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DID THE CLASSICAL GOLD STANDARD PROMOTE INFLATION CONVERGENCE?

Abstract

Adherence to the classical gold standard entailed nominal exchange rate rigidity between member countries. A failure of price levels to co-move between members would thus lead to real exchange rate misalignment, with potential trade imbalances and financial crises following. We examine inflation differentials between gold standard (and for comparison, non-gold standard) members. Results indicate generally less correlation of prices across countries than in subsequent Bretton Woods and floating regimes. Examination of inflation differentials indicates a general but not universal pattern of less persistence in these differences during the gold standard than in later monetary regimes. The lesser persistence in differentials, however, might not be attributable to gold adherence, as some of the pairs had a country rarely or never pegged to gold. In addition, previous research has found fewer nominal rigidities in the classical gold standard years, making for easier price adjustment. Finally, we use the sequential panel selection method (SPSM) with panel unit root tests over the gold standard. We find there is no pattern between gold adherence and the persistence of inflation differentials. Overall, results suggest little if any impact of gold adherence on inflation co-movement between countries.

Keywords: Inflation; Gold Standard; Exchange Rate Regimes
JEL Classifications: E30; F33; N00

Riassunto

Il sistema del gold standard ha favorito la convergenza dell'inflazione?

L'adesione al gold standard ha implicato la rigidità del cambio nominale tra i paesi membri. L'incapacità del livello dei prezzi di fluttuare armoniosamente all'interno dei paesi avrebbe pertanto indotto il disallineamento dei tassi di cambio, con conseguenti deficit commerciali e crisi finanziarie. Vengono esaminati i differenti livelli di inflazione tra i paesi appartenenti al gold standard (e per confronto con quelli di paesi non aderenti a questo sistema). In generale i risultati

indicano una minore correlazione tra i prezzi dei paesi membri del gold standard rispetto alla correlazione dei prezzi nel periodo del sistema di Bretton Woods o del regime di cambi fluttuanti. Queste stime indicano un modello generale ma non universale di minor persistenza di queste differenze durante il gold standard rispetto ai sistemi monetari successivi. Questa minor persistenza però potrebbe non essere attribuibile all'adesione al gold standard, in quanto, nel calcolo della correlazione, sono state considerate anche coppie di paesi in cui almeno un paese non era membro del gold standard. Inoltre, la ricerca precedente aveva evidenziato la presenza di minori rigidità nominali nel periodo del gold standard, rendendo più semplice l'aggiustamento dei prezzi. Infine, viene utilizzato il metodo sequenziale panel selection (SPSM) con test a radice unitaria per il periodo del gold standard. Non è stata trovata una relazione tra l'adesione al sistema gold standard e il persistere di differenziali di inflazione. In generale, questi risultati suggeriscono che aderire al gold standard, qualora influenzasse i movimenti dell'inflazione tra i paesi, lo farebbe in maniera irrilevante.

1. Introduction

The classical gold standard, lasting from 1870 to 1914 for some nations, greatly restricted nominal exchange rate movement. If prices and the (nearly fixed) nominal exchange rate do not adjust to create a real exchange rate reflecting purchasing power parity (PPP), this will produce an arbitrage opportunity to investors which would in principle push prices toward purchasing power parity. This arbitrage activity did entail some transactions costs, and thus the nominal exchange rate did vary within narrow "gold points" (Flandreau and Maurel, 2005). Thus the classical gold standard functioned more like a target zone than an absolutely fixed exchange rate regime such as a currency union. Nonetheless, the extent of nominal exchange rate movement was narrow (see Officer, 1996, for a discussion of the evolution of gold points) and adherence to the gold standard meant only miniscule room for the nominal exchange rate to eliminate deviations from PPP. Thus co-movement of inflation was necessary to avoid real exchange rate misalignment.

A rigid exchange rate system like the gold standard could have a disinflationary effect although the magnitude of such an effect is an open question (see Chiu *et al.*, 2012). Indeed, the high prices and exchange rate instability following the collapse of the international gold standard motivated governments, especially that of Great Britain, to try to restore gold convertibility after the first World War. This issue was pressed at the Genova Conference of 1922 which set up the gold exchange standard of 1925-1931, although this standard would eventually come apart during the Great Depression (see Pittaluga (2023) for a discussion on how the lack of cooperation among central banks damaged the viability of the gold exchange rate standard). And low, and particularly convergent inflation rates between member countries is helpful in avoiding real exchange rate misalignment and balance of payments crises that threaten the viability of a fixed exchange rate system. Thus the issue of whether a fixed exchange rate regime experiences inflation convergence among its members has been the topic of studies on modern pegged monetary arrangements such as the potential East African Community currency union (Dridi and Nguyen, 2019) and the eurozone (Busetti *et al.*, 2007, among other papers).

There have been previous papers on inflation and the classical gold standard (Bordo, 1993; Miles, 2015). These papers did not focus, however, on inflation differentials between member countries, nor between member and non-member countries for comparison. We thus examine inflation convergence for a sample of countries which includes both nations faithful to their gold peg, and others which were rarely or never on the gold standard. We obtain data from the Jordi-Schularick-Taylor microhistory database on inflation for a sample running from 1870 to 2020. We first examine the simple rolling correlations of inflation over different years, and compare average correlations over the classical gold standard, Bretton Woods and recent floating exchange rate regimes.

