Global Macro Strategy

Big Macro 01: Are Low US Yields Here to Stay?

Strategy

Global

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Equilibrium Real Rates Hold the Key

As the Fed prepares to exit a 7-year period of zero policy rates, few topics are as hotly debated as the sustainability of the current low-yield regime in the US. To some, low US yields are the quintessential bubble. To others, low US yields are here to stay; they reflect grim growth prospects. Whether you invest in bonds, equities, credit or Emerging Markets, you need to know where US rates will likely settle once the Fed has finished normalising policy back to neutral. Largely, this depends on the level of *"equilibrium real rates."*

Equilibrium Real Rates Have Likely Declined more than the Fed Appreciates

We estimate that the equilibrium real rate is currently 90bps, more than 200bps below its level of 15 years ago. This is above recent estimates, such as the ones suggested by Larry Summers, but it is more than 75bps below the implied median Fed assessment.

Different Models, Similar Conclusion

To arrive at our estimate we use four distinct modelling approaches. Some produce results that are heavily tied to the relevant macro assumptions; others are more macro-agnostic. Nonetheless, all four converge to a similar answer. In the process, we update and build on some of the seminal models in the literature (Laubach and Williams 2001).

Are US Yields a Bubble at the Moment?

Not really. Our model results imply that 5 year US swap rates 5 years forward (currently at 2.9%) should hover at a "fair range" between 2.6% and 3.8%. From a valuation perspective, the closer 5y5y forward rates trade to the lower end of this band, the more likely is a correction towards the middle of the range, and vice versa.

What Would Make Us Change Our Mind?

There are several factors which, if they changed, would lead us to update or even revisit our framework. The most important two would be: a) evidence of stronger "trend" growth or b) Fed steps to actively reduce the size of the balance sheet beyond market expectations based on Fed communications. Both would lead our trading range for 5y5y forward rates higher than the current 2.6-3.8 range.

Low yields perpetually…

US 10y nominal yields may have rebounded from lows of about 1.64% in late January to levels near 2.35%, much closer to the averages of the last four years. But they are still more than 200bps below the average levels of the previous cycle, more than 60bps below the absolute lows of the previous cycle and only 50bps above the extreme lows observed during the peak of the Euro-area crisis in 2012.

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And it is not just the absolute level; it has also been a while. Low US yields have persisted for 7 years now – a period typically associated with a full economic cycle has only seen long-term rates linked with economic stagnation.

Obviously, this is a cyclical phenomenon in part. The depth of the recession, the constraints of the zero-lower-bound and the numerous factors that led to a very gradual recovery allow only for a very slow pace of policy tightening and interest rate normalisation over the next few years.

The real conundrum, however, lies beyond the cyclical horizon. Looking 5 or 10 years out, the US interest rates curve implies medium-term rates will only land a touch above 3%, 200bps below the previous cycle's average levels.

...a bubble with cross-asset implications or a growth omen?

In the eyes of the perpetual bubble hunter, this is the elephant in the room, the quintessential source of vulnerability to asset prices and the aggregate economy. Nobel Laureate Robert Shiller has argued that there is a striking overvaluation in US bonds, which goes above and beyond the impact of central bank monetary policy operations and will likely lead investors to eventually realise losses across assets.

To others, low long-term rates reflect macro fundamentals and are here to stay. Larry Summers' secular stagnation thesis represents the most prominent expression of the view that a series of short-term macro developments have led the US economy to equilibrate at a lower level of real rates in the long run. In this view of the world, low real (and hence nominal) rates reflect frail medium-term growth prospects. As discussed in Larry Summers' work US real rates near zero may persist for a long period of time (Summers 2014).

Overall, there is significant uncertainty around the level at which US nominal and real yields are likely to land 3-5 years from now, once the Fed is done normalising policy rates. And despite the fact that we focus on the US, this is an area of uncertainty for bonds globally.

This uncertainty has an impact across asset classes. Professor Jeremy Stein, a former member of the Board of Governors of the Federal Reserve, has warned against the yield-seeking speculative behaviour that a compression in yields can result in, ultimately creating broader financial stability concerns (Stein, 2013).

Box 1 discusses some of the likely key drivers of lower US yields. The discussion brings one overarching point to the fore: while part of the decline in US yields is cyclical and may reverse, there are good reasons to believe that part of it is structural. This part may persist for a significant period of time and deeply affect a) the pricing of the long-end of the US curve and b) the Fed's interest rate setting decisions.

BOX 1

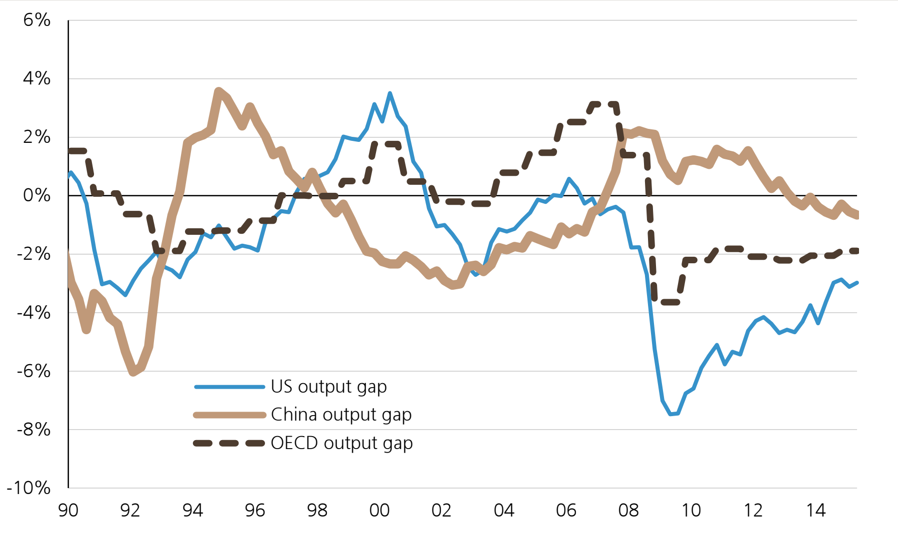
While part of the US yields' decline may reverse with the cycle…

US (short and long term) rates are bound to rise eventually but it may take a significant amount of time. But part of the decline may never fully reverse (at least within the course of the next cycle). By extension the same holds for global rates.

A number of factors typically associated with lower US rates are clearly cyclical. Therefore they are bound to fade as the US (and global) recovery strengthens and broadens.

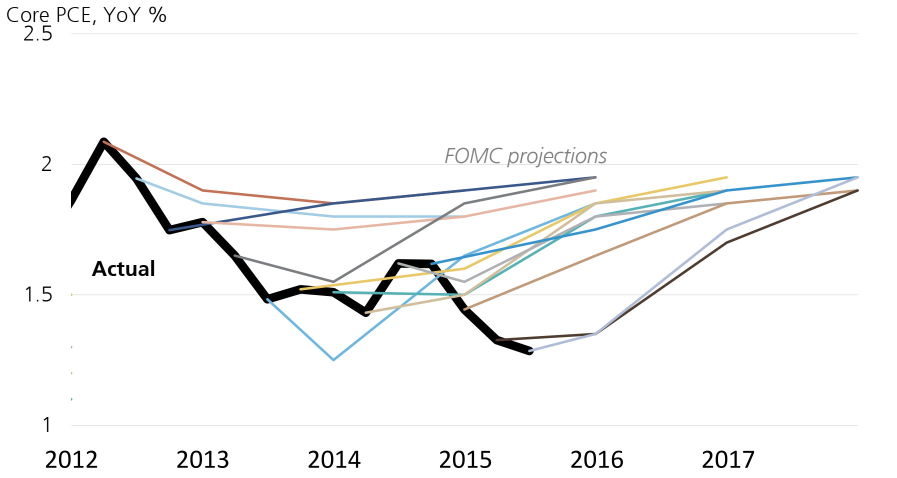
1. *A deep and global cycle.* The output gap that opened up post the Great Financial Crisis (GFC) has been deep. It has taken many years of above-trend growth to narrow it down. And arguably there is still a level of slack in the US economy. At the same time, the global cycle has been desynchronised and it has weighed on US activity (whether via the channel of trade, global corporate earnings or confidence). The crisis in the Euro-area and procyclical policies adopted in the aftermath have created a large level of slack in one of the two largest economies on the planet. Growth dynamics are only starting to recover shyly from largely suppressed levels. Chinese growth dynamics continue to point to a gradual and persistent slowdown; and there may be evidence that capacity is being underutilised (Figure 1). Finally, as we have discussed in our research, Emerging Markets more broadly are facing growth challenges. The US recovery is bound to broaden and extend in 2016 and there are signs that the Euro-area recovery may be gaining steam. The Chinese and the EM cycles on the other hand may take some extra time until they start contributing to a tighter global output gap.

