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A Century and Three-Quarters of the Bank Rate and Long-term Interest Rates in the United Kingdom

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1 Introduction

This paper examines the relationship in the United Kingdom between the Bank rate (or other monetary policy rate) and long-term interest rates over a period going back to the mid-nineteenth century. This time frame enables us to examine the relationship between the monetary policy rate and the long-term interest rate at times when there was a well-established gold standard (1844-1913), a period of instability in the policy regime (the interwar years 1919-1939), years of policy by discretion, with and without a fixed exchange rate system (1952-1997), and a period with formal inflation targeting (1997-2013). Recent literature has been concerned with the role of the policy regime in determining the sensitivity of long-term rates to changes in policy rates as well as to other current disturbances. Inflation targeting, for example, by anchoring long-term inflationary expectations, is argued to produce an environment where long-term interest rates " jump around a bit less and businesses and investors might find it easier to draw up long-term contracts.[1]" In the same vein, Ben Bernanke (2004, p.166), in proposing a formal inflation target for the United States, argued that "the apparently high sensitivity of long-term nominal interest rates to Fed actions suggests some uncertainty about the Fed's long-run inflation target."[2] The response of long-term interest rates to monetary policy rates over several regimes is of interest in this respect.

The title of this paper is a reference to R.G. Hawtrey's (1938) book, *A Century of the Bank Rate.* Hawtrey conducted "most laborious *ad hoc* statistical investigations [D.H. Robertson(1937)]" of Bank of England interest rate policy from 1844 to the early 1930s. For these investigations he constructed a data set of all changes in the Bank rate from September 1844 to June 1932 along with the price of Consols near to the time of each policy action. A central question in Hawtrey's study was the relationship between the Bank rate and the long-term interest rate with implications for the relative roles of long- and short-term interest rates in the transmission mechanism of monetary policy. Hawtrey argued that it was the short rate that mattered; the long-term rate being only

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[1] Rogoff, Kenneth (2005, April 23). A Case for Financial Transparency. *Financial Times,* p.13.

[2] Bernanke cites Gurkaynak, Sack and Swanson (2005) for empirical evidence that under Federal Reserve procedures at the time 'private agents' views of long-run inflation were not strongly anchored. Gurkaynak, Levin and Swanson (2010) study the response of long horizon forward interest rates to monetary and other "surprises" and conclude that inflationary expectations were more firmly anchored in the United Kingdom after the adoption of a formal inflation target relative to before or to the United States for the same period.

slightly influenced by the Bank rate. As D.H. Robertson put it "Mr. Hawtrey expands and illustrates the principle (familiar to readers of Pigou and Lavington) that the repercussions on the long rate of a change in the short rate which is expected to be reversed before long is likely to be relatively small…"[3]

J.M. Keynes in his *Treatise on Money (1930)* took the opposite view that it was the long-term rate which was important via its effect on fixed investment. He provided informal statistical evidence that monetary policy via the bank rate had substantial effects on the long-term rate. While granting that "it may seem illogical that the rate of interest fixed for three months should have any noticeable effect on terms asked for loans of twenty years or more." He concludes that "the influence of the short-term rate of interest on the long-term rate is much greater than anyone who argued on the above lines would have expected [Keynes (1930), p.316)]."[4]

For the most part Hawtrey's focus was on the Gold Standard period from 1844 to World War I. Keynes's focus was on the post-War I period when the gold standard was not in effect or was precarious. Keynes and Hawtrey focused on conditions in different monetary policy regimes.

Thus for the transmission mechanism of monetary policy we have the Hawtrey Effect via the bank rate directly and the Keynes Effect via the long-term rate. For the Keynes Effect to operate, the bank rate (or other policy instruments) must have a significant effect on the long-term rate. The question of whether it is the short rate or the long rate that is important for the transmission mechanism of monetary policy is not just or primarily a question of historical interest. In New Keynesian models that are widely used in policy analysis today: which is it? Simple versions of the earlier generation of Keynesian models, today they might be called *canonical* forms, centered on Hicks's *IS-LM* model in which the interest rate was the long-term rate. We have this on good authority: Hicks (1946, p.148; 1967). Likewise, on good authority, from Michael Woodford (2011) we have that in the canonical New Keynesian model, the interest rate is the short-term rate "directly under control of the central bank (p.727)". What about more detailed versions of New Keynesian models? There is no theoretical reason to exclude the Keynes Effect, but as in earlier models a significant effect of monetary policy rates (or other policy instruments) on the long-term rate is required for it to operate. Moreover, to

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[3] The quotes from D.H. Robertson are from his review of *A Century of the Bank Rate* (*Economic Journal*, 49, March 1937, pp.94-96).

[4] In addition to statistical evidence, Keynes offers "some sound reasons based on the technical character of the market, why it is not unnatural that this should be so (p.316)." We return to these at a later point.

incorporate the Keynes Effect would require a second interest rate in the model.

The "investigations" here will focus on the relationship between the Bank of England policy rate and the long-term rate of interest in the United Kingdom over several monetary policy regimes dating back to 1844. In each regime we examine the implications of this relationship for the transmission mechanism of monetary policy. Section 2 begins with some summary statistics and an examination of the properties of the data series. Sections 3-5 examine the Gold Standard period (1844-1913), the post-World War II years from 1952 to 1997 and the inflation targeting period from 1997 to 2013. We turn in Section 6 to the interwar years (1919-1939) which pose particular statistical problems but are of considerable interest. Section 7 summarizes and concludes.

2. Descriptive Statistics and Preliminary Analysis

The data was collected at monthly frequency from different sources. The short-term interest rate (STIR) is measured by monthly averages of the Bank of England Rate. The long-term interest rate (LTIR) is the monthly average of the yield of Consols of the United Kingdom government until the late 1950s and the 20-year government security rate thereafter.

2.1 Summary Statistics

Summary statistics for the data are shown in Table 1. More detailed descriptions of these series and the other data used in the study are provided in Appendix A along with a listing of data sources.

The Gold Standard years that we consider begin with January 1844 and extend to December 1913. We omit the World War I years. For now we also omit the interwar years but we return to this period at a later point. We start the post-World War policy regime, which we characterize as policy by discretion (1952-1997), after an adjustment period. The inflation targeting period begins in mid-1997 when United Kingdom government granted the Bank of England operational independence to set interest rates in order to reach the Government's inflation target[5]. In Table 1 the summary statistics for this period end in December 2008 just before the lower bound for the policy rate was reached.

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[5] Further formal changes were implemented in the 1997 Bank of England Act

Table 1: Summary Statistics

	1844.01-2008.12	1844.01-1913.12	1952.01-1997.06	1997.07-2008.12
Short-term Interest Rate				
Mean	4.9	3.6	8.1	5.1
Median	4.0	3.2	7.0	5.0
Standard Dev.	3.0	1.4	3.5	1.1
Max.	17.0	10.0	17.0	7.5
Min.	2.0	2.0	2.5	2.1
Observations(#)	1980	840	546	138
Long-term Interest Rate				
Mean	5.5	3.2	9.9	5.5
Median	4.0	3.2	9.8	5.5
Standard Dev.	3.4	0.3	3.5	0.7
Max.	19.1	4.1	19.1	8.0
Min.	2.6	2.6	4.3	3.7
Observations(#)	1980	840	546	138

Source: Authors based on Statistical Abstract for the UK, Bank of England, and NBER.

The table shows that the mean and standard deviation of the long-term interest rate are lowest for the Gold Standard period and highest for the discretionary post-World War II years with values for the inflation targeting period in between. The short-term rate never breached a two percent minimum level over this period; that came in January 2009. The pattern over the sub periods for the mean of the short-term rate was the same as for the long rate. The standard deviation of the short-term rate was higher for the Gold-Standard period than in the inflation targeting years but highest for the discretionary World War II years.

Table 2 shows correlation coefficients for the whole period and three sub periods between the short- and long-term rates both in levels and first differences. For both level and first differences, the rates are most highly correlated in the discretionary post-World war II sub period. Correlation coefficients for the Gold-Standard sub period are lowest.

Table 2

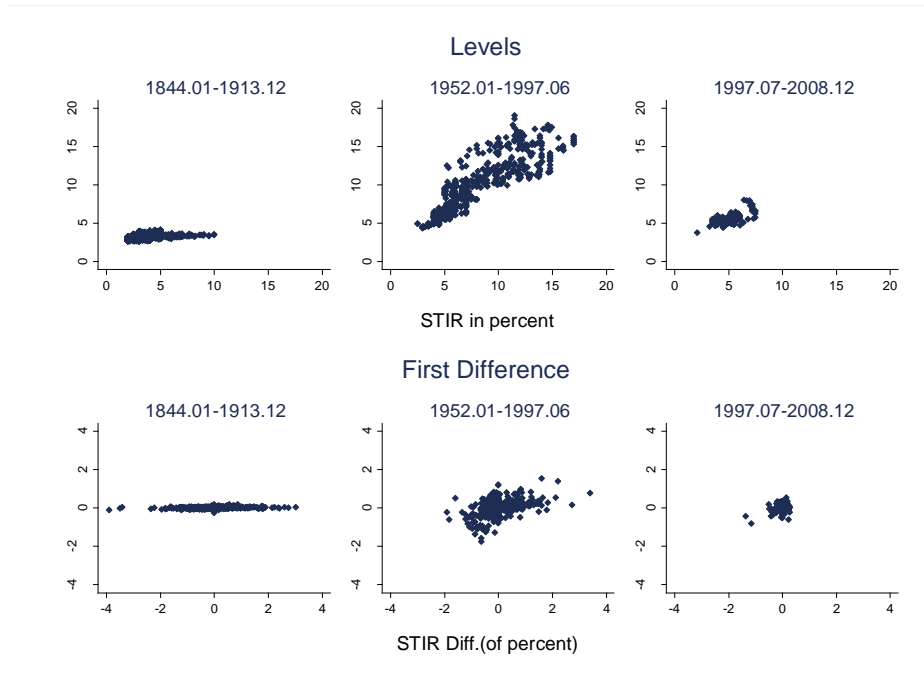| Period	Correlation Levels	Correlation First Difference
1844.01-2008.12	0.8673	0.2493
1844.01-1913.12	0.3501	0.2513
1952.01-1997.06	0.8606	0.4201
1997.07-2008.12	0.6673	0.2689

Figure 1

Figure 1 is a scatter diagram in levels and first differences for the short-term and long-term rates for each sub period. The closer positive association in the middle sub period is evident.

