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ABSTRACT

There is a long-standing debate as to whether the Fisher effect operated during the classical gold standard period. We break new ground on this question by developing a market-based measure of general inflation expectations during the gold standard. Since the gold-silver price ratio was widely used to track inflation during the gold standard period, we are able to derive a measure of inflation expectations using the interest-rate differential between Austrian silver and gold perpetuity bonds with identical terms. Our empirical evidence suggests that inflation expectations exhibited significant persistence at the weekly, monthly, and annual frequencies. We also find that market participants updated long-run inflation expectations following short-run changes in the forward silver price of gold. The evidence suggests the operation of a long-run Fisher effect during the classical gold standard period.

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Searching for Irving Fisher

Several studies have found that *ex post* inflation rates are uncorrelated with the level of nominal interest rates during the classical gold standard period even though the Fisher equation is an empirical relationship based on inflation expectations.[1] One possible explanation for the failure of the Fisher equation in this earlier period is that inflation expectations were nearly zero given the low level of persistence in annual measures of *ex post* inflation rates (Barsky, 1987; Bordo and Kydland, 1995; Fisher, 1930; Friedman and Schwartz, 1982).[2] Other possible explanations for the lack of correlation between nominal interest rates and inflation rates include the hypotheses that financial markets had money illusion or that investors did not understand the quantity theory of money (Summers, 1983; Cagan, 1984; Choudry, 1996; Barsky and Delong, 1991).

Several scholars have attempted to estimate price and inflation expectations during the gold standard period to test for the presence of a Fisher effect using time series econometric models (Capie, Mills, and Wood, 1991; Perez and Siegler, 2003). An obvious limitation to this approach is that we do not have a very good idea of the economic model that market participants used to form inflation expectations (Barsky and DeLong, 1988). Other studies have looked at the relationship between actual inflation and nominal interest rates to test for the presence of a Fisher effect. Summarizing the literature, McCallum (1984) points out that studies of pre-World War I changes in the

[1] Many studies have found that nominal interest rates during the gold standard are correlated with the price level rather than the rate of inflation. Barsky and Summers (1988) argue that that this positive correlation is a direct result of the fact that the price level in the inverse of the price of gold. Benjamin and Kochin (1984) argue that Gibson's Paradox during this period is a spurious relationship.

[2] For a discussion of inflation expectations during the gold standard period, see Barsky and DeLong (1983). For an analysis of the persistence of inflation during the gold standard period and later, see Burdekin and Siklos (1996). Harley (1977) analyzes prices and interest rates in the UK during the gold standard period to test Gibson's Paradox.

price level have simply shown that past inflation cannot forecast future inflation and therefore say very little about inflation expectations or the failure of the Fisher effect during the gold standard period.[3]

To break new ground on this issue, we collect high-frequency asset price data that allow us to compute a market-based measure of inflation expectations for the 19th century. In particular, we use data on Austrian gold, silver, and paper government bonds to compute measures of inflation expectations at high and low frequencies during the classical gold standard period and test for the presence of a long-run Fisher effect. Austria was the only major European country during the classical gold standard period that issued gold, paper, and silver perpetuity bonds that actively traded on the leading financial exchanges of Europe including London, Paris, Berlin, Amsterdam and Vienna for most of the gold standard period, 1880-1913.

We use the interest-rate differential between Austrian silver and gold bonds to derive an *ex ante* market-based measure of inflation expectations. Our use of the silver-gold interest-rate differential is motivated by the observation that the gold-silver price ratio was a widely followed price. The *Economist,* for example, regularly reported on activity in the silver market in their weekly summary of financial markets. Moreover, we find evidence of a long-run cointegrating relationship between Austrian silver and paper bonds. This suggests that silver bonds are a good proxy for overall inflation expectations in Austria.

Our empirical analysis suggests that inflation expectations were not a white noise process during the gold standard period. We find economically meaningful persistence in inflation expectations at the weekly, monthly, and annual frequencies. We then test for

[3] For an analysis of the Fisher effect during the post-WWII period, see Mishkin (1981, 1992).

the presence of a Fisher effect by comparing our measure of inflation expectations computed from Austrian bonds with a short-run measure of inflation expectations calculated from the spot and futures market for the silver price of sterling (gold). We show that short-run changes in inflation expectations Granger-cause long-run inflation expectations. We interpret our findings as evidence of the operation of a Fisher effect during the classical gold standard period.

The next section of the paper discusses our data on Austrian bonds during the classical gold standard period. In section III, we analyze the time series properties of inflation expectations during our sample period in Austria and then test for a long-run Fisher effect. The last section discusses our findings and their implications.

II. Austria and the Gold Standard

To derive a market-based measure of inflation expectations and to test for the presence of a Fisher effect during the gold standard period, we assembled a new database of weekly prices of Austrian gold, silver, and paper sovereign debt issues over the period 1880-1911 using bond quotations from the *Economist*.[4] Austria tapped international capital markets on a significant scale following the passage of the Law of March 16, 1876, which authorized a 16 million florin bond issue that was exempt from Austrian taxes and paid interest half-year in gold in Vienna and other European exchanges including Amsterdam, Berlin, Brussels, Frankfurt, and Paris. Morys (2008) estimated that foreigners held approximately 80 percent of the debt issue. In 1910, the *Stock Exchange*

[4] The *Economist* and *The Times* stopped quoting prices for Austrian paper bonds in 1911.

Official Intelligence reported that there were more than 490 million Austrian Kroner gold bonds unredeemed that traded on markets throughout Europe.

Austria also issued silver bonds on the leading European exchanges. Issued in 1868, the bonds were perpetuity obligations and subject to a 16 percent income tax. The coupon payments on the fiver percent silver bonds were payable half-yearly on February or August 1st or on May 1st and November 1st (*Stock Exchange Official Intelligence*, various issues). There was approximately 519 million Kroner of outstanding silver bonds in 1910.

Finally, Austria issued floated large amounts of government debt throughout Europe in its own currency. Initially issued in the late 1860s, the paper bonds were perpetuity obligations and subject to a 16 percent income tax. The coupon payments on the paper bonds were payable half-yearly on February or August 1st or on May 1st and November 1st (*Stock Exchange Official Intelligence*, various issues). Like the silver bonds, the paper debt did not contain a sinking-fund and had a five percent coupon. The market value of unredeemed paper bonds exceeded more than 886 million Kroner in 1910. Morys (2008) finds that approximately 20 percent of the paper bonds were held by foreign investors. Only the UK, France, Germany, Netherlands, and the United States were also able to sell large bond issues in their home currency on several European markets during the classical gold standard period.

