Global Macro Strategy

Big Macro 02: Is The Fed's Hiking Path Mispriced?

Strategy

Global

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The market thinks the Fed cycle will be long and protracted

The US economic recovery has become broader and deeper. The Fed has acknowledged the need for rate hikes ahead. And our US economics view concurs. But this is not your typical hiking cycle; macro uncertainty has been high enough for the Fed to signal a cautiously timed and paced tightening process. The market has taken the view that the cycle will start soon, it will be gradual and protracted.

Is the market wrong?

It depends on three key questions:

1) Where are we going? We expect a lower terminal rate than the Fed

We already addressed this in our report In Big Macro 01 (September 09, 2015). We estimated equilibrium real rates at 90bps currently, more than 200bps below levels of 15 years ago. This is consistent with a terminal Fed Funds rate of about 3%; it is higher than the levels suggested by Larry Summers but lower than the median Fed assessment.

2) Where are we? How much slack is there in the economy?

In this report, we consider two plausible scenarios. The first is broadly consistent with our US economics views of some limited residual slack in the economy. The second focuses mostly at broad labour market indicators and assumes a larger degree of slack.

3) How will the Fed act? Earlier and slower or later and steeper?

We also simulate two paths for the Fed. In the first, the Fed hikes early on and in a linear fashion consistent with a Taylor Rule-like reaction function. In the second, the Fed postpones the first hike until uncertainty dissipates, but then catches up steeply in a fashion consistent with Janet Yellen's "Optimal Control" paradigm. To do this we also assess the impact of rate hikes on growth and inflation.

Where is the opportunity if the market is wrong?

The market reflects a scenario of limited economic slack and a Taylor Rule-like Fed reaction function. However, our simulations of the alternative possible scenarios reveal:

- A poor risk-reward in paying front-end (e.g., 2-3y) rates. In fact there may be room to receive and harvest 30-45bps of carry.
- The risk-reward for 10y rates is balanced. 10y yields could settle about 50bps above current levels if the Fed refrains from hiking until H12016 (and then steeply catches up).
- In contrast, the earlier and more frontloaded the hikes, the higher the odds that intermediate and long-end bonds rally outright (and curves flatten).

Where our framework could be wrong

Although our scenario assumptions are moderate and probable, the output gap could be more extreme in either direction. However, we think these tail risks are symmetric to our projections. We will change our projections as the Fed takes steps to actively reduce the size of its balance sheet beyond market expectations; a risk our US Economics team has highlighted. And we will regularly update our underlying econometric work to pick up any signs of structural shifts in the economy.

Understanding the Fed's dilemma

It seems quite clear on the surface. After nearly seven years of zero interest rates and a number of unconventional policy operations, the Fed is about to embark on policy tightening. Since the appearance of the first green shoots to growth in Q1 2009, the US economic recovery has run a long way. The gap between the level of real output and standard metrics of potential output – the output gap – has started to narrow. Despite temporary set-backs, capacity utilisation in the manufacturing sector is gradually heading towards pre crisis levels. And, consistently, the labour market has improved, with near-term unemployment approaching levels last seen at the onset of the crisis in early 2008 (Figure 1). The FOMC has communicated that the time has come for the Fed to consider a paced process of gradual financial conditions tightening. And – data permitting – it will do so before year-end. Our US Economic team expects the Fed to start raising rates in the September 16 -17 meeting (US Economic Perspectives 18 August 2015).

However, things are a lot less certain than they appear. A set of broader indicators still point to risks of meaningful residual slack. Low levels of core inflation, a sharp decline in the participation rate in the US labour market post the 2008 crisis, very low wage growth and a significant number of underemployed individuals working part-time (who would instead like to work full time) all raise the risk that it may still be too early for the Fed to hike (Figure 2). Also, financial conditions have tightened after the recent equity sell-off and external (China-driven) risks have intensified. The Fed has recognised the underlying uncertainty and has reassured investors that the timing and the pace of policy tightening will be gradual, cautious and data dependent. But is that appropriate? Or, is it enough?

The market anticipates a long and protracted Fed tightening cycle that ultimately results in Fed Funds rates levels below what one would have expected in past cycles. While the tightening is expected to commence late this year, it is unlikely to lead to policy rates north of 1% in a year from now. 3% rates are only expected to arrive in 5-6 years. And the Fed's terminal rate projection of 3.75% for Fed Funds seems unattainable to the eyes of the market. Is the market complacent? To respond, we first need to reduce the Fed's dilemma into three key "Axes of Uncertainty". In turn, they will provide the backdrop for us to simulate different paths for Fed-Funds rates, reflecting different macro outcomes.