2.2 Time Series Properties of the Data

One of the statistical procedures used in later section of the paper is to calculate impulse response functions from estimated VARs to study the relationship between the short-term and long-term interest rates as well as among other variables. Proper specification of these VARs depends on the time series properties of the data. Table 3 shows the results of tests for unit roots in the data series using the Augmented Dickey-Fuller procedure. The test is run for the whole sample period and three sub periods with the series in levels and first-differences. For all samples the series show no evidence of unit roots when expressed as first-differences. So our discussion refers to the tests in levels form.

For the whole period, the short-term rate and wholesale price inflation appear to be stationary but a unit root cannot be rejected for the long-term rate. Given the view taken here that there were several shifts in the policy regime, the sub period results are of more interest.

For the Gold Standard era, the test results have the same pattern as for the whole period. A unit root for the short-term rate is rejected but one for the long-term rate is not.

If we conclude that the series are not integrated of the same order, it can be taken as an indication of a weak or no relation between the two rates. The quite different properties of the two interest rates during the Gold Standard era are illustrated in a less formal way by the plots of the series in Figure 2. Failure to reject a unit root does not, of course, indicate that the series is non stationary.

Table 3: Unit Root Test – Augmented Dickey-Fuller

Type of variable and test	Short-term interest rate (critical Value)	Long-term interest rate (critical Value)	Inflation Wholesale (critical Value)	Critical Value 10%
Levels				
1844.01-2008.11	-3.75	-1.43	-4.70	-1.65
1844.01-1913.12	-6.76	-0.42	-4.46	-1.65
1952.01-1997.06	-2.03	-1.59	-1.68	-1.65
1997.07-2008.12	0.43	-2.59	-0.82	-1.65
First Difference				
1844.01-2008.11	-32.32	-32.91	-29.95	-1.65
1844.01-1913.12	-22.58	-28.08	-21.00	-1.65
1952.01-1997.06	-15.08	-16.75	-18.11	-1.65
1997.07-2008.12	-3.20	-8.59	-6.61	-1.65

Null Hypothesis of unit root. Critical-value lower (more negative) than -1.65 means rejecting unit root hypothesis
Dickey Fuller test includes intercept.

For the regimes we characterize as the post-World War II discretionary policy (1952-1997) and inflation targeting (1997-2008), the test results are mixed. For the first of these regimes, the short-term and wholesale price inflation rates appear to be stationary while only the long-term rate appears stationary in the second. Because we want to test whether the policy change between these two periods was in fact a significant regime change we perform some further test of the properties of the series. These tests are the Phillips-Peron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The null is the presence of the unit root for the first of these and stationarity for the second.

The PP tests results parallel those of the ADF tests. The KPSS tests, however, reject stationarity of *all* the series for both the 1953-1997 and 1997-2008 periods at the 0.10 level.

The interest rate variables are our central focus. We will proceed by assuming that either these series are in fact stationary, an assumption often made on theoretical grounds for interest rates; or that the two rates if non stationary they are co-integrated. In either of these cases, VAR estimation with the interest rates as percentages and inflation (CPI or WPI) as a log first difference will result in consistent estimates.[6]

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[6] See Sims, Stock and Watson (1990) and Lutkepohl and Reimers (1992)

Prior to proceeding in this way, we run tests for co-integration. The VARs we estimate will contain the two interest rates (2-variable system) or the interest rates plus the CPI or WPI inflation rate (3-variable system). The time periods of interest are the two post-World War II policy regimes. For each of these systems except one the Johansen test rejects the null of zero co-integrating vectors at the 0.10 level. The exception is for the case of the 2-variable system for 1997-2008.

Figure 2

UK: Long-term and Short-term Interest Rate
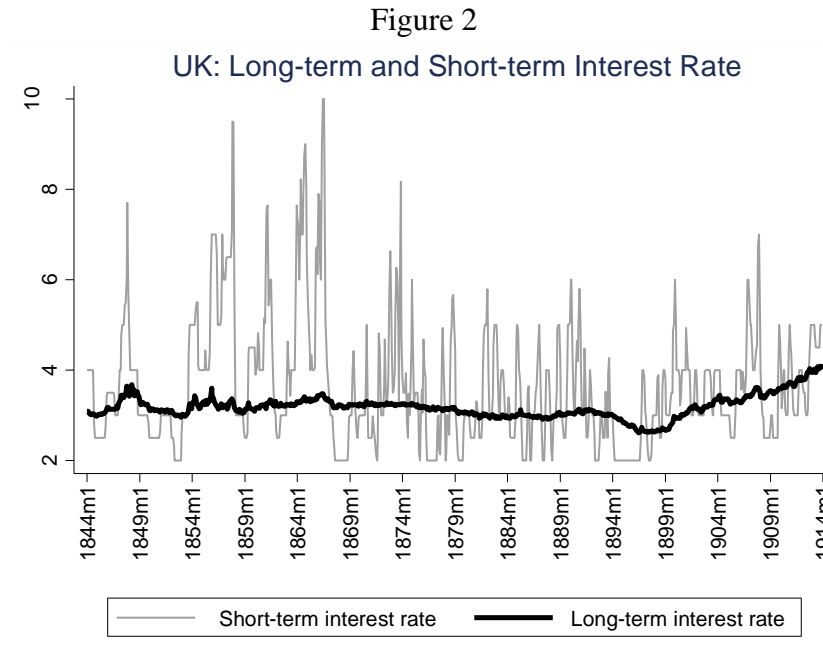
The selection of the lag length of the VAR is also a critical issue. Not enough lags usually generate non robust estimates of parameters. On the other hand a large number of lags consume important degrees of freedom. For some periods we consider a large sample that allows us to add several lags. For others degrees of freedom are more of a consideration. From a theoretical point of view the number of lags should not be large. The expected pass-through from short-term interest rate to long-term interest rate should be almost immediate or very short if markets are efficient. The dynamics of the relationship will, however, involve other variables.

Table 4 shows the results of several standard tests for the optimal lag length. The lag span selected was 4 based on the Hannan and Quinn information criterion and Schwarz information criteria. Three other criteria indicate a longer 9 lag specification as optimal. Note the lag tests were performed over the period 1844-2008 to allow for a general guideline for periods in later analysis. In some cases for sub periods we will simply choose a lag length of 12—a common choice with monthly data.

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Table 4: Lag Selection Criteria

Lag	LR	FPE	AIC	HQIC	SBIC
0		25.182100	3.22410	3.22410	3.22410
1	15332	0.010457	-4.56252	-4.55835	-4.55117
2	436.46	0.008411	-4.78024	-4.77189	-4.75753
3	91.559	0.008061	-4.82270	**-4.81018***	**-4.78864***
4	9.8275	0.008054	-4.82362	-4.80694	-4.77822
5	7.2816	0.008057	-4.82326	-4.80240	-4.76650
6	4.2764	0.008072	-4.82137	-4.79634	-4.75326
7	1.4088	0.008099	-4.81802	-4.78882	-4.73856
8	16.177	0.008066	-4.82217	-4.78880	-4.73136
9	**16.346***	**0.008032***	**-4.82641***	-4.78887	-4.72425
10	4.8032	0.008045	-4.82479	-4.78308	-4.71128
11	7.5216	0.008047	-4.82455	-4.77866	-4.69968
12	2.3471	0.008070	-4.82167	-4.77162	-4.68546

LR: Likelihood Ratio Test
FPE: Final Prediction Error
AIC: Akaike Information Criteria
HQIC: Hannan and Quinn information criterion
SBIC: Schwarz Criteria
Lag selection was performed over 1844.01-2008.12

3. The Gold Standard

Hawtrey's main focus was on the period when the Bank of England operated under the 1844 Bank Charter Act. The act split the banking and note issue functions of the Bank. Note issue by the Bank was tied to the gold bullion reserve that the Bank held. During this period the Bank rate was the main instrument of policy.

The task for the bank rate was to keep the gold reserve at the proper level. An increase in the Bank rate would, for example, cause a rise in net imports of gold. This would be due to funds attracted by the higher rate but also due to a fall in imports of goods as the level of domestic economic activity fell due to the higher rate. This Hawtrey termed a fall in the external drain. Also a fall in the level of domestic economic activity would lead to a fall in the internal drain as less gold was used in domestic transactions. During much of the period there was a ban on issuance of notes of less than five pound denominations. Thus much currency demand was a demand for gold coin.

3.1 The Transmission Mechanism

The particular mechanism by which Hawtrey believed that the Bank rate would affect trade was that a rise, for example, would "make traders less willing to hold stocks

of goods with borrowed money (p.162)". Once a credit cycle was underway, however, other areas of trade were affected. The price level and levels of output and employment would fall.

The short-term rate was then the key link as the Bank rate affected the rates offered by the discount brokers who provided credit to traders. And while Hawtrey allowed that "It may be taken as axiomatic that the short-term rate of interest has some relation to the long-term rate… It is rather slight (p.146)". To be substantial the effect must be expected to be permanent and this will not be the case.

3.2 VAR Analysis

To examine the operation of monetary policy during the Gold Standard period Hawtrey compiled an impressive data set. In addition to data for the Bank rate and the price of Consols over a nearly 100-year period, his data set included observations at various frequencies for bullion reserves, wholesale prices, net imports of gold, the internal drain of gold from reserves, and unemployment among others. His examination of the data took what we would call today the narrative approach. We supplement that examination in a more formal way with impulse response functions computed from estimated VARs in this sub section. In the next sub section we consider estimates of rolling regressions.

For the data from Gold Standard era, the unit root tests in Table 3 provide strong evidence that the Bank rate series is stationary. For consistent estimation of the VAR it must then be the case that the yield on Consols is a stationary series for this period albeit one with a high degree of auto-correlation. Under this assumption we estimate VARs and calculate impulse response functions for 1844-1913.

The first impulse response functions are from an estimated 2-variable VAR containing on the Bank rate (STIR) and the yield on Consols(LTIR). These impulse responses are shown as the solid lines (marked Basic) in Figure 1. The response of the long-term rate to the bank rate is as Hawtrey argued rather slight, less than 5 basis points per one percentage-point change in the Bank rate. The Bank rate shows a larger response to the yield on Consols. Hawtrey observed this in his analysis of the data and ascribed it to the effect of common influences on the two rates.

To examine this possibility and to check the robustness of our estimate of the effect of the Bank rate on the long rate, we estimate two 3-variable VARs. The additional variable in the first of these is the rate of inflation as measured by the wholesale price index. In the second the added variable is the ratio of the gold bullion reserve to total

Bank of England liabilities. Impulse responses of from the first of these specifications are shown as the dotted lines in Figure 3 (marked Robust_I) and for the second by the dashed lines (marked Robust_II).

The estimated response functions of the LTIR to STIR innovations show a similar pattern to the one described before. The response of STIR to LTIR is reduced somewhat by the inclusion of inflation in the VAR.

