m_{1,t} + e_t m_{2,t} + \bar{e}_t \bar{m}_{2,t}. \tag{8}$$

The firm then decides the quantity $n_{i,t}$ of coins to mint, and the quantity $\mu_{i,t}$ of coins to melt. At the end of the period, the firm pays profits Π_t, in the form of coins, to the household.

The household maximizes utility (5) subject to the cash-in-advance constraints (8), (6), (7), the budget constraint:

$$m_{1,t+1} + e_t m_{2,t+1} \leq \Pi_t + (m_{1,t} + e_t m_{2,t} + \bar{e}_t \bar{m}_{2,t+1} - p_t c_t - q_{1,t} h_{1,t} - q_{2,t} h_{2,t}) \tag{9}$$

and the restriction that and

$$d_{i,t+1} = d_{i,t} + h_{i,t} + Q_{i,t+1} - Q_{i,t}, \tag{10}$$

given initial stocks $m_{i,0}$ and $d_{i,0}$.

[4]It will also require moving the American stock of overvalued silver $\bar{m}_{US}$ out of the gold bloc.

The firm maximizes profits

$$\Pi_t = p_t\xi_t + n_{1,t} - \mu_{1,t} + q_{1,t}h_{1,t} + e_t n_{2,t} - e_t\mu_{2,t} + q_{2,t}h_{2,t} \tag{11}$$

subject to $n_{i,t} \geq 0$, $m_{i,t} \geq \mu_{i,t} \geq 0$, and the condition

$$h_{i,t} = \mu_{i,t} - n_{i,t}. \tag{12}$$

An equilibrium is a collection of prices $\{p_t, q_{i,t}, e_t\}$ and quantities $\{c_t, h_{i,t+1}, d_{i,t+1}, m_{i,t+1}, n_{i,t}, \mu_{i,t}\}$ such that households choose c_t, $h_{i,t+1}$, $d_{i,t+1}$, $m_{i,t+1}$ to maximize their utility taking prices as given, firms choose $n_{i,t}$, $\mu_{i,t}$ to maximize profits taking prices as given, and markets clear: $\xi_t = c_t$ and $m_{i,t+1} = m_{i,t} + n_{i,t} - \mu_{i,t}$.

The firm's first-order conditions are, for gold, that $q_{1,t} \geq 1$ and $n_{1,t} = 0$ if $q_{1,t} > 1$; $\mu_{1,t} = 0$ if $q_{1,t} < 1$; $\mu_{1,t} = m_{1,t}$ if $q_{1,t} > 1$. For silver, they are that $q_{2,t} \geq e_t$ and $n_{2,t} = 0$ if $q_{2,t} > e_t$; $\mu_{2,t} = 0$ if $q_{1,t} < e_t$; $\mu_{2,t} = m_{2,t}$ if $q_{2,t} > e_t$. The implications are that $q_{1,t} \geq 1$ and $m_{1,t+1} = 0$ if $q_{1,t} > 1$; $q_{2,t} \geq e_t$ and $m_{2,t+1} = 0$ if $q_{2,t} > e_t$. That is, the price of gold jewelry is no less than 1, and all gold coins have been melted if it is above (gold coins are the numeraire). The price of silver jewelry is no less than e_t and all silver coins have been melted if it is above. Since $\alpha_{i,t} > 0$ for all i, t, then the cash-in-advance constraints (6) and (7) must be met, and the price of jewelry must always be 1 and e_t respectively.

The household's first-order conditions include the constraints and

$$v_i(d_{t+1}) = \frac{q_{i,t}}{p_t}u'(c_t) - \beta E_t\left[\frac{q_{i,t+1}}{p_{t+1}}u'(c_{t+1})\right] \tag{13}$$

$$E_t\left[\left(\frac{e_{t+1}}{e_t} - 1\right)\frac{u'(c_{t+1})}{p_{t+1}}\right]\begin{cases} \leq 0 & \text{if } m_{1,t} + \bar{e}_t\bar{m}_{2,t+1} > p_t\alpha_{1,t}\xi_t, \\ \geq 0 & \text{if } e_t m_{2,t} > p_t\alpha_{2,t}\xi_t, \end{cases} \tag{14}$$

$$\beta\max\{E_t\left[\frac{u'(c_{t+1})}{p_{t+1}}\right], E_t\left[\frac{e_{t+1}}{e_t}\frac{u'(c_{t+1})}{p_{t+1}}\right]\} \leq \frac{u'(c_t)}{p_t}, \tag{15}$$

with (15) holding at equality when (8) does not bind, and use of the notation $v_i(d_{t+1}) = \partial v/\partial d_i(d_{1,t+1}, d_{2,t+1})$.

Equation (13) is an asset pricing equation for jewelry, inequalities (14) require that one currency not be dominated in rate of return by the other if it is held outside its bloc, inequality (15) places a lower bound of 1 on the gross nominal rate of interest.

In equilibrium, the household conditions can be written:

$$v_1(d_{t+1}) = \frac{u'(\xi_t)}{p_t} - \beta E_t\left[\frac{u'(\xi_{t+1})}{p_{t+1}}\right] \quad (16)$$

$$v_2(d_{t+1}) = e_t\frac{u'(\xi_t)}{p_t} - \beta E_t\left[e_{t+1}\frac{u'(\xi_{t+1})}{p_{t+1}}\right] \quad (17)$$

while (12) and (8) imply that

$$\begin{aligned} p_t\xi_t &= m_{1,t+1} + \bar{e}_{t+1}\bar{m}_{g,t+1} + e_t m_{2,t+1} \\ &= (\hat{Q}_{1,t+1} - d_{1,t+1}) + e_t(\hat{Q}_{2,t+1} - d_{2,t+1}) \end{aligned} \quad (18)$$

where the "adjusted" total stocks are defined as $\hat{Q}_{1,t+1} \equiv Q_{1,t+1} + \bar{e}_{t+1}\bar{m}_{g,t+1}$ and $\hat{Q}_{2,t+1} \equiv Q_{2,t+1} - \bar{m}_{g,t+1}$.

Given the exogenous processes ξ and $\hat{Q}_i$, the equilibrium sequences e, d_1 and d_2 must solve equations (16), (17) and (18), subject to the constraints (6), (7), and (14).

In the case where no country adheres to bimetallism (which was the case after 1873), then $\alpha_{1,t} + \alpha_{2,t} = 1$ for all t and the equations can be written as

$$v_i(d_{t+1}) = \alpha_{i,t}\frac{u'(\xi_t)\xi_t}{\hat{Q}_{i,t+1} - d_{i,t+1}} - \beta E_t\left[\alpha_{i,t+1}\frac{u'(\xi_{t+1})\xi_{t+1}}{Q_{i,t+2} - d_{i,t+2}}\right] \quad (19)$$

$$e_t = \frac{\hat{Q}_{2,t+1} - d_{2,t+1}}{\hat{Q}_{1,t+1} - d_{1,t+1}}\frac{\alpha_{2,t}}{\alpha_{1,t}}. \quad (20)$$

3.2 Steady states and counterfactual

Velde and Weber (2000) show conditions under which bimetallism, defined as an equilibrium in which $e_t = e$ and $m_{i,t+1} \geq 0$, is a possible outcome. There is a range of possible exchange rates, or legal ratios between gold and silver, compatible with bimetallism. The range is determined by the exogenous variables, namely the total stocks of gold and silver, and also the sizes of the gold and silver blocs.

The equations describing steady states with bimetallism are

$$v_1(d) = (1-\beta)u'(\xi)/p \quad (21)$$

$$v_2(d) = e(1-\beta)u'(\xi)/p \quad (22)$$

$$p\xi = \hat{Q}_1 - d_1 + e(\hat{Q}_2 - d_2) \quad (23)$$

with $\hat{Q}_1 - d_1 \geq \alpha_1 p\xi$, $\hat{Q}_2 - d_2 \geq \alpha_2 p\xi$.

The method of the counterfactual is as follows. We will use the equations characterizing the steady states of the model. Let a ˜ denote a counterfactual value for a variable. Let $X = (1-\beta)u'(\xi)\xi$ which does not change under the counterfactual.

The actual variables satisfy

$$\begin{aligned} v_1(d)(\hat{Q}_1 - d_1) &= \alpha_1 X & (24)\\ v_2(d)(\hat{Q}_2 - d_2) &= \alpha_2 X & (25)\\ e &= \frac{v_2(d)}{v_1(d)} = \frac{\hat{Q}_1 - d_1}{\hat{Q}_2 - d_2}\frac{\alpha_2}{\alpha_1}. & (26) \end{aligned}$$

For each year, we take the exogenous values of ξ_t, $\hat{Q}_{i,t}$, $\alpha_{i,t}$ as given. We remove the United States from the gold bloc, which changes $\alpha_{1,t}$ and $\hat{Q}_{i,t}$ to the counterfactuals $\tilde{\alpha}_{1,t} = \alpha_{1,t} - \alpha_{US,t}$ and $\tilde{Q}_{i,t}$. We check first if there is a bimetallic solution at the ratio $e = 1$, by finding $\tilde{d}_1$ and $\tilde{d}_2$ solving $v_1(\tilde{d}) = v_2(\tilde{d})$ and

$$v_1(\tilde{d})(\tilde{Q}_1 - \tilde{d}_1) + v_2(\tilde{d})(\tilde{Q}_2 - \tilde{d}_2) = X = v_1(d)(\hat{Q}_1 - d_1)/\alpha_1$$

and also satisfying

$$\begin{aligned} \tilde{Q}_1 - \tilde{d}_1 &\geq (\alpha_1 - \alpha_{US})(\tilde{Q}_1 - \tilde{d}_1 + \tilde{Q}_2 - \tilde{d}_2) & (27)\\ \tilde{Q}_2 - \tilde{d}_2 &\geq \alpha_2(\tilde{Q}_1 - \tilde{d}_1 + \tilde{Q}_2 - \tilde{d}_2). & (28) \end{aligned}$$

If the first equation is violated, the US is effectively on the silver standard and the equations are

$$\begin{aligned} v_1(\tilde{d})(\tilde{Q}_1 - \tilde{d}_1) &= (\alpha_1 - \alpha_{US})X & (29)\\ v_2(\tilde{d})(\tilde{Q}_2 - \tilde{d}_2) &= (\alpha_2 + \alpha_{US})X & (30)\\ & & (31) \end{aligned}$$

If the second condition is violated, then the US is effectively on the gold standard and the equations are

$$\begin{aligned} v_1(\tilde{d})(\tilde{Q}_1 - \tilde{d}_1) &= \alpha_1 X & (32)\\ v_2(\tilde{d})(\tilde{Q}_2 - \tilde{d}_2) &= \alpha_2 X. & (33)\\ & & (34) \end{aligned}$$

The counterfactual price level in the gold bloc can be computed as

$$\tilde{p} = \frac{v_1(d)}{v_1(\tilde{d})} p$$

and that in the silver bloc as $\tilde{p}/\tilde{e}$. When bimetallism exists, they coincide.

4 Data

I make use of the following annual data, from 1873 to 1913:

(a) the average value in December of the gold-silver ratio,

(b) the total stock of gold and silver in the world at the end of the year,

(c) the stock of gold and silver coin in each country at the end of the year,

(d) the actual price level in the United Kingdom, taken to represent the gold bloc.

4.1 Sources of the series

Series (a) and (d) are taken from Friedman (1990). Series (b) is described in Velde and Weber (2000) and are essentially the same as that in Friedman (1990). The major difference with Friedman concerns series (c). Friedman took his data in Kitchin (League of Nations, 1930) and Drake (1983). They have the unfortunate feature that, between 1873 and 1890, when the price of silver falls by 40% relative to gold, gold nonmonetary stocks rises by 15% relative to silver. This is difficult to reconcile with the kind of preferences for gold and silver that I wanted to use, so I looked for alternative estimates of monetary stocks.