We next gauge the persistence of inflation differentials. If there is a shock to the difference in inflation rates between countries, and this shock is slow to dissipate, it will lead to changes in the real exchange rate if the nominal exchange rate is (essentially) fixed, as in the gold standard. We will again compare findings for this persistence over the gold standard to those in later monetary regimes.

Finally, we study the stationarity of inflation differentials. Univariate unit root tests will have low power with the limited number of observations over any monetary regime. We thus employ the cross-sectionally augmented Im, Pesaran and Shin (CIPS) panel unit root test. We distinguish which particular differences are stationary, or most persistent, with the sequential panel selection method (SPSM).

To anticipate our results, we find inflation co-movement was for the most part lower in the gold standard years than in later regimes. We find that in most cases inflation differentials did exhibit less persistence during the gold standard than in later years. However, while this result may at first glance appear to indicate greater price cohesion under gold, many of the differentials exhibiting this pattern involved countries that were rarely if ever pegged to gold. In addition, previous research has revealed the 1870-1914 years entailed fewer nominal rigidities than later periods. This, and not the gold standard may have led to faster price adjustment.

Lastly, the SPSM analysis indicates that a number of differentials involving countries with little if any commitment to gold had more of a clear tendency to stationarity in inflation differentials than some nations firmly committed to the metallic standard. Overall results thus indicate that gold did not have a strong effect in promoting inflation convergence across member nations.

This paper proceeds as follows. The next section describes the previous literature. The third describes our data and methodology. The fourth section details our results, and the fifth concludes.

2. Previous literature

The classical gold standard required, if not completely fixed nominal exchange rates, little movement in this metric for member countries. Co-movement of inflation is necessary, when the nominal exchange rate is stable to avoid real exchange rate misalignment. This assumes productivity and consumer preferences are stable between countries (the Balassa-Samuelson effect indicates that high productivity growth in a country leads to real exchange rate appreciation, all else constant, and an increase in consumer preferences for foreign goods can lead to real depreciation).

In terms of the "impossible trinity", the gold standard usually entailed an openness to international investment, exchange rate rigidity, and hence a lack of monetary policy independence (Jordà *et al.*, 2020). Bordo and James (2015) discuss the trilemma in the context of the gold standard. Bazot *et al.* (2022) note that some countries on the periphery of the gold standard employed capital controls to limit gold convertibility. Still, whatever the deviations from perfect capital mobility or nominal exchange rate inflexibility, being on the classical gold standard meant a near fixed nominal peg. This had a number of possible implications for macroeconomic outcomes, such as the cost of capital for member versus non-member countries (see Pittaluga and Seghezza (2021) and their chapter on the gold standard for a comprehensive discussion of the motives for joining and macroeconomic consequences of this monetary regime). As with any other such policy regime, convergence of price levels across countries was necessary to avoid real exchange rate misalignment and subsequent macroeconomic imbalances. The convergence of prices is important for the sustainability of the peg.

Dridi and Nguyen (2019) examine the suitability of Burundi, Kenya, Rwanda, Tanzania and Uganda for a common currency in the East African Community (EAC). To that end, the authors examine the persistence and stationarity of inflation differentials among the five countries (see Lare-Lantone and Anaruo (2022) for a discussion of the West African currency union). Busetti *et al.* (2007) investigate inflation convergence for euro countries. Like Dridi and Nguyen, Busetti *et al.* (2007) examine the stationarity of inflation differentials. These authors find evidence that inflation appeared to be convergent before the euro was adopted but has started to diverge for some country pairs since the euro came into being.

Bordo (1993) studied inflation (but not inflation differentials between countries) for the G-7 countries (Canada, France, Germany, Italy, Japan, UK, US) during the 1881-1913 gold standard period, as well as the subsequent Bretton Woods and floating regimes. All of these nations pegged to gold for the 1881-1913 years the author examines. Bordo finds that inflation in these seven nations was lower during the classical gold standard than subsequently, and lower under Bretton Woods than the post-1971 floating regime. He states:

"the evidence based on country and period averages of very low inflation in the gold standard period and of a lower inflation rate during Bretton Woods than the subsequent floating period is consistent with the traditional view on price behavior under fixed (commodity-based) and flexible exchange rates" (p. 127).

Bordo goes on estimating the persistence of inflation in each country over the different monetary regimes with autoregressive (AR(1)) models. He finds that the gold standard witnessed the smallest level of persistence compared to the interwar, Bretton Woods and floating eras for Canada, France, Japan, UK and US. For Germany and Italy the smallest coefficients are observed during Bretton Woods. Low AR coefficients suggest relatively fast adjustment to an inflation shock. Similarly, Bordo *et al.* (2010) state:

"under the gold standard the price level tended to be mean-reverting, reflecting the operation of market forces according to the classical commodity theory of money" (p. 516).

Somewhat in contrast to these findings for the United Kingdom, Caporale and Gil-Alana (2020) examine persistence in UK inflation over a very long time span (1210-2016) using fractional integration methods. The authors do find that persistence in UK inflation seems to have increased since the end of World War I, which may support the idea that gold provided (or was at least coincident with) greater adjustment to price shocks. They also find, however, in contrast to Bordo's results, that

"on the whole, monetary and exchange rate regimes do not appear to have had a significant impact on the stochastic behavior of inflation if one takes a long-run historical perspective" (p. 162).