Figure 3: Impulse Response Functions - Robustness
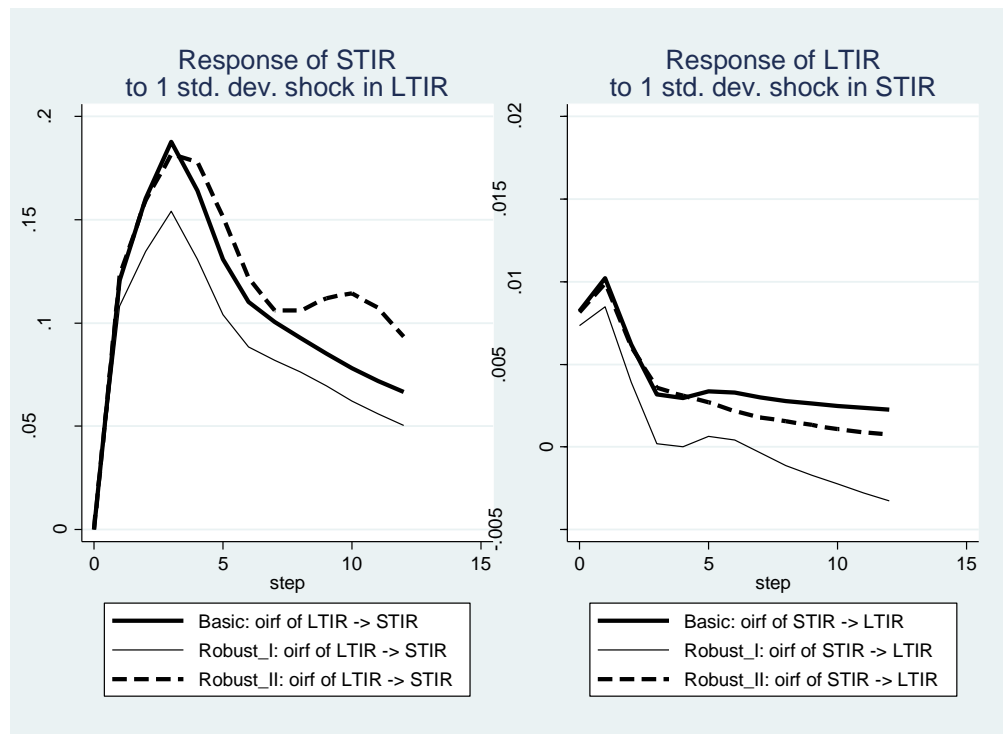
3.4 Estimates of Rolling Regressions

The English historian C.V. Wedgewood pointed out that history is written from standpoint of the end back to the beginning. The historian never knows what it was like to be present at the creation and thus know the beginning only. The nineteenth century Gold Standard was a durable monetary policy regime but that wasn't known in 1844. The not too distant past at that point had witnessed a World War lasting almost a quarter century costing 300,000 British lives and over a billion pounds. The monetary turmoil during and following the wars with Napoleonic France consisted of inflationary and deflationary periods described, for example, in Viner (1965). The 1844 Bank Act was a subject of heated controversy between the Banking School and Currency schools.

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In this paper we examine the response of the long-term interest rate to the short-term policy rate as a measure of the degree that the monetary regime anchored long-term inflationary expectations. In this sub section we examine the estimates of this response coefficient from rolling regressions to measure how quickly the regime set up by the Bank Act of 1844 gained credibility and the degree to which that credibility was threatened by various crises in later years.

The procedure is to estimate the following simple model on a 36-month rolling basis

$$(1) \ \text{LTIR}_t = \beta_1 * \text{STIR}_t + \text{C}$$

Prior to examining the Gold Standard years in particular, in figure 4 we show the rolling regression coefficients for the whole period (1844-2009)[7]. The chart shows clearly that the Gold Standard era was, as measured by this metric, a regime where long-run inflationary expectations were anchored to a much greater degree than in any that followed.

Figure 5 shows the results of the estimation for just the Gold Standard (January 1848- December 1915)). Here with the different scale, variation in the estimated coefficients can be seen more easily. The estimated coefficients showing the response of the yield on Consols to the Bank rate are most stable and closest to zero over a period from approximately the late 1850s to the mid-1890s. Prior to that, from 1848-1857 there is what may be a period when the regime gains credibility and the response coefficient declines. From the mid-1890s, there is more variation in the estimate of the response coefficient and an upward movement over the last five years or so.

There are two other features of figure 5. First, in addition to showing the coefficient from a simple regression of long-term rate on the Bank rate, the chart shows the plots of this coefficient estimated from two regressions containing additional variables. One (the dotted line) shows the estimated response coefficient from a regression which adds the inflation rate (measured by the rate if change in the CPI) as a variable[8]. The second (the dashed line) is from a regression adding the ratio of bullion reserves to Bank of England liabilities. The pattern of the estimates follows the same

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[7] The coefficient estimates for the model are given in Appendix C. This appendix also shows estimated coefficients of the expanded models in Figure 5.

[8] The CPI inflation rate is used here for comparability with charts for later sub periods. Because monthly data is available only post-World War I, monthly observations are interpolated from annual data.

pattern as the estimate from the simple regression. Variation in the estimated response coefficients are not due the common influence on both interest rates from these additional variables.

The second feature in figure 5 is the inclusion of the dates of a number of domestic and international crises that may have been perceived as threats to the stability of the gold standard. The dates included were chosen before constructing the chart, most directly from G.M. Trevelyan's (1937) *British History in the Nineteenth Century and After (1782-1919).* Wars and other international events may have had an effect at the beginning and end of the period. During the period referred to above as one of highest stability (late 1850s to mid-1890s), little effect is apparent. Near the end of the period one can see a rising pattern in the coefficients accompanying the international events that culminated in World War I.[9]

The impulse response functions in Figure 3 and the coefficients from rolling regressions shown in figures 4 and 5 provide support for R.G. Hawtrey's conclusion the during the Gold Standard era monetary policy actions via changes in the Bank rate had "rather slight" effects on the long-term interest rate measured as the yield on Consols. In our interpretation this was at least in part due to the fact that the monetary regime anchored long-term inflationary expectations.

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[9] Between 1910 and 1914 there were the Balkan Wars, a Russian-Austrian crisis and for Britain a crisis over the Irish question that threatened an army mutiny.
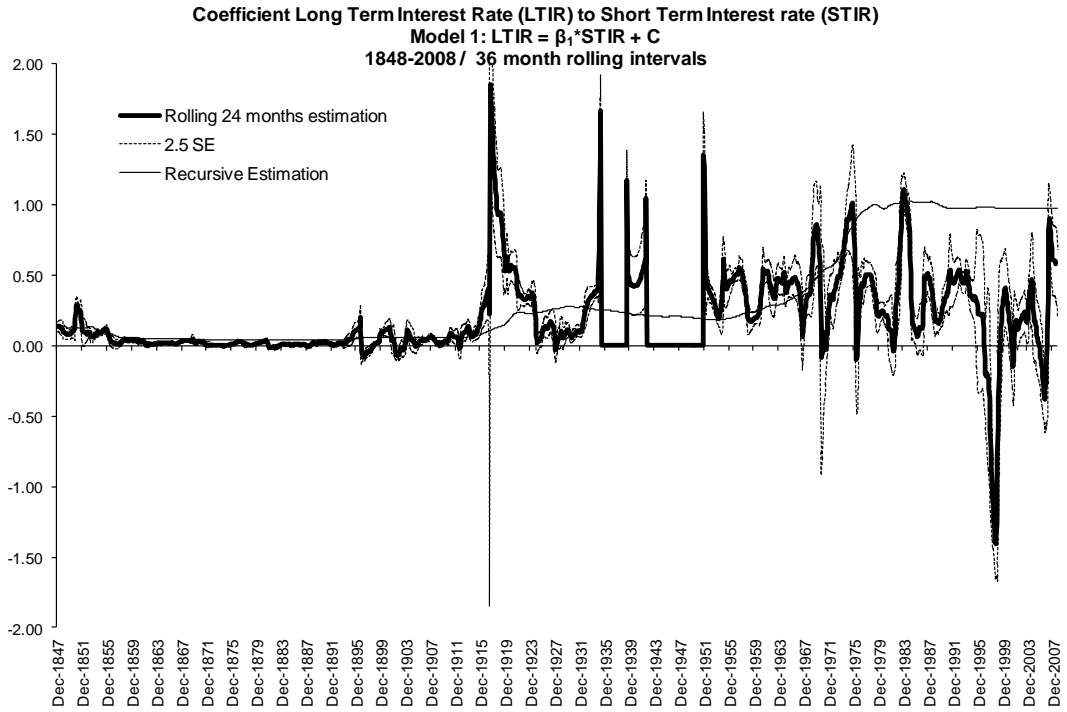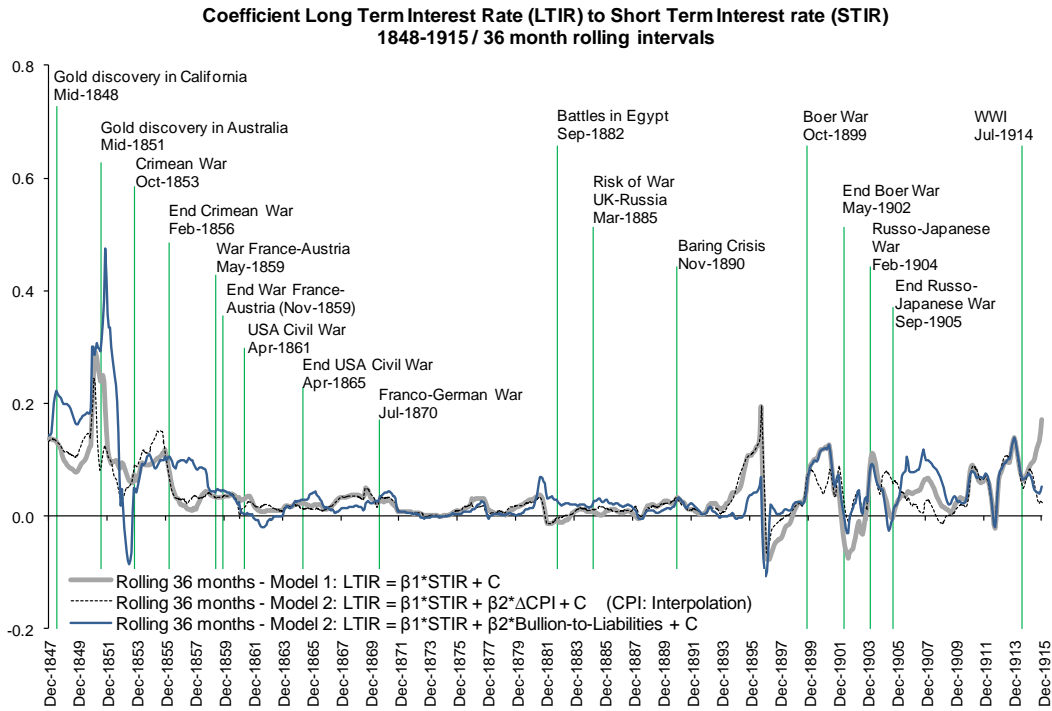
Figure 4

Coefficient Long Term Interest Rate (LTIR) to Short Term Interest rate (STIR)
Model 1: LTIR = β_1*STIR + C
1848-2008 / 36 month rolling intervals

Figure 5

Coefficient Long Term Interest Rate (LTIR) to Short Term Interest rate (STIR)
1848-1915 / 36 month rolling intervals

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4. Policy by Discretion: 1952-1997

The aim here is to consider policy regimes which differ in the degree that they are likely to have anchored long-term inflationary expectations. The time period examined in this section (1952-1997) is one we characterize as policy under discretion. It is a period of 56 years and there were certainly changes in policy objectives and procedures during these years. We will take these into account but for believe that its characteristic of policy by discretion is the defining feature.