Kitchin and Drake had both estimated monetary stocks as residuals: they estimated how much gold and silver was produced each year, and how much went into industrial uses; the remainder accruing to money stocks. To come up with another estimate, I estimated money stocks directly by adding up national money stocks for each year, and took nonmonetary stocks to be the residual. The *Annual Reports* (U.S. Secretary of the Treasury 1873–1914) provide estimates of these national money stocks for a growing list of countries in 1873, 1878 to 1883, 1892 to 1907 and 1909 to 1913. Using Maddison's (1995) data, I find that the sample of countries in the *Reports* represents half of world output in 1873, three quarters in 1883,

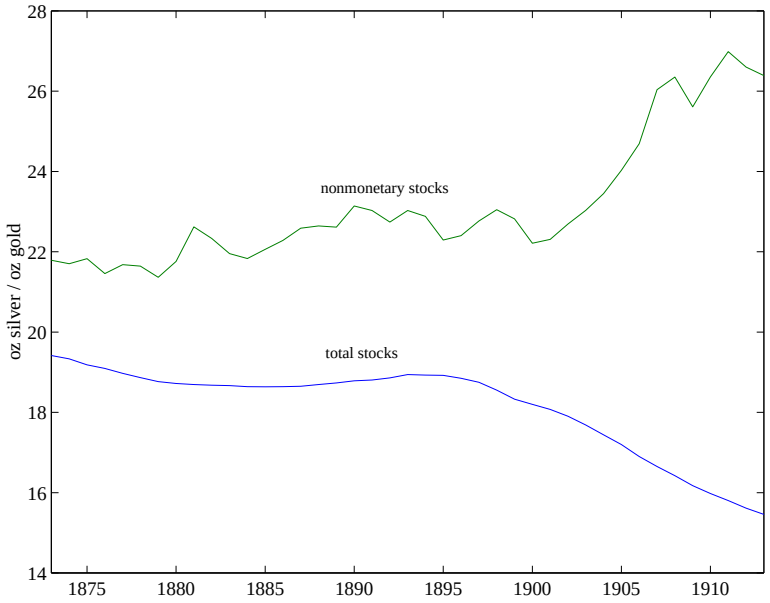

Figure 1: Ratio of total and nonmonetary stocks of silver and gold, 1873-1913.

and over 90% after 1892. The *Reports*' estimates can be improved on the basis of recent scholarship for some countries, together accounting for about 50 to 55% of world output. They thus represent a large, but not sufficient fraction of the world. I have relied on the Director of the Mint's estimates for the remaining countries, with interpolations and guesses for missing years (see the Appendix for details). All told, my estimates cover between 92 and 98% of world output over the sample period.

As it turns out, the estimates of nonmonetary stocks for 1873 are quite close to those of Kitchin and Drake used in Velde and Weber (2000), but diverge after that date. Figure 2 plots the market ratio against the ratio of estimated stocks. The slope is negative, which is an improvement.

4.2 Estimation of preferences

The specification of preferences over stocks of nonmonetary metal that I use is a constant elasticity of substitution:

$$v(d_1, d_2) = \left[(ad_1)^\rho + {d_2}^\rho\right]^{1/\rho}.$$

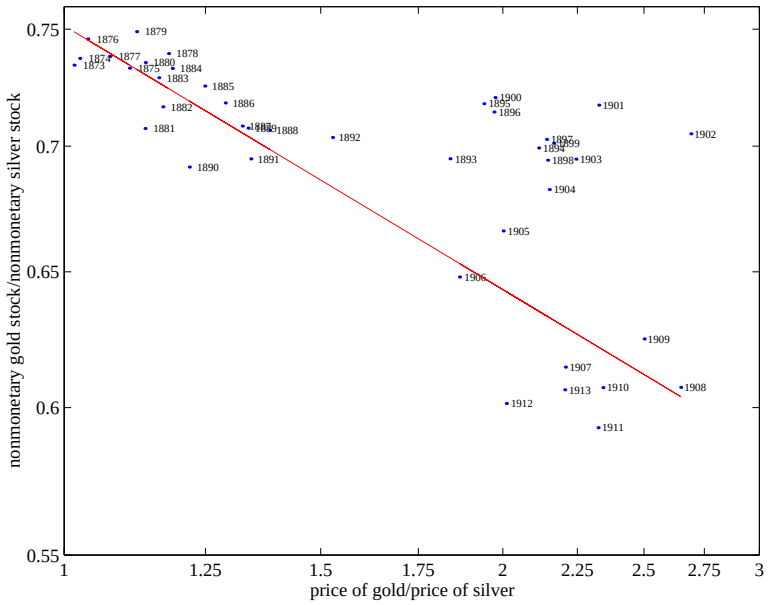

Figure 2: Gold-silver market ratio (December average for each year) plotted against ratio of estimated worldwide nonmonetary stocks, in logs. The regression line is computed excluding the observations for 1894 to 1903 (see text). Units are normalized so that a gold-silver ratio of 1 corresponds to the US legal ratio of 16.

Our specification obviates the need for a time series of world income.

In equilibrium, the market ratio is the ratio of marginal utilities:

$$1/e = a^{\rho}(\frac{d_1}{d_2})^{\rho-1}.$$

As Figure 2 suggests, there is a somewhat anomalous period from 1893 to 1903. In 1893, India discontinued free minting of silver, and at the same time Austria and Russia committed to a gold standard, and the American silver purchases came to an end. The resulting fall in the price of silver was not accompanied by an immediate adjustment in quantities. I use the sample from 1873 to 1893 and 1904 to 1913 only.

The stand taken here is that Estimation by ordinary least squares yields (standard errors in parentheses):

$$\log(d_1/d_2) = \quad -0.224\log(e) \quad -0.286 \tag{35}$$

$$\qquad\qquad\qquad\quad (0.0172) \qquad (0.0085) \tag{36}$$

which means an elasticity of substitution between gold and silver of -0.22. I then estimate $\rho = 1 - 1/0.224 = -3.46$ and $a = \exp[(\frac{\rho-1}{\rho}) * (-0.286)] = 1.445$.

Figure 3 plots the actual gold-silver ratio and the ratio predicted by the model. As expected, the model deviates from the actual ratio in the period 1894–1903, but does well before and after. In what follows, I will take the results of the counterfactual to be more dependable outside the period 1894–1903.

4.3 Uses of the series in the counterfactual

The variables in the model are the total stocks Q_i, nonmonetary stocks d_i, monetary stocks m_i and $\bar{m}_2$, gold-silver ratio e, world output ξ, shares of world output in the gold and silver blocs α_i. I have corresponding data series for all but ξ and α_i. The shares α_i are computed as shares of the money stocks of each bloc in the world money stock, where the silver bloc's stock is valued in terms of gold at the market ratio (this makes equation 20 hold by construction). Finally, as I only need $X = (1-\beta)u'(\xi)\xi$, I compute it as $X = v_1(d)(\hat{Q}_1 - d_1) + v_2(d)(\hat{Q}_2 - d_2)$, using the estimated preferences for v.