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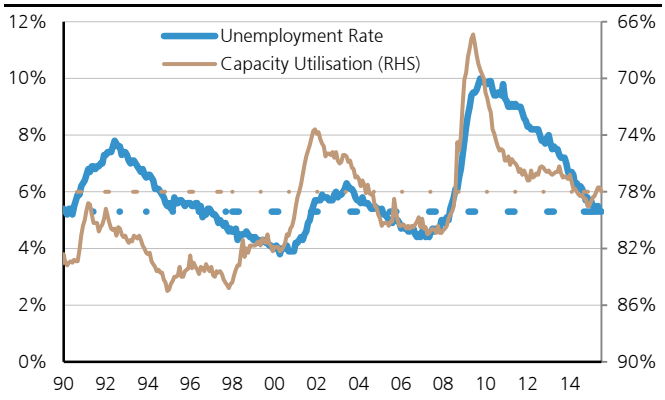
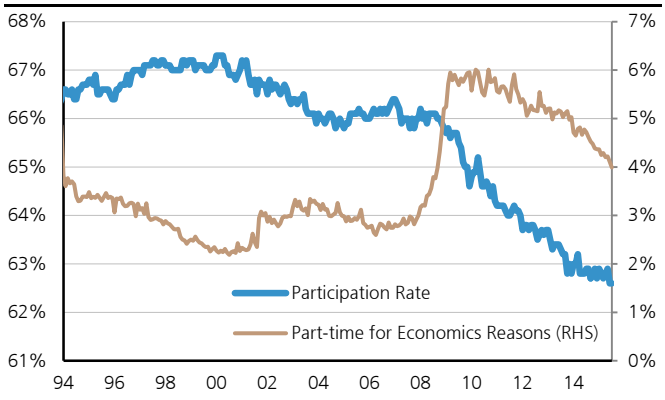
Jeremy Chalder *for his research assistance*

Figure 1: The US economy has come a long way…



Source: Haver Analytics, U.S. Bureau of Labor Statistics, Federal Reserve Board

Figure 2: …but risks of meaningful residual slack remain



Source: Haver Analytics, U.S. Bureau of Labor Statistics

The three axes of uncertainty for the Fed

The Fed's dilemma, and by extension the shape of the US curve, can be collapsed into three key questions, three key areas of uncertainty:

a) *Where we are*. What is the degree of slack in the US economy? Is the US cycle of economic recovery mature enough to justify tighter policy yet?

b) *Where we want to go*. The ultimate level of policy rates consistent with an economy in equilibrium (with inflation at target and minimal slack).

c) *How we get there*. The pace of policy tightening that the economy can sustain and will allow the Fed to achieve its policy goals.

Sizing the degree of slack in the economy is tantamount to taking a view on the hotly debated trend growth level

Where are we? The degree of slack in the US economy is key in understanding how early or late the Fed is in commencing the tightening cycle. If the Fed starts tightening monetary policy before slack has diminished sufficiently, then it risks softening growth rates, declining asset prices and deteriorating inflation dynamics, at a critical stage of the economic recovery process. If the Fed hikes well after capacity constraints emerge, it would then risk over-stimulating the economy, creating asset price bubbles and losing control of long-term inflation expectations.

There is significant uncertainty about the level of slack in the US economy, as we later discuss in more detail. The economy has grown at a reasonable pace over the last six years and by most measures it has gone a long way towards closing the output gap. Yet a lot of these metrics rely largely on different assessments of trend growth, with some indicating that there is considerable further scope before spare capacity is exhausted. Slow-moving and backward-looking metrics of the Non-Accelerating Inflation Rate of Unemployment (NAIRU) imply that further reductions in headline unemployment may trigger pressure on wages. Yet broader labour market metrics, including wage growth indicators, the rate of underemployment and dynamics in labour force participation, argue that we are a long way from seeing tightness in the US labour market.

The end of the upcoming US rate hiking cycle is a moving target even for the Fed

Where do we want to go? The Fed is likely to continue raising policy rates until they reach a level consistent with inflation near 2% and unemployment near NAIRU. This is one of the most hotly debated subjects in the policy circles at the moment. There is increasing agreement that, relative to past cycles, this terminal rate has declined over the past decade in the US and abroad. But there is very little agreement on the extent of the decline and its sustainability. For instance, the Fed's SEP argues for a return to rates closer to 3.75%. The market expects the Fed Funds rate to hover below 3% in the long run.

In Big Macro 01 we estimate the level of nominal rates consistent with the Fed's targets at about 2.9%. To reduce the dimensions of the problem at hand, we will use our analysis and postulate that, in the medium term and as the economy re-equilibrates, the Fed is likely to land at a Fed Funds target rate of *about 3%*.

"Hawkish" and "dovish" policy paths take on a new meaning

How do we get there? The pace of tightening is largely a function of how the Fed reacts to incoming data and how its own policy actions (or lack thereof) interact with growth and inflation dynamics. A linear reaction function (the closest thing to a Taylor rule for policy rates) implies a steady normalisation of policy rates to neutral levels. Smoothing out the path for rates allows for milder interest rate increases in the future. But also, in the face of uncertainty, it risks a growth and inflation slowdown that may hurt the economic recovery and ultimately delay the achievement of the Fed's overall policy goals.

In contrast, a "lower for longer" approach by the Fed, one that would be consistent with Janet Yellen's Optimal Control policy framework, would ensure that enough time has passed for the economic recovery to be well on track. Afterwards, aggressive policy tightening may be required, potentially even in a sharp manner. There is a risk here; financial conditions may stay too loose for too long and create overvaluations across asset prices, which, when the time of aggressive tightening comes, may burst and endanger financial stability in the US or abroad. Vice-chairman Dudley (2015) has argued that the FOMC needs to keep an eye on overall financial conditions in its rate setting decisions.

In this piece, we will illustrate the uncertainty around a) the level of slack and the b) pace of tightening and derive bounds, outside which we would be inclined to pay or receive in the front/mid-part of the curve.

Some slack vs lots of slack

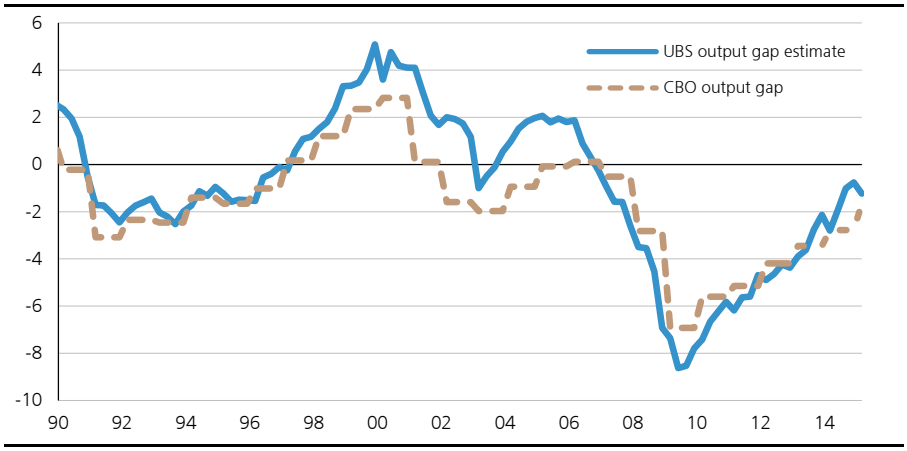
Even 1% of difference in slack estimates will make a big difference

We consider two scenarios that capture a reasonable range of uncertainty over the degree of slack currently present in the US economy. The first scenario is closer to the views of our US economists; the level of slack in the US economy has declined to modest levels and is bound to narrow further in the months ahead. The second scenario looks at broader labour market indicators and postulates a larger degree of resource underutilisation in the US economy.

1. Some residual slack (output gap of about 1%). Standard headline statistical measures of slack in the US economy tell us that the large output gap that emerged in the aftermath of the Great Financial Crisis (GFC) has diminished to a significant extent. Our own measure of the output gap introduced in our first Big Macro (Big Macro 01) points to a reasonably narrow output gap about 1%, down from a massive output gap of about 8% in 2009. This metric follows a historic path broadly consistent with standard measures such as the CBO's annual output gap series. It also points to slightly less slack than the CBO's estimate indicates (Figure 3).

   A standard translation to labour market indicators using Okun's law would yield an unemployment gap of less than 50bps, also taking into account the large degree of error in these rules of thumb particularly at this stage of the cycle. As the unemployment rate declines, this gap is bound to narrow further. And this is among the key reasons the rates market anticipates interest rate hikes to commence between September and December 2015.

Figure 3: UBS output gap estimate points to limited residual slack



Source: UBS, Haver Analytics, Congressional Budget Office

2. Lots of slack (output gap near 2%). The decline in short-term unemployment to levels close to standard estimates of NAIRU, is among the key arguments supporting the view of diminishing macro slack. However, looking at the difference between short-term unemployment and NAIRU may underestimate the true degree of labour market slack in the current cycle. A growing amount of academic literature (Blanchflower and Levin, 2015) argues that a true estimate of labour market slack needs to take into account additional factors. This includes the sharp decline in the US participation rate, as well as the still-elevated level of part-time workers that would like a full-time job.

   The participation rate in the US labour force has fallen more than 300bp since 2008, to a current level of 62.6%, the lowest since 1977. A large part of this decline is undoubtedly structural as our US Economics team has also argued, with increasing retirements from the baby-boom generation reducing participation. However, it is probably not all structural. In a weak labour market, some who would classify themselves as retired tend to come back as labour market conditions improve. This is important, as recent empirical work (Blanchflower and Posen, 2014) has shown that these workers exert a similar downward effect on wages as an unemployed person does. The CBO estimates the potential labour force at 158.2mn people, which would yield a participation rate of around 63.0%, implying a participation gap of 40bp.

   Those working part-time for economic reasons number around 6.5mn, or 4.1% of the labour force. Pre-2008, the average was closer to 3.2%. If we assume that there has been a structural jump in this category, and that equilibrium is now closer to 3.6%, that still implies an underemployment gap of around 20bp. Adding the three gaps yields an estimate of labour market slack closer to 95bps[1]. Again, using Okun's law, this roughly corresponds to an output gap of about 2%.

Neither of the two scenarios is extreme in our view, and we think both are reasonably moderate manifestations of the same underlying source of data uncertainty. As such, they capture a more hawkish and a more dovish outcome for the US economy, both within the realm of plausible outcomes.

Fed's reaction function: "earlier & slower" or "later & steeper"

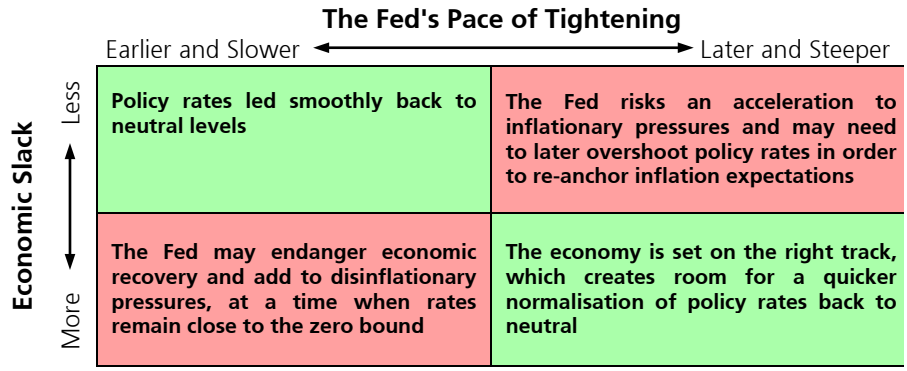
In the face of uncertainty, the Fed will interpret incoming data to decipher the stage of the cyclical recovery. How it reacts to the data will be equally important:

The risk in delivering a meaningful level of tightening early on is that the Fed may underestimate the level of slack in the economy and thus trigger a deceleration in the business cycle followed by disinflationary dynamics. Instead, the Fed can afford to wait until there is firm evidence of capacity constraints in the US economy. A 'wait and see' stance, however, has its own risks too; it risks economic overheating and a destabilisation in inflation expectations. We outline this dilemma in Figure 4.

We model two different paths for the Fed; one in which it tightens early on and in a linear/steady fashion and one in which it postpones tightening until there is a clear view that the economy is heating up, with the understanding that at that point it would need to hike aggressively.

[1] Participation gap = 63% potential - 62.6% actual = 40bps
Underemployment gap = ½ (hours vs full-time) * (4.1% current -3.6% structural) = 25bps
Unemployment gap = 5.1% current – 4.8% NAIRU = 30bp

Figure 4: The Fed's dilemma



Source: UBS

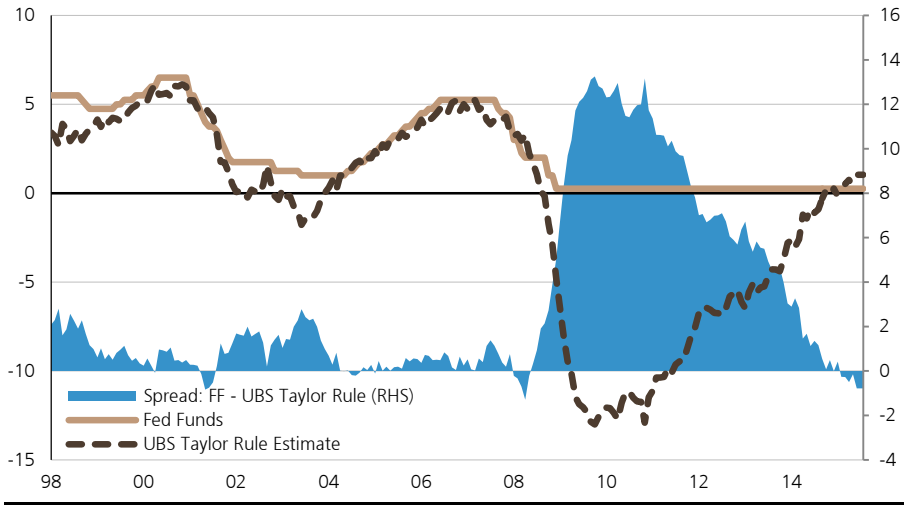
1. Earlier and Slower (A Taylor Rule). Before the great financial crisis, market analysts and academic researchers would largely rely on a simple linear rule very similar to the one published by Taylor (1999). With this rule, the Fed's reaction function reflects the rate of inflation, the equilibrium real rate, the output gap (weighted by a corresponding coefficient) and the gap of inflation to target (again, weighted by a corresponding coefficient). In Figure 5, we show how closely one such manifestation of the Taylor rule has tracked Fed Funds between 1999 and 2008 (this manifestation assumes equilibrium real rates around 2%, sensitivity to the inflation gap near 0.5 and sensitivity to the output gap near 1.5).

   We replicate a similar Taylor rule, this time incorporating the result from Big Macro 01 (pointing to equilibrium real rates at levels just short of 1%).

   The 2008-2015 experience has revealed the limitations to such an approach. At the heart of the slow pace of recovery has been a policy challenge known as "the liquidity trap"; the fact that in a deep recession, zero nominal rates (and mildly negative real rates) are still quite high vs what the central bank ought to deliver. While clearly, cyclical drivers demand nominal rates at deeply negative levels, the zero bound constraints policy makers from delivering the rates appropriate for the relevant stage of the cycle.

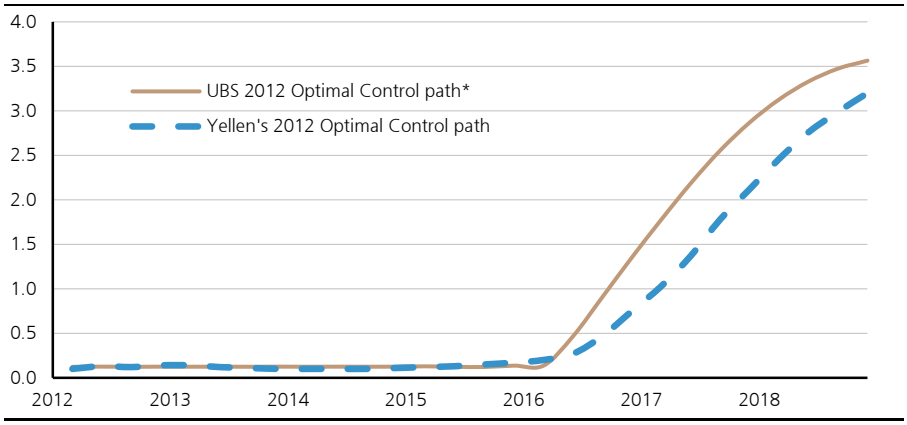
'Earlier and slower' is trickier if you have underestimated economic slack

Figure 5: Limitations of the Taylor Rule at the lower bound



Source: UBS calculations, Bloomberg, Haver Analytics

Figure 6: UBS replication of Yellen's 2012 Optimal Control exercise



Source: UBS, Yellen (2012). *Simulation run as of Q1 2012.

'Later and steeper' is trickier if you overdo the waiting

2. Later and Steeper (An Optimal Control Policy Path). In her landmark speech, Chair Yellen (Yellen 2012) advocated policy guidance that would lay out an explicit path for rates several years down the line. This guidance would be consistent with an "optimal" rates path, where the Fed credibly commits to tightening policy well after it has become clear that the slack in the economy is diminishing and that inflation pressures are building up.

   Deeply entrenched in this concept is the notion that future spending decisions (whether for consumption or for investment purposes) are not a function of current interest rates but of forward rates. A policy-driven anchoring in interest rate expectations would help frontload future spending and help the economy grow out of the "liquidity trap".

   This parabolic rates path is produced by an "Optimal Control" rule. The rule seeks to minimise deviations of unemployment from NAIRU and inflation from target jointly, while allowing for rates to converge to the equilibrium level in the long run as the cyclical recovery deepens.

   The upshot of the Optimal Control analