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MEASURING THE "WORLD" REAL INTEREST RATE

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ABSTRACT

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Measuring the "World" Real Interest Rate

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Over the past couple of decades, and especially since the financial crisis in 2008-09, real interest rates have collapsed. For much of the past two years they have been negative. But they have been trending down for some while. In part, this is the result of the creation of a global capital market as countries such as China and members of the former Soviet Union have participated in a growing transfer of saving from the emerging economies to the advanced economies.[1] It also reflects the impact of demographic changes on household savings.[2] And in part it reflects deliberate policy choices by central banks in advanced economies. But how far have real rates fallen?

This note tries to compute a measure of the "world" real interest rate and, where possible, a measure of the implied future real rate. It makes no attempt to explain the fall in real rates, but it asks how we might try to measure real interest rates in a global capital market. It also makes public our estimates of the "world" real interest rate so they can be used by other researchers.

The "real rate" requires careful definition. For most purposes the relevant concept is an *ex ante* rate which subtracts from the actual nominal rate the expected rate of inflation. Reliable quantitative measures of inflation expectations are notoriously hard to come by and refer only to expectations over time horizons too short to be useful for analysing saving and investment. So in this note we use measures of real rates on government bonds that are issued with inflation protection. Such *ex ante* measures of real rates are much less volatile than *ex post* rates when there are significant and unexpected changes in inflation, as in the 1970s and 1980s, or in equilibrium real rates, as seen more recently.

Following the inflation surge in the 1970s, governments in the advanced economies wanted to back their own determination to reduce inflation by offering bonds that offered complete insurance against inflation in order to avoid paying a risk premium for investors' uncertainty about the course of inflation. Such inflation-indexed bonds had been used in inflation-prone countries such as Brazil and Israel, but have now become common among the major

[1] The "savings glut" hypothesis put forward by Bernanke (2005).
[2] Backus et.al. (2013).

countries of the G7. Britain introduced inflation indexed-linked gilts in 1981, and finally even the United States followed in 1997. Table 1A and Table 1B show the list of countries now offering inflation protected government bonds. Many of these are long-term instruments which therefore provide a market-based measure of long-term real interest rates. The inflation rate against which they offer protection is a general measure of consumer price inflation.[3] So such measures of real rates do not measure own real rates on particular capital assets such as housing or equipment investment. They should be used cautiously but they do provide a useful indication of the real rate relevant for overall levels of savings.

Given the relatively small number of index-linked instruments that have been issued by governments we focus mainly on ten-year real bond yields, although we present some results on forward rates. Properly constructed, the term structure of the world real interest rate should embed a great deal of information. Gürkaynak et al. (2012) provide a theoretical overview of the macroeconomic information contained in the term structure of interest rates, and Joyce et al. (2010) and Gürkaynak et al. (2010) apply some of this theory to study real interest rates in the UK and the US, respectively. Ejsing et al. (2007) construct a term structure of European real interest rates, while Campbell et al. (2009) give an excellent historical discussion of movements in both UK and US real rates. But there has been no previous attempt to create a world real interest rate, so we hope that our updated measure will be useful to policymakers and applied economists studying global trends.

One might be tempted to use the real rate offered on US Treasury Inflation-Protected Securities (TIPS) as a measure of the world real rate. These securities were first issued in 1997. But there are two reasons for wanting to incorporate information from other countries. First, expectations of changes in the real exchange rate of the US dollar would bias the estimate from the underlying common real rate in the world capital market. Secondly, the real rate in the US might underestimate the world real rate if the US is seen as a safe harbour with a correspondingly lower, possibly negative, risk premium. Equally, other countries might have to offer a higher real rate to offset adverse country-specific factors such as expectations of real exchange rate depreciation or potential default risk on sovereign debt. Evidence of one or other of these effects is evident in the data for Italy. A final reason for not wanting to rely solely on any one country, even the United States, is to avoid confounding

[3] Inflation risk and liquidity premiums also play a role in the pricing of inflation-indexed bonds, so the "break-even" inflation rate is not a perfect measure of expected inflation.

idiosyncratic with underlying economic factors. For example, there was a large liquidity premium in the early months after the issue of US TIPS.

We start with the arbitrage relationship implying that the nominal (in terms of dollars) rate of return on bonds in country j, i_j, equals that on dollar bonds, $i_\$$, adjusted for two factors. The first is that the nominal exchange rate of country j in terms of US dollars, $e_{j\$}$, may be expected to fall, and so a higher return on assets denominated in country j's currency will be required to satisfy investors. Second, because dollar assets may have a safe haven value, and so be a better hedge against the future consumption of global investors, assets in country j will have to offer an additional premium, π_j, to compensate investors for the risk.

$$i_j = i_\$ - (\Delta e_{j\$}) + \pi_j$$

In some cases that risk premium may reflect a concern about default by the government of country j. That would be a justifiable concern for countries that borrow in currencies other than their own, as was true for some Latin American countries before their 1980s debt crisis and is now for some members of the European Monetary Union. But where governments are able to borrow in their own currency the main risk for overseas investors is a depreciation of the currency – reflected in the second term on the right hand side of the above equation. Large and persistent movements in expected exchange rates often are compensation for differences in inflation across countries. So differences in nominal interest rates might be expected to be larger than differences in real rates, and for much of the post-war period that was evident.