Some scholars have characterized nineteenth-century Austria as a financially underdeveloped, agriculturally-oriented economy, suggesting that it belonged to the periphery rather than to the core of European gold standard countries like the United Kingdom, France, or Germany. However, the fact that Austria was able to issue paper debt successfully throughout Europe suggests that it may have more closely resembled a core gold standard country. In contrast to countries on the periphery, Austria suffered “original sin” only to the extent that its debt was denominated in gold, silver, and paper florin (Eichengreen and Hausmann, 1999; Bordo, Meissner, and Redish, 2005). A depreciation in the paper florin, for example, would require Austrian authorities to collect more tax revenues (in paper florin) to service its debt denominated in gold florin.[5]

In addition, Austria’s standard of living prior to World War I compares favorably to other core gold standard countries, such as France and Germany (see Figure 1). Further, Austria was one of the leading European military powers of the late nineteenth century and its financial markets appear to have been well developed and integrated (Good, 1977). An integrated network of joint stock banks with an extensive branching system (including the important Viennese banks) emerged in the 19th century to lend to businesses throughout the Austrian empire. Further, Austria borrowed from the German model of universal banking in forming institutions such as the Creditanstalt fur Handel und Gewerbe (1855), and it created a central bank in 1816, modeled after the Bank of France, which had the exclusive right to issue notes.

The issuance of sovereign debt denominated in gold, silver, and paper is also partly a function of its monetary history. Austria was on the silver standard for much of the nineteenth century, but like many other countries, went onto the gold towards the end of the century. The Compromise of 1867 between Austria and Hungary gave constitutional foundations for a monetary union with the silver florin as the monetary standard and a central bank with no authority to print new currency issues. Despite this

[5] This was true even after Austria joined the gold standard. As shown in the *Amsterdamsch Effectenblad*, after Austria joined the gold standard, the coupons for paper bonds often traded at a discount to the coupons for gold bonds.

agreement, Austria and Hungary disagreed over the management of monetary policy. In addition to a monetary union, Hungary wanted overdraft facilities and a central bank office in Budapest. In July 1878, Austria and Hungary renewed the “Compromise of 1867” for ten years, but changed the name of the central bank from the Austrian National Bank to the Austro-Hungarian Bank. This new agreement created central bank offices in Budapest and Vienna with both German and Hungarian as the official languages of the monetary institution.

But after 1879, the florin was no longer convertible into silver. The exchange-rate system then began to resemble a float more than a peg. Silver florin traded for as much as seven percent from the mint par ratio and, as shown in Figure 2, exchange rates exhibited significant fluctuations in the 1880s. Austria then joined the gold standard in August 1892 after renewing the “Compromise” with Hungary for a second time. At this point, it also established the kronen (crown) as its new currency. The kronen’s value was fixed in terms of gold and complete control of the money supply was given to the central bank. The credibility of this new monetary regime was further buttressed in 1899 when Hungary was granted full parity with Austria in the management of the central bank. Investors reacted favorably to this new power-sharing arrangement: large capital inflows from the leading European financial centers including London, Paris, and Berlin occurred in response (Tullio and Wolters, 2007).

Flandreau and Komlos (2001) argue that even though Austria never formally established gold convertibility prior to World War I, the country was a *de facto* member of the gold standard by 1896 because of the stability of its exchange rate. For example, Tullio and Wolters (2007) show that the Austrian exchange rate vis-à-vis other major gold standard countries (England, France, and Germany) fluctuated within a range of about 15 percent between 1876 and 1891 and just eight percent between 1892 and 1895. The share of metallic-backed notes to paper notes issued by the central bank increased from an average of 53 percent over the period 1876-1895 to an average of nearly 75 percent over the period 1896-1914 (Tullio and Wolters, 2007). After 1896, the exchange rate for the Austrian crown relative to other gold standard countries fluctuated only two percent and +/- 0.4 percent from mint par (Flandreau and Komlos, 2001; Tullio and Wolters, 2007). Figure 2 confirms that Austrian exchange rates were remarkably stable after the country joined the gold standard. Based on the behavior of the exchange rate, Flandreau and Komlos (2001) conclude that Austria was a country that was neither a core nor a peripheral member of the gold standard, but rather somewhere in between.

III. Empirical Analysis of the Fisher Effect

A. Model and Estimating Inflation Expectations

The Fisher equation states that the nominal interest rates on a given sovereign debt obligation is equal to the real interest rate plus the expected rate of inflation. The nominal interest rate for Austrian silver bonds can therefore be written as:

(1) $i_t^S = r_t + \pi_t^{e,S}$,

where r_t is the real interest rate and $\pi_t^{e,S}$ is the expected rate of silver inflation. Likewise, the Fisher equation for Austrian gold bonds is:

(2) $i_t^G = r_t + \pi_t^{e,G}$.

Inflation expectations for the gold bond are denoted by $\pi_t^{e,G}$. The silver-gold interest-rate differential can be obtained by subtracting equation (2) from equation (1), which yields:

(3) $i_t^S - i_t^G = \pi_t^{e,S-G}$.

Equation (3) states that the silver-gold interest rate spread is equal to the expected rate of inflation in the silver-gold price ratio.

To carry out our empirical analysis, we make three assumptions about the bonds and investor behavior: (1) investors are risk-neutral; (2) the real interest rate is the same for both bonds given that the Austrian government issued the two debt obligations; and (3) silver and gold bonds have identical default risk. The third assumption of identical default risk appears reasonable since Austria faithfully repaid its sovereign debt between 1880 and 1913. Given that the silver and gold bonds were widely held by foreign investors, Austria could not differentially default on the silver bonds without damaging its reputation in international capital markets. Even if there were some differential default risk between silver and gold bonds, the premium is not likely large enough to have a qualitative impact on our analysis.

Figure 3 plots current yields on a weekly basis for the Austrian gold, silver, and paper bonds from January 1880 to April 1911. The three series tend to move together, with the gold bond having the lowest interest rate over the course of the sample period. As shown in Table 1, the average interest rate for Austrian gold bonds during the gold standard period is about 430 basis points with a standard deviation of 39 basis points. The interest rate on silver debt averaged approximately 555 basis points with a standard deviation of 61 basis points. The average interest rate for paper bonds over the entire sample period was 559 basis points with a standard deviation of 63 basis points. Bond yields were highest during the silver standard for these three debt issues. Following the adoption of the gold standard, the average yield for the gold bonds fell by approximately 60 basis points and more than 100 basis points for the silver bonds.