Other studies which did not examine the classical gold standard did compare inflation over Bretton Woods and the later flexible exchange rate era. Darby and Lothian (1989) found the cross-sectional standard deviation for inflation across twenty OECD countries lower during Bretton Woods than in later years. Similarly, Bayoumi and Eichengreen (1994) found that the standard deviation of inflation in the floating regime was higher than during Bretton Woods.

Despite the theory and these findings on the performance of the gold standard and other fixed exchange rate regimes, there are reasons to question whether such monetary rules actually lower inflation. First, membership in a fixed exchange regime has been shown to increase borrowing – capital flows (Eichengreen and Hausmann, 1999). It is not clear why this should be the case. Gupta *et al.* (2015) point out:

"Arguably a monetary union facilitates capital flows between member countries during booms and hence the build-up of imbalances" (p. 3126).

Thus capital can flow from some countries – say the UK in the classical gold standard, into others. This would raise inflation in the recipient country while slightly lowering it in the surplus nation (this phenomenon certainly occurred in the euro zone, as investment went from Germany into nations such as Ireland and Spain, leading to real exchange rate misalignment and eventual crises).

In addition factors besides policy can affect inflation. Cicarelli and Mojon (2010) study inflation for twenty-two OECD countries over 1960-2008. This period spans different policy regimes (Bretton Woods and floating exchange rates) and many different levels of commitment to price stability among the different nations over nearly sixty years. Despite these different policy approaches, the authors find seventy percent of the variation in inflation for these different nations is explained by a global common factor.

Miles (2015) examines co-movement for price levels over the classical gold standard using methods developed by Mink *et al.* (2012). In particular, the author employs a decomposition to accurately isolate cyclical co-movement. Results indicate that adherence to the gold standard did not lead to greater price co-movement.

While the previous papers have yielded information on price co-movement over the gold standard, they did not directly examine the properties of inflation *differentials*. Studies of inflation co-movement in currency unions typically examine the topic with the convergence, or lack thereof, of inflation differentials. Busetti *et al.* (2007), Dridi and Nguyen (2019), as discussed, are two prominent examples. We will accordingly study whether the gold standard had "convergent" effects on the inflation differences of eight nations.

3. Data and methodology

We obtain data on national price levels from the Jordà-Schularick-Taylor database (https://www.macrohistory.net/database/). The data is annual and runs from 1870 to 2020. We choose eight countries for our sample – Canada, France, Germany, Italy, Japan, Spain, UK and US. Seven of these nations – all but Spain – are the same G-7 countries examined in Bordo (1993). We also choose Spain for our sample for comparison purposes, as Spain was never on the gold standard. Thus in our sample, Canada, France, Germany and the UK all maintained their pegs to gold over the entire 1870-1913 years. The US was on gold from 1879 to 1914. Japan only began adhering to gold in 1897. Italy tied itself to gold for only ten years, from 1884-1894. Having some nations that did not adhere closely to gold will help us get a clearer picture of the role the gold peg played in inflation convergence than would be the case if we simply examined inflation differentials for a set of countries that were faithfully on gold. We note that some of these countries, such as the UK, were in the Single European Market for most of the floating period of the sample, and that others (France, Germany, Italy and Spain), are both in the Single European Market and members of the euro common currency, a point we will return to when discussing our results.

We obtain price level data from the Jordà-Schularick-Taylor database and calculate inflation as the year-on-year percentage change. We then estimate the five-year rolling correlation for inflation rates for the eight countries. Next, we examine the averages of the rolling correlations over the entire 1875-2020 sample (we start in 1875 for this exercise as we are employing five-year moving averages). Then, to compare this metric across regimes, we then examine the average rolling correlations during the 1875-1913 gold standard years, the 1946-1970 Bretton Woods period, and the 1974-2020 floating regime. We will then examine which regimes exhibit the most and least correlation. We do not examine the interwar period, as it has the shortest span of any regime and there were varied monetary policies – UK famously re-pegged the pound to gold at a parity that hurt trade competitiveness, and other nations exhibited different levels of commitment to gold.

We next gauge the persistence of shocks to inflation differentials among the eight countries. While Caporale and Gil-Alana (2020) estimated the fractional integration parameter for the level of inflation over a millennium, our sub-samples are too short to allow for efficient estimation of this coefficient. We thus estimate the autoregressive coefficient over the entire sample and through each of the aforementioned monetary regimes. Bordo (1993) also estimated AR models over the gold standard and other monetary arrangements. However, Bordo examined the persistence of inflation in each country. In contrast, we will examine AR models for inflation differentials between the eight countries. If the gold standard had the effect of keeping price levels from moving apart, more so than a policy of flexible exchange rates, one might expect a lower AR coefficient during gold compared to that with floating exchange rates.