For a given maturity, the arbitrage relationship of the first equation can be expressed as an equivalent relationship for real interest rates, denoted by r, and real exchange rates, denoted by E.

$$r_j = r_\$ - E(\Delta E_{j\$}) + \pi_j$$

To obtain an estimate of "the" world real rate, an average of real rates across countries would eliminate the effect of expected changes in real exchange rates since across countries that effect must average zero. Moreover, since the arbitrage relationship is expressed in terms of rates of return, a simple unweighted average would be the right method to choose. That, however, leaves to one side the risk premium. In dollar terms, that premium is zero. In trying to measure world real interest rates it might be more sensible to recognise that the risk premium on dollar assets is, at times, artificially depressed because of a dollar safe haven effect. In other words, the dollar risk premium is negative. That implies incorporating into a measure of world real rates some average of risk premia over all countries which would mean averaging real rates across countries. But in this case the danger of using an unweighted average is that small countries with high risk premia could have a disproportionate impact on the estimate of the world real rate. Possible weights would be the shares of countries' issues of indexed-linked bonds in the total stock of such assets, shares in total consumption, or shares in total GDP. For the sake of simplicity, and without great damage to the results, we have chosen to use GDP weights.

We present below estimates of the average ten-year real rate for the G7 countries excluding Italy. The reason for the exclusion is that recent movements in the real rate in Italy have been dominated by changes in the implicit risk premium associated with the possibility of default or exit from the European Monetary Union. In the spring of 2011, ten-year real rates in Italy were around 2 ½%. By the end of the year they had more than doubled to almost 6%. They remained high through much of 2012 before falling back significantly in 2013. But they remained well above the levels of either the US or UK. Changes in the risk premium associated with Italian membership of monetary union would contaminate an estimate of the world real rate.

Averaging across countries should also remove most of the effect of expected changes in real exchange rates. In the results below we present both weighted and unweighted estimates of ten-year real rates and implied forward ten-year real rates (that is the real rate expected to prevail between year 10 and year 20).

Another reason for differences among countries relates to the inflation index used to define the degree of inflation protection. In the US the measure is the CPI inflation rate; in the UK it is the retail price index (RPI) which overstates the CPI inflation measure by as much as around 1 percentage point on average over the period as a whole, thereby depressing the apparent real yield on indexed bonds. Miller (2011) shows that the *ex post* wedge between RPI and CPI inflation in the UK was rather volatile. But the relevant concept for our purposes is the *ex ante* expected wedge. From 2004 the Treasury Panel of Economists published the average private forecaster's expectation of the RPI-CPI wedge over the following five years. Since expected changes in relative prices should have largely passed through by around five years these are reasonable estimates of the *ex ante* wedge over the following decade. Broadly speaking, the wedge was around 0.5 percentage points until 2008 when it rose to around 1 percentage point, and has recently increased a little further. During the period since 2008, when there were sharp movements in relative prices, there is some short-run volatility in the wedge. We have, therefore, used a five-year moving average of the reported wedge as our estimate of the wedge relevant to ten-year real interest rates. And prior to 2004 we have assumed that the wedge was 0.5 percentage points, which accords with the discussion of inflation measures in contemporary Bank of England *Inflation Reports*. Our estimate of the wedge is shown in Table 2. We have adjusted the measured real yield on UK indexed gilts by adding our estimate of the *ex ante* wedge between RPI and CPI inflation to the market yield based on indexation to RPI. The adjustment eliminates much of what would otherwise appear to be a level difference between real rates in the UK and US (see Figure 2 below).

In order to make comparisons over time, it is necessary to calculate the real rate of interest for a given time horizon. But any given index-linked security experiences a reduction in its duration each year of one year. With a limited number of index-linked instruments in issue at any one time, it is necessary to interpolate the yields of different securities of different maturities to calculate a yield curve for the real rate in each country. That is not possible for all the countries that issue index-linked government debt because of the small number of securities. Table 3 shows the number of observations for each country since 1983 when the UK launched its programme of index-linked gilts.

There are two main yield interpolation methods used in the literature. Spline-based nonparametric techniques can match observed bond yields arbitrarily well. But idiosyncratic factors can produce bond yields which reflect temporary market factors, and so matching them too closely can yield implausible estimates of other objects of interest, such as forward rates. Hence economic analyses of yield curves typically assume the parametric form for instantaneous forward rates at horizon *n*:

$$f(n) = \beta_0 + \beta_1 \exp\left(-\frac{n}{\tau_1}\right) + \beta_2 \left(\frac{n}{\tau_1}\right) \exp\left(-\frac{n}{\tau_1}\right) + \beta_3 \left(\frac{n}{\tau_2}\right) \exp\left(-\frac{n}{\tau_2}\right)$$

This functional form was first used by Svensson (1994), who extended the form introduced by Nelson and Siegel (1987) (who implicitly set $\beta_3 = 0$).