For approximately the first half of the period Keynesian principles were central to policymaking. Keynes (1930, p.234) had written that one would not " expect that the rules of wise behavior by a central bank could be conveniently laid down—having regard to the immense complexity of its problems and their varying character in varying circumstances—by act of Parliament." Good policy required discretion. The latter half of the period was heavily influenced by Margaret Thatcher's version of "monetarism" not Keynesianism. But Thatcher also leaned towards discretion. She famously commented that Britain did not need to join the EMS because if she wished the pound to shadow the German mark she could achieve this; if she did not see such a policy as desirable, outside the EMS she was free to do otherwise--so much for the benefits of policy by commitment. For almost the whole of the period of Conservative Party government from 1979 until 1997 ultimate authority over interest rate policy rested with the Chancellor of the Exchequer.

4.1 Views of the Transmission Mechanism

By the early 1950s, the Keynesian view of the monetary transmission mechanism was dominant. According to this view, monetary policy works via the effect of the long-term interest rate on fixed investment. Details were worked out in the *Treatise on Money (1930)*. The Hawtrey Effect was as Hicks (1967) put it a "dead letter". Thus the transmission mechanism was predicated on monetary policy having substantial effects on long-term interest rates. At the time this does not seem to have been in doubt. Here again Keynes view had won out over Hawtrey's. The fact that the policy regime had changed was important here. Hicks noted that since the mid-1930s, the long rate had become "remarkably variable." Whether policy induced changes in the Bank rate would affect the long rate depended on whether it "looks as if it (the Bank of England) means business."

Doubts about the effectiveness of monetary policy centered instead on the effects of

long-term interest rates on investment. Hick was among the doubters calling the Keynes Effect also a dead letter. The view expressed for, example, in the Radcliffe Report was that "interest rates of themselves have little or no effect on spending decisions."[10] This did not necessarily lead to the view that monetary policy was ineffective though some reached that conclusion. Other emphasized the credit availability channel and wealth effects.[11] Those effects, however, also worked predominantly via the long-term interest rate as in Keynes's view.

Thus, during this period the link between the short-term policy rate and the long-term interest rate was a key one in the transmission mechanism. We turn to examining that link.

4.2   VAR Analysis

Figure 6 shows impulse response functions from a two-variable VAR containing the short and long-term interest rates, our modern version of Hawtrey's *ad hoc* statistical investigations. As explained in Section 2 we specify the interest rate variables as percents. The lag length for the VAR estimation is twelve.

In contrast to the corresponding impulse response functions for the Gold Standard period in Figure 3, Figure 6 shows a substantial significant response of the long-term rate to the short-term policy rate. In response to a one percentage-point rise in the policy rate the long term rate initially rises approximately 0.4 percentage points. The response declines gradually and is significant for 21 months. There is also a significant response of the short-term rate to the long rate. This perhaps represents the effects of other variables.

Figure 7 contains impulse response functions calculated from estimates of a three-variable VAR where the CPI inflation rate is added to the system[12]. The estimated response of the long-term rate to the policy rate is much the same as in Figure 6. Both the short and long-term rates respond positively and significantly to the inflation rate. The response of the short rate to the long is much diminishes with the inflation rate included in the system.

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[10] See Gurley J. (1960) "The Radcliffe Report and Evidence," p.674

[11] See, for example, Robert Roosa (1951).

[12] We also estimate a three variable VAR with WPI inflation. Impulse responses from that system show a response of the long rate to the policy rate very similar to those in Figure 6. A difference is that the short-term rate shows much less response to WPI relative to CPI inflation. The response of the long rate is somewhat smaller.

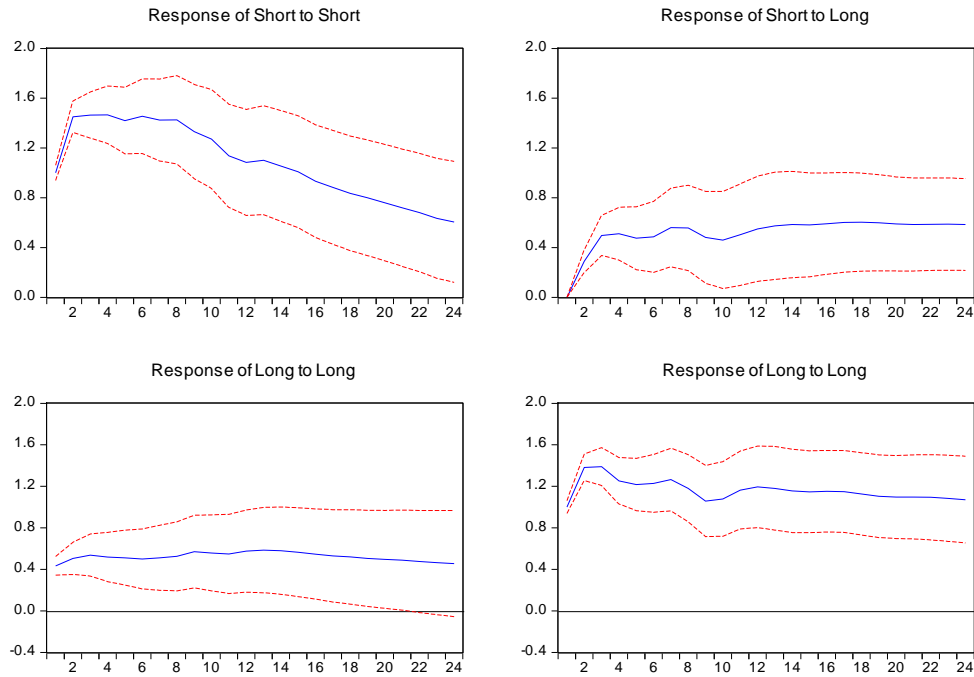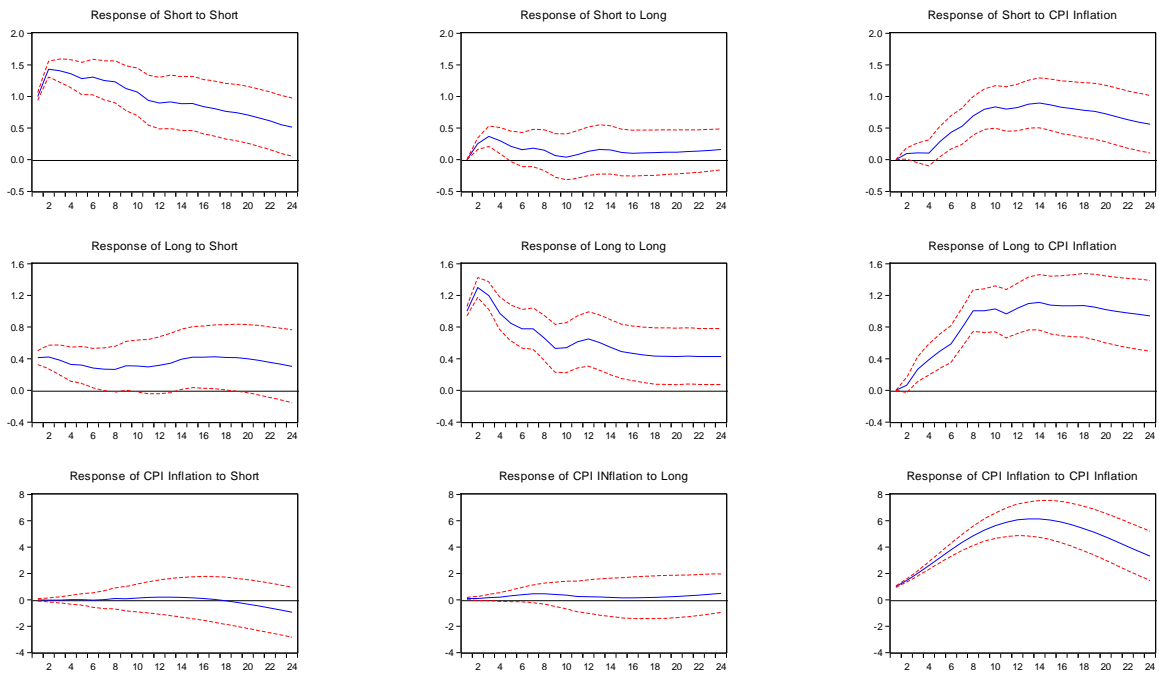## Figure 6: Post-WWII Period (1952-1997): Interest Rates

Response of Short to Short

Response of Short to Long

Response of Long to Long

Response of Long to Long

Figure 7: Post WWII Period (1952-1997): Interest Rates and CPI Inflation

Response of Short to Short

Response of Short to Long

Response of Short to CPI Inflation

Response of Long to Short

Response of Long to Long

Response of Long to CPI Inflation

Response of CPI Inflation to Short

Response of CPI INflation to Long

Response of CPI Inflation to CPI Inflation

The impulse response functions in Figure 7 show little effect on inflation either directly from the short-term rate or indirectly through the long rate. There is, however, no

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price puzzle.

The results in Figures 6 and 7 are consistent with long rates being more sensitive to changes in the monetary policy rate in this regime of policy by discretion where there was no explicit anchor to long-term inflationary expectations. There were of course other factors at work and other explanations for the results.

4.3 Results from Rolling Regressions

The other investigative tool we use is a rolling regression technique. Regressions are run over rolling 36 month intervals. We run a simple regression of the long rate on the short rate and another adding the CPI inflation rate to control for one common factor influencing both rates. Figure 8 plots the coefficient on the short-term policy rate in these rolling regressions over the years 1953-1997. The figure also shows the dates of some events that might have been sources financial instability. Some of these were clearly more serious than others.