Figure 1: A wide global output gap may be weighing on US and Global yields



Source: Haver Analytics, UBS. US output gap - Congressional Budget Office. China output gap - Oxford Economics Global Forecasts. OECD output gap - OECD economic outlook

Figure 2: Inflation has consistently surprised to the downside, capping yields

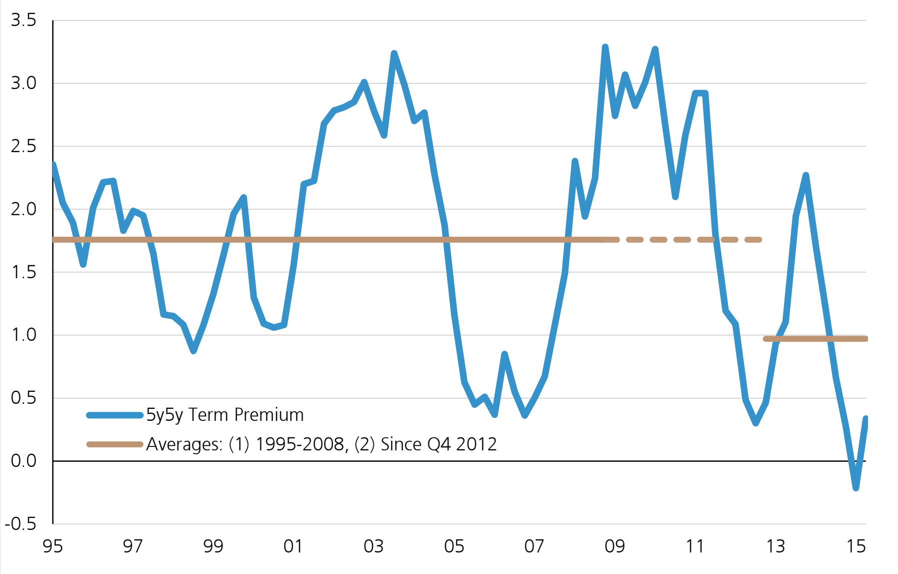


Source: UBS, Federal Reserve. Mean FOMC participants' projections for core PCE deflator (Q4/Q4).

2. _Global disinflation_. By extension, global inflation dynamics have mirrored the trends in the global output gap. This has been among the most surprising macro developments for markets. A large part of this is attributable to the decline in commodities prices. Although in the near term these dynamics are likely to remain bearish (particularly in China-sensitive commodities such as metals), the medium-term dynamics are for stabilisation as the curve forwards suggest. That said, soft inflation trends have been visible in core inflation too; and this is more consistent with the global output gap story (Figure 2 shows how Federal Reserve officials' continual projections of higher core inflation have failed to materialise). The effects of this trend on globally priced goods via the channel of competition will likely impact US inflation beyond the import share of consumption (which is small in a relatively closed economy such as the US). In turn, disinflation likely weighs on nominal wage dynamics (if not real wages too). And all else equal, domestic prices will need to rise further on the margin in order to compensate for imported disinflation

3. _Suppressed term premia_. There is evidence that term premia are suppressed in the US and globally. In theory, the US interest rate curve should simply consist of incremental expectations of policy rates at different points in time. However, research suggests that investors typically demand a level of additional compensation to assume duration and interest rate risk. It is widely acknowledged that central bank sovereign bond purchases have had a dampening effect on domestic term premia and indirectly on the term premia of major bond markets. The Fed estimates that its own QE programme may be responsible for more than 100bps of tightening in term premia. Figure 3 demonstrates the lower average term premia post Fed's QE. Removal of policy accommodation is likely to eventually restore term premia to average levels. That said, asset sales are a policy tool for a much more mature stage of the recovery cycle, at least judging by the Fed's current revealed preference of policy tightening instruments.

Figure 3: Suppressed term premia* due to CB purchases: another factor suppressing yields



Source: UBS, Haver Analytics. * Treasury 5y5y term premium by NY Fed's Adrian, Crump, and Moench (2013).

...structural drivers imply that part of the decline may persist

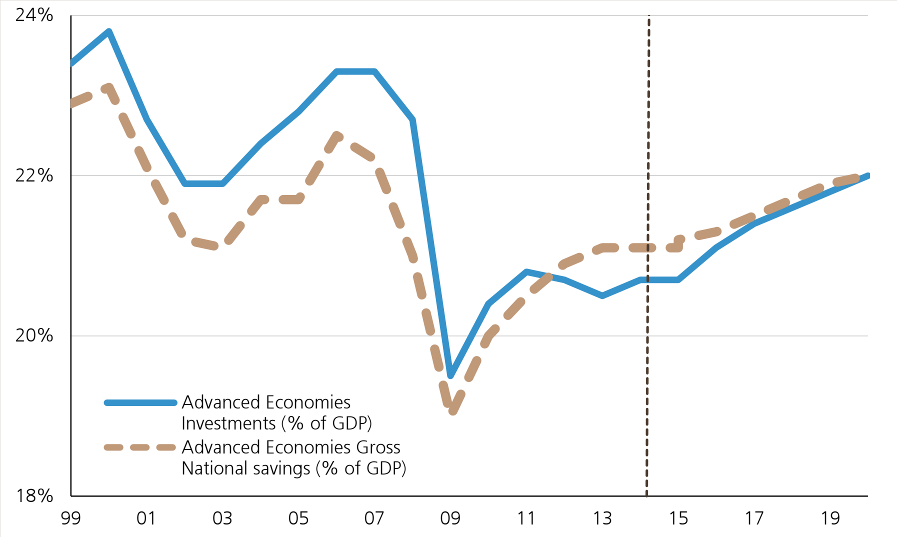
It is equally important to keep in mind that there are strong arguments for why the decline in rates may persist for a lengthy period of time. And why it may even be likely that part of the decline does not fully reverse in the forecast horizon (5-10 years). Either because certain secular factors weigh on growth, inflation and rates for a protracted period of time, or because deep underlying macroeconomic shifts such as demographics affect structural aspects of the US and global economy.

1. *Higher G10 net savings*. A parallel increase in the supply of savings in developed economies met by declining investment demand (Figure 4) implies a suppression of the equilibrium rate for reserve currencies. On a global macro level, this mirrors the reduction in net savings of Emerging Economies. The broad macro assumption is that this G10 thrift is triggered in part by significant risk-aversion dynamics that have long outlasted the immediate impact of the GFC (see Haldane 2015). As such, it is likely to suppress advanced economy yields, assuming a level of home bias from G10 investors and assuming no large scale reversal from major reserve holdings in Asia and the Middle-East.

   It can be shown that EM rates have by and large mirrored shifts in G10 rates globally and as of the last 7 years; they have anchored EM yields at low levels too. Thus, the lower savings balance in EMs has not necessarily led to higher EM yields. Instead it has manifested itself in weaker EM currencies, as EM yields have not been high enough to offer sufficient compensation for investors to assume the FX depreciation risk that a deteriorating external position implies.

   There is also a version of the higher G10 net savings argument that points to much deeper fundamental drivers including a higher propensity for households, corporates and (in places such as the Euro-area) governments to save, and a lower return on global capital leading to structurally lower rates. But such variables are notoriously difficult to observe directly and accurately.

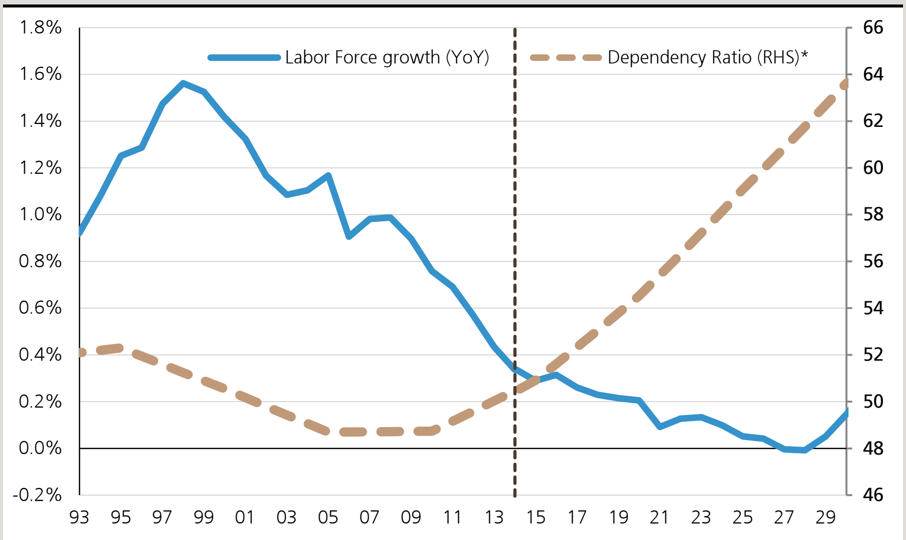
Figure 4: Net savings in developed economies have risen, suppressing yields



Source: Haver Analytics, International Monetary Fund

2. *Demographics.* Demographic factors such as declining US labour force growth and rising dependency ratios (Figure 5) will likely suppress interest rates in the long run. Directly, slower labour force growth implies slower trend growth, which as we will discuss later is tightly linked to lower real rates. At the same time, we are about to witness a sharp increase in the US dependency ratio driven by an ageing population, which implies higher savings ahead of retirement. Indirectly, a slowly growing and ageing labour force likely faces slower productivity growth (while more experienced employees exhibit higher levels of productivity, productivity growth is greater for younger cohorts who join the labour market and gain experience over time). As such, lower productivity growth may also be linked to lower returns on capital. These trends are structural and likely to persist for longer.