Integrating the instantaneous forward rates gives the zero-coupon spot yields:

$$y(n) = \beta_0 + \beta_1 (1 - \exp\left(\frac{-n}{\tau_1}\right))(\frac{\tau_1}{n}) + \beta_2[(1 - \exp\left(\frac{-n}{\tau_1}\right))(\frac{\tau_1}{n}) - \exp\left(\frac{-n}{\tau_1}\right)] + \beta_3[(1 - \exp\left(\frac{-n}{\tau_2}\right))\left(\frac{\tau_2}{n}\right) - \exp\left(\frac{-n}{\tau_2}\right)]$$

Given a set of observed yields, minimizing the squared deviations between the predicted and the observed yields will generate estimates of the parameters. This is the methodology used by the Federal Reserve and many other central banks to estimate bond yield curves. Weighting bonds by the inverse of duration, as Gürkaynak et al. (2010) suggest, tends to improve estimator performance. Moreover, because bonds are typically indexed with a lag, and are not seasonally adjusted, bonds of extremely short duration – around two years or less – should not be used in the estimation.

Note that strong identification of all six parameters requires, at a minimum, observing yields at several different maturities – including some long-term bonds, preferably of maturities of at least 10 years. If sample size is an issue, the more parsimonious specification of Nelson and Siegel (1987) may be preferable.

In what follows we focus on real rates for each of the G7 countries. The Bank of England and the Federal Reserve publish their estimates of the yield curve on their websites.[4] Our yield estimates for Canadian, French, Italian, and Japanese bonds are from Bloomberg. Bloomberg does not yet offer data on yields on German inflation-indexed bonds, so we estimate them directly using the methodology of Nelson and Siegel (1987) and pricing data from Thomson Reuters. One could also estimate directly a world real yield curve pooling observations from all countries though this places strong restrictions on the changes over time in country-specific differences in real rates (but see Ejsing et al. (2007) for an estimate of a "European" real interest rate).

We present two estimates of a "world" interest rate. The first estimate is the simple average of the estimated spot yields on 10-year bonds, averaged across all G7 countries for which data are available (except Italy). The second estimate performs the same exercise, but weights each country according to their average real GDP over the whole time period.[5]

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[4] Data for the US are available at http://www.federalreserve.gov/pubs/feds/2008/200805/200805abs.html. Data for the UK are available at http://www.bankofengland.co.uk/statistics/Pages/yieldcurve/archive.aspx.

[5] Weighting countries by current real GDP, rather than GDP averaged over the time period, produces almost identical results.

Figure 1 shows the estimated time series for the “world” real interest rate from 1985 to late 2013 for both the weighted and the unweighted series. Remarkably, the two estimates are virtually impossible to distinguish, except for an episode – beginning in 1999 and lasting about two years – when the US enters the sample. US inflation-indexed bonds were highly illiquid at that time, and carried a significant liquidity premium that faded slowly over the next two to three years. (See Gürkaynak et al. (2010) for more information).

Table 4 shows average values of the weighted real rate for five-year periods. It shows very clearly the decline in real rates starting in the late 1990s, and continuing through and after the banking crisis of 2007-09.

The fact that our weighting scheme barely matters is reassuring, and suggests that movements on bond yields are highly correlated across countries. Table 5 shows that this is indeed the case, though the behaviour of Japanese and especially Italian bonds in the recent recession is an exception. It seems therefore quite reasonable to talk about a “world” interest rate.

Table 6 provides our raw estimates of the weighted and unweighted “world” real interest rate, so that other researchers may use them. These estimates are derived entirely from UK yields before the US enters the sample in 1999Q1, and as already mentioned US yields contained a significant liquidity premium for their first two years. Therefore we regard our estimates as more reliable after 2001 than before.

Figure 2 shows ten-year forward rates for the two countries for which it is possible to compute such long-term forward rates (using yields out to twenty years) – the US and UK. They could be seen as a better guide to expected long-term rates because in principle they abstract from the current very low values of spot rates which are affected by short-run policy rates and the expansion of central bank balance sheets. The secular decline in real rates is clearly apparent.

Figure 3 shows that there are differences between the rate for the US and the unweighted “world” real rate. Both decline over the sample period but the US rate is not identical with our estimate of the “world” rate. Indeed, it may be that the difference between the US real rate and the average of real rates in the rest of the G7, reflecting in part the safe haven effect of assets held in the US, is a proxy for global risk aversion. Figure 4 shows that measure for the period 2003-13 (once the illiquidity premium after the introduction of US TIPS had diminished and stabilised). It seems to capture the low risk aversion prior to the recent financial crisis and the high risk aversion more recently. It might be interesting to explore whether this measure contains information useful as a measure of global risk aversion and so for macro-prudential policy.[6] In future it might be possible to incorporate data from countries beyond the G7 to examine alternative measures of global risk aversion. The gap between real rates in the US and the rest of the G7 is a rather conservative indicator of risk.