As in the Gold Standard period if a crisis threatens changes in the policy regime it will increase uncertainty about long-term inflation and this will in turn make the long-rate more sensitive to changes in the policy rate. As Hicks (1967, p.94) put it during these years "no one knows how long a crisis will last so a rise in the short term rate has more effect than implied by its arithmetic effect"

Figure 8
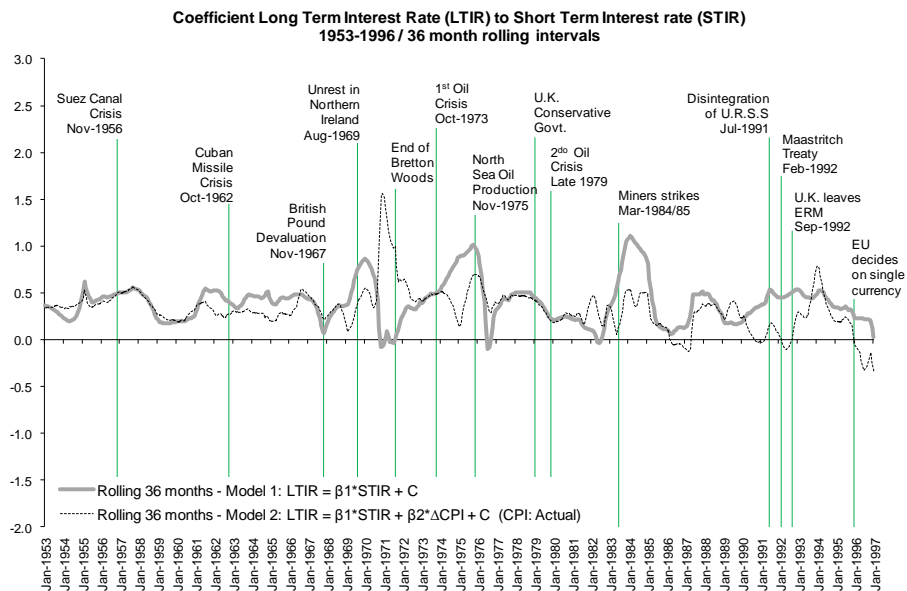
The chart shows that the response of the long rate to the monetary policy rate as

measured by the coefficient in the rolling regression was more volatile in the flexible exchange rate part of the period. There is also some pattern of higher responses in crisis periods such as the Suez crisis, years leading up to the breakdown of the Bretton Woods system, the first oil shock in the mid-1970s and the recession and year-long miner's strike in the early to mis-1980s. Adding the inflation rate to the rolling regression reduces the variation in the coefficient on the short rate but in most cases does not change its pattern.[13]

5. Inflation Targeting: 1997-2013

Formal inflation targeting begins in May of 1997 with the granting to the Bank of England of full operational independence within an inflation targeting framework. One advantage cited for inflation targeting is that commitment to a numerical target inflation rate will anchor long-run inflationary expectations. As explained in the introduction, one result should be that long-term interest rates will become less sensitive to changes in the short-term policy rate as well as other nominal disturbances in the economy.

The inflation targeting framework in the United Kingdom is still in effect. Beginning in 2009, however, the policy rate hit its effective lower bound and since then has not been the main policy instrument. Our examination the effects on the long-term interest rate resulting from changes in the policy rate is therefore confined to the 1997-2008 period.

5.1 Views of the Monetary Policy Transmission Mechanism

We argued at the beginning of the previous section that the framework guiding the discretionary policy framework of the immediate post-World War II years was Keynesian macroeconomic theory. The guiding theory behind inflation targeting as practiced by the Bank of England and other central banks would appear to be the New Keynesian models, especially the monetary policy models of Michael Woodford and Lars Svensson[14]It is useful then to begin by examining the transmission mechanism in the

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[13] An exception is in the years before the breakdown of the Bretton Woods system.

[14]A key reference for these models is Woodford (2003). It should be said that no central bank strategy is determined by a particular theory. Central bankers are subject to many influences. Still different strategies have their formal underpinning in economic theories especially in this era where most many central banks

New Keynesian model.

      A central relationship in the New Keynesian monetary policy model is the forward-looking Phillips Curve which can be written as

(2) $\pi_t = E_t\pi_{t+1} + \alpha y_t + u_t$

Where π is the inflation rate, y is the output gap, u is a productivity shock, and E_t denotes the rational expectations operator. Inflation targeting influences actual inflation by managing inflationary expectations.

      Monetary policy also operates within the framework by controlling the output gap via control of the short-term interest rate. This channel can be seen from the second structural equation of the New Keynesian model often termed the *IS* equation though it is actually a form of the consumer's Euler equation

(3) $y_t = ar_t + bE_t y_{t+1} + c$

where r is the short-term interest rate which is "under the control of the central bank." Often the short-term interest rate is specified as following a "Taylor Rule"—though not in the Svensson and Woodford variants of the model[15].

      The model places the New Keynesians in the camp of the "short-enders" with Hawtrey rather than the "long-enders" with Keynes. There is no role for the long-term interest rate in the model. In New Keynesian models that add a term structure equation [e.g. Gurkaynak, Sack and Swanson (2005)] the long-term bond is a redundant asset[16].

      It is not accidental that inflation targeters should be "short-enders". In the Introduction we quoted Ben Bernanke's (2004) statement that the apparent high sensitivity of nominal long-term rates to Fed actions suggests some uncertainty about the Fed's long-run inflation target." An implication of this view is that with a long-run inflation target firmly anchored by a credible inflation targeting regime, the long-term interest rate will be largely unresponsive to movements in the policy rate .

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are headed by monetary economists.

[15] On this point, see Svensson (2003).

[16] Should the model then be called the New Hawtrey rather than New Keynesian model: Probably not. It is of interest that some versions of the model resuscitate the Hawtrey effect in the form of the working capital channel. See for example Ravenna and Walsh (2006).

5.2   Evidence from VARs

Figure 9 shows impulse response functions calculated from a two-variable VAR containing the long-and short-term interest rates for the period May 1997-December 2008. Details of the specification of the VAR are the same as for those in the previous section.

The figure indicates that a one-percentage point rise in the short-term policy rate increases the long-term rate substantially for a short period though the confidence interval is quite wide. The effect, however, is insignificant after 3 months and becomes negative (though insignificant) after 8 months. This is in contrast to the 1952-1997 period (Figure 6) where the effect of the policy rate on the long-term rate is substantial, positive and significant for almost the whole 24 months covered by the impulse response function.

The impulse response functions in Figure 10 are calculated from a 3-variable VAR that includes the CPI inflation rate as well as the two interest rates. The impulse response of the log-term rate to the short-term policy rate is very small and only significant for a few months.

Figure 10 also indicates very little response of CPI inflation to the policy rate. This might not, however be of concern to supporters of inflation targeting who believe that the expectations channel is most important for control of inflation.

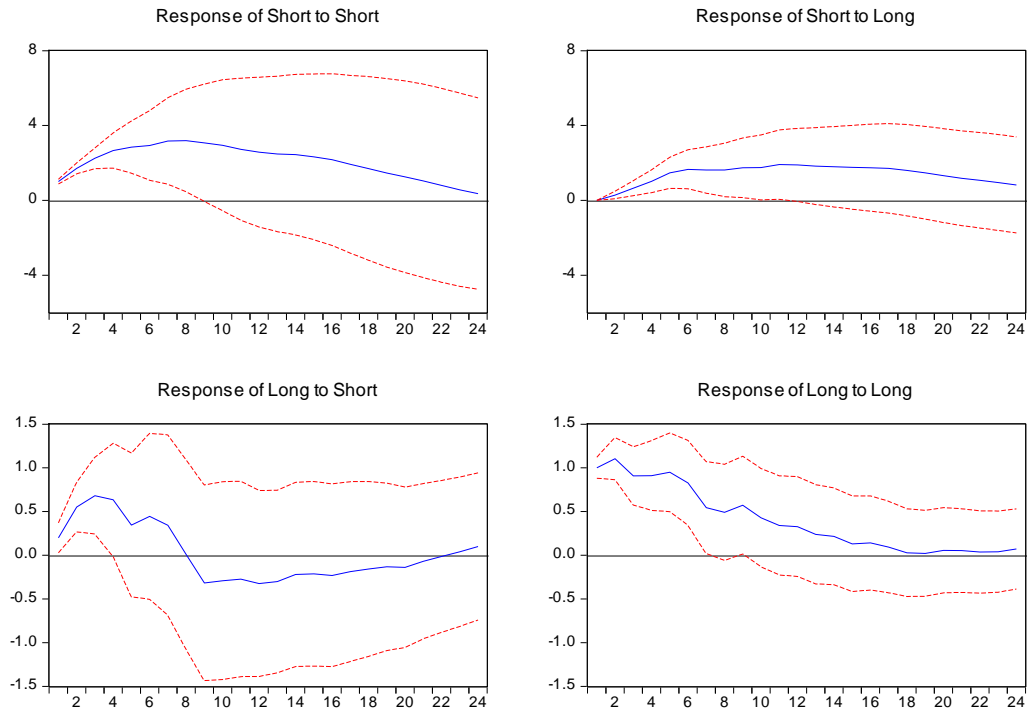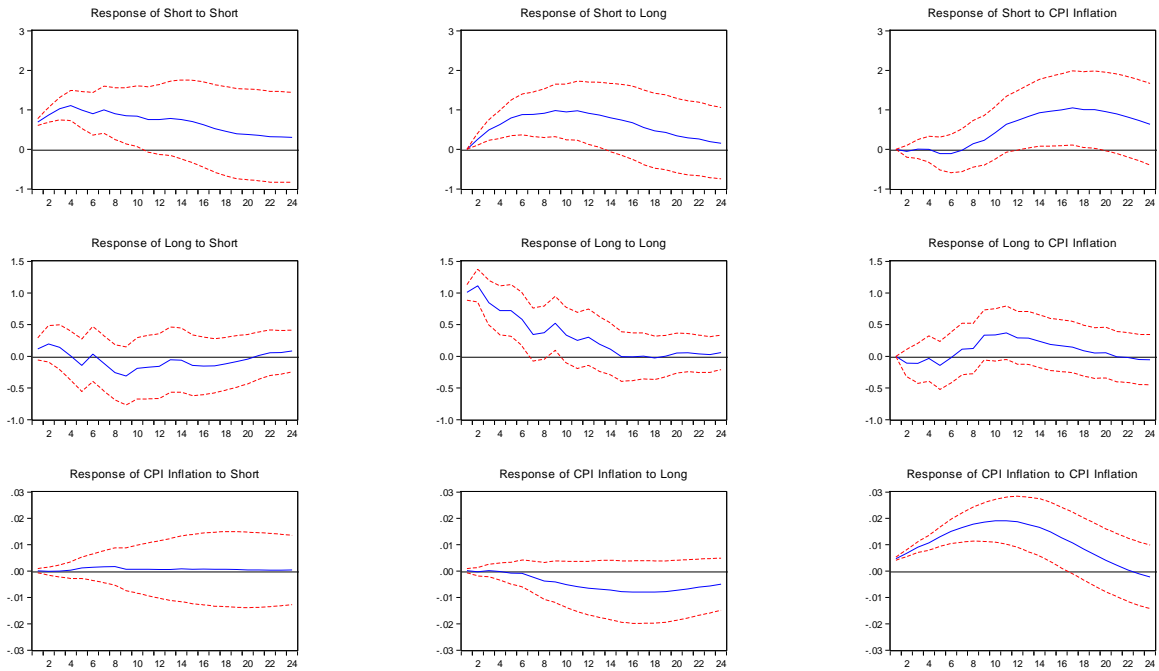## Figure 9: Inflation Targeting (1997-2008): Interest Rates