Figure 5: Demographic factors likely linked to lower levels of rates (dotted line for projections)



Source: UBS, Haver Analytics, United Nations. * Dependency ratio is ratio of population age 0-14 and 65+ per hundred of population age 15-64.

3. *Deleveraging.* The 2008 Great Financial Crisis (GFC) set in motion various dynamics restraining private sector credit growth primarily via financial institutions in the US and elsewhere. There is still some debate as to whether deleveraging dynamics are still weighing on credit growth & GDP growth and are thus boosting market preference for liquid sovereign bonds. Residual risk aversion, *macroprudential policy overhaul* and the sheer stock of debt that has built up during the past cyclical expansion are all thought of as key drivers of persistent deleveraging dynamics.

This is not an exhaustive list of arguments in the debate. Other arguments (e.g. rising income inequality, shortage of safe assets, behavioural exuberance, etc.) have been suggested (see White House report for a broad discussion – White House 2015). A detailed analysis of all the different potential drivers of US and global interest rates is beyond the scope of this paper. However, an overarching point transpires; part of the move in rates is driven by slow-moving secular or even structural factors. These may persist for a significant time and are likely to continue to affect a) the pricing of the long-end of the US curve and b) Fed rate decisions.

Why you need to know where US real rates are going

Regardless of their asset class or geographic focus, investors need to know where US interest rates are likely to settle once the Fed normalises policy back to neutral. As the Fed is likely to continue delivering stable inflation near 2% in the long run, what investors really need to know is the "equilibrium real rate". And they need to know this today (not at the end of the Fed cycle). For three reasons:

a) The equilibrium real rate is a key variable that affects and informs the Fed's own decisions today. If for instance the Fed estimated that a 3% level of real policy rates is consistent with inflation near 2% and output close to trend at equilibrium, then the current negative level of the real policy rate would be deemed to be significantly accommodative. As the level of slack in labour markets diminished, they would be pressed to hike rates urgently and rapidly. But if that estimate was much lower – e.g. at 1% or less, then the need for urgent and rapid hikes would moderate. In fact the lower this equilibrium rate level is, the more cautious the Fed should be with each hike.

b) The equilibrium real rate is key in understanding whether US rates are a bubble. One can generally think of forward rates 5+yrs from now as 1) the market's expectation of the level at which rates will stabilise once the Fed has normalised policy accommodation back to neutral levels, plus 2) some premium for investors to assume interest rate risk. 5y rates 5y forward currently hover near 2.88%. Adjusting for standard estimates of term premia, we can assume that the market expects equilibrium rates to average out around 2.5% in the long run (for estimates of Term Premia see Adrian, Crump and Moench 2013). If the actual underlying equilibrium rate ends up being significantly higher than that, then the investors who receive rates today with a long-term horizon stand to lose money as policy rates land at higher levels.

c) The equilibrium rate is key for most assets globally. For instance, if market expectations embedded in the US curve underestimate the potential for higher rates in the future, then the discount rate used to price US equities today is too low. As rates normalise higher, equities (in the US and abroad) could face headwinds (that need to be offset by stronger earnings growth). The same holds for US credit. EM assets may come under more direct and acute pressure.

How we estimate equilibrium real rates

In this paper we attempt to provide a reasonable estimate of where equilibrium US real rates likely are at the moment. As mentioned earlier, assuming stable inflation near 2% in the long run, equilibrium real rates are the key determinant of where nominal Fed Funds are likely to hover, once Fed policy has normalised back to neutral (Nominal Fed Funds Terminal Rate = 2% + Equilibrium Real Rate).

The seminal literature in the field acknowledges that there is wide model uncertainty with different specifications and different assumptions on economic structure leading to meaningful deviations in estimates. For that reason we will combine equilibrium real rates estimates from four different perspectives and gauge the combined message they send.

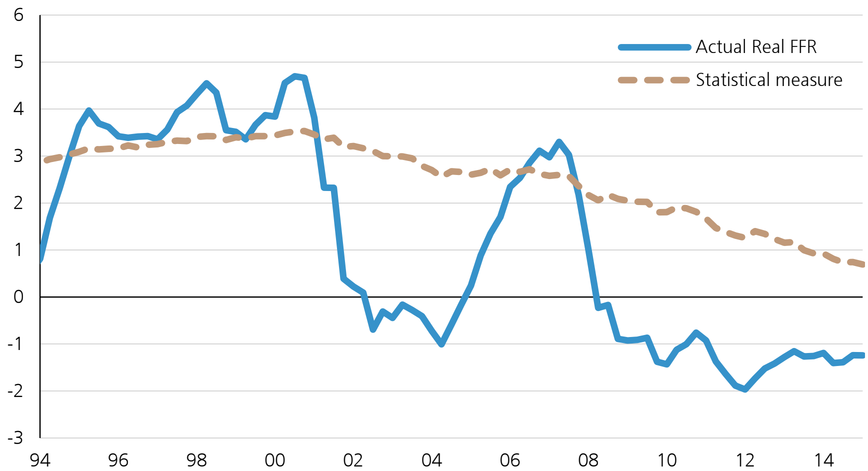
There is a trade-off across these four perspectives: the heavier the assumptions on the underlying structure of the US economy, the richer the economic intuition but also, the more sensitive the model results to these underlying assumptions.

Statistical gauge captures a declining trend in real rates

We will start with a purely statistical gauge of long-term trends in real rates, without imposing any underlying structure in the macro dynamics that drive real rates. Our approach breaks down the history of real fed-funds shifts (fed-funds ex inflation) into a) a slow moving trend, b) cycles of persistent shifts in real rates that are largely driven by past (autoregressive) shifts, c) random shocks. We mostly wish to capture the slow-moving trend component and to do that, we rely on averages over different rolling windows. In Statistical Appendix 1 we discuss our trend-cycle decomposition in more detail. We argue that our approach avoids some of the pitfalls that standard techniques such as the Hodrick Prescott filter tend to exhibit.

Figure 6 shows that there is a strong trend towards lower real rates. The trend likely began in the early 00's. The last datapoints point to equilibrium real rates in the area of 1%, down from 3% in the late 90's. The upcoming Fed hikes are likely to help this metric stabilise around current levels. Without further macro intuition, however, it is hard to make any additional judgement on future trends.

Figure 6: Statistical measure of US real rates trend points to a decline to 1%



Source: Bloomberg, UBS

The link between real rates and the output gap points to lower equilibrium real rates

As a second step we will develop an intuitive framework of our own that relies heavily on the relationship between equilibrium real rates and trend growth – box 2 explains the economic intuition behind the link.

BOX 2

It is all about real rates and trend growth

In the context of the US, where inflation expectations are well anchored around the Fed's target (2%) and where default risk is postulated to be zero, the question of long-run equilibrium rates effectively becomes a question of long-term equilibrium **real** rates. As discussed earlier, the long-term equilibrium real rate is the level of policy rates at which inflation reaches target and actual output converges to potential output (zero output gap).

It can be shown in a standard optimal growth model that in the long run, real rates settle at levels consistent with i) potential output growth and ii) time preference. Inversely, deviations of interest rates from the long-term rate are crafted by policy makers to offset a deviation of output from potential output.

Intuitively, economic agents are called to distribute their earned income between current consumption and saving for future consumption. The more they consume today the more they forego in terms of future consumption and vice versa; the more they save the more current consumption they sacrifice. As savings compound in the future by the prevailing interest rate, the level of rates is crucial in this economic decision. In equilibrium, the interest rate reflects the preference (or dis-preference) of economic agents to sacrifice one unit of consumption today in favour of consumption in the future.

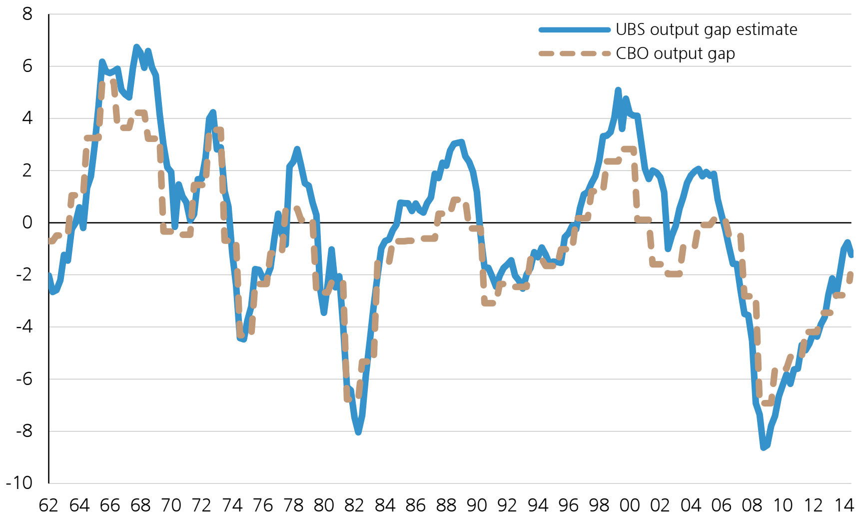
This dilemma reflects deep structural preferences of current consumption vs future consumption. These preferences are difficult to estimate directly but also unlikely to change meaningfully, even over long periods of time. For all intents and purposes we will assume that these preferences are unchanged, an assumption which by all standards seems reasonable for our investment horizon.