Figure 3 shows that the interest rates on silver and paper bonds are nearly identical and the two series may contain a common stochastic trend. . We employ the Engle-Granger two-step procedure to test for cointegration between paper and silver bonds. The λ_{MAX} statistic of 134.44 suggests that the null hypothesis of no cointegration can be rejected at conventional levels of significance.[6] We find even stronger results when Austria was a *de jure* member of the gold standard (1892-1911) or for the period from 1896 to 1911 – when Austria was *de facto* on the gold standard and the Austrian exchange rate exhibited very small fluctuations away from mint par. Using either of the *de jure* or *de facto* start date for Austria's adoption of the gold standard, we are unable to reject the null hypothesis that the paper and silver bonds share the same stochastic trend. This finding suggests that the silver-gold interest rate differential is not only a measure of inflation expectations in the relative price of silver and price, but it is also a measure of overall inflation expectations in the Austrian economy.

The silver-gold price ratio was widely quoted in the financial press as an important indicator of inflation during the entire gold standard period. Consider the following an excerpt from a manufacturer to the Editor of the *Economist*:

> The great event of the last few weeks has been the rise in silver [price of gold]. It is the supposed cause of a considerable rise in the prices of many commodities, and if the predictions of bi-metallists are worth anything, it ought to have greatly improved the position of the cotton spinner and manufacturer. (*Economist*, May 24, 1890, p. 665)

[6] We are also able to reject the null of no cointegration using the Johansen cointegration test.

Prof. J.S. Nicholson, quoted in the *Economist*, noted "that the fall in the gold price of silver has coincided almost exactly with the fall of the gold prices of commodities in general" (*Economist*, February 10, 1894, p.171). Since consumer price indexes or wholesale price indexes were not yet widely available to investors and market participants, they relied on information from the silver price of gold to form expectations about the broader movements in prices.

Figure 4 plots our weekly measure of inflation expectations, $\pi_t^{e,S-G}$, alongside weekly current yields for Austrian paper-bonds for the period January 1880 to April 1911. The simple correlation coefficient between paper interest rates and inflation expectations is approximately 40 percent. Inflation expectations over the entire sample period averaged 1.25 percent (125) basis points and accounted for approximately 22 percent of the nominal interest rate (inflation expectations/nominal interest rate). Since inflation expectations were relatively stable (the standard deviation is less than three percent), the empirical evidence also indicates, as suggested by Shiller and Siegel (1977), that movements in real interest rates were probably more important than inflation expectations in driving fluctuations in Austrian nominal interest rates.

B. Persistence of Inflation Expectations

To examine the time-series properties of long-run inflation expectations during the classical gold standard period, we first test for a unit root using the Augmented Dickey-Fuller-GLS test. The null hypothesis of a unit root can be rejected at the one-percent level of significance.[7] To measure the persistence of inflation expectations, we estimated ARIMA models for the entire sample period as well as the periods when Austria was a member of the silver and gold standards. As shown in Table 2, inflation expectations in Austria are best characterized by an AR(3) process over the entire sample period. The sum of the autoregressive coefficients is over 97 percent, which indicates a high degree of persistence in inflation expectations. The constant indicates that investors expected inflation expectations of approximately 1.23 percent per year. For the silver standard period, we also find a high degree of persistence. Inflation expectations are best characterized by an AR(2) process. The sum of the autoregressive coefficients during the silver standard period is over 97 percent. The coefficient on the constant term in the equation suggests that financial market participants expected inflation to average approximately 1.51 percent per year.

For the gold standard period, we estimate ARIMA models from August 1892 to April 1911, and find that the best model for inflation expectations is an AR(2) model. Table 2 shows that the level of inflation persistence drops to about 94 percent. Although we observe a slightly lower level of persistence in inflation expectations after Austria joined the gold standard, there is a marked reduction in the average level of inflation expectations from 1.51 percent to 1.06 percent. These findings suggest that there was significant persistence in inflation expectations and that joining gold reduced the average level of inflation expectations by roughly 30 percent.

One possible critique our analysis thus far is that the large persistence in inflation expectations may be driven by the use of high frequency data in the estimation process.

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[7] We experimented with lag lengths of 1 to 12 for the unit root tests. In all cases, we were able to reject the null hypothesis of a unit root at the five percent level of significance.

We therefore re-estimated the baseline empirical results using end-of-month data. The ARIMA models of monthly inflation expectations are presented in Table 3. The results are similar to those employing the weekly data. Inflation expectations followed an AR(1) process when the country adhered to the silver standard and inflation persistence is greater than 90 percent and significant at the one-percent level. For the gold standard period, inflation expectations are best modeled as an AR(1) process. Although inflation expectations are once again not a white noise process, the coefficient on the autoregressive term falls by roughly 12 percent, from 95 to 83 percent.

Using annual data, we find similar results for the persistence of inflation. The constant term shown in Table 4 indicates that annual inflation expectations averaged more than one percent over the full sample period. Again, we find that there is significant persistence in inflation expectations: the sum of the two autoregressive terms is nearly 90 percent. Hence, using weekly, monthly, or annual data, we find substantial persistence in inflation expectations during the gold standard period as measured by the silver-gold interest rate differential.

Another possible critique of our analysis is that Austria's commitment to gold might have been perceived as less credible than other western European countries, and hence the analysis of inflation expectations we derive for it may not be very representative of gold club members. That is, inflation expectations for non-credible members of the gold standard may be much larger than for countries that strictly adhered to the monetary rule. While Austria was a newer member of the gold standard in comparison to France, Germany, and the UK, it does not appear that market participants viewed its commitment to gold as substantially less credible than these countries.

Mitchener and Weidenmier (2008) provide evidence that Austria was one of the most credible gold standard monetary regimes during the period 1870-1913: market participants expected the Austrian kroner to depreciate approximately three percent after the country joined the gold standard based on the premium of paper over gold bonds. The level of expected depreciation is considerably smaller than several other gold standard countries including the United States, Argentina, Brazil, Chile, India, Mexico, and Russia. We therefore interpret our results as providing a lower bound on the size and persistence of inflation expectations for the average core country during the classical gold standard period.