We next turn to testing for the stationarity of the inflation differentials. Given the relatively short span of data for some subsamples, we follow Busetti *et al.* (2007) and Dridi and Nguyen (2019) and employ panel unit root tests. We use the cross-sectionally augmented Im, Pesaran and Shin test. An advantage of panel unit root tests is the increased power that comes from having more than one cross-sectional unit (in our case there are twenty-eight inflation differentials). Using univariate unit root tests on each differential would likely entail very low power for the testing procedure.

However, a disadvantage of panel unit root tests is that rejecting the null hypothesis that all series are non-stationary does not generally tell us which series have unit roots and which do not. The alternative hypothesis is that at least one of the series in the panel is stationary, with no indication of which or how many series are stationary. We thus apply a method developed by Chortareas and Kapetanios (2009) who were testing the validity of purchasing power parity. These authors developed a technique called the sequential panel selection method (SPSM). As these authors explain, a univariate unit root test will often lack power. A panel unit root test will have more power, but there is a problem making inference on which series in the panel are stationary or have unit roots. The cross-sectionally augmented Im, Pesaran and Shin (CIPS) test, for instance, posits as the null hypothesis that all series in the panel have unit roots, while the alternative hypothesis states that at least one of the series is stationary. There is, however, no way to know, by conducting just one such test, which or how many series in the panel are stationary or non-stationary if one rejects the null hypothesis.

Chortereas and Kapetanios (2009) propose a method to use the power of a panel test but still be able to discern which individual series have and lack unit roots. The method entails first testing for a unit root with all of the series in the sample using the CIPS test. If the null of a unit root is not rejected at this stage, we conclude all series are I(1) and cease testing. If the null is rejected, one examines the individual cross-sectionally augmented ADF (CADF) test statistics and removes the series with the lowest (usually most negative) from the sample. In this way, the series that appeared most likely stationary, or least persistent, is removed. The CIPS test is then re-applied to the remaining sample, and if the null is not rejected, one concludes that the remaining series are non-stationary. However, if the null is rejected at this stage, the series with the lowest CADF in the remaining sample is removed. The process is repeated until either the null is not rejected or is not rejected for the last two series. In this way, the series – in our case inflation differentials – can be examined to see which inflation differentials are stationary, with the benefit of a more powerful test than univariate methods. And we can order and detect which differentials had the most and least persistence by ordering the CADF test statistics and see if there was some relationship between this persistence and adherence to gold.

4. Results

Table 1 contains the rolling correlation output. To reiterate, five-year rolling correlations were calculated for the twenty-eight inflation differentials over the whole 1870-2020 sample, and over the gold standard (1875-1913), Bretton Woods (1946-1970) and floating (1974-2020) subsamples. The last column of the table, labeled “ordering”, shows the policy regimes under which there were the highest and lowest average rolling correlations. So for the Canada/France pair the rolling correlations are on average higher in the floating years than during Bretton Woods and higher under Bretton Woods than during the classical gold standard.

These results provide little support for the idea that fixed exchange rates either on the classical or Bretton Woods gold standards, led to greater price co-movement. In twenty of twenty-eight cases, the floating regime of 1974-2020 exhibited greater correlation than occurred in the 1875-1913 gold standard or the 1946-1970 Bretton Woods regime. In thirteen cases, the rolling correlations are higher under flexible exchange rates than during Bretton Woods, and higher under Bretton Woods than under classical gold. These pairs are Canada/France, Canada/Spain, France/Germany, France/Japan, France/Spain, France/UK, France/US, Germany/Italy, Germany/Japan, Germany/Spain, Germany/US, Japan/UK and US/Spain. Of these thirteen pairs, seven involved countries whose currencies were not always tied to gold over 1875-1913. Italy, for example, was on gold only from 1884-1894, Japan started pegging only in 1897, and Spain never pegged to gold. On the other hand, six of these pairs were between countries that were highly faithful to gold.

We note that in four of these thirteen cases (the France/Germany, France/Spain, Germany/Italy and Germany/Spain pairs), both countries in the pair were in the euro zone or its predecessor, the exchange rate mechanism (ERM) during much of the floating sample period. This fixed exchange rate and common currency for part, although not all of the sample could help explain the closer co-movement of these pairs relative to that under gold. However, even if the euro helped lead to greater inflation co-movement among these members, it is another indication that gold was not a force for converging price levels relative to other monetary regimes.

For ten pairs, correlations were higher under floating exchange rates than under the classical gold standard, and higher under gold than under Bretton Woods. These pairs are Canada/Italy, Canada/Japan, France/Italy, Italy/Japan, Italy/Spain, Italy/UK, Italy/US, UK/Spain, UK/US. While results for these ten pairs do not provide support for the power of a fixed exchange rate regime (Bretton Woods) to lead to convergent prices, there is at best limited inference we can draw for the impact of gold. This is owing to the fact that only one pair (UK/US) contained two countries pegged on gold for the majority of the sample.

In three cases (Canada/Germany, Canada/US and Germany/UK) correlation is higher under Bretton Woods than under floating exchange rates, and higher under floating exchange rates than during the classical gold standard. These pairs do exhibit evidence against the convergent power of gold, as all were faithful to their gold peg but exhibit the least co-movement over 1875-1913.