Response of Short to Short

Response of Short to Long

Response of Long to Short

Response of Long to Long

Figure 10: Inflation Targeting (1997-2008): Interest Rates and CPI Inflation

Response of Short to Short

Response of Short to Long

Response of Short to CPI Inflation

Response of Long to Short

Response of Long to Long

Response of Long to CPI Inflation

Response of CPI Inflation to Short

Response of CPI Inflation to Long

Response of CPI Inflation to CPI Inflation

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5.3 Results from Rolling Regressions

Figure 11 shows the coefficient on from a simple rolling regression of the long-term rate on the short-term rate and from a regression which adds the CPI inflation rate as a control. The rolling regressions are for 36-month sample for the period May 1997 to December 2009.

Figure 11

Coefficient Long Term Interest Rate (LTIR) to Short Term Interest rate (STIR)
1997-2009 / 36 month rolling intervals
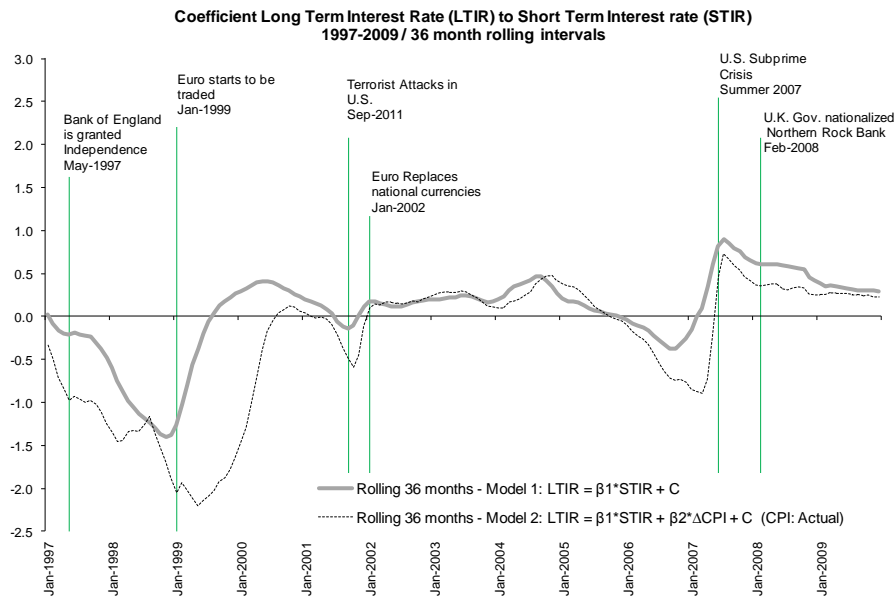
As with the impulse response functions, estimated responses of long rates to policy actions for the inflation targeting years are quite different from those in the 1952-1997 period. For the first 2-3 years the response coefficients are negative. Increases in the policy rate, for example, reduce the long-term rate. Inflation targeting began with Gordon Brown's announcement of Bank of England operational independence on May 6, 1997. The policy regime was formalized by legislation in October 1997 with an effective date of June 1, 1998. Over the period from the May 1997 announcement to the June 1998 effective date the short-term rate rose from 6.2 percent to 7.5 percent while the long-term rate fell from7.9 percent to 6.3 percent. This is the pattern reflected in the coefficient from the rolling regressions over the late 1990s. A plausible explanation is that as the inflation targeting regime gained credibility long-term inflationary expectations became better anchored at the low target level and the long-term interest rate fell. This is consistent with the finding of Gurkaynak, Levin and Sack (2010, p.1216.) that "far-forward inflation compensation" fell sharply over this interval.

For 1997-2009 as a whole, the estimated coefficients on the policy rate are generally smaller when positive—relative to the preceding period—or negative. The

estimated coefficients do rise sharply in the months leading up to the financial crisis in 2007-08 then fall back.

Taken together the results from VAR analysis and the estimated rolling regressions show much less evidence of a channel for monetary policy via an effect on the long-term interest rate—the channel emphasized by Keynes.

6. The Interwar Years

The period between the World Wars would have been the hardest in which to form expectations of long-run inflation rates or anything else. From the standpoint of a policy regime, Britain formally left the Gold Standard in 1919, returned to it in 1925 and left again in 1931. Post-1931 there was no formal monetary policy or exchange rate regime. The interwar period was characterized by high inflation followed by deflation with high unemployment throughout the period. Although Keynes's theory of the monetary policy transmission mechanism is not grounded directly in uncertainty about the monetary regime, it is in line with his view of expectations formation in this very uncertain environment. In this view articulated most fully in Chapter 12 of the *General Theory* and Keynes (1937) he argued that "Knowing that our own individual judgment is worthless, we endeavor to fall back on the judgment of the rest of the world, which is perhaps better informed….The psychology of a society of individuals each of whom is endeavoring to copy the copy of the others leads to what we may strictly term a convention judgment [Keynes (1937), p.214].

6.1 Views of the Monetary Policy Transmission Mechanism

Keynes deprecated the Hawtrey effect. D.H. Robertson (1937, p.94) states Hawtrey's view that "decisions of merchants to alter the size of their stocks can be an almost completely effective instrument for controlling the level of economic activity." Keynes (1930, p.130) argues that "it is not reasonable to assign to the *expense* of high Bank rate a preponderating influence on the dealers in stocks." Expectations of price movements would be of much greater importance.

An interest rate channel is important in the Keynesian monetary policy transmission mechanism but is the long-term rate that matters. The role of monetary policy, laid out in the *Treatise Vol.2,* is to control fixed business investment and thus stabilize aggregate demand.

6.2 Keynes's Empirical Investigations

Keynes's transmission mechanism requires an effect on the long-term rate from changes in the Bank rate. Hawtrey's empirical research, which is supported by the results in Section 3, found only very weak effects on the yield on Consols as a result of changes in the Bank rate.

Relying on annual data from 1919-1929 in the *Treatise* Keynes reaches a different conclusion. He argues that if one takes account of the fact that the amplitude of the Bank rate series is four times greater than that of the yield in Consols, the two series move closely together (p.316). A one percentage-point change in the Bank rate might be expected to result in a 0.25 percentage-point change in the yield on Consols with larger effects on other longer-term rates.

We formalize his test with a simple regression of Consols' yield on the bank rate (both which Keynes expressed as index numbers, base=100 in 1924)[17].

The result is

(4)   Yield = 71.2 + 0.28 Bank Rate R^2 = 0.85   D.W.= 0.83
                (4.75)   (7.02)

The coefficient on the Bank rate is quite close to Keynes's posited value of 0.25 and significant (t-statistics are shown in parentheses).

6.3 Results from VAR Analysis.

Keynes's analysis looks at only annual data from the first half of the interwar years. A more thorough analysis of the data is called for. The period does, however, pose problems for empirical research. Regime shifts within the period are a serious possibility especially with resumption of the Gold Standard and then its demise. Moreover, the Bank rate is set at 2 percent from June 1932 until the end of the period. Recognizing these problems we postponed an examination of this period until after consideration of the other regimes. We proceed with caution with the estimation of VARs.

For estimation we end the sample with March 1933 to eliminate most of the months when the bank rate was fixed at its minimum value. We look for evidence of

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[17] We do not make Keynes's adjustment for the amplitude of fluctuations in the series. A regression of the yield on Consols on the Bank rate where both are percentages yields a coefficient of 0.30.

variation in the response of the long rate to the bank rate in rolling regressions in the next section. The specification of the VARs is the same as previous sections. The interest rates are entered as percents and the inflation rates are log first-differences.[18] Impulse response functions are shown in Figures 12-14.

Figure 12: Interwar Years (1919-1933): Interest Rates
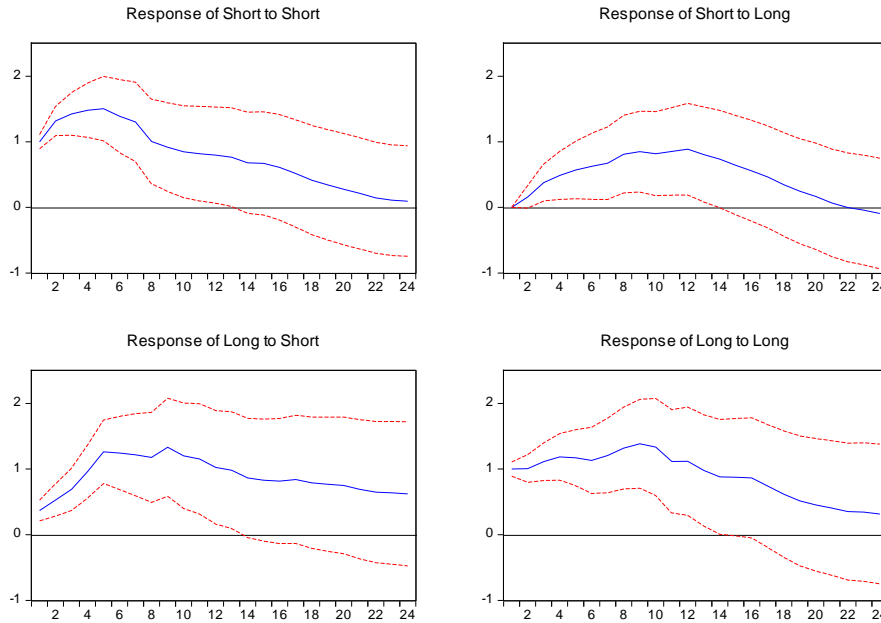
The impulse response functions in Figure 12 are from a VAR containing only the two interest rates. The response of the yield on Consols to a one-percentage-point rise in the Bank rate is substantial peaking a more that one for one then falling back to zero by the end of the 24-month period. The effect is significant for 13 months. The response pattern is quite similar in the impulse response functions from a 3-variable VAR where WPI inflation is the added variable (Figure 14). When the CPI inflation rate is the third variable (Figure 13), the response of the yield on Consols to a rise in the Bank rate is smaller, peaking at 0.7 percentage points for a one percentage point rise in the bank rate. This response is significant for only 7 months[19].