But growth and particularly trend growth play a significant part here. Strong expected growth in the future implies an expectation for higher incomes ahead and a desire to either save less today or even borrow against future income. This should press interest rates higher until that future income becomes attractive again (or borrowing against it becomes punitive).

Trend growth determines the long-term path of incomes ahead. Trend growth incorporates concepts such as labour force growth, capital stock growth, productivity of labour and productivity of capital (together, total factor productivity). Distributional questions aside, the higher the trend growth, the higher the growth in production factors and likely productivity too, the higher the profitability of investments, and ultimately the higher the level of labour income.

Therefore one thing is clear from a theoretical macro perspective. At the heart of long-term real rate modelling lies its link to trend growth. And it is this link we attempt to explore and exploit in the rest of this paper.

Figure 7: Our own estimate of the US output gap (%)



Source: UBS, Haver Analytics, Congressional Budget Office

The Fed sets policy rates according to fluctuations in the economic cycle. The deeper the decline in output below trend, the lower the Fed is likely to push nominal and by extension real rates below their equilibrium levels. In other words, the deeper the output gap (current output vs trend), the more negative the real rates gap (real rates vs. equilibrium real rates). To the degree that the cycle in real rates commoves consistently with the real business cycle, the trend in equilibrium real rates should match trend growth (Box 2).

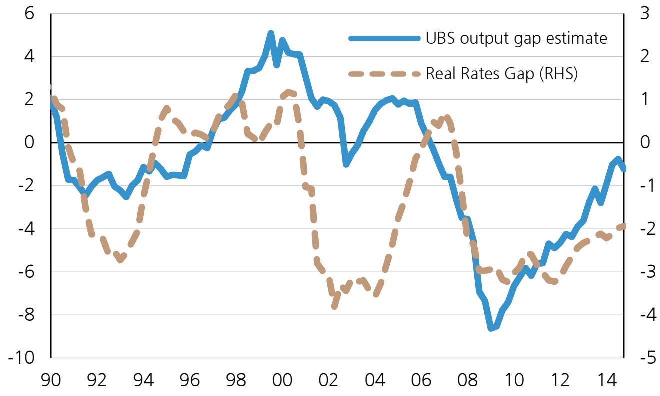
Intuitively, the track record of the US economy post the GFC demonstrates low levels of GDP growth (slightly above 2%). In the meantime there is evidence that the output gap has narrowed (as declining near-term unemployment metrics imply). This is a sign of slowing trend growth and it is reasonable to assume that equilibrium real rates have declined in tandem.

We now need an estimate of the US output gap. To decompose trend and cycle we use a similar approach to the one we used earlier in our statistical measure of trend in real rates. While our Output Gap (Figure 7) features a forward- and backward-looking gauge of trend growth, it avoids some of the key pitfalls of the Hodrick-Prescott filter (Statistical Appendix 2 discusses in more detail).

We also need an estimate of the real interest rate gap. We look at the gap between current real rates and our metric of trend in real rates. As Figure 8 shows, deviations of real rates from trend have indeed matched shifts in the output gap.

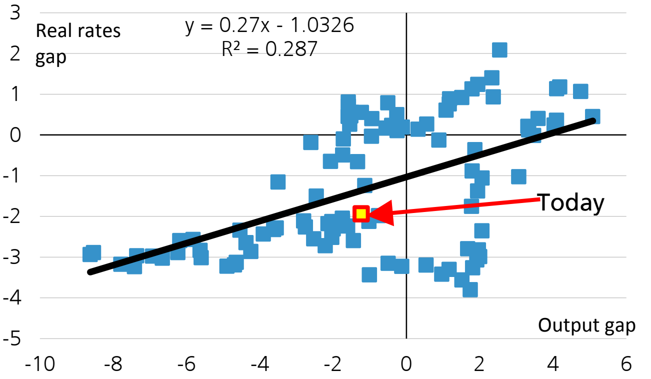
Lastly, we run a simple regression between the modelled real rates gap and the output gap. We control for lagged values of real rates and the output gap and extract the long-term relationship between the two. Figure 9 offers a rough visualisation of the relationship between the two variables. It shows that today's low real rates are broadly in line with the level of the output gap, according to past relationships of the two metrics.

Figure 8: Real rates gap mirrors the cycle



Source: UBS, Haver Analytics, Bloomberg

Figure 9: Real rates today broadly in line with output gap



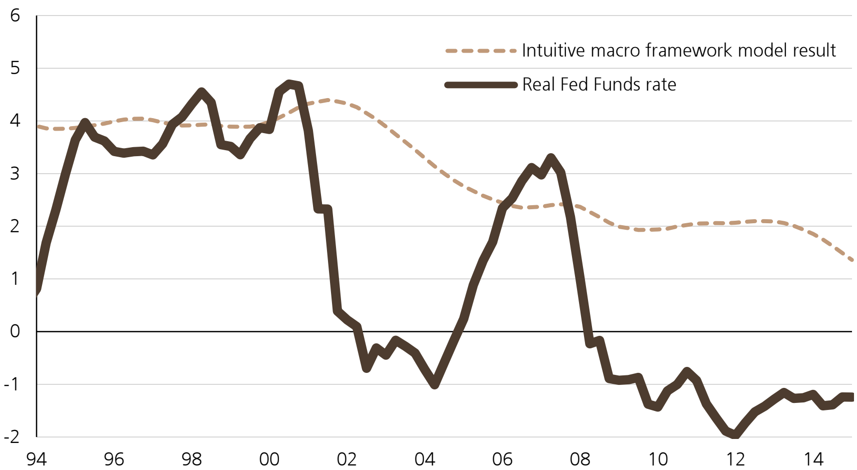
Source: UBS, Haver Analytics, Bloomberg

Using the coefficients from our regression, the current level of real rates and the current level of the output gap, we back out an indirectly observed, implied "equilibrium real rate" along our sample. We smooth out the implied estimate over the average length of a full cycle (8 years).

Our intuitive framework confirms the original macro postulation; equilibrium real rates have likely declined, close to, or even below 1% (Figure 10). There is still an output gap in the US economy and hence there is a cyclical component to ultra-low real rates (currently at negative levels). And that cyclical component will reverse into higher real rates as the Fed normalises policy to neutral levels.

But, still, market participants should be measured in their expectations of how high real rates may rise. The output gap has narrowed and real rates have remained abnormally low without any early signs of inflation pressures picking up just yet. That, combined with the aforementioned evidence of lower trend growth can be seen as indirect evidence of a lower equilibrium real rate.

Figure 10: Intuitive macro framework: consistent with lower eq. real rates



Source: UBS, Haver Analytics, Bloomberg

Imposing stricter macro structure: lower real rates results persist

Exploring the link between trend growth and equilibrium real rates further, we take an additional step towards enhancing the macro content behind our modelling frameworks. The additional macro structure also comes at a cost; the results are quite reliant on a number of the macro assumptions embedded (although not as reliant as in DSGE models such as Curdia, et al. 2015). And this is exactly why in the end we will compare the signals that different approaches send into one average estimate.

Initially, we will update the seminal modelling framework that most of the academic literature on the subject tends to reference (Laubach and Williams 2001). Larry Summers has looked at an earlier update of the model to show that equilibrium real rates had declined to near zero around 2011. This is an econometric model using an approach borrowed from the field of physics (a state-space representation of the economy) and making Neo-Keynsian structural assumptions about underlying macro dynamics.

In very rough terms our model is built around the following set of macro relationships:

a) A trend-cycle decomposition producing an estimate of the output gap.

b) A stochastic process that links real interest rates to trend growth and shocks that follow a random walk.

c) A dynamic specification of the I-S curve (investment/savings), which links the output gap to lags of the interest rate gap and lags of the output gap.

d) A dynamic specification of the Phillips curve, where inflation is driven by lags in the output gap and past rates of inflation.

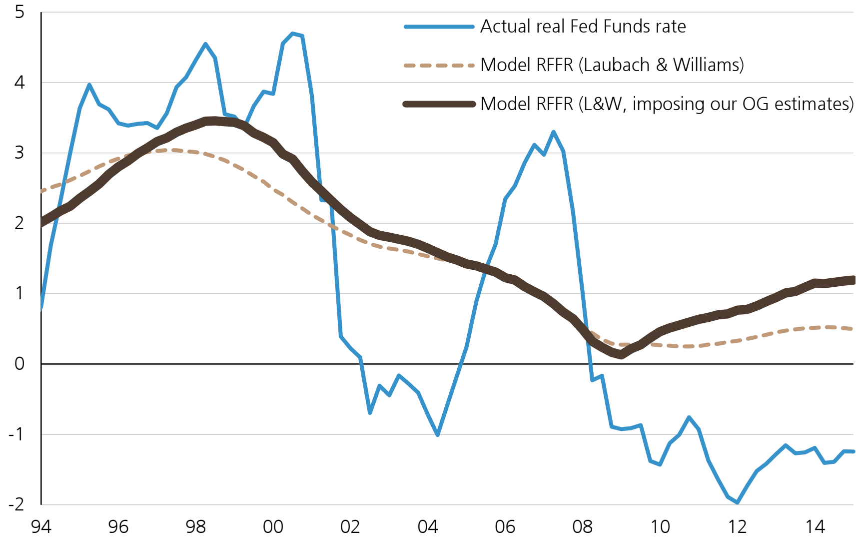
In essence this helps us produce a concise reduced form specification of the key structural aspects of the US economy. Past cyclical fluctuations and shifts in real rates away from the equilibrium rate drive trends in the output gap. The inflation process that drives part of the variability in real rates is driven by past inflation shifts and shifts in the output gap (with a lag). And the long-term equilibrium interest rate is driven by trend output dynamics. In Statistical Appendix 3, we explain the state-space paradigm and our own improvements on it that help enhance statistical robustness.

The brown dotted line in Figure 11 presents our estimate of the updated results for the Laubach and Williams model. Consistent with Larry Summers' thesis, real rates have declined sharply between the late 1990s and 2011. What is interesting vis a vis Larry Summers' work is that the estimate for equilibrium real rates has likely stabilised and not quite at zero levels.

Improving on the cycle: imposing our estimate of the output gap

As hinted earlier, there is significant model uncertainty linked to the state-space representation. The relevant literature highlights this uncertainty (Clark and Kozicki 2004). One key area of uncertainty is the choice of the output gap metric. Our earlier approach allows the output gap to be endogenously determined by the model but without much judgement on whether the current (or past) output matches economic intuition.

Figure 11: State space models point to lower equilibrium real rates



Source: UBS, Haver Analytics, Bloomberg

In fact, a close look at the implied output (eq. real rates near zero) implies very limited slack in the economy (if not even capacity constraints). While most of the 2008 output gap has declined by now, we think that broad economic indicators as well as third party output gap metrics (eg CBO) point to a residual level of slack in the US economy.

In our last model approach, we enrich the economic intuition of the Laubach and Williams framework by imposing a path for the output gap consistent with our own estimates. We consider this path to also be consistent with past business cycle dynamics and plausible levels of slack featured in the US economy currently. Barring a temporary collapse in equilibrium real rates around the 2008 crisis, real rates have hovered around 1% in the pre-math and the after-math of the GFC.

Both approaches point to a secular in equilibrium real rates vs the late nineties. And while the latter approach places equilibrium real rates 100bps above the levels Larry Summers has referred to, it still places it 75bps below the FOMC's Summary of Economic Projections (June 2015).

These results are broadly consistent with recent findings by the IMF (Pescatori and Turunen 2015), which uses a similar framework but approached from a different angle.

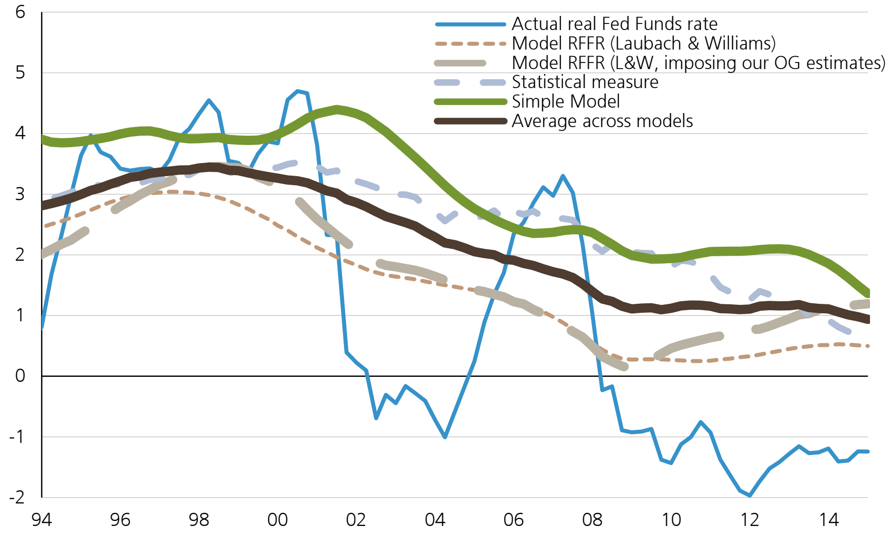
Equilibrium real rates at 90bps…

Different models impose different levels of macro structure and produce results consistent with the underlying economic assumptions.

But interestingly – and clearly not by construction – they converge to one key message; equilibrium real rates have likely declined over the last fifteen years. Most estimates converge to a current level close to or slightly below 1%. Equilibrium real rates also appear to have largely stabilised over the last few years.

Figure 12 illustrates the point as it gathers results from our four different models together. The dark brown line draws an average across models that approach the same question from a different angle and with a different degree of complexity but also different levels of restrictions in terms of their statistical assumptions.

Figure 12: Different models converge: Equilibrium real rates at 90 basis points



Source: UBS, Haver Analytics, Bloomberg

…implies risk of a shallower Fed tightening cycle…

What does this mean for the Fed? Currently, the cross-model average points again to an equilibrium real fed funds rate around 90bps. We will assume that the Fed's implicit goal for inflation will credibly remain close to 2%. This means that at a terminal nominal fed funds rate of about 3%, monetary policy will be neutral.

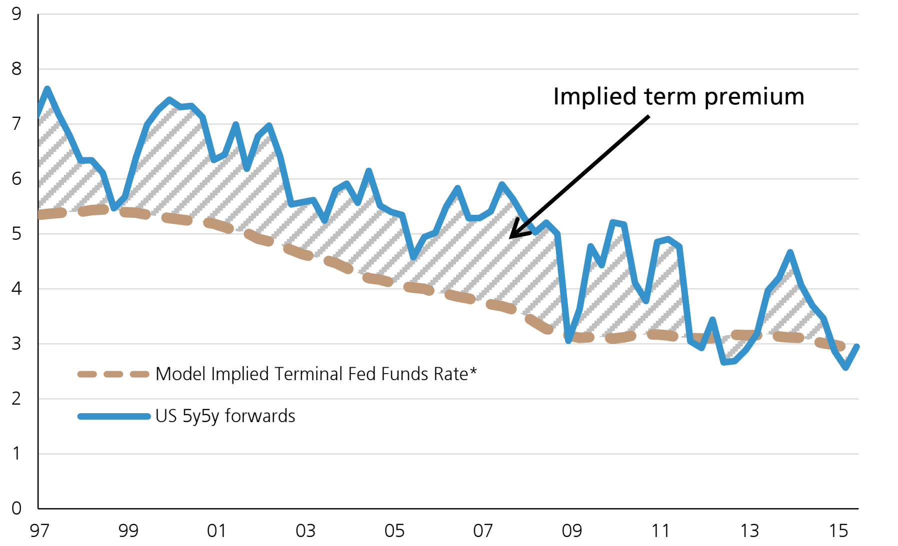
This is below the Fed's own assessment of where policy rates are going. In their latest Summary of Economic Projections they envisage Fed Funds rates at 3.75% in the long run. This implies equilibrium real rates near 175bps, which is more than 75bps above our own estimates (FOMC June 2015). The Fed median estimate has declined over time (by a total of 50bps since June 2012).

From our perspective, should the Fed realign their own estimates closer to our model results, this will also moderate their assessment of how low current policy rates are vs equilibrium and how loose monetary conditions are at current policy rates. The net result would be for a gradual and shallower tightening cycle.

In contrast, if the Fed follows a faster pace of normalisation towards a higher rate but our estimates prove to be correct, we may see markets react negatively via risk sentiment deterioration across pro-cyclical assets (equities and credit) and towards lower bond yields at the long end of the US curve.

In our upcoming Big Macro 02 paper we will examine in detail the different paths via which the Fed is likely to arrive at the terminal rate and the policy risks and market risks around each path.

Figure 13: Decline in Long-term US yields Matches Trends in Equilibrium Rates



Source: UBS, Haver Analytics, Bloomberg.*Cross-model avg. estimate equilibrium real rates + 2% exp. inflation

…implies long-term rates are not a bubble

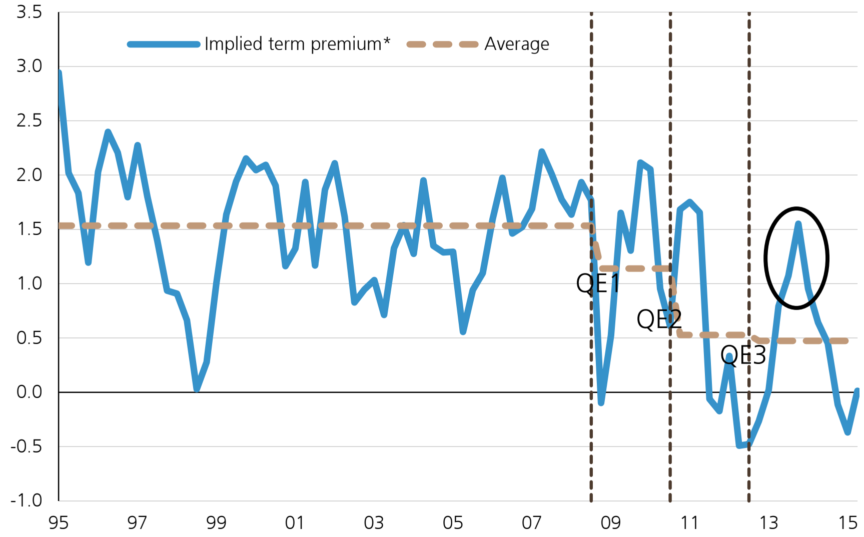
We will now argue that a Terminal Rate for (Nominal) Fed Funds slightly below 3% (2% inflation +0.9% equilibrium real rates) is broadly consistent with market pricing. To gauge market expectations we will focus on 5-year US swap rates 5 years forward (hence 5y5yfwd rate). 5y5yfwd rates consist of three key components: a) the market's expectation of the long-run equilibrium real rate, b) the market's inflation expectation 5y5y forward and c) some premium for investors to assume duration/interest rate risk (hence the "Term Premium").

The dotted line in Figure 13 presents the level of Terminal Fed Funds rates implied by the evolution of our Equilibrium Real Rates estimate over time + the 2% inflation that the Fed can be expected to deliver and has been able to deliver on average and in the long run. The light blue line is the 5y5yfwd rate in the US over a long sample. The comparison of the two variables reveals two key points:

1. The long-term trend decline in 5y5yfwd rates matches the modal decline in equilibrium rates, particularly up until 2009-2010. This is very interesting because this result is not by construction. Our model estimates are not based on asset prices or long term-trends in rates. And at least in principle, 5y5yfwd rates are less affected by near-term shifts in policy rates and more driven by expectations of long-term equilibria. In essence it reassures us about the sustainability of market trends. And vice versa, it offers us a level of confirmation with respect to our results.

2. Term premia have likely declined as one would expect post Fed's QE. One can think of the gap between 5y5yfwd rates and our model output in Figure 13 as a reflection of "term premia". The fact that the gap tends to diminish at times of crisis ('98, '08, '10-'12 etc) confirms this intuition. That gap has declined since 2008 as can also be seen in Figure 14. In the chart we average out the level of premia following each one of the Fed's QE operations. Post QE3, premia have hovered around 50bps on average, 100bps below pre-QE levels. This is consistent with the Fed's own assessment of a suppression of US term premia by more than 100bps due to Fed's Treasury purchases (Engen, et al. 2015) and with the estimates of our US Economists (Harris 2015).

Figure 14: Since 2009 most of the decline in long-term rates is likely to reflect term premium compression



Source: UBS. *5y rate 5y forward – (model real rate + 2% inflation)

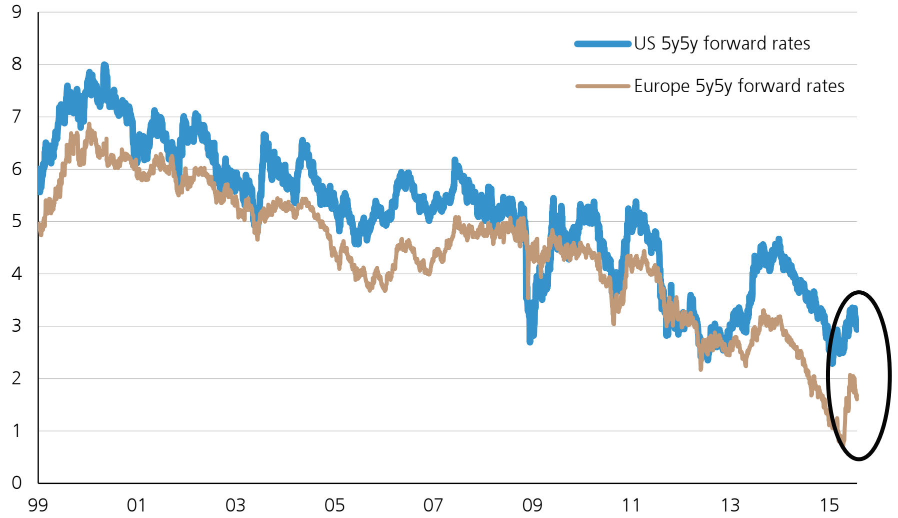
The upshot is that long-term interest rates are broadly in line with our estimated levels of equilibrium real rates AND the compressed term premia that the quantitative easing operations imply.

Fed's balance sheet: a pivot-point for long-term bond valuation

It is important to dwell a bit more on this last point. Firstly, our assessment that long end forwards in US rates are fairly priced is contingent on the Fed maintaining its balance sheet unchanged for the foreseeable future. An unchanged Fed balance sheet implies that term premia at the long-end stay compressed. The Fed has signalled that the first bouts of monetary tightening will be delivered via higher policy rates and not via balance sheet reduction. However, this clearly highlights the Fed's own dilemma; while the normalisation of policy rates will mostly push front-end rates higher (and curves flatter), it is unlikely to have anything but a temporary effect on long end forwards. And vice versa, any signal that policy tightening may involve a shift in the Fed's balance sheet will likely trigger a significant adjustment of more than 100bps in long rates (and a steeper curve). The "taper-tantrum" during the summer of 2013 gives an indication of the kind of shock to term premia, a shift in market expectations of the size of the Fed's balance sheet can trigger (Figure 14).

Secondly, it is important to acknowledge that it is not just about the Fed; it is also about the ECB, BOJ, etc. More specifically, there is a significant probability that quantitative easing operations in Europe primarily but potentially even in Japan may have further suppressed US term premia. For instance, since the market first started anticipating ECB bond purchases in the second half of 2014, 5y5y rates in the US declined by 50bps. Not all of that reflects spill-overs in term premia – some of that reflects the decline in front end rates there too and the spill-overs from a lower EUR/$ exchange rate. But, given the very tight co-movement between 5y5yfwd rates in the US and in Europe (Figure 15), it is fair to argue that part of the recent premium compression in the US curve may reflect QE from abroad. In that sense, a reversal in easing operations from the ECB or the BOJ could stir the waters for US bonds too. Given the different stages of the cycle in the US and abroad, foreign tightening is a more distant risk to US bond valuations.

Figure 15: Europe's QE is likely to have contributed to expected US term premium compression



Source: Bloomberg

Where to receive – where to pay

In this section we will attempt to define a trading band for 5y5yfwd rates around a central "fair" value. The idea is that the closer we are to the lower end of the band, the more inclined we would be to pay long-term rates with a reasonable degree of confidence. And vice versa, the closer we are to the high end of the band, the more likely we are to recommend receiving long-term rates.

Our framework offers an anchor on the "fair" level of market expectations for nominal interest rates in the long run. It does not offer a strict quantification on the "appropriate" level of term premia.

That said, we are not completely in the dark. We know that since the late 90's and before the Fed's asset purchases began, 5y5yfwd rates have traded over our nominal anchor at an average premium of 150bps. By the same token, since QE3 was announced, our implied term premium metric has averaged around 50bps for 5y5yfwd rates – but this 50bps estimate is on the high side. For two reasons:

First, it includes the "taper-tantrum" days, a period of high market uncertainty over the future size of the Fed's balance sheet. As argued earlier, we do not expect the Fed to signal a shift in their balance sheet soon and if they do, we will revisit our analysis appropriately.

Second, the choice of sample is diluting the effect of ECB and BOJ easing on US term premia.

An estimate of a term premium around 30bps in 5y5y rates is more appropriate. It is consistent with a narrower sample that avoids the two aforementioned upward biases. It is also consistent with the scale of decline in US term premia from the Fed's QE that some of the most prominent models on the subject (discussed and illustrated earlier) roughly imply.

Combined with our estimate for Terminal (Nominal) Fed Funds of around 2.9%, a term premium of 30bps implies that 5y5yfwd swap rates should hover around a central value of 3.2%.

We need to establish a trading band around this central value. This band reflects uncertainty from volatile markets. For instance, the gap between 5y5y rates and our own metric of equilibrium nominal interest rates has a one standard deviation of about 75bps since the mid-nineties (quarterly data). This band also reflects model uncertainty. Our 90bps estimate of equilibrium real rates reflects an average of different models, each one incorporating different economic assumptions. Different model results range +/-40bps around our mean estimate.

These two areas of uncertainty (model and market driven) are not necessarily independent and additive. In part, they can reflect similar investor concerns (has a big macro event affected the unobservable equilibrium real rate, is the Fed policy consistent with a return to equilibrium rates in a 5y-10y horizon etc.). Rather than compound the two ranges we would average them out and define a trading band of roughly 60bps around 3.2%.

On average, this means that, the closer 5y5yfwd swaps rates trade towards 2.6% the more likely it becomes that long-term US rates are overvalued. And vice versa, US long-term rates start looking cheap with 5y5y rates at about 3.8%.

What would change our assessment?

While our tactical recommendations in US rates will be largely based on short-term macro shifts, the closer 5y5y swap rates trade to either end of the 2.6-3.8% range, the stronger the long-term valuation considerations in our trading strategy. But this is not a range set in stone. A list of factors would lead us to update our framework. And that update may lead us to revise this range. More specifically:

a) Evidence of shifts in trend growth. We could observe a series of quarters of growth close to 3% without any visible acceleration in inflation and with evidence of stronger productivity growth. Put together, this would stand as evidence of stronger trend growth and it would likely positively affect our equilibrium real rates estimates. And vice versa.

b) Evidence of a different implicit inflation target. Throughout our analysis we have assumed that the FOMC are true to an implicit inflation target of about 2%. Should the Fed assign less significance in achieving an average rate of inflation near 2% and the market starts pricing such a long-term inflation miss, then we would need to challenge our assumption as well.

c) An unanticipated shift in Fed (and potentially ECB) policy to actively reduce its balance-sheet size, particularly as it pertains to high duration USTs. As discussed extensively earlier, this would imply US term premia could rise by 100bps or more.

d) Shifts in global factors (commodity prices, Chinese and Euro-area trend growth etc.) that could affect external demand and terms of trade in a permanent fashion.

None of these four factors is very likely to play out within a market-relevant forecast horizon. But if and when it does, we will update our framework.

What would make us revisit our framework and where we could be wrong?

We have attempted to approach the issue of equilibrium real rates from various angles, each one with a different level of assumptions regarding the underlying macro drivers of real rates. Still, our framework is deeply reliant on strong and

persistent macroeconomic relationships. If evidence emerges that these relationships are shifting (eg, a change in the slope of the Phillips curve), we would need to re-estimate our model too. It is unlikely though that such structural shifts are manifest in a horizon of a couple of years or so.

We would also need to revisit our framework if we wake up to a "data mirage" – i.e. if we ex-post observe large-scale revisions in critical data such as output levels, unemployment levels and rates of realised inflation. Such events are quite rare and unlikely.

Where could we be wrong? We could be slow in capturing shifts in macro relationships. A possible critique to our approach is that it focuses on statistical observations of underlying trend growth and the output gap and their link to real rates. It is not trying to model the underlying macro currents that drive trend growth, saving behaviour and real rates. As such, it may be less quick to highlight possible tentative shifts in variables that will eventually drive equilibrium real rates higher or lower.

Instead we could model real rates directly as a function of demographic variables, balances of savings across different sectors of the economy, productivity metrics and global variables. That said, these methods have a very high margin of error. Often, the underlying assumptions on the macro relationships tend to be arbitrary. And finally, the complexity of the subject and the limited availability of robust data on a global level make such approaches much riskier and less tractable overall.

Finally, as discussed earlier, these estimates are not static (in fact equilibrium real rates vary over time) or certain (as we discuss earlier there is significant model uncertainty). For that reason we prefer to consider a range around which long term intrest rate forwards are likely to trade in equilibrium and in line with "fair value" and we will regularly revisit our calculations to update this range.

There is also the view that we may hover at the higher bounds of our estimated range. This view argues that trend growth may be higher than the slow growth rate of the past six years implies; we have gone through a series of exceptional events between 2008 and now, which have weighed on growth instead (see Hamilton et al., 2015), Elements of our US economics view also highlight the upside risks to future growth and real rates.

Statistical Appendix 1

A Statistical Measure of the Long-Term Trend in US Real Rates

Let $i(t)$ denote the nominal federal funds rate at quarter t and $\pi(t)$ denote the ex-post historical inflation rate. Denote by $r(t)$ the ex-post read federal funds rate, i.e. $r(t)=i(t)-\pi(t)$. The statistical properties of the real rate allow us to treat it as a stationary (or at least locally stationary) time series. Under this assumption one can consider an autoregressive representation for the real rate as:

$$r(t) = a(0,t) + a(1,t)r(t-1) + \dots + a(p,t)r(t-p) + u(t) \qquad \text{(A1.1)}$$

where a(j,t), j=0,…,p, are the model's coefficients to be estimated, p is the model's autoregressive order (which can be time-varying, see below) and $u(t)$ is the unobservable random component, assumed to be white noise (zero mean and constant variance). If the process is only locally stationary over some window of time then we can assume that the model's coefficients are constant (≡parameters) over that window, i.e. a(j,t) = a(j) over the length of time t of the rolling window; if the process is globally stationary then the coefficients are constant for the entire length of the time series. When the coefficients are treated as constants we can solve for the long-run equilibrium. For the case of a globally stationary series we have that the long-run equilibrium is the mean of the time series, obtained as:

$$m = a(0)/[1-a(1)- \dots -a(p)] \qquad \text{(A1.2)}$$

where we see that the coefficients do not depend on time. For the case of practical interest, where we consider only a locally stationary time series, the long-run equilibrium is time varying and obtained as:

$$m_w(t) = a_w(0,t)/[1-a_w(1,t)- \dots -a_w(p,t)] \qquad \text{(A1.3)}$$

over some rolling window W of observations, say t = s+1, … , W+s, for s = 0, 1, … , T-W, with T being the full length of the time series. However, the appropriate length of the rolling window is unknown and it might itself be time-varying, i.e. expressed as W(t). To address this uncertainty we use rolling window averaging, where we estimate equation (1.3) using different values for W, say w1, … wk, and average the resulting estimates as in:

$$r^*(t) \equiv m_{avg}(t) = [m_{w1}(t) + m_{w2}(t) + \dots + m_{wk}(t)]/k \qquad \text{(A1.4)}$$

which is our final estimate of $r^*(t)$. Note that each rolling window estimate can have its own model order p, i.e. p can change as we go through the observations in the sample. Finally, also note that this estimate is entirely a "real time" estimate as it makes use of information available on and before the current period t.

The advantages of this approach are essentially two: first, it avoids making any stringent modelling assumptions beyond that of local stationarity on the time series of the real rate and, second, it treats the equilibrium real rate as a natural product of the series itself (that is, the long-run mean of the process) and applies smoothing via averaging to obtain the final estimate we are after. The disadvantages are also essentially two: first, we cannot be ex ante sure that our choice of rolling windows is such that the assumption of local stationarity is preserved and, second, we do not take into account economic determinants of the real rate. However, we address the second of these potential pitfalls in Appendix 3.

Statistical Appendix 2

The UBS Estimate of Potential Output and Output Gap

The trend-cycle decomposition we utilised in Appendix 1 can be used – with modifications – for estimating potential output and thus the output gap. Let $y(t)$ denote the log of real GDP at quarter t. There is a huge literature dealing with the statistical properties of the variable of interest and there is no conclusive evidence as to what these may be (including unit-root non-stationarity with or without breaks, trend-stationarity with or without breaks and many other suggested data generating processes for $y(t)$). Here we take a simpler, but highly realistic, approach on the way we can treat the real GDP series that allows us to construct a measure of potential output/output gap which is very highly correlated with measures obtained from much more complicated models (including the model in Appendix 3 but also the measures published by the FRB/US model).

In our approach we let y(t) be a locally trend-stationary time series. This makes sense as it allows us to have changes in both the trend slope of real GDP (thus to have changes in potential output which contains this trend) and, as before, to have changes in the memory pattern of the real GDP residuals after removing this trend. We explain this in more detail below.

We start off with the following specification:

$$y(t) = b(0,t) + b(1,t)t + \zeta(t) \qquad \text{(A2.1a)}$$

$$\zeta(t) = a(0,t) + a(1,t)\zeta(t-1) + \ldots + a(p,t)\zeta(t-p) + \varepsilon(t) \qquad \text{(A2.1b)}$$

where b(0,t), b(1,t) are the model's trend coefficients and a(j,t), j=0,…,p, are the model's residual coefficients (all are to be estimated), $\zeta(t)$ is the locally stationary, unobservable cycle component of real GDP (note this is not the cycle for the output gap) and $\varepsilon(t)$ is the unobservable random component, assumed to be white noise (zero mean and constant variance). If the process is locally trend stationary over some window of time then we can assume that the model's coefficients are constant (i.e. they are parameters) over that window. This is the same assumption we made in Appendix 1 but here comes with two caveats: first, we can exclude the global trend stationary assumption (since it is documented that the trend in real GDP has exhibited several structural shifts over the years) and, second, we do allow for forward-looking, trend-stationarity by assuming that the local trend at quarter t is a function of both past and future observations. This second caveat is not as strong an assumption as it might seem at first sight because all parametric models for potential output construct it in a similar fashion, e.g. by Kalman fixed point smoothing which runs back and forth in time.

Thus, we proceed by first estimating the trend component of the series of a rolling window of observations by estimating b(0,t) and b(1,t) of equation (2.1a) by least squares over the observations of that rolling window; then, we extract the corresponding residuals say $z(t) = y(t) - b(0,t) - b(1,t)*t$ and estimate the parameters of equation (2.1b) using $z(t)$ in place of $\zeta(t)$. The estimate of potential output $y_w(t)$ is then the sum of the local trend estimate plus the long-run mean of the residuals, i.e.:

$$y_w(t) = b(0,t) + b(1,t)t + m_w(t) \qquad \text{(A2.2a)}$$

$m_w(t) = a_w(0,t)/[1-a_w(1,t)- \dots -a_w(p,t)]$ (A2.2b)

where we have, as before in Appendix 1, some rolling window W of observations, say t = s+1, … , W+s, for s = 0, 1, … , T-W, with T being the full length of the time series. However, here we use a window of odd length and our estimates in the two equations above are taken on the midpoint of the window's observations – thus using forward-looking information in constructing our potential output measure for that window – for as long as there are enough future observations; at the end of the series our estimates are necessarily "real time" and use only past and current observations. Finally, we take averages over the rolling windows we consider to construct the final measure of potential output $y^*(t)$:

$y^*(t) \equiv y_{avg}(t) = [y_{w1}(t) + y_{w2}(t) + \dots + y_{wk}(t)]/k$ (A2.3)

and our measure of the output gap then becomes:

$o(t) = y(t) - y^*(t)$ (A2.4)

It is of interest to note that our estimation approach produces an output gap estimate that is highly correlated with more complicated, larger-scale models estimates, and that its "real time" component (corresponding roughly to the post-crisis recovery after 2008) almost matches the pattern of such models but also the economic intuition of the post-crisis economic recovery process in the US.

Statistical Appendix 3

A State-Space Model for the Joint Determination of the Output Gap and the Long-Run, Equilibrium Real Rate

The literature on the determination of the long-run, equilibrium real rate offers a rather compact parametric representation of how this rate interacts with basic macroeconomic variables, notably the output gap and inflation. It is interesting to note that, unlike the statistical approach in Appendix 1, this representation does not depend directly on the level of the observed real federal funds rate but rather on the underlying economic dynamics. Thus, the material presented in Appendix 1 nicely complements what we are about to discuss below.

There are three observable variables in the model, output, the real rate and inflation, and three unobservable, latent variables (called state variables), potential output, potential output growth and the equilibrium real rate. The main links among these variables are given in the following equations, which are written in compact form without explicitly writing the associated coefficients (details can be found in Laubach and Williams 2001):

$$y(t)-y^*(t) = f_y[y(t-1)-y^*(t-1), r(t-1)-r^*(t-1)] + \varepsilon_y(t) \quad \text{(A3.1)}$$

$$\pi(t) = f_\pi[y(t-1)-y^*(t-1), \pi(t-1)] + \varepsilon_\pi(t) \quad \text{(A3.2)}$$

$$y^*(t) = y^*(t-1) + g(t-1) + \eta(t) \quad \text{(A3.3)}$$

$$g(t) = g(t-1) + \zeta(t) \quad \text{(A3.4)}$$

$$r^*(t) = 4cg(t-1) + \theta(t) \quad \text{(A3.5)}$$

The first equation links the observable output with potential output, with lags of the output gap (there are two lags in actual estimation to account for the cyclicality of the output gap, we only show one for illustration), and with lags of the real rate gap (there are also two lags of the rate gap, with a common coefficient); $\varepsilon_y(t)$ is the unobservable random component assumed to be white noise and $f_y[\ldots]$ is a linear function of its elements. The second equation links observable inflation with lags of the output gap (one lag used in estimation) and with lags of past inflation (eight lags are used, with their coefficients constrained to sum to unity); $\varepsilon_\pi(t)$ is the unobservable random component for this equation, also assumed to be white noise, and $f_\pi[\ldots]$ is also a linear function of its elements. These equations are the, so-called, signal equations for the observable variables; note that the real rate does not have an equation of its own.

Next we have the state equations that describe the evolution of the non-observable latent or state variables. The third equation models potential output as a double random walk: potential output is a function of past potential output and past growth in potential output, the latter also being a function of its own past value, as given by the fourth equation. The evolution of potential output and its growth rate are controlled by constraints that are imposed on the variances of their random components, $\eta(t)$ and $\zeta(t)$, relative to the variance of the random component of observable output $\varepsilon_y(t)$. Finally, the fifth equation describes the evolution of the long-run, equilibrium real rate as a function of growth in potential output and a random component $\theta(t)$. Note that in this set-up the equilibrium real rate is determined exclusively by the growth rate of potential output, i.e. by the

underlying economic dynamics. Specification errors and estimation uncertainty thus weigh heavily on the results that one obtains from this modelling attempt. Furthermore, note that in order to get potential output one has to rely on the assumption that the specification for the link between potential output and output is the correct one, over the whole period of estimation – and in general to accept that the system's coefficients do not exhibited structural changes over the sample. With these caveats in mind we estimated all parameters of this system of five equations by maximum likelihood and the final series of required state variables were obtained, using the final parameter estimates, via Kalman fixed point smoothing.

As noted in the main text, an alternative approach into using such a parametric system of equations was to consider our own measure of the output gap, as obtained in Appendix 2. This can take some of the extra uncertainty from the estimation, assuming of course that our measure of the output gap is "better" than the one obtained from the full system. We can also see this as part of our robustness/sensitivity analysis. We thus slightly modified the equations (A3.1) through (A3.5) to be able to use $o(t)$ from equation (A2.4) as follows:

$$o(t) = f_y[g(t), o(t-1), r(t-1)-r^*(t-1)] + \varepsilon_o(t) \quad \text{(A3.6)}$$

$$\pi(t) = f_\pi[y(t-1)-y^*(t-1), \pi(t-1)] + \varepsilon_\pi(t) \quad \text{(A3.7)}$$

$$g(t) = \rho g(t-1) + \zeta(t) \quad \text{(A3.8)}$$

$$r^*(t) = \lambda + 4g(t-1) + \theta(t) \quad \text{(A3.9)}$$

where we can see that (a) there is no equation for potential output (b) the output gap is a function of its time-varying growth rate with the rest of the specification being unchanged in equation (A3.6) (c) output gap growth is modeled as an autoregressive process, with ρ being estimated as less than one, and (d) the equilibrium real rate is still driven by the growth in output gap but now the model includes a constant term λ. The same caveats and estimation/filtering methods apply as in the first system.

References

Adrian, T., Crump, R. K. and Moench, E. 2013. Pricing the Term Structure with Linear Regressions. Federal Reserve Bank of New York – Staff Reports.
www.newyorkfed.org/research/staff_reports/sr340.pdf

Clark, T. E. and Kozicki, S. 2004. Estimating equilibrium real interest rates in real-time. Deutsche Bundesbank.
http://econstor.eu/bitstream/10419/19499/1/200432dkp.pdf

Curdia, V., Ferrero, A., Ng, G. and Tambalotti, A. 2015. Has U.S. Monetary Policy Tracked the Efficient Interest Rate? Journal of Monetary Economics 70.
http://www.frbsf.org/economic-research/files/wp2014-12.pdf

Engen, E. M., Laubach, T. and Reifschneider, D. 2015. The Macroeconomic Effects of the Federal Reserve's Unconventional Monetary Policies. Finance and Economic Discussion Series 2015-005. Board of Governors of the Federal Reserve System.
www.federalreserve.gov/econresdata/feds/2015/files/2015005pap.pdf

Federal Open Market Committee. June 2015. Minutes of the Federal Open Market Committee – Summary of Economic Projections. Board of Governors of the Federal Reserve System.
http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20150617.pdf

Haldane, A. G. 2015. Stuck - speech by Andy Haldane. Bank of England.
http://www.bankofengland.co.uk/publications/Pages/speeches/2015/828.aspx

Hamilton, J. D., Harris, E. S., Hatzius, J. and West, K. D. 2015. The Equilibrium Real Funds Rate: Past, Present and Future. NBER Working Paper No. 21476.
http://econweb.ucsd.edu/~jhamilto/USMPF_2015.pdf

Harris, M. 2015. Inside the Crystal Ball—How to Make and Use Forecasts. John Wiley & Sons.

Laubach, T. and Williams, J. C. 2001. Measuring the Natural Rate of Interest. Board of Governors of the Federal Reserve System.
www.federalreserve.gov/pubs/feds/2001/200156/200156pap.pdf

Pescatori, A. and Turunen, J. 2015. Lower for Longer: Neutral Rates in the United States. International Monetary Fund.
https://www.imf.org/external/pubs/ft/wp/2015/wp15135.pdf

Stein, J. C. 2013. Speech. At the "Banking, Liquidity and Monetary Policy," a Symposium Sponsored by the Center for Financial Studies, Frankfurt, Germany. Board of Governors of the Federal Reserve System.
http://www.federalreserve.gov/newsevents/speech/stein20130926a.htm

Summers, L. H. 2014. U.S. Economic Prospects: Secular Stagnation, Hysteresis, and the Zero Lower Bound. Business Economics, Vol. 49, No. 2.
http://larrysummers.com/wp-content/uploads/2014/06/NABE-speech-Lawrence-H.-Summers1.pdf

White House, 2015. Long-term Interest Rates: A Survey.
https://www.whitehouse.gov/sites/default/files/docs/interest_rate_report_final_v2.pdf

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Neutral	FSR is between -6% and 6% of the MRA.	42%	32%
Sell	FSR is > 6% below the MRA.	13%	20%
Short-Term Rating	**Definition**	**Coverage**[3]	**IB Services**[4]
Buy	Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.	less than 1%	less than 1%
Sell	Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.	less than 1%	less than 1%

Source: UBS. Rating allocations are as of 30 June 2015.
1:Percentage of companies under coverage globally within the 12-month rating category. 2:Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.
3:Percentage of companies under coverage globally within the Short-Term rating category. 4:Percentage of companies within the Short-Term rating category for which investment banking (IB) services were provided within the past 12 months.

KEY DEFINITIONS: Forecast Stock Return (FSR) is defined as expected percentage price appreciation plus gross dividend yield over the next 12 months. **Market Return Assumption (MRA)** is defined as the one-year local market interest rate plus 5% (a proxy for, and not a forecast of, the equity risk premium). **Under Review (UR)** Stocks may be flagged as UR by the analyst, indicating that the stock's price target and/or rating are subject to possible change in the near term, usually in response to an event that may affect the investment case or valuation. **Short-Term Ratings** reflect the expected near-term (up to three months) performance of the stock and do not reflect any change in the fundamental view or investment case. **Equity Price Targets** have an investment horizon of 12 months.

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Unless otherwise indicated, please refer to the Valuation and Risk sections within the body of this report.

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