There is one pair – Canada/UK – that does stand as a single counterpoint to most results on rolling correlation. For this pair, both pegged to gold for all years in which the regime existed, the average correlation was highest under classical gold and lowest in the more recent flexible exchange rate years. However, Japan and Spain have their highest correlation on gold, and neither was faithful to the peg. Indeed, Spain never pegged to gold at all. These rolling correlation results indicate that tying the national currency to gold did not have an impact on inflation convergence.

We next turn to examining the persistence of shocks to inflation differentials. If a fixed exchange rate system such as gold limits inflation rates from diverging among members, we should expect less persistence in inflation differences between them. Table 2 displays the results for the AR coefficients estimated for the whole sample, the classical gold standard (1870-1913), the Bretton Woods years (1946-1970) and under flexible exchange rates (1974-2020).

In the majority of cases (fifteen of twenty-eight) the AR coefficient is the smallest during gold, higher under Bretton Woods and highest under floating exchange rates. This result would appear to indicate the gold standard played a better role in lowering inflation differences than subsequent monetary arrangements. A closer inspection, however, shows the evidence is not so clear-cut. Of the fifteen pairs in this group, seven (Canada/Germany, Canada/UK, Canada/US, France/Germany, France/US, Germany/UK and UK/US) were steadily pegged to gold for most of the sample. However, eight of these pairs (Canada/Italy, Canada/Spain, France/Spain, Germany/Italy, Italy/UK, Italy/Spain, UK/Spain and US/Spain) had at least one country not on gold for the majority of the sample. Thus it is not clear that gold is responsible for quick adjustment, even during the gold standard years. In addition, prices may well have been more flexible and faster to adjust during the gold standard years than after World War I, which may have led to less persistence in inflation differentials. Bayoumi and Eichengreen (1996) and Chernyshoff *et al.* (2009) both present results suggesting that prices were indeed more flexible and less subject to rigidities in the gold standard than later. This helps explain the relative longevity of the gold standard and the difficulties of maintaining gold pegs in the interwar years.

There are ten differentials for which the AR coefficient under floating was greater than that under gold, which was higher than that during Bretton Woods (Canada/Japan, France/Italy, France/Japan, Germany/Japan, Germany/Spain, Germany/US, Italy/Japan, Italy/US, Japan/Spain, Japan/US). This again may seem to provide at least some support for the idea that fixed exchange rates create faster adjustment to shocks (we note that two of these ten pairs- France/Italy and Germany/Spain – were in the euro zone for part of the floating years, which might make it hard to draw conclusions regarding exchange rate rigidity and persistence of differentials. However, the analysis of structural breaks, to be discussed below, indicates no role for the euro in affecting inflation differential persistence). While other studies have also compared inflation metrics over classical gold, Bretton Woods and floating periods, the comparisons are not apples-to-apples. Exchange rates were rigid under both classical gold and Bretton Woods, but the former was a period of relatively free capital flows, while the latter had strong restrictions on capital mobility. And of course the floating regime had high capital mobility and flexible exchange rates. So it is not clear that exchange rate policies, as opposed to other factors such as capital mobility or price flexibility deserve credit for faster adjustment.

We have purposely split the sample at different points that correspond to different monetary policies, just as was done in previous studies on the gold standard. However, splitting the sample like this runs afoul of the "endogenous break" problem highlighted by Hansen (1992). We thus estimate these models over the entire sample, and test for endogenous breaks using the Bai-Perron method. We allow for up to two breaks for each inflation differential. The dates on which significant breaks were found are listed on the right-most column of Table 2. For the fifteen pairs that exhibited greater persistence under floating exchange rates than Bretton Woods, and the least under gold, ten have significant breaks in the 1920s, just after the gold standard and World War I. Although, as noted, we do not estimate persistence over the interwar period, since the AR coefficients rose over Bretton Woods, and later flexible exchange rates, these 1920s breaks represent an increase in the persistence of inflation differentials. Moreover these breaks represent the beginning of the interwar years and their associated turbulence for currency markets. Four of ten breaks are pairs with Germany, which experienced hyperinflation that did not end until 1924.

While overall it may seem that gold was associated with less persistence, of the ten pairs in this group with breaks (Canada/Germany, Canada/Spain, France/Germany, France/US, Germany/Italy, Germany/UK, Italy/Spain, Italy/UK, UK/Spain, US/Spain) six were not pegged to gold for most of the sample, so the role of gold in maintaining fast adjustment is not clear. In addition, four of these fifteen pairs (France/Spain, France/US, Italy/Spain, Italy/US) have breaks in 1945 or 1949, at the beginning of Bretton Woods.

For the ten pairs where the AR coefficients were highest on floating exchange rates, smaller on gold and smallest during Bretton Woods, nine of the ten (Canada/Japan, France/Italy, Germany/Japan, Germany/US, Germany/Spain, Italy/Japan, Italy/US, Japan/US and Japan/Spain) also have breaks in the 1920s, in all cases in 1923 or 1924. Three of these pairs are with Germany, and again the 1920s were the beginning of highly varied monetary regimes across formerly gold-pegged nations. Six of these ten (Canada/Japan, France/Italy, Italy/Japan, Italy/US, Japan/Spain, Japan/US) also had breaks in 1945 or 1946, the beginning of the Bretton Woods regime. These breaks may signal a decrease in persistence. Note that for these six pairs, all involve at least one nation at most sporadically on gold. The Bretton Woods system more firmly limited nominal exchange rate movements, and this may have had a greater impact on price adjustment.