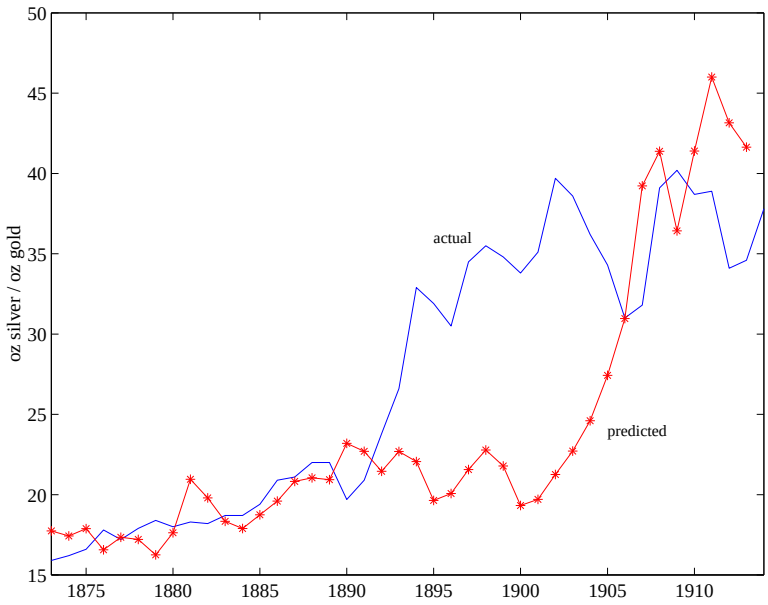

Figure 3: Gold-silver ratio, actual and predicted.

5 Friedman revisited

The results of the counterfactual exercise are displayed in Figures 4, 5, and 6, where I compare the actual series with Friedman's and our counterfactuals.

The broad thrust of the results is to confirm Friedman's finding of greater price stability in the 1880s, but not over the whole period. I find that the market ratio would have been initially below 16, meaning that the US would have begun on a gold standard, minting only gold coins. Quickly, however, the US would have been on an effective bimetallic standard, and the market ratio would have been stabilized at 16:1. Ultimately, however, gold would have been driven out by silver in the US money stock and, by 1903, the US would have been definitively on silver.

As long as bimetallism would have been in effect, the price level in the US would have been pegged to the price level in the gold bloc. The gold-bloc price level would have been more stable than it actually was, and our counterfactual price level for the gold bloc is very close to that of Friedman, until 1896. But, after the US is pushed off bimetallism, US prices rise dramatically, almost doubling over a decade, while prices in the gold bloc rise less

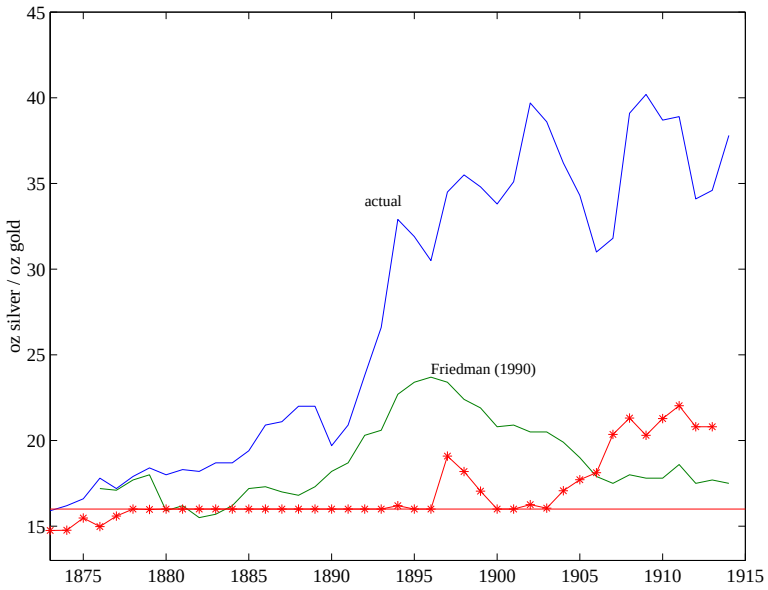

Figure 4: Gold-silver ratio, actual, in Friedman's counterfactual, and in our counterfactual (stars).

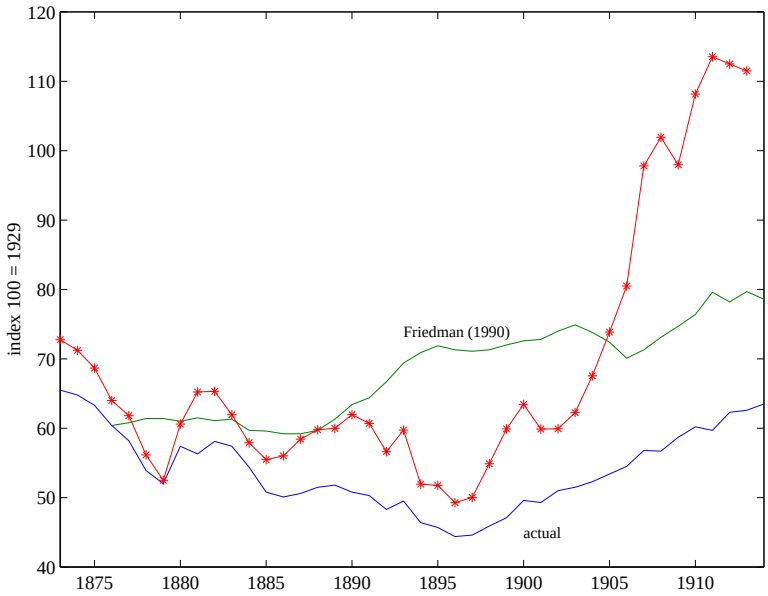

Figure 5: Price level in the US (silver bloc): actual, in Friedman's counterfactual, and in our counterfactual (stars).