Figure 5A shows a more high-frequency plot of daily real rates in the UK and US during 2013. The two series move closely together. The sharp rise in the middle of 2013 reflects the market speculation about the timing of withdrawal of monetary stimulus that accompanied the signs of recovery in the real economy in both countries and the attempts by the Federal Reserve and the Bank of England to manage expectations about the pace of that withdrawal. Figure 5B shows a similar figure for 10 year 10 year forward rates. Those forward rates still show a marked rise in the US, although much less so in the UK. The sharp fall in the real rate in the UK at the beginning of 2013 reflects the unexpected announcement by the Office for National Statistics that reforms to the measurement of RPI inflation (to bring it closer to CPI) that would have reduced the wedge between RPI and CPI inflation would not be implemented. Yields fell 33 basis points on the announcement, the third largest daily change ever. Equally, rates in late 2012 were boosted by expectations of the change.[7] Such large and idiosyncratic movements in a market as established as the UK provide yet another warning against relying too heavily on yields from any one country as a proxy for a world interest rate.

Interestingly, there was little reaction of real rates to the US debt deal on 17 October 2013. The larger influence was changing expectations about monetary policy the timing of withdrawal of monetary stimulus.

Overall, the broad shape of the decline in real rates since the late 1990s is clear from both the series for US TIPS alone and our estimate of the "world" real rate. But the differences may reveal useful information about expected changes in real exchange rates and a measure of global risk aversion.

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[6] This idea was suggested to us by Iain de Weymarn at the Bank of England.

[7] These idiosyncratic movements in British yields at the end of the sample are responsible for the fact that, while US yields are highly correlated with both British and German yields, the correlation between British and German yields is fairly low (.49). See Table 5.

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Table 1A: G7 Countries with Index-Linked Government Bonds in 2013

Country	Year First issued	Inflation Measure	Maximum Maturity (Years)	Bonds Outstanding on 10/29/13
United States	1997	CPI	30	37
Canada	1992	CPI	34	6
France	1998	CPI/HICP	33	12
Germany	2006	HICP	11	4
Italy	2004	CPI	32	11
Japan	2004	CPI	10	15
United Kingdom	1981	RPI	55	23

HICP refers to the European Harmonized Index of Consumer Prices, excluding tobacco.

Table 1B: Non-G7 Countries with Index-Linked Government Bonds in 2012

Country	Year First issued	Inflation Measure	Maximum Maturity (Years)	Bonds Outstanding in May 2012
Australia	1985*	CPI	24	5
Brazil	1964*	IPCA	45	15
Chile	1956	UF (CPI)	30	47
Colombia	1967	CPI	N/A	N/A
Denmark	2012	CPI	11	1
Greece	1997*	HICP	50	3
Hong Kong	2011	CPI	3	1
Iceland	1964	CPI	21	3
Israel	2001	CPI	31	6
Mexico	1983*	CPI	30	11
Poland	2004	CPI	11	2
South Africa	2000	CPI	21	6
South Korea	2007	CPI	10	3
Sweden	1994	CPI	30	7
Thailand	2011	CPI	10	1
Turkey	2007	CPI	10	10
Uruguay	2002	CPI	13	N/A

Source: Thomson Reuters and Barclays (2012). Some countries have issued indexed-linked bonds in the past but no longer have a substantial index-linked bond market, including Argentina, Finland, and Hungary. Globally, the market is growing quickly; for example, New Zealand first issued linkers in 2012, while India followed in 2013. * indicates that there has been a significant pause between bond issuances; N/A denotes information that was not available to the authors at the time of writing.

Table 2: Estimated Wedge in Expected RPI and CPI Inflation in the UK, 1985-2013

Year	**Percentage Points**
1985-2000	0.50
2001	0.50
2002	0.51
2003	0.52
2004	0.51
2005	0.52
2006	0.54
2007	0.56
2008	0.64
2009	0.76
2010	0.90
2011	1.03
2012	1.18
2013	1.26

Table 3: Number of Indexed Government Bonds, G7 countries 1984-2013

	Canada	France	Germany	Italy	Japan	UK	US
1984	0	0	0	0	0	2	0
1985	0	0	0	0	0	2	0
1986	0	0	0	0	0	2	0
1987	0	0	0	0	0	3	0
1988	0	0	0	0	0	3	0
1989	0	0	0	0	0	3	0
1990	0	0	0	0	0	3	0
1991	0	0	0	0	0	3	0
1992	0	0	0	0	0	3	0
1993	1	0	0	0	0	4	0
1994	1	0	0	0	0	4	0
1995	1	0	0	0	0	4	0
1996	1	0	0	0	0	4	0
1997	2	0	0	0	0	4	0
1998	2	0	0	0	0	4	0
1999	2	0	0	0	0	4	1
2000	2	1	0	0	0	4	2
2001	3	1	0	0	0	4	2
2002	3	1	0	0	0	4	3
2003	3	2	0	0	0	5	3
2004	4	2	0	0	0	5	3
2005	4	3	0	2	3	5	6
2006	4	5	0	2	6	6	8
2007	4	5	1	3	9	8	11
2008	5	6	1	4	13	11	14
2009	5	7	1	5	14	12	17
2010	5	7	2	6	14	14	21
2011	6	9	2	7	14	15	25
2012	6	10	3	9	14	18	29
2013	6	11	4	10	14	21	33