Also, as noted, the euro common currency may in principle have had an impact on the persistence of inflation differentials. However, none of the breaks occur during the euro, or at any time of major changes even in the exchange rate mechanism which led to the euro. Thus it seems unlikely that the common currency had an impact on the persistence of inflation differentials. This finding is not inconsistent with that of Busetti *et al.* (2007) who found that the levels of inflation differentials if anything actually rose subsequent to the introduction of the common currency.

We next turn to the panel unit root tests in Table 3. Panel unit root tests were employed in Busetti *et al.* (2007) and Dridi and Nguyen (2019) to examine inflation convergence in the euro and potential East African currency union, respectively. We will employ panel unit root tests to the gold standard years. Given that Chortareas and Kapetanios (2009), whose SPSM method we will apply here, used the CIPS test, we will do so here as well. The CIPS test itself, applied to the twenty-eight inflation differentials, has greater power than univariate unit root tests, but only indicates whether all series have unit roots (the null hypothesis) or that at least one series is stationary (the alternative). If the null is rejected, we have, on the basis of this one test, no indication of which or how many differentials are stationary. However, with the SPSM method, we first test all twenty-eight differentials for a unit root under the gold standard. The null is rejected, so at least one differential is stationary. We then remove the differential with the lowest CADF test statistic, and re-run the test with the remaining differentials (the differential with the lowest CADF is thus the "most" stationary and least persistent). If we reject the null of a unit root with this test, we then repeat the process, removing the differential with the lowest CADF, and so on. We will order the differentials from lowest, or least persistent, to highest and most persistent. Indeed, we can reject the null for any sub-sample. This result does make intuitive sense. Inflation is usually stationary, so the difference of two inflation rates is also likely stationary. However, we will still observe the CADF statistics and which of them appear least persistent.

As displayed in Table 3, the pattern with the CADF stats does not indicate a role for gold in promoting or inhibiting inflation convergence. Some differentials between nations with a firm commitment to gold do rank high in terms of having low CADF test statistics. For instance, Canada/Germany has the lowest CADF using the SPSM method, and the differentials for France/US, Canada/France, Canada/US, and France/UK are ranked sixth, seventh, ninth and tenth, respectively. On the other hand, there are pairs between Germany and Italy (eleventh), Japan and Spain (twelfth), Italy and Spain (thirteenth), and Canada and Italy (fourteenth) which have at least one country not firmly committed to gold in the pair, and which have lower CADF statistics than country pairs faithful to gold such as France/Germany, France/US, Germany/US and US/UK.

The least persistent pairs by the size of the CADF stats are France/Italy and Italy/UK, and of course Italy was only briefly pegged to gold. But again, there is simply no clear pattern in terms of showing gold helped or hindered convergence, and there are numerous pairs that were at most loosely tied to gold that show less persistence than some where there was a clear, lasting commitment to the metallic peg.

5. Conclusion

The gold standard was certainly a distinct policy compared to later Bretton Woods and floating monetary regimes. As such, some have credited certain macroeconomic attributes and outcomes to gold. Bordo and Rockoff (1996), for example, credit pegging to gold with lower borrowing costs. Later research, however, such as Ferguson and Schularick (2006) found that there was no such impact on the cost of capital. See also Gnagne and Bonga-Bonga (2020) for a discussion of exchange rate volatility on financial markets.

Some other authors, drawing on the literature on exchange regimes and trade (see Frankel and Rose, 2002; Wolf and Ritschl, 2011 and Upadhyaya *et al.*, 2020) claim that adherence to gold may have had a palpable impact on increasing trade between members. Lopez-Cordoba and Meissner (2003) for instance find that adopting gold had a sizeable impact on trade flows. On the other hand, Flandreau and Maurel (2005) present results indicating the impact was more modest.

We find that, despite potential *a priori* expectations regarding the impact of a monetary regime like the gold standard, which greatly limits nominal exchange rate movement, there is little evidence that inflation convergence was aided by gold. This lack of a clear impact could have lessons for countries contemplating fixed exchange rate regimes today, such as eastern European nations deciding whether to adopt the euro. If fixing the exchange rate leads to little inflation convergence, there will be real exchange rate appreciation for countries that enter such an arrangement with higher inflation than other members. This could lead to indebtedness and crises.

Busetti *et al.* (2007) find that the run-up to the euro, through the exchange rate mechanism (ERM) was associated with inflation convergence among future euro countries, but there was inflation divergence among these countries once the euro was in place. And of course there were crises in Ireland and Spain, which experienced capital inflows and real exchange rate appreciation after joining the euro. Thus the inability of rigid exchange rates to palpably lower inflation should be taken as a potential warning regarding future fixed exchange rate regimes. Also note that exiting from a common currency such as the euro could be more costly than ending a gold peg. See Acocella (2022) for a discussion of the costs and benefits of exiting the euro.