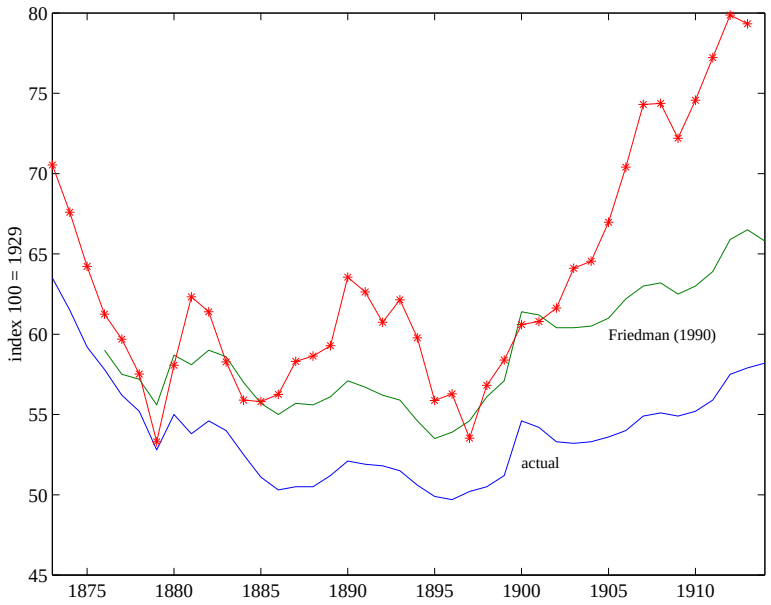

Figure 6: Price level in the UK (gold bloc): actual, in Friedman's counterfactual, and in our counterfactual (stars).

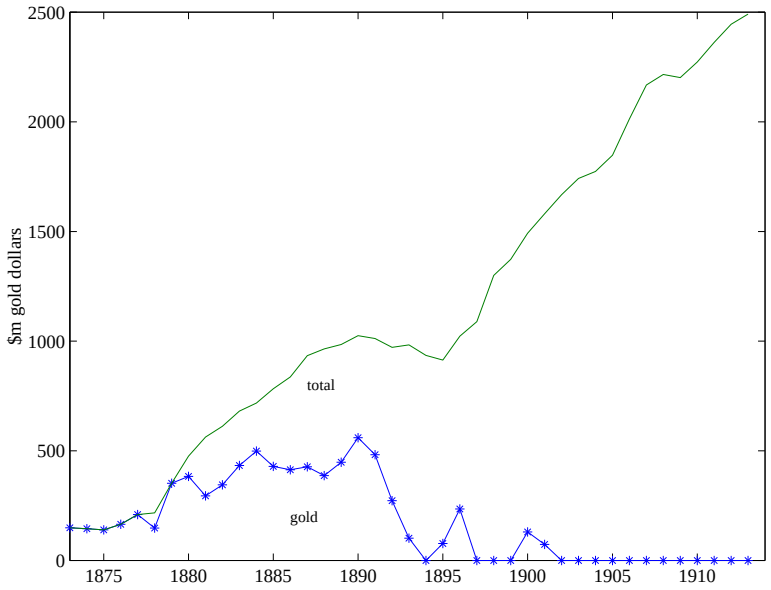

Figure 7: Counterfactual amount of US gold money stock, and total US money stock.

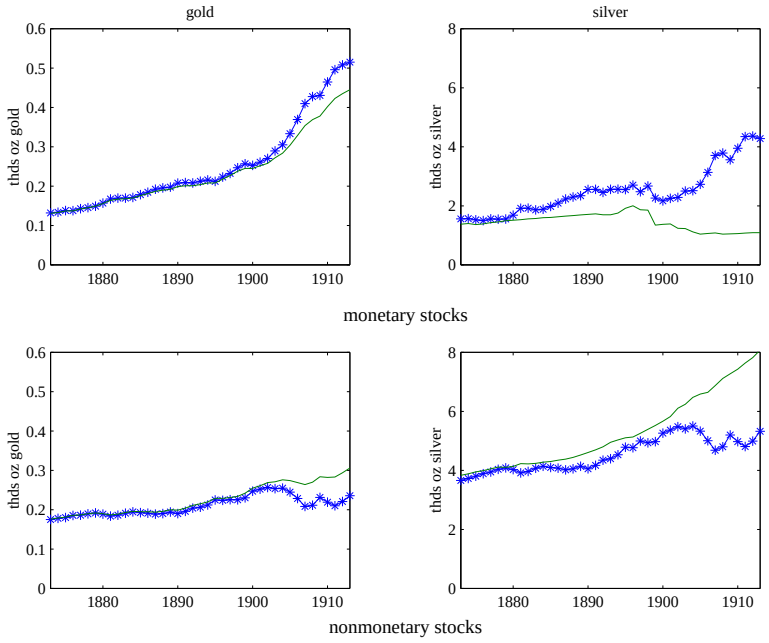

Figure 8: Counterfactual stocks of gold and silver.

strongly, but higher than in Friedman's calculation.

What explains the difference? Given the differences between the models and the data, it is difficult to say. I can only give an intuitive description of what happens in our counterfactual.

Consider first the question of the standard. In our counterfactual, the US goes from effective gold, to bimetallism, to effective silver. The pattern, and its causes, can be seen by computing the bounds on allowable bimetallic ratios imposed by the total stocks and by the size of the gold and silver blocs under the counterfactual. The result is shown in Figure 9.

The 16 ratio is above the bounds at first in the gold standard region, then within the bounds, then in the silver standard region. Two factors move around the bounds: the total stocks of each metal, and the monetary demands of the rest of the world, which in turn result from each country's choice of standard, and each country's share of world economic activity. As Figure 1 shows, silver became relatively scarce after 1896, which should have tended to push a bimetallic country toward the gold standard. Figure 9 shows that the US would have been pushed instead to the silver standard. This results from the fact that an increasing number of countries adopted the gold standard, and that the demand for money