C. Testing for a Long-Run Fisher Effect

We now provide a straightforward test of the long-run Fisher effect's operation during the classical gold standard era. We analyze the relationship between the 60-day forward and spot silver price of gold and our measure of inflation expectations based on interest rate spreads. The forward market for silver began operation in the early 1890s, so we collected weekly a new data set on silver prices from contemporaneous newspapers. The *Manchester Guardian* began regularly reporting data on 60-day forward silver contracts in March 1894 while the *Economist* began reporting on the silver market in January 1896. We use the spot and forward silver price of gold (as expressed in pound sterling) to compute an annual measure of short-run inflation expectations for the period March 17, 1894 to April 28, 1911.

Our measure of short-run inflation expectations (assuming that inventory costs are constant over time) can be written as:

$$\pi_t^{e,SR} = 60{,}000 * \frac{s_t^F - s_t}{s_t}, \qquad (4)$$

where $\pi_t^{e,SR}$ are inflation expectations, s_t^F is the 60-day forward silver price, and s_t is the spot silver price of sterling (gold). The right hand side of equation (4) is multiplied by 60,000 (=6*100*100) to convert inflation expectations into an annual measure expressed in basis points. The short-run measure of inflation expectations computed from the silver spot and forward markets averaged -170 basis points with a standard deviation of 487 basis points over the entire sample period. Figure 5 shows our short and long-run measures of inflation expectations. The short-run measure of inflation expectations is significantly more volatile than the long-run measure of inflation expectations.

We estimate Granger causality tests to examine the relationship between our short-run and long-run measures of inflation expectations. We first test the short-run measure of inflation expectations using the Augmented Dickey-Fuller-GLS test. The null hypothesis of a unit root can be rejected at the five-percent level of significance. We then estimate Granger causality tests for the entire sample period for which we have data on the silver forward market. A lag length of 18 weeks is chosen for the empirical analysis based on the Akaike Information Criteria (AIC).[8] The empirical results are presented in Table 5. Our short-run measure of inflation expectations Granger causes the interest-rate differential between silver and gold bonds at the one-percent level of significance. This suggests that market participants updated long-run inflation expectations based on

[8] We considered lag lengths up to 26 weeks (half a year) for the empirical analysis.

changes in short-run inflation expectations. The result is consistent with recent research, which has found that long-term US government bonds respond to short-run macroeconomic and financial surprises (Gürkaynak et. al, 2005). On other hand, we do not find evidence that our long-run measure of inflation expectations Granger causes changes in short-run inflation expectations. This is not very surprising given that long-run inflation expectations largely reflect information over a longer time horizon than 60 days.

We follow-up the Granger-causality tests with an impulse response analysis, and give the forward/spot silver market the second ordering in the Choleski decomposition. By placing silver second in the ordering, we provide a lower-bound estimate of the impact of a one-standard deviation shock of short-run inflation expectations on long-run inflation expectations (measured by interest rate differential). Figure 6 shows that a one-standard deviation shock to short-run inflation expectations increases long-run inflation expectations by 30 basis points over two years (cumulative impulse response). As the graph indicates, the impulse response is statistically different from zero (at the 95 percent confidence level) from about the 25 to 70 week horizon. The result implies that a depreciation in silver (i.e. an increase in short-run silver inflation expectations) increases the Austrian silver-gold interest rate differential.

As a robustness check, we also estimate the relationship between long and short-run inflation expectations over the *de facto* gold standard period – 1896 to April 1911. As Table 6 shows, we also find that short-run inflation expectations Granger-cause long-run inflation expectations over this sample period, but not vice-versa. Impulse response functions for the period 1896-April 1911 are shown in Figure 7. As the figure indicates, a shock to short-run silver inflation expectations increases long-run inflation expectations by more than 28 basis points over two years.

V. Conclusions

Macroeconomists and economic historians have long searched for the operation of Irving Fisher's eponymous effect during the classical gold standard period. We show that Fisher and his effect may be lurking in the inflation expectations of Austrian sovereign debt issues of the 19th century. We compute one of the first, high-frequency market-based measures of general inflation expectations for the classical gold standard period so that we can test for the presence of the Fisher effect. Previous studies have used gold bonds and econometric models to examine the relationship between nominal interest rates and inflation. We believe that our measure, the interest rate differential between silver and gold bonds, provides a more direct approach for studying the behavior of long-run inflation expectations during the gold standard period. Our measure is motivated by the fact that the gold-silver price ratio was widely followed by contemporary market participants and the fact that our measure of inflation expectations does not rely on modern econometric tools and software to calculate.

Our analysis of inflation expectations, proxied by the interest rate differential between silver and gold bonds, suggests several conclusions. First, the adoption of the gold standard reduced the average level of inflation expectations in Austria. Joining the gold standard led to a 30 percent drop in inflation expectations, from 1.5 percent to 1.1 percent, as measured by decisions made in financial markets. We also find that there is considerable persistence in long-run inflation expectations at the weekly, monthly, and annual frequencies. The empirical analysis suggests the presence of a Fisher effect given that changes in inflation expectations computed from the forward market for silver Granger cause movements in the Austrian interest-rate differential between silver and gold bonds. Market participants updated long-run inflation expectations following short-run changes in the future silver price of gold. Investors during the classical gold standard period required an inflation premium that was built into nominal interest rates as long as the debt obligation was denominated in silver or paper rather than gold.