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TABLE 1 – *Correlation Results*

Pair	1875-2020	Gold	Bretton	Floating	Ordering
Canada/France	0.433247	0.120407	0.470658	0.622519	FL>Bret>Gold
Canada/Germany	0.323429	0.112569	0.463854	0.383606	Bret>FL>Gold
Canada/Italy	0.348685	0.231864	-0.021156	0.583791	FL>Gold>Bret
Canada/Japan	0.179448	0.145337	0.01978	0.25757	FL>Gold>Bret
Canada/Spain	0.339733	0.221579	0.349309	0.374609	FL>Bret>Gold
Canada/UK	0.468311	0.447069	0.393603	0.377358	Gold>Bret>FL
Canada/US	0.671237	0.497408	0.827681	0.657335	Bret>FL>Gold
France/Germany	0.351416	0.139293	0.346092	0.57021	FL>Bret>Gold
France/Italy	0.44435	0.221154	0.085334	0.81964	FL>Gold>Bret
France/Japan	0.163473	-0.187848	0.211815	0.396808	FL>Bret>Gold
France/Spain	0.220969	-0.169655	0.296717	0.476281	FL>Bret>Gold
France/UK	0.353819	0.120845	0.231026	0.562652	FL>Bret>Gold
France/US	0.220969	0.070299	0.438689	0.66471	FL>Bret>Gold
Germany/Italy	0.326726	0.21531	0.329071	0.475224	FL>Bret>Gold
Germany/Japan	0.207452	0.007839	0.293331	0.39588	FL>Bret>Gold
Germany/Spain	0.332051	0.199861	0.344512	0.429912	FL>Bret>Gold
Germany/UK	0.478557	0.428037	0.562371	0.506907	Bret>FL>Gold
Germany/US	0.362468	0.094578	0.333844	0.565937	FL>Bret>Gold
Italy/Japan	0.315032	0.324159	0.256046	0.363882	FL>Gold>Bret
Italy/Spain	0.45104	0.478583	0.243283	0.615656	FL>Gold>Bret
Italy/UK	0.432283	0.256363	0.124527	0.599127	FL>Gold>Bret
Italy/US	0.343374	0.289952	-0.01056	0.526615	FL>Gold>Bret
Japan/Spain	0.215723	0.289594	0.014161	0.190428	Gold>FL>Bret
Japan/UK	0.292648	0.036743	0.078535	0.530426	FL>Bret>Gold
Japan/US	0.240256	0.117453	0.094615	0.403389	FL>Gold>Bret
Spain/UK	0.457103	0.458876	0.077398	0.467401	FL>Gold>Bret
Spain/US	0.37172	0.266796	0.344209	0.493155	FL>Bret>Gold
UK/US	0.483341	0.42604	0.409405	0.527189	FL>Gold>Bret

The first column displays the country pairs; the second shows the average of the five-year rolling correlation over the entire sample. The third displays the average rolling correlation over the 1870-1913 gold standard years. The fourth is the average of the rolling correlation in the 1946-1970 Bretton Woods sub-sample, and the fifth shows the average correlation in the 1974-2017 floating exchange rate regime. FL denotes the floating rate period of 1974-2017, Bret the Bretton Woods regime of 1946-1970 and Gold the Classical Gold standard of 1870-1913. Thus an ordering of FL>Bret>Gold indicates that correlation was on average higher in the floating years than during Bretton Woods, and was higher during Bretton Woods than during the gold standard.

TABLE 2 – *AR Coefficients*

Pair	1875-1920	Gold	Bretton	Floating	Breaks
Canada/France	0.713485	0.0006	0.762119	0.5777	1918, 1949
P-value	0.000	0.996	0.000	0.000	
Canada/Germany	-0.006757	-0.1322119	0.049578	0.796722	1924
P-Value	0.9348	0.4058	0.8107	0.000	
Canada/Italy	0.413296	0.065009	0.115835	0.765089	1985
P-Value	0.000	0.6837	0.2771	0.000	
Canada/Japan	0.131161	0.317894	0.095296	0.530945	1924, 1946
P-Value	0.1107	0.0321	0.001	0.0001	
Canada/Spain	0.278345	-0.221438	0.305908	0.817301	1920
P-Value	0.0006	0.1584	0.1316	0.000	
Canada/UK	0.381605	-0.089561	0.37001	0.630372	1907
	0.000	0.5761	0.0712	0.000	
Canada/US	0.204055	0.007143	0.34	0.459667	None
P-Value	0.0089	0.9616	0.1011	0.0016	
France/Germany	-0.006757	0.180435	0.737646	0.913429	1924
P-Value	0.9348	0.2528	0.000	0.000	
France/Italy	0.238804	0.06074	-0.324715	0.802647	1923, 1945
P-Value	0.0034	0.7021	0.0367	0.000	
France/Japan	0.057075	0.318568	0.041406	0.704946	None
P-Value	0.4892	0.029	0.0361	0.000	
France/Spain	0.5272	-0.090538	0.632377	0.738093	1920, 1949
P-Value	0.000	0.5637	0.0001	0.000	

Autoregressive models were estimated for all twenty-eight inflation differentials. The second column displays the results for the entire sample, while the third displays the AR parameter calculated over just the Classical Gold Standard years. The fourth column shows the AR coefficient estimated over the 1946-1970 Bretton Woods regime, and the fifth shows the results over the 1974-2017 floating exchange rate years. The last column displays the breaks, obtained using the Bai-Perron test when the AR model is estimated for the whole sample, with a maximum of two breaks allowed.

TABLE 2 - *(continued)* *AR Coefficients*

Pair	1875-1920	Gold	Bretton	Floating	Breaks
France/UK	0.72537	-0.130805	0.769469	0.611869	1922, 1949
P-Value	0.000	0.3984	0.000	0.000	
France/US	0.69135	-0.007833	0.727478	0.889079	1922, 1949
P-Value	0.0000	0.9532	0.000	0.000	
Germany/Italy	-0.006757	-0.63916	0.032913	0.912387	1924
P-Value	0.9348	0.6874	0.769	0.000	
Germany/Japan	-0.006757	0.306195	0.088821	0.603262	1924
P-Value	0.9348	0.0376	0.0021	0.000	
Germany/Spain	-0.006757	-0.152541	0.030065	0.921492	1924
P-Value	0.9348	0.3284	0.8865	0.000	
Germany/UK	-0.006757	0.042433	0.241497	0.796124	1924
P-Value	0.9348	0.78757	0.2465	0.000	
Germany/US	-0.006757	0.235209	-0.085681	0.659204	1902, 1924
P-Value	0.9348	0.0915	0.6868	0.000	
Italy/Japan	-0.19467	0.292911	0.085833	0.839073	1924, 1946
P-Value	0.0173	0.0496	0.0004	0.000	
Italy/Spain	0.368685	-0.070905	0.015464	0.436373	1923, 1945
P-Value	0.000	0.6543	0.8787	0.0031	
Italy/UK	0.410947	-0.062046	0.158917	0.701462	1923, 1945
P-Value	0.000	0.6943	0.1515	0.000	
Italy/US	0.395942	0.242467	0.079077	0.887443	1923. 1945
P-Value	0.000	0.102	0.4238	0.000	
Japan/Spain	0.112616	0.277266	0.082338	0.709477	1924, 1946
P-Value	0.1714	0.0642	0.0044	0.000	

Autoregressive models were estimated for all twenty-eight inflation differentials. The second column displays the results for the entire sample, while the third displays the AR parameter calculated over just the Classical Gold Standard years. The fourth column shows the AR coefficient estimated over the 1946-1970 Bretton Woods regime, and the fifth shows the results over the 1974-2017 floating exchange rate years. The last column displays the breaks, obtained using the Bai-Perron test when the AR model is estimated for the whole sample, with a maximum of two breaks allowed.

TABLE 2 - *(continued)* *AR Coefficients*

Pair	1875-1920	Gold	Bretton	Floating	Breaks
Japan/UK	0.132511	0.330873	0.098381	0.288443	1924, 1946
P-Value	0.1071	0.0255	0.0012	0.0499	
Japan/US	0.1243	0.306749	0.089911	0.615408	1924, 1946
P-Value	0.1309	0.0439	0.0017	0.000	
Spain/UK	0.275723	-0.132468	0.472581	0.660271	1920
P-Value	0.0007	0.402	0.0174	0.000	
Spain/US	0.399065	0.081219	0.443076	0.860163	1920
P-Value	0.000	0.6025	0.029	0.000	
UK/US	0.505979	0.252481	0.466217	0.714855	None
P-Value	0.000	0.0731	0.0188	0.000	

Autoregressive models were estimated for all twenty-eight inflation differentials. The second column displays the results for the entire sample, while the third displays the AR parameter calculated over just the Classical Gold Standard years. The fourth column shows the AR coefficient estimated over the 1946-1970 Bretton Woods regime, and the fifth shows the results over the 1974-2017 floating exchange rate years. The last column displays the breaks, obtained using the Bai-Perron test when the AR model is estimated for the whole sample, with a maximum of two breaks allowed.

TABLE 3 - *Gold Standard Panel Unit Root SPSM Results*

Sequence	Pair	Test Statistic
1	Canada/Germany	-5.30512
2	Germany/Spain	-5.25839
3	Germany/Japan	-5.2535
4	UK/Spain	-5.09649
5	Canada/Spain	-5.03887
6	France/US	-4.93002
7	Canada/France	-4.90973
8	Canada/Japan	-4.8299
9	Canada/US	-4.87097
10	France/UK	-5.1293
11	Germany/Italy	-5.06374
12	Japan/Spain	-4.8835
13	Italy/Spain	-4.84478
14	Canada/Italy	-4.75297
15	Canada/UK	-4.33986
16	Italy/Japan	-4.27543
17	Germany/UK	-4.73577
18	France/Japan	-4.6674
19	Japan/UK	-4.91718
20	Japan/US	-4.49787
21	US/Spain	-4.19582
22	UK/US	-4.11586
23	France/Spain	-3.84475
24	Germany/US	-3.60458
25	Italy/US	-5.36645
26	France/Germany	-5.58098
27	France/Italy	-5.34601
28	Italy/UK	-5.34601

The CIPS test was applied to all inflation differentials over the 1870-1913 gold standard years. The Sequential Panel Selection Method (SPSM) was then applied, in which each pair with the lowest CADF test statistic was removed from the sample, and the CIPS test run again on the remaining pairs. As displayed, the CIPS test statistic is lower than the one percent critical value on all cases.