Table 4: 5 Year Average of Yields on 10 Year Bonds

1985-1989	4.27
1990-1994	4.15
1995-1999	3.88
2000-2004	2.86
2005-2009	1.85
2010-2013	0.48

Table 5: Correlation Matrix of Spot Yields on 10 Year Bonds, Full Sample

	Canada	France	Germany	Italy	Japan	UK	US
Canada	1.00						
France	.84	1.00					
Germany	.86	.69	1.00				
Italy	-.61	-.25	-.05	1.00			
Japan	.61	.59	N/A	.71	1.00		
UK	.95	.84	.49	-.63	-.22	1.00	
US	.99	.91	.94	-.64	.19	.89	1.00

Note that, because yields are available at different times for different countries, correlations are not directly comparable between countries.

Table 6: Estimates of the Weighted and Unweighted World Real Interest Rate

Quarter	Weighted Real Rate	Unweighted Real Rate
2013Q4	0.539	0.605
2013Q3	0.524	0.571
2013Q2	-0.483	-0.286
2013Q1	-0.391	-0.139
2012Q4	-0.457	-0.140
2012Q3	-0.101	0.203
2012Q2	0.054	0.254
2011Q1	0.193	0.437
2011Q4	0.297	0.499
2011Q3	0.976	1.104
2011Q2	1.124	1.233
2010Q1	1.166	1.193
2010Q4	0.911	1.014
2010Q3	1.295	1.322
2010Q2	1.588	1.439
2010Q1	1.570	1.519
2009Q4	1.574	1.554
2009Q3	1.933	1.837
2009Q2	2.027	2.056
2009Q1	2.627	2.468
2008Q4	2.216	2.144
2008Q3	1.569	1.639
2008Q2	1.365	1.434
2008Q1	1.569	1.585
2007Q4	2.013	1.965
2007Q3	2.291	2.236
2007Q2	1.965	1.934
2007Q1	2.019	1.897
2006Q4	1.918	1.765
2006Q3	2.093	1.932
2006Q2	1.906	1.730
2005Q1	1.945	1.719
2005Q4	1.542	1.450
2005Q3	1.449	1.413
2005Q2	1.456	1.491
2005Q1	1.479	1.514
2004Q4	1.610	1.631
2004Q3	1.882	1.918
2004Q2	1.662	1.840
2004Q1	2.155	2.215
2003Q4	2.057	2.124
2003Q3	2.021	2.075
2003Q2	2.121	2.178
2003Q1	2.535	2.573
2002Q4	2.402	2.587

2002Q3	3.120	3.083
2002Q2	3.341	3.276
2002Q1	3.498	3.350
2001Q4	3.289	3.375
2001Q3	3.447	3.368
2001Q2	3.290	3.234
2001Q1	3.469	3.247
2000Q4	3.774	3.483
2000Q3	3.791	3.437
2000Q2	3.761	3.422
2000Q1	4.062	3.402
1999Q4	3.870	3.411
1999Q3	3.764	3.191
1999Q2	3.661	3.055
1999Q1	3.694	3.189
1998Q4	3.066	3.066
1998Q3	3.360	3.360
1998Q2	3.465	3.465
1998Q1	3.592	3.592
1997Q4	3.795	3.795
1997Q3	4.123	4.123
1997Q2	4.058	4.058
1997Q1	3.979	3.979
1996Q4	3.960	3.960
1996Q3	4.255	4.255
1996Q2	4.147	4.147
1996Q1	3.905	3.905
1995Q4	4.069	4.069
1995Q3	4.172	4.172
1995Q2	4.340	4.340
1995Q1	4.339	4.339
1994Q4	4.063	4.063
1994Q3	4.129	4.129
1994Q2	3.500	3.500
1994Q1	2.908	2.908
1993Q4	3.599	3.599
1993Q3	3.728	3.728
1993Q2	3.410	3.410
1993Q1	4.510	4.510
1992Q4	4.465	4.465
1992Q3	4.876	4.876
1992Q2	4.927	4.927
1992Q1	4.934	4.934
1991Q4	4.745	4.745