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[18] Unit root tests for the interwar period fail to reject a unit root in either of the interest rate series but generally do reject a unit root in the inflation series. The Johansen co-integration test rejects the hypothesis of no co-integrating vectors for the VARs we run. Our assumption is then that the variables in the systems are stationary or (in the case of the two interest rates) co-integrated.

[19] Impulse responses were also calculated from VARs estimated through the end of the interwar years (1939:8). They are quits similar to those in Figures 6-8.

Both of the inflation series show negative responses to the bank rate and yield on Consols. These are, however, rather weak.

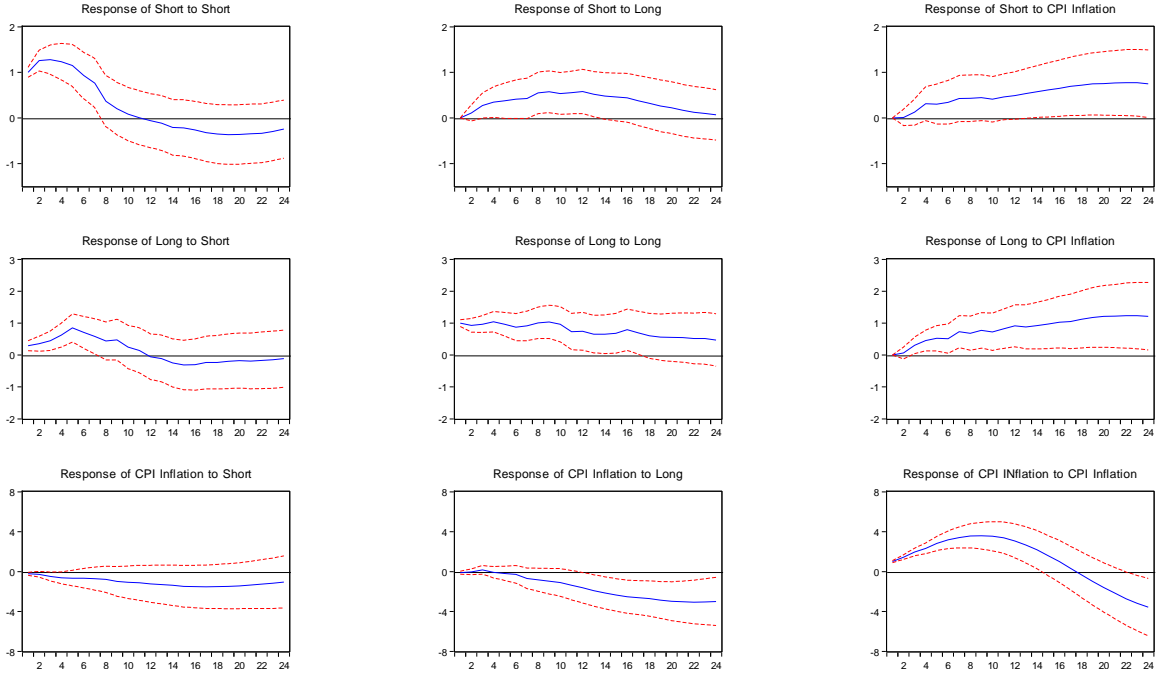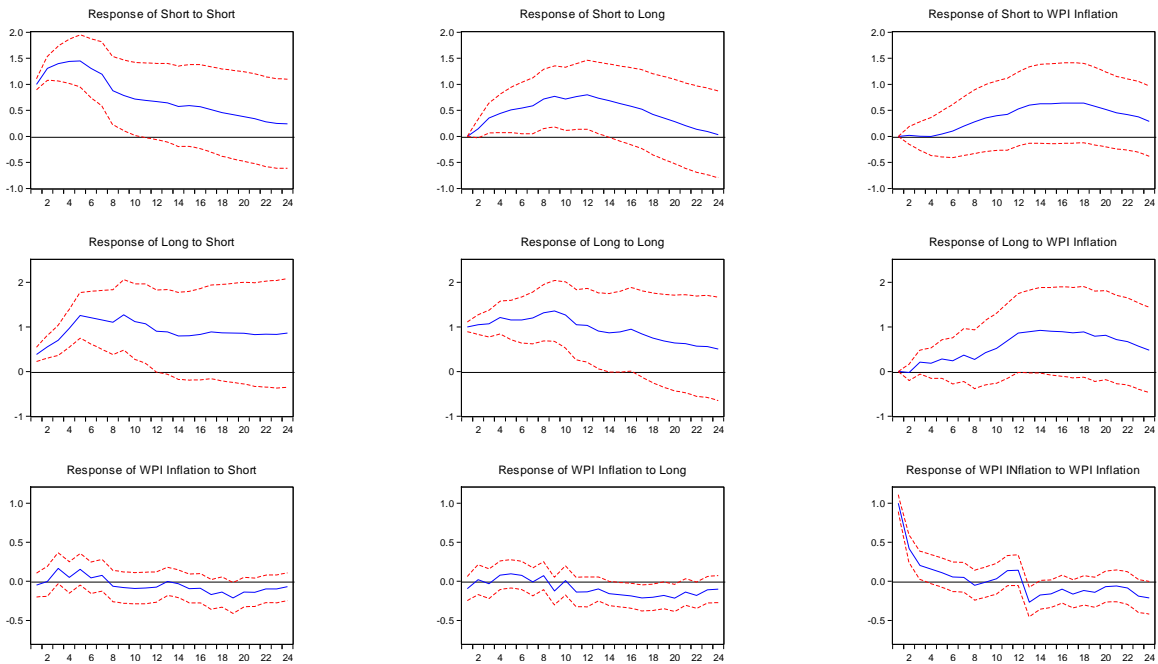Figure 13: Interwar Years (1919-1933): Interest Rates and CPI Inflation

Figure 14: Interwar Years (1919-1933): Interest Rates and WPI Inflation

6.4 Results from Rolling Regressions

Figure 15 shows a plot of the coefficient from a rolling regression of the Consol yield on the bank rate as well as from a regression that also includes the CPI rate of inflation. The rolling regressions are for 36-month intervals. The time period covers December 1920 to December 1932.

Figure 15

Coefficient Long Term Interest Rate (LTIR) to Short Term Interest rate (STIR)
1920-1933 / 36 month rolling intervals
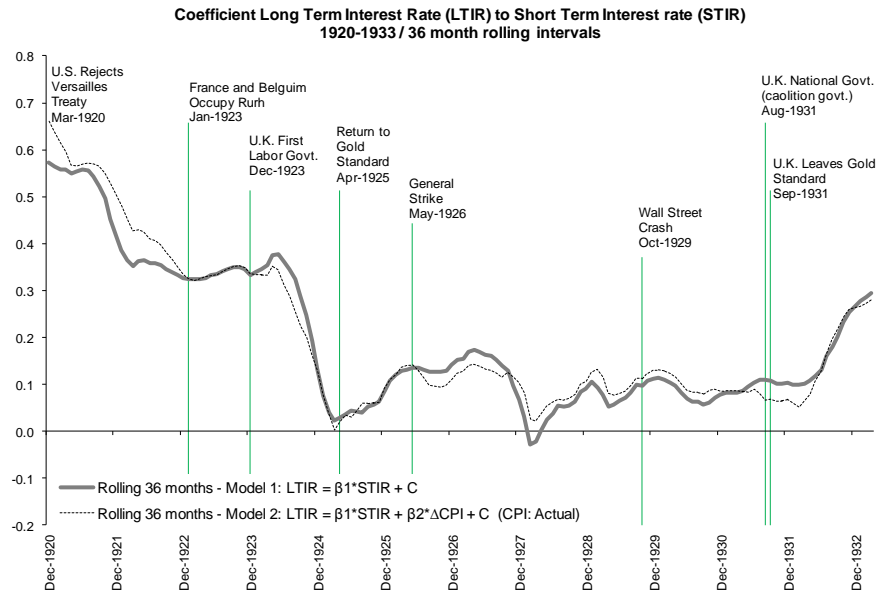
The estimated response coefficients are high at the beginning of the period (0.6-0.7) just after the official end of the Gold Standard in April 1919. The response coefficients then decline over a five year period. The decline is pronounced in the year leading up to the resumption of the Gold Standard in April 1925. The estimated response coefficients then remain mostly centered around 0.1 until Britain leaves the Gold Standard in September 1931. Thereafter the coefficients rise until the end of the period in December 1932.

Overall, the estimated coefficients follow a path consistent with an influence of the monetary regime on the response of the yield on Consols to the Bank rate. Many of other factors were, of course, at work.

7. Conclusion

R.G. Hawtrey was born in 1879 and would have taken it for granted that in times of peace long-run inflationary expectations were anchored by the Gold Standard. Given the

limited goals of monetary policy in that regime, changes in the Bank rate would have been expected to be temporary and have little effect on the long-term interest rate. This meant that the transmission mechanism for policy was via the short-term rate: the Hawtrey Effect.

Keynes was working in the interwar years, an era of much less certainty about the long-term inflation rate and much else. When Britain went off gold in September of 1931, the Bank rate was set at 6 percent due to fear of inflation. To Hawtrey "That was to cry Fire, Fire in Noah's flood (1938; p.145)." Keynes saw what he believed were more significant effects on long-term rates from changes in the Bank rate. He incorporated them into his view of the transmission mechanism by which changes in the long rate affected fixed investment: the Keynes Effect. The results here (Sections 3 and 6) support both Hawtrey and Keynes.

For the half century following World War II, although there was less monetary uncertainty than during the interwar years, our results indicate no return to the level of anchored inflationary expectations that existed during the Gold Standard era. During this period changes in the Bank rate (or other policy rate) continued to have significant sustained effects on the long-term interest rate (Figures 6,7 and 8). The Keynes Effect was operative. The goals of monetary policy had become more complex; policy was by discretion and whether changes in the bank rate would be maintained depended as Hicks put it on whether the public believed that the Bank of England "means business."

The move to formal inflation targeting in the late 1990s was a regime shift explicitly aimed at anchoring long-term inflationary expectations. One hoped for advantage was to reduce the effects on long-term rates from changes in the monetary policy rate and other short-run nominal disturbances. Our results are consistent with some success for the regime shift in this regard. An implication of this success is that the regime shift would weaken or eliminate the Keynes Effect. The monetary policy transmission mechanism would have to be via the short rate—some modern equivalent of the Hawtrey Effect. This is consistent with the New Keynesian models that provide the theoretical underpinning for inflation targeting.

In recent years given the zero-bound problem that has restricted the effectiveness of policy rates, major central banks have turned to additional policy instruments such as forward guidance and purchases of long maturity assets to try to influence long-term rates. Following the logic of our analysis such measures would be needed normal times as well if monetary policy is to affect long-term rates in a regime of well anchored long-run inflationary expectations.

Appendix A: Statistical data and Sources:

Short Term Interest rate (STIR): monthly average of the Bank of England rate. Source Bank of England. The series was constructed using:

- 01-Jan-1844 – 15-Oct-1972: Bank Rate
- 16-Oct-1972 – 24-Aug-1981: Minimum Lending Rate
- 25-Aug-1981 – 25-Aug-1982: Minimum Band 1 Dealing Rate
- 26-Aug-1982 – 05-May-1997: Minimum Band 1 Dealing Rate[20]
- 06-May-1997 – 02-Aug-2006: Repo Rate
- 03-Aug-2006 – 31-Dec-2008: Official Bank Rate

Long Term Interest Rate (LTIR): was proxied with monthly averages yields of the Consols (British Consolidated Annuities). Data on monthly average prices was collected from Statistical abstract of the United Kingdom.

$$\text{Long Term Interest Rate} = \text{Consols yields} = \frac{\text{Cupon consols in month t}}{\text{Average price consols in month t}}$$

Consols coupons changed along time. The following table shows the coupons:

- Coupon 3.00%: Jan-1844 – Dec-1988
- Coupon 2.75%: Jan-1889 – Apr-1903
- Coupon 2.50%: May-1903 – Dec-1956

This changes determined jumps in the series. In order to correct these jumps, a new serie was constructed starting with the data of the 3.00% coupon and then using the changes in the subsequent series to keep consistency. The Long Term Gov. Yields published by IMF-International Financial Statistics was used after 1956. The serie is mostly consistent with the series published with NBER, but still shows some differences with the serie published by Klovland (1994).

Below is the time structure of the inputs:

- Jan-1844 – Dec-1851: Yields Consols 3.00%, Source NBER Macro-history.
- Jan-1852 – Feb-1888: Yields Consols 3.00%. Source: UK Statistical Abstract.
- Mar-1888 – Mar-1903: Yields Consols 2.75%. Source: UK Statistical Abstract.

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[20] Data refers to the minimum published rate the Bank discounted bills at to relieve money market shortages (excludes late assistance and repurchase and sale agreements).

- Apr-1903 – Nov-1938: Yields Consols 2.50%. Source: UK Statistical Abstract.
- Dec-1938 – Dec-1948: Yields Consols 2.50%. Source: The Economist.
- Jan-1949 – Dec-1956: Yields Consols 2.50% Source: UK Statistical Abstract.
- Jan-1957 – Dec-2008: Long Term Gov. Yields. Source: IMF International Financial Statistics, series "11261...ZF…"

Ratio Bullion to Bank of England Total Liabilities (R_BTL): Ratio of Bullion to Total Liabilities of the Bank of England. Source Statistical Abstract of the United Kingdom. Data was available on quarterly bases. A quadratic interpolation of the ratio was done. Consistent data was available only till 1924.

Inflation (Inf_WPI): inflation was calculated as the 12 month change over the Wholesale price index. Data was collected from different sources:
- Jan 1844-1845: Gayer, A., Rostow, W., and A. Schwartz (1953)
- Jan 1845-Dec 1890: Klovland (1993)
- Jan 1891-Dec 1938: NBER Macro-History dataset
- Jan 1939-Dec 1954: UK National Statistics office (WPI 1938=100)
- Jan 1955-Dec 1957: estimated based in UK National Statistics Office (WPI 1949=100)
- Jan 1958-Dec 1979: OECD Datasource (PPI 2000=100)
- Jan 1980-Dec 2008: UK National Statistic Office (PPI 2005=100).

Appendix B: Additional Unit Roots Test

To apply VAR methodology we need that the series be stationary or cointegrated. One way to check if series are cointegrated is to run simple OLS and then perform the unit root tests over the residuals of that regression. If the residuals do not have a unit root test then it is possible to state that the variables are cointegrated[21] and therefore apply the VAR methodology. Results in the table below show the results for the different periods.

Table II.1: Unit Root Test on Residuals[22]

Type of variable and test	Residuals (P Value)	Critical Value 10%
Augmented Dickey Fuller		
1844.01-2008.11	-6.58	-2.90
1844.01-1913.12	-7.06	-2.90
1952.01-1997.06	-3.30	-2.90
1997.07-2008.11	-2.03	-2.90

Null Hypothesis of unit root. P-value smaller than -2.9 means rejecting unit

root. Dickey Fuller with no intercept

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[21] Recall the definition of cointegration: "…there to be linear combination of integrated variables that it is stationary; such variables are said to be cointegrated" Enders (1995) p. 355.

[22] Residual of OLS estimation Long Term Interest Rate = a + b*Short Term Interest Rate.

Appendix C: OLS models used in rolling regression over the full sample

Table V.1: OLS Regression

	(1)	(2)	(3)
	LTIR	LTIR	LTIR
Short Term Interst Rate UK	0.08	0.07	0.06
	(11.54)***	(12.23)***	(5.51)***
annual change WPI UK		0.01	0.01
		(3.47)***	(3.58)***
Ratio Bullion/Total Liab. UK			-0.01
			(1.69)*
Constant	2.92	2.94	3.23
	(124.70)***	(133.55)***	(18.84)***
Observations	864	864	864
R-squared	0.12	0.16	0.16

Robust t statistics in parentheses

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

References:

Bank of England (http://www.bankofengland.co.uk/statistics/rates/baserate.pdf)

Bernanke, B., (2004). Inflation targeting, Federal Reserve Bank of Saint Louis *Review,*86, pp.165-68.

Berument H., and Froyen R., "Monetary Policy and U.S. Long Term Interest Rate: How close are the linkages?" (Forthcoming)

Berument H., and Froyen R., " Monetary Policy and Long Term Interest Rate under Inflation Targeting: The New Zealand Experience" (forthcoming)

Cook, T. and Hahn T., (1989) "The effects of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s" Journal of Monetary Economics, 1989, 24(3) pp. 331-51.

Capie, F and Webber A. (1985) "A Monetary History of the United Kingdom 1870-1982" Vol I and II, George Allen & Unwin, London.

Deane, P. and Cole W.A., 1967, *"British Economic Growth 1688-1959"* Cambridge, University Press.

Enders, W., 1995, *"Applied Econometric Time-Series"*. (John Wiley and Sons: New York)

Gayer, A., Rostow, W., and A. Schwartz, "The Growth and Fluctuations of the British Economy 1790-1850", Oxford University Press 1953.

Gürkaynak R., Sack B., and Swanson, E., 2005 "The Sensitivity of Long-Term Interest Rate to Economic News: Evidence and Implications for Macroeconomic Models", American Economic Review, Vol 95, No. 1 (Mar., 2005) pp 425-436.

Gurkaynak, R., Levin, A.,and Swanson, E.(2010) "Does inflation targeting anchor long-run inflation expectations? evidence from the U.S., UK, and Sweden," *Journal of the European Economic Association*, 8, December, pp.1208-42.

Gurley, J. (1960) "The Radcliffe report and evidence," *American Economic Review*, 50, June, pp.672-700.

Hawtrey, R. G.(1938) *"A Century of Bank Rate"* London, Longmans, Green.

Hicks, J. (1946). *Value and Capital.* London: Oxford University Press.

Hicks, J. (1967), *Critical Essays in Monetary Theory.* London: oxford University Press.

Homer S. and Sylla R., 2005, *"A History of Interest Rates"* 4th Ed. John Wiley and Sons

Keynes, J.M. (1930) *A treatise on money.* Vol. II, London: Macmillan.

Keynes, J.M. (1936) *The general theory of employment, interest and money,* London: Macmillan.

Keynes, J.M. (1937)" The General Theory of Employment," *Quarterly Journal of Economics,* 57, pp.209-223.

Klovland, Jane Tore, (1994) "Pitfalls in the estimations of the yields of British Consols 1850-1914" The Journal of Economic History, Vol. 54 No. 1 (Mar., 1994) pp. 164-187.

Klovland, Jane Tore, (1993) "Zooming in on Sauerbeck: Monthly Wholesale Prices in Britain 1845-1890", Explorations in Economic History, Vol. 30, pp. 195-228.

Lutkepohl,H. and Reimers, H (1992) "Impulse response analysis of co-integreted systems," *Journal of Economic Dynamics and Control*, 16, pp.53-78

Office for National Statistics UK http://www.statistics.gov.uk/

Ravenna, F. and Walsh, C. (2006) "Optimal monetary policy with the cost channel" *Journal of Monetary Economics,* 53, May, pp. 199-216.

Roley V. and Sellon, G. Jr., "Monetary Policy Actions and Long Term Interest Rates" Economic Review – Forth Quarter 1995, Federal Reserve Bank of Kansas City.

Roosa, R.V., (1951) "Interest rates and the central bank," in *Money, Interest and Growth*. New York: Macmillan.

Rudebusch, G. "Interest Rates and Monetary Policy", Economic Letter, Federal Reserve Bank of San Francisco, 97-18; June 13, 1997 (http://www.frbsf.org/econrsrch/wklyltr/el97-18.html)

Rozeff, M.,, 1975, "The Money Supply and the Stock Market: The Demise of a Leading Indicator", Financial Analysts Journal, Vol., 31, No. 5 (Sep.-Oct., 1975) pp.18-20, 22-24, 26, 76.

Statistical abstract of the United Kingdom.

Sims, C.A., Stock, J.H., and Watson, M.W., (1990), "Inference in linear time series models with unit roots," *Econometrica, 58*. pp. 113-44.

Svennson, L. (2003) "What is wrong with Taylor rules," *Journal of Economic Literature,*41, pp.426-477.

Viner, J. (1965) "*Studies in the theory of international trade,"* New York: A.M. Kelley.

Woodford, M. (2003) *"Interest and prices."* Princeton: Princeton University Press.

Woodford, M. (2011), Optimal monetary stabilization policy. In Benjamin M. Friedman and Michael Woodford (eds.), *Handbook on Monetary Economics.* Amsterdam: Elsevier.

Trevelyan, G., 1937,*"British History in the Nineteenth Century and After (1782-1919)",* Logmans, Green and co.