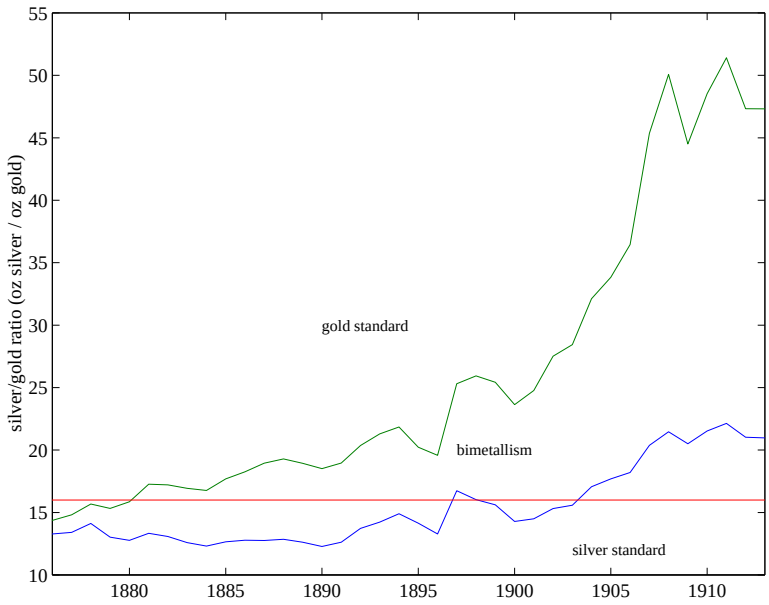

Figure 9: Upper and lower bounds on the legal ratios compatible with bimetallism, under the counterfactual.

from those countries grew very fast. In the counterfactual they need gold, and they take it from the US, which replaces it with silver, to the point where it has no gold left. The gold-silver ratio ceases to be pegged to 16, and silver now depreciates.

Once the US currency is effectively on a silver standard, the US price (silver price of goods) is the price level in the gold bloc (gold price of goods) times the gold-silver ratio. Moving the US from the gold bloc to the silver bloc decreases the overall demand for gold and increases that for silver; that has two effects, a cheapening of gold (rise in gold price of goods) and an appreciation of silver (fall in the gold-silver ratio), compared to what actually happened. These two effects work in opposite directions on the US price level. Whether the US price level would have been stable depends on how these two series move over time, and which effect dominates the other.

To understand a little better the potential effect on the gold-silver ratio, consider again Figure 1, which plots actual ratios of stocks of silver and gold. The bottom line is the ratio of worldwide supplies. It clearly falls after 1896, as gold becomes more abundant. The top line is the ratio of nonmonetary stocks, or jewelry. It moves in the opposite direction: more

silver is used in jewelry. If one forgets about monetary uses of the metals for a moment, this seems counter-intuitive: as gold becomes more abundant, it ought to be used more. But this is a period where monetary uses are changing considerably, both because more countries are abandoning silver and adopting gold, and also because gold-bloc countries are growing very rapidly. This frees up silver for jewelry, and also takes away gold from jewelry.

Moving the US from the gold to the silver bloc goes against this, by propping up the demand for silver and reducing the demand for gold. The quantitative question is whether this is enough to bring down the gold-silver ratio at a time when gold prices are going up.

After the abandonment of silver in India and much of Asia, further increases in silver supply were not absorbed by monetary stocks as previously. In our counterfactual, the United States is able to absorb much of what the former silver countries did not take up (Figure X). As a result, monetized silver forms 40% of the world stock of silver, as it did in 1873. Thus, moving the US from the gold to the silver bloc does reduce the nonmonetary uses of silver, but not enough to reverse the trend in relative prices, only to dim it.

Friedman finds a rise in the gold-silver ratio, but in the 1890s, when the gold bloc price level is at its lowest, the latter cancelling the former to a large extent. I find a rise in the gold-silver ratio of a similar extent (about 70%), but in the period after 1900. As it happens, it coincides with a 25% rise in prices in the gold bloc, larger than in Friedman's calculation. As Figure 8 shows, monetary gold is higher in the counterfactual in the 1900s (in spite of the US moving from the gold bloc), because I treat gold demand endogenously, and cheaper gold means the remaining countries need more of it to carry out their transactions. The effect turns out to be fairly large.

5.1 India's choice

Our counterfactual took as given what the rest of the world actually did, in terms of monetary systems. The year 1893 was particularly decisive. In that year, India, which had been on a silver standard, suspended free coinage of silver, effectively unpegging its currency, the rupee, from the falling price of silver. Within a few years, the government of India had established a variant of the gold standard, known as the gold exchange standard: the actual currency in India remained the silver rupee, but its value was pegged to gold, or more precisely to the British pound sterling, in the following way: the government bought and sold rupees in

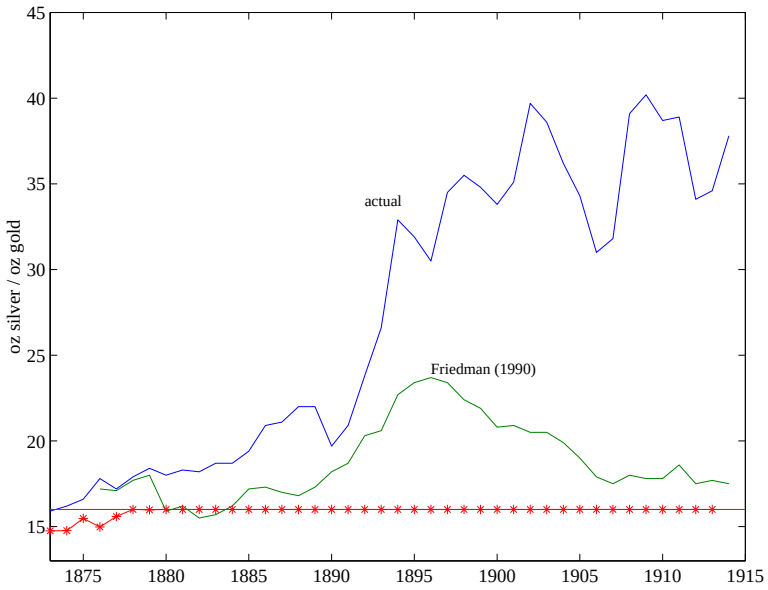

Figure 10: Gold-silver ratio, actual, in Friedman's counterfactual, and in our counterfactual (stars).

India at a fixed price in exchange for pounds sterling in London (see Keynes 1913). Similar systems were later used by other Asian countries when they switched from silver to gold, demonstrating that the medium of exchange and the price to which it was pegged were distinct issues.

The reason India abandoned silver was its falling price, which was generating inflation in India and making imports more expensive (the argument that Indian exports were thereby made more competitive did not appeal to the authorities, since profits returned to British investors were depreciating).

Clearly, under our counterfactual, such a fall in the price of silver does not happen. It is therefore logical to imagine that India would not have abandoned silver. By keeping India in the silver bloc, I can postpone the end of American bimetallism by a few years; the growing demand from the gold bloc remains overwhelming. However, two other countries made a switch to the gold standard at about the same time: Austria-Hungary in 1892, and Russia in 1897. With India, these countries account for 20% of world GDP in 1913, slightly more than the United States. It turns out that keeping them all in the silver bloc is enough to

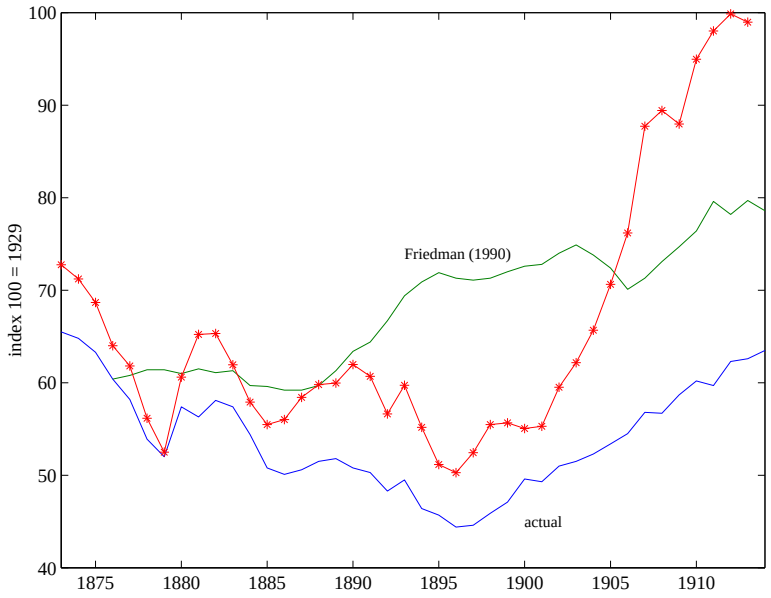

Figure 11: Price level in the US (silver bloc): actual, in Friedman's counterfactual, and in our counterfactual (stars).

save bimetallism until 1913, as indicated by the variant plotted in Figure 10. The gold-silver ratio remains almost constant at 16 throughout the period.

What happens to the US price level in this counterfactual? The result is shown in Figure 11. I see the same pattern until 1900, obviously; I still see a rise in prices afterwards, but more moderate.

6 Conclusion

The results of my counterfactual partly vindicate Friedman's exercise, and in some ways reinforce it. The US would have remained a bimetallic country for twenty years, and its price level (indeed, price levels around the world) would have been more stable. However, abandonment of silver by other countries would have ultimately forced the US off bimetallism and onto the silver standard, where it would have been alone with China. The sharp depreciation of silver in the early 20th century would have induced considerable inflation. In short, the stability of the price level in the 1870s and 1880s would have been paid with

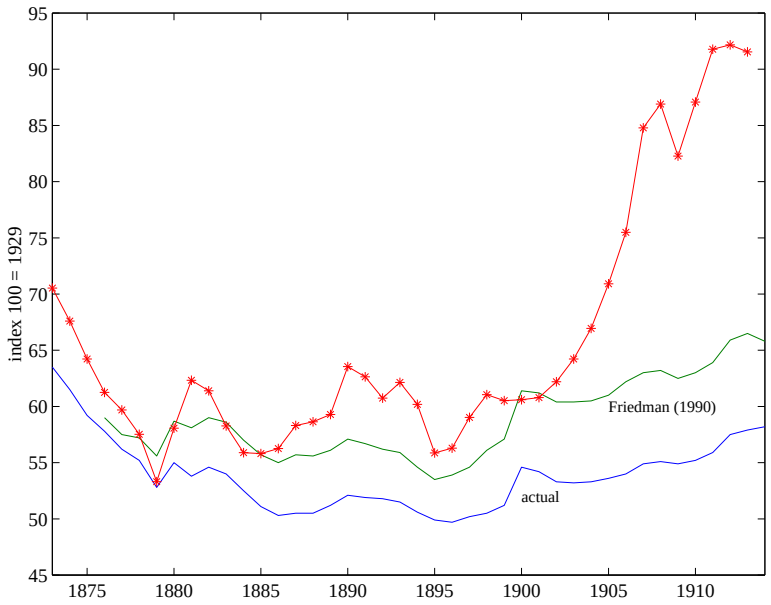

Figure 12: Price level in the UK (gold bloc): actual, in Friedman's counterfactual, and in our counterfactual (stars).

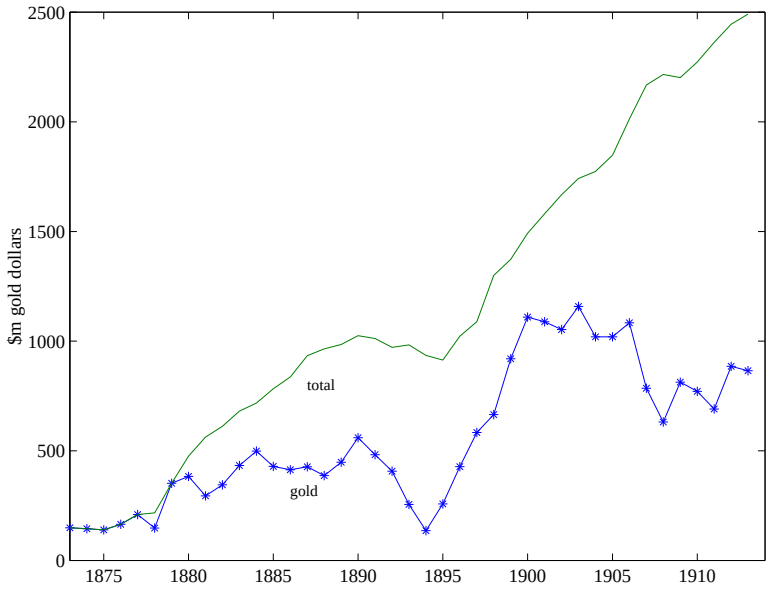

Figure 13: Counterfactual amount of US gold money stock, and total US money stock.