1991Q3	4.357	4.357
1991Q2	4.274	4.274
1991Q1	4.231	4.231
1990Q4	4.520	4.520
1990Q3	3.884	3.884
1990Q2	4.285	4.285
1990Q1	3.558	3.558
1989Q4	4.049	4.049
1989Q3	4.219	4.219
1989Q2	4.059	4.059
1989Q1	4.315	4.315
1988Q4	4.292	4.292
1988Q3	3.978	3.978
1988Q2	3.943	3.943
1988Q1	4.282	4.282
1987Q4	4.638	4.638
1987Q3	4.440	4.440
1987Q2	3.890	3.890
1987Q1	4.540	4.540
1986Q4	4.430	4.430
1986Q3	4.041	4.041
1986Q2	4.667	4.667
1986Q1	4.651	4.651
1985Q4	4.262	4.262
1985Q3	4.498	4.498
1985Q2	4.056	4.056
1985Q1	4.191	4.191

Figure 1: Spot Yields on 10 Year Bonds, G7 Excl. Italy, Quarterly: 1985 - 2013

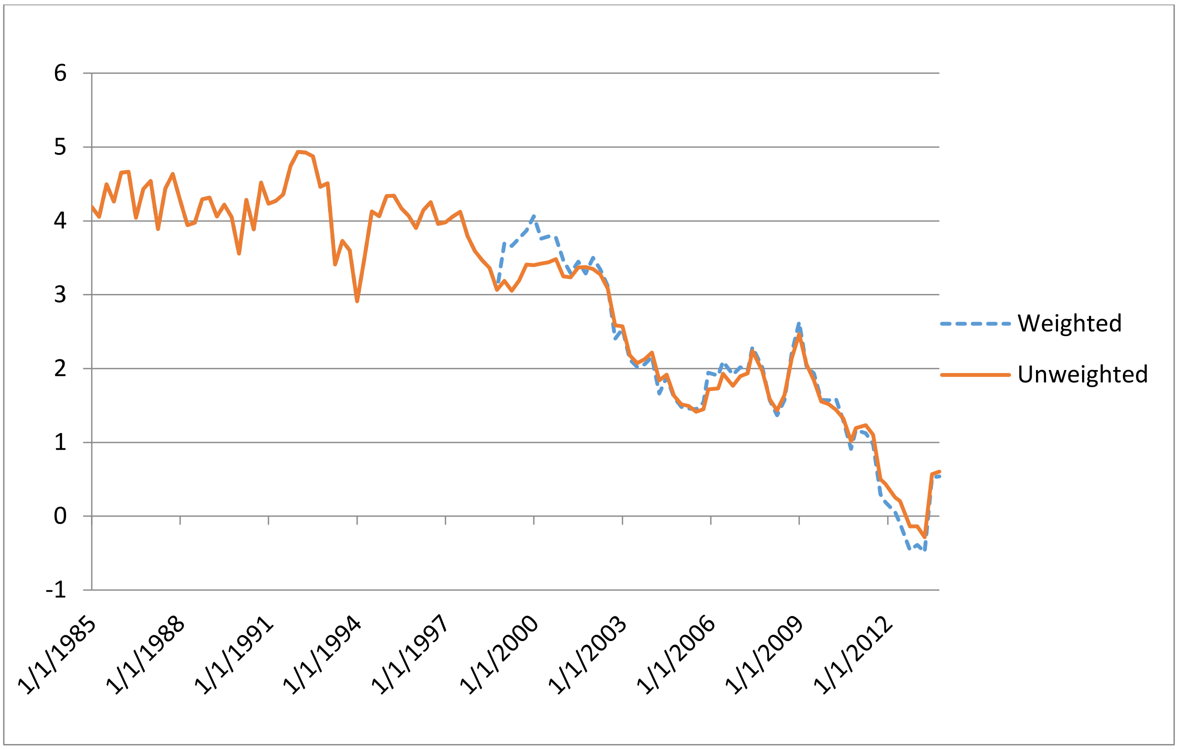

Figure 2: 10 Year 10 Year Forward Rates in the UK and US, Quarterly: 1986-2013

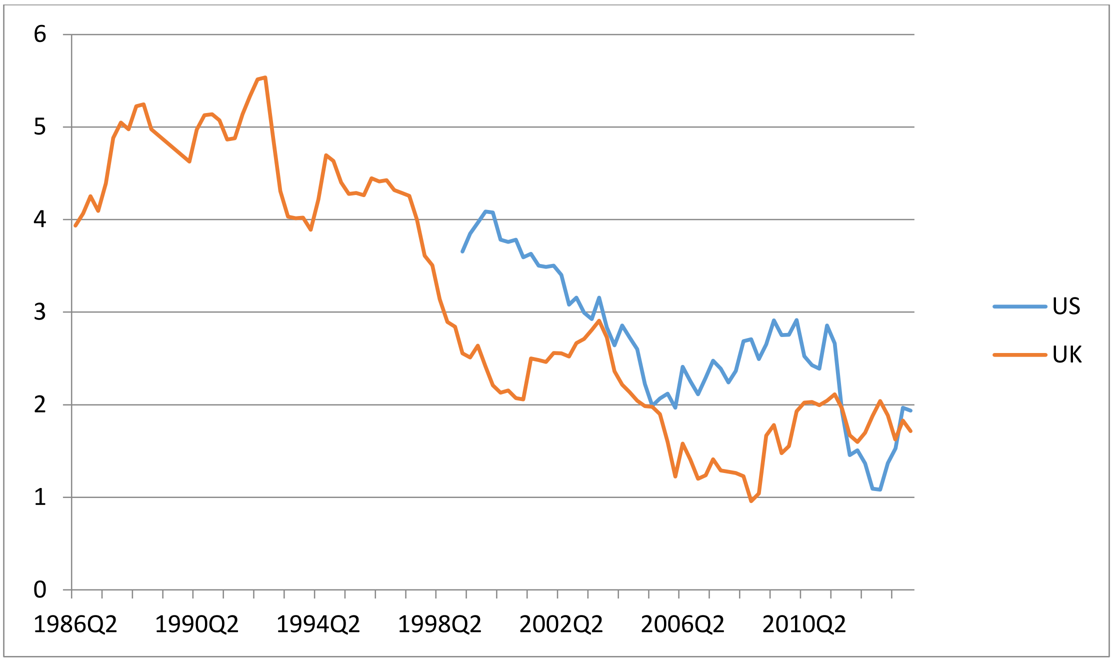