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Table 1. Mean Austrian Interest Rates, 1880-April 1911 (Basis Points)

	Whole Period (Std. Deviation)	Gold Standard (Std. Deviation)	Silver Standard (Std. Deviation)
Gold	430.134 (38.572)	405.53 (10.064)	466.767 (36.168)
Silver	555.108 (61.265)	511.581 (13.015)	619.903 (45.470)
Paper	559.887 (63.685)	515.010 (13.224)	626.691 (48.681)

Table 2. ARIMA Models of Inflation Expectations(Weekly Data)

	Whole Period	Silver Standard	Gold Standard
Constant	123.15*** (11.300)	151.14*** (12.393)	106.019*** (1.689)
AR(1)	0.791*** (0.025)	0.772*** (0.038)	0.855*** (0.032)
AR(2)	0.141*** (0.031)	0.206*** (0.038)	0.084*** (0.032)
AR(3)	0.057** (0.025)		
Observations	1631	655	976

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. ARIMA Models of Inflation Expectations (Monthly Data)

	Whole Period	Silver Standard	Gold Standard
Constant	122.765*** (12.809)	149.879*** (15.430)	106.075*** (1.92)
AR(1)	0.971*** (0.012)	0.948*** (0.028)	0.830*** (0.037)
AR(2)			
AR(3)			
Observations	375	149	225

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. ARIMA Models of Inflation Expectations
(Annual Data)

	Whole Period
Constant	122.576*** (14.257)
AR(1)	1.485*** (0.153)
AR(2)	0.608*** (0.154)
Observations	30

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5
Long-Term Fisher Effect
Granger Causality Tests (F-tests)

Granger Causality Test	F-test
Short-run($\pi_t^{e,SR}$)→Long-Run($\pi_t^{e,S-G}$)	39.371***
Long-run ($\pi_t^{e,S-G}$)→Short-Run($\pi_t^{e,SR}$)	21.419

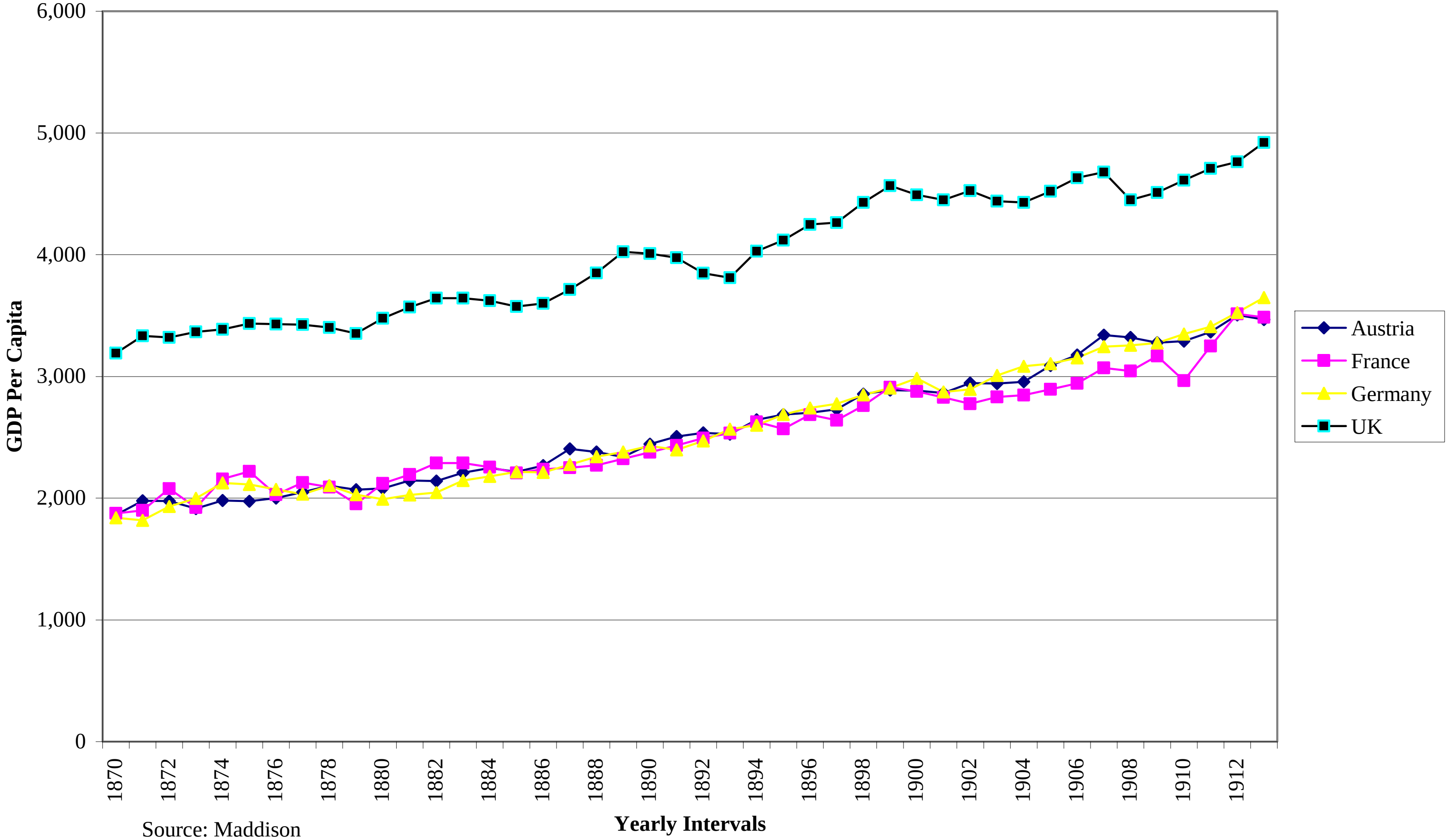
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6
Long-Term Fisher Effect
Granger Causality Tests (F-tests)

Granger Causality Test	F-test
Short-run($\pi_t^{e,SR}$)→Long-Run($\pi_t^{e,S-G}$)	37.762***
Long-run ($\pi_t^{e,S-G}$)→Short-Run($\pi_t^{e,SR}$)	16.853