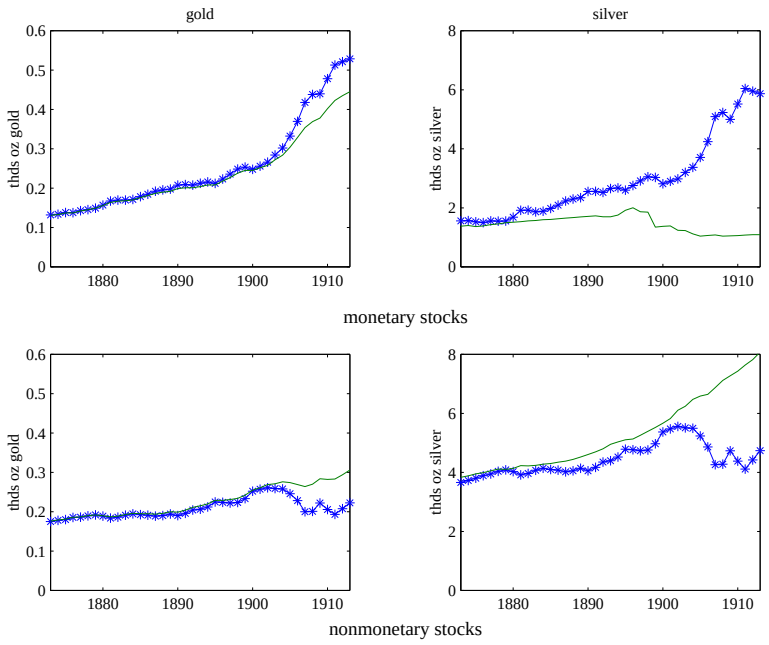

Figure 14: Counterfactual stocks of gold and silver.

higher inflation in the 1900s.

This result raised a question: Would it have made sense for other countries to have followed the policies they did follow, given that continued adherence to bimetallism by the US would have modified the outcome profoundly? Without modelling countries' policies it is difficult to answer that question, but a counterfactual exercise that prevents the big silver countries from adopting gold as they did in the 1890s saves bimetallism up to World War I.

7 Appendix 1

The *Annual Report of the Director of the Mint* published estimates of gold, silver and paper stocks of money for foreign countries, first in 1873, then from 1878 to 1883, and finally every year from 1892 (except 1908). Over time, the number of countries covered grew, and the estimates were progressively improved. The estimates are given in US dollars. The stocks of gold can be converted to troy ounces at \$20.69 per troy ounce. The stocks of silver can also be converted into weights using the legal ratio for silver currencies, which the *Reports* provide: when the ratio is N, then silver is being valued at \$20.69/N per troy ounce. The ratio might be different for large and small silver denominations, in which case one needs to know the proportions of each type of coin in the total stock.

For a dozen countries, I have replaced the estimates from the *Reports* with figures from more recent scholarship. In many cases only the total coin stock is reported by these more recent studies, in which case I used the proportion of gold and silver coins (and, when needed, the proportion of small and large denominations) of the *Reports*.

For the other countries, I have used the figures from the *Reports*. Gaps are interpolated linearly. When the estimates for a given country first appear later than 1873, I assume that the first reported value was also the true value from 1873.

China: The *Reports* rely on Haupt (1884) who guessed a silver money stock of £150m. I estimate the money stock in China based on a regression of total coin stocks on GDP. The GDP figures are those of Maddison (1995) adjusted for current borders. The estimated relation is:

$$\log(M) = \underset{(0.066587)}{1.0622 * \log(Y) +} \underset{(0.20835)}{1.1831} \tag{37}$$

$$\tag{38}$$

$$\tag{39}$$

The predicted values for China's money stock in 1870, 1900, and 1913 are then linearly interpolated.

France: gold and silver stocks to 1909 from Sicsic (1989) and Flandreau (1995). The gold amount is converted to dollars at \$0.193 per franc. The silver stock comprises 5F coins with 90% silver and subsidiary coinage with 83% silver; I use the US Mint reports's estimate of the share of 5F pieces in the total silver stock. After 1909 I assume that the silver stock

is constant and the gold stock grows at the same rate as the average of the US, UK, and Germany.

Germany: from 1876, Rolnick and Weber (1995) have separate gold and silver series, converted to dollars at $0.238 per Mark. Prior to 1876 they only have total coin. I estimate the stock of silver in 1873 using the fact that 7.474m lb of silver were withdrawn to 1880, at 90M per lb (Laughlin 1886, 141). Until 1900 the silver stock contained a mix of thalers and subsidiary silver; I use the US Mint reports' estimates of the shares of each.

India: Atkinson (1909), Keynes (1913). Silver circulation in rupees converted to dollars at market exchange rate, to ounces at R2.909 per oz.

Italy: total coin in Rolnick and Weber (1995) converted at $0.193 per Lira. I use the US Mint reports to estimate the share of gold and silver in the total coin stock.

Japan: total coin in Rolnick and Weber (1995) converted at $0.498 per yen. Silver amounts converted to weights at a 16.18 ratio until 1896, 32.36 in 1897–98, 28.75 after.

Netherlands: gold and silver stocks in Rolnick and Weber (1995), converted at $0.402 per gulden. Silver amounts converted to weights at a 15.5 ratio.

Portugal: gold and silver stocks in Rolnick and Weber (1995), converted at $1.08 per thousand Milreis. Silver amounts converted to weights at a 14.08 ratio.

Russia: 1873-84: stocks from the *Reports*, see also the *Report* of 1887, p. 316. Nominal values are converted to dollars at $0.772 per ruble. Silver amounts are converted to weights at 15.45 in 1885, 15.5 in 1892–97, 23.24 after.

Spain: gold and silver stocks in Rolnick and Weber (1995), converted at $0.193 per peseta. Silver amounts converted to weights at a 15.5 ratio.

United Kingdom: total coin in Rolnick and Weber converted to dollars at $4.866 per pound sterling. I then use the US Mint reports for the silver stock and assign the rest of total coin to gold. Silver amounts converted to weights at a 14.28 ratio.

United States: 1873–78, US Mint reports and interpolation; 1879–1913, Rolnick and Weber 1995. Silver amounts converted to weights at a 16 ratio.

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