Figure 3: Unweighted "World" Real Interest Rate vs. Yields on US TIPS

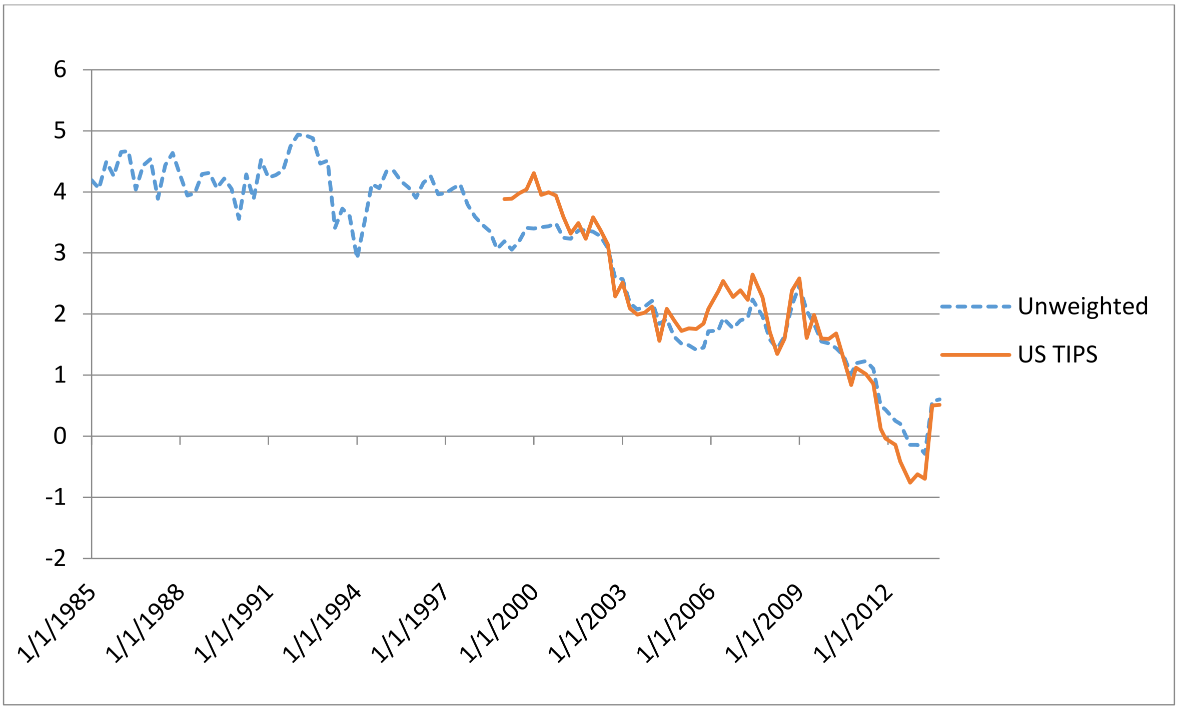

Figure 4: US Real Rate Minus Average for Rest of G7

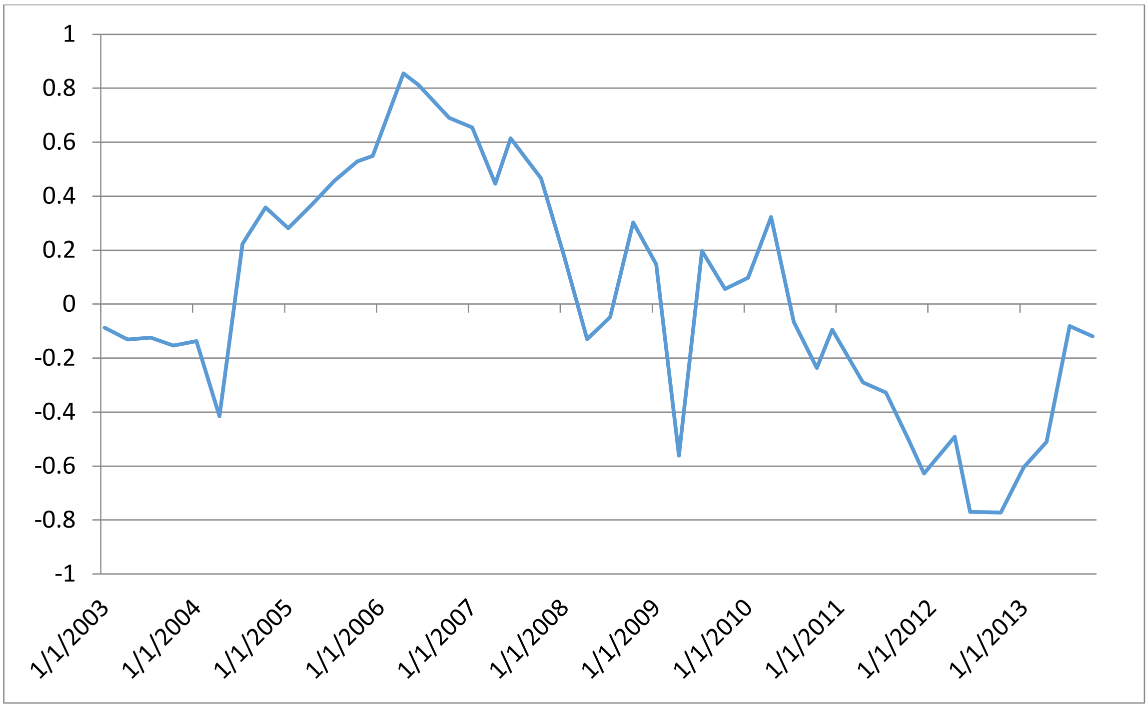

Figure 5A: Spot Yields on 10 Year Bonds, US and UK, 2013

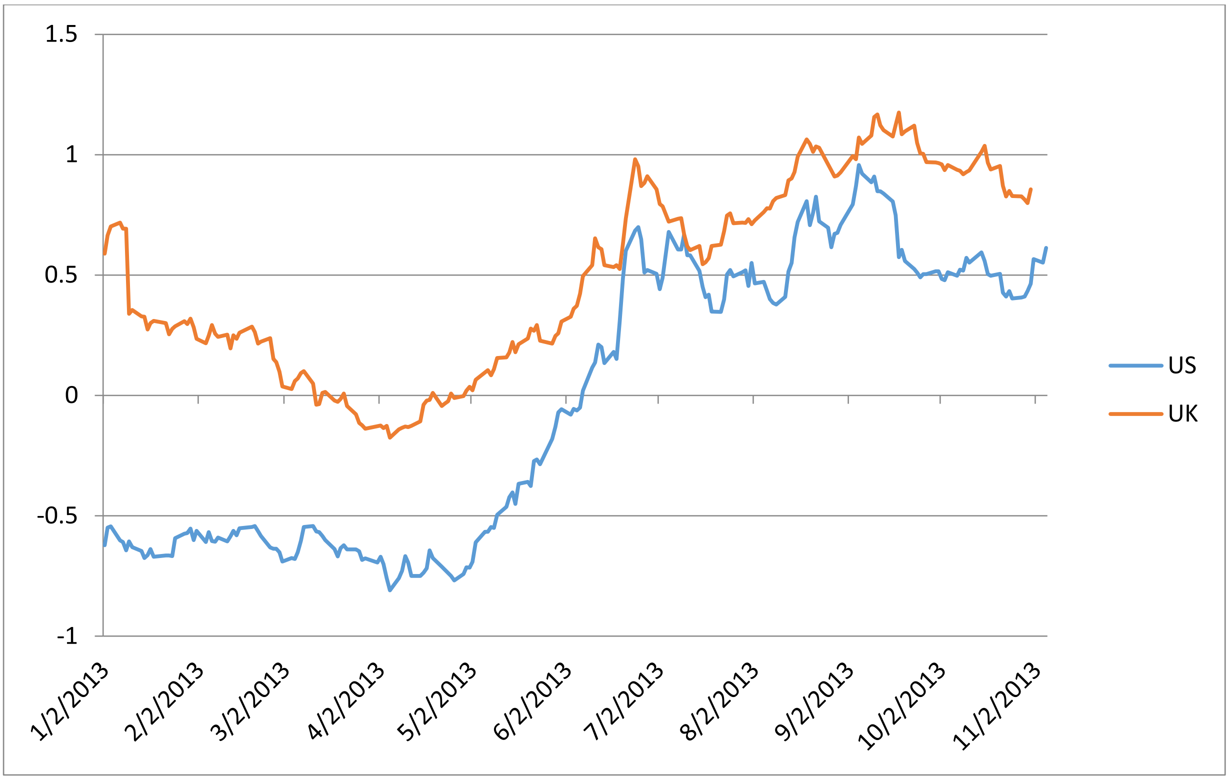

Figure 5B: 10 Year 10 Year Forward Rates, US and UK, 2013