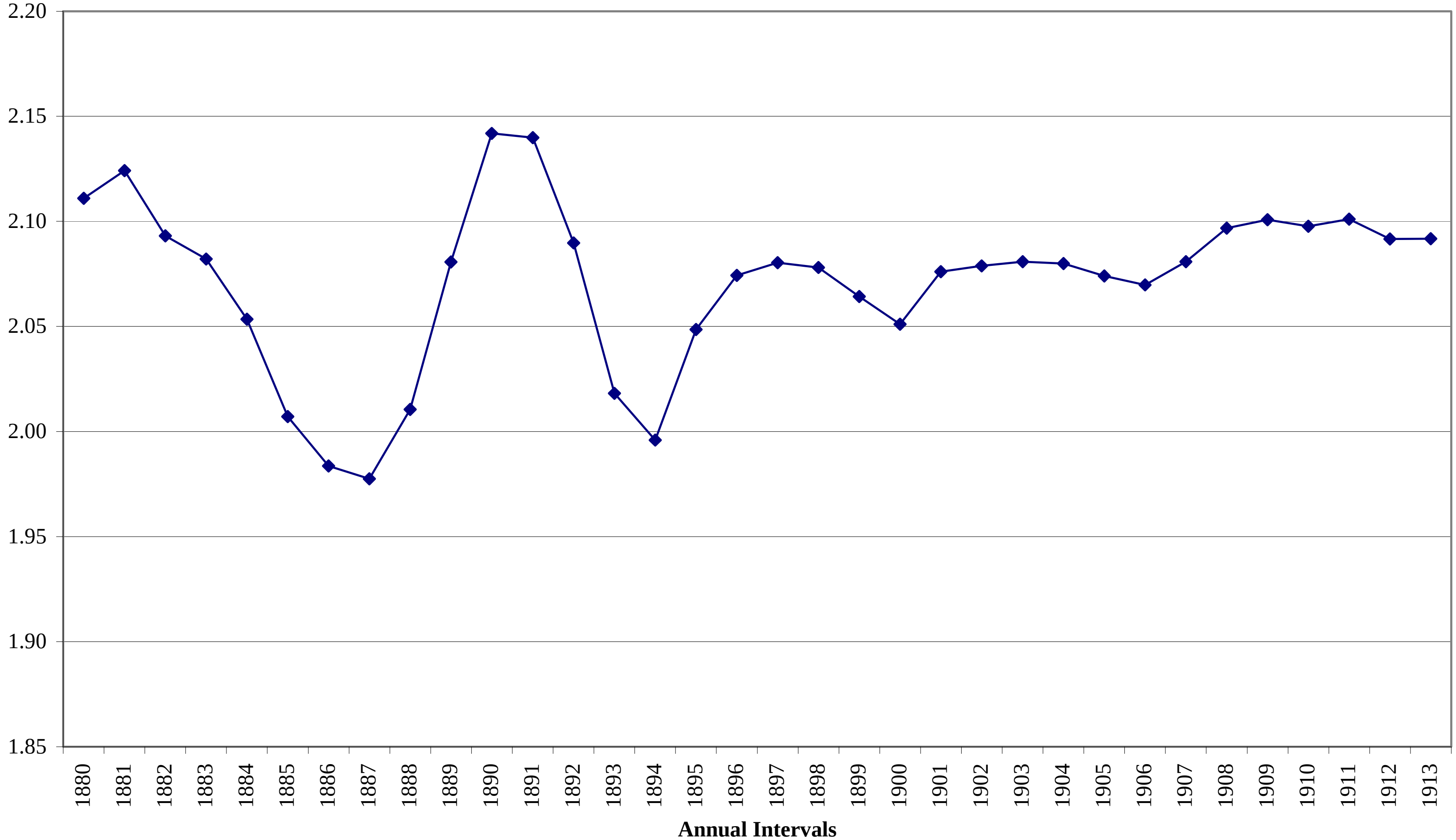
* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1
GDP Per Capita, 1870-1913



Source: Maddison

Figure 2
Franco-Austrian Exchange Rate 1880-1913



Source: Flandreau and Zumer (2004)

Figure 3
Austrian Gold, Silver, and Paper Bonds, 1880-April 1911
(Basis Points)

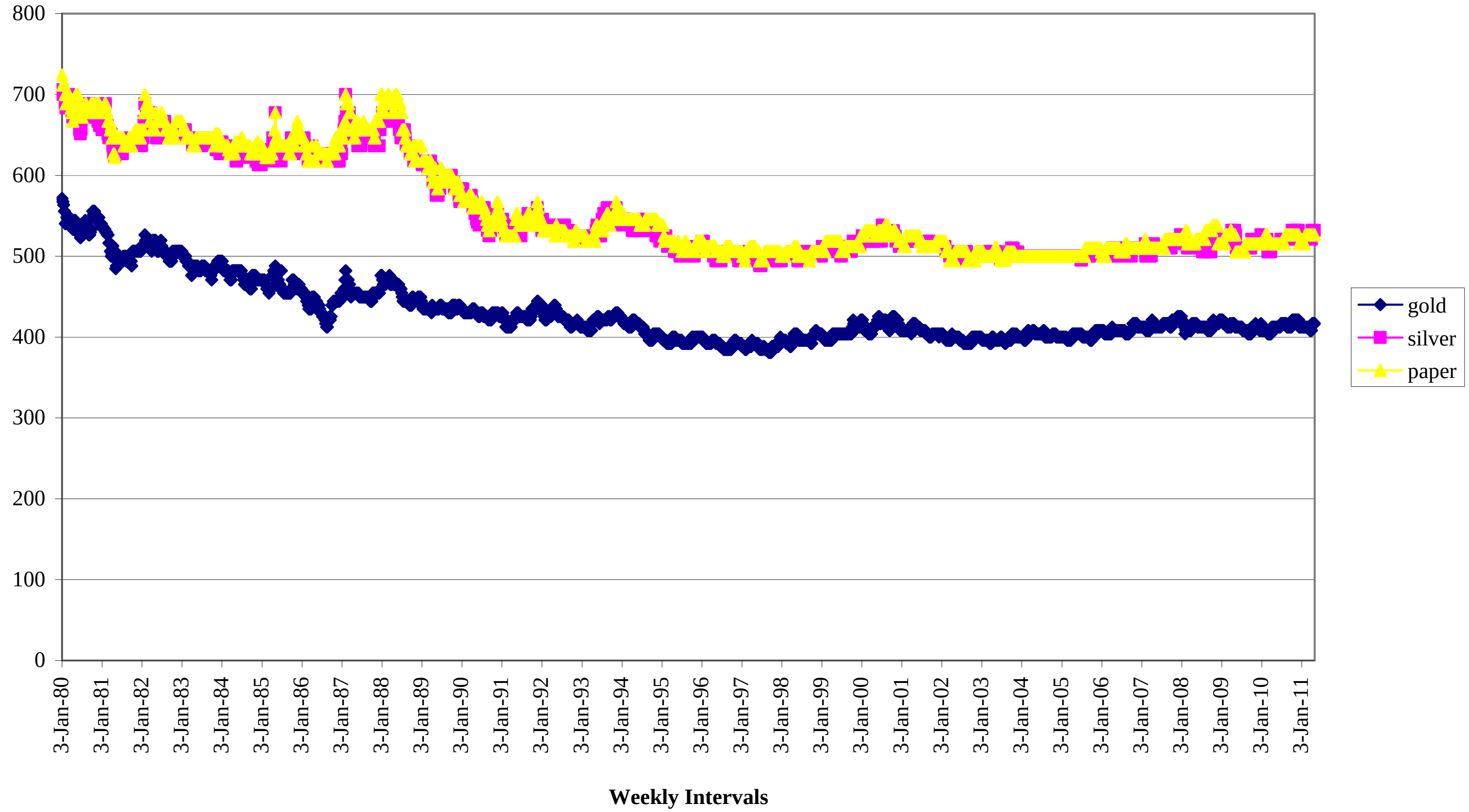


Figure 4
Austrian Inflation Expectations and Nominal (Paper) Interest Rates, 1880-April 1911
(Basis Points)

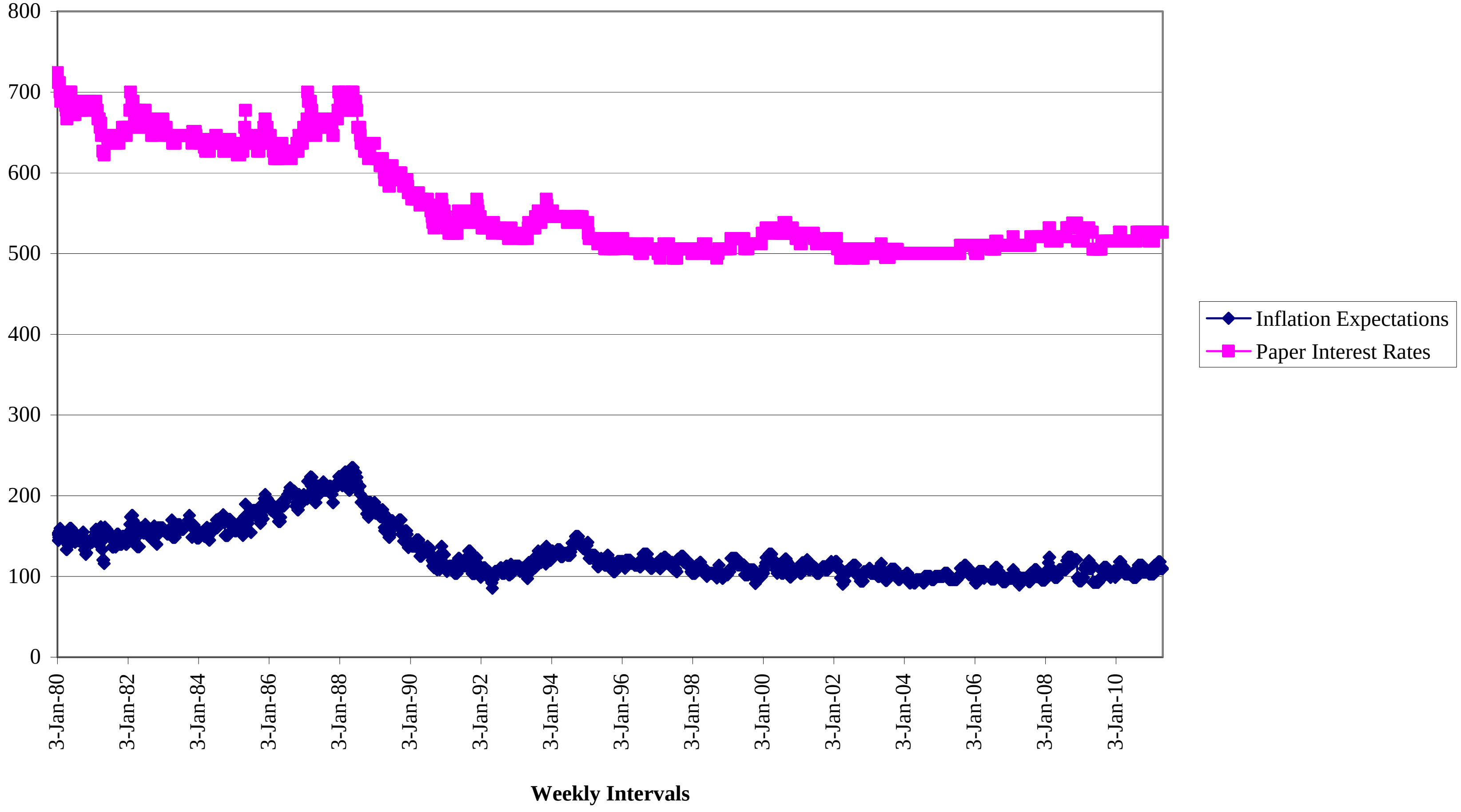


Figure 5
Long and Short-Run Inflation Expectations
March 1894-April 1911
(Basis Points)

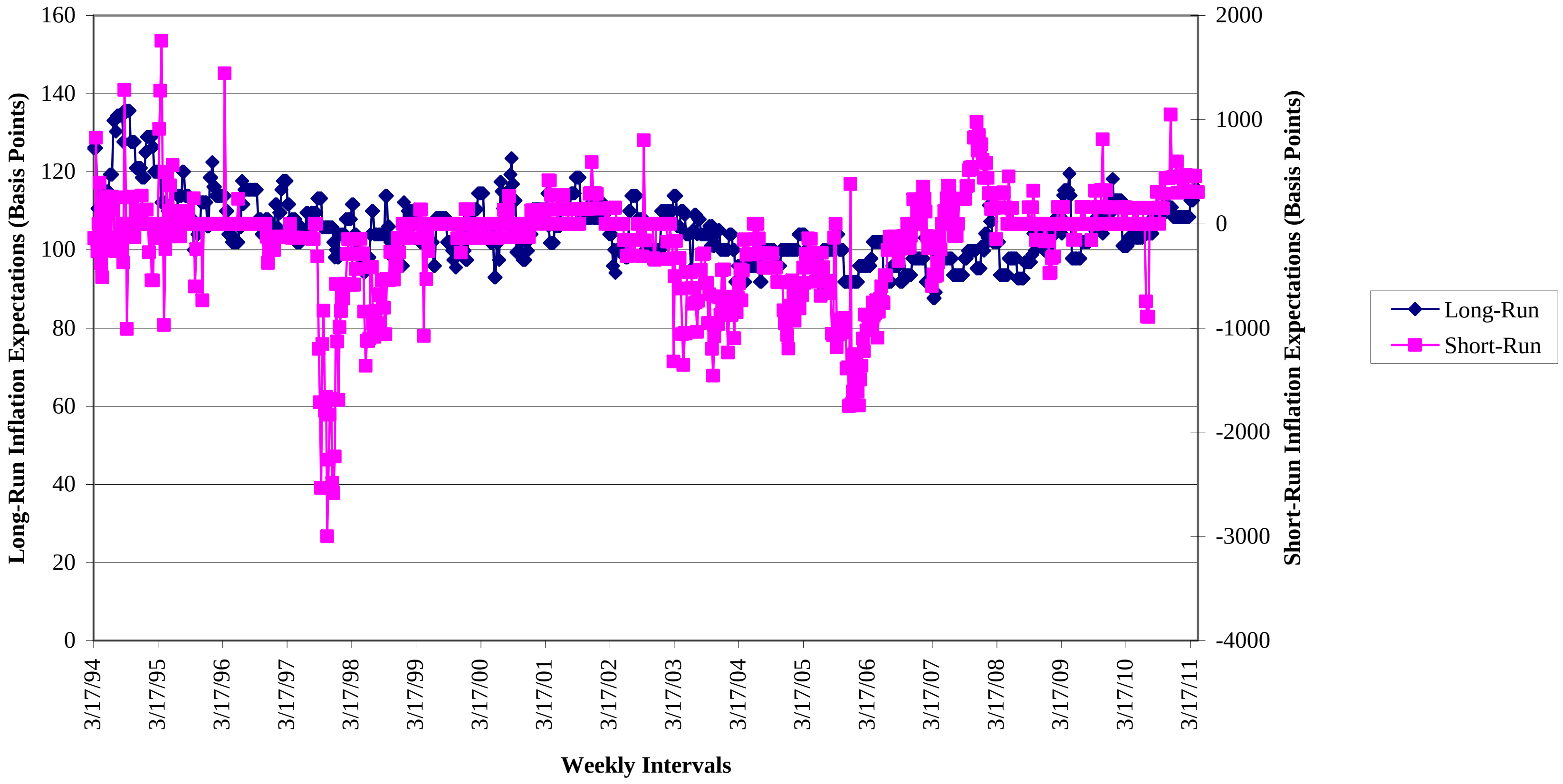


Figure 6
Response of Long-Run Inflation Expectations to a
One-Standard Deviation Shock to Short-Run Inflation Expecatations
(95% Confidence Intervals)

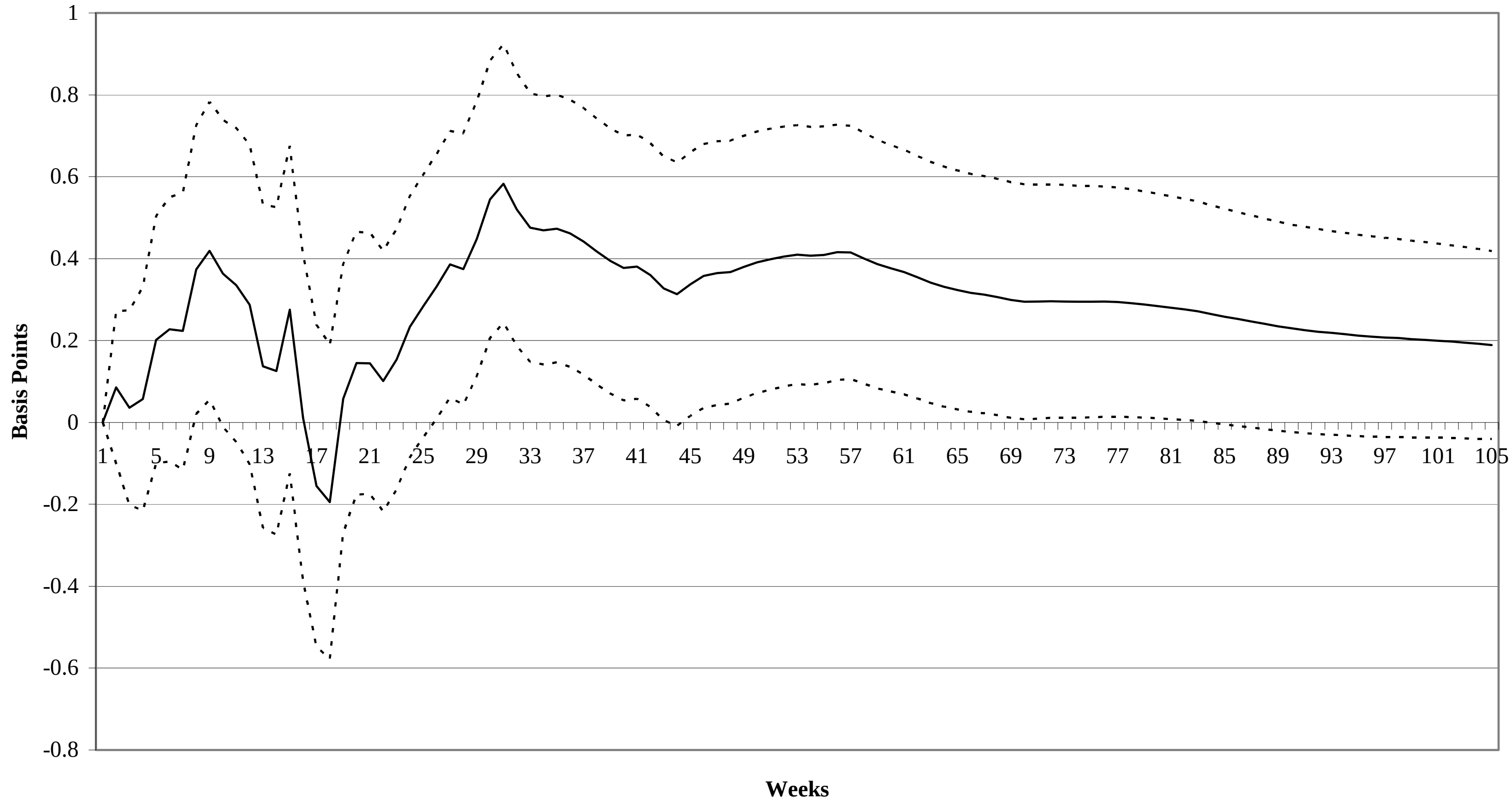


Figure 7
Response of Long-Run Inflation Expectations to a
One-Standard Deviation Shock to Short-Run Inflation Expecatations
(95% Confidence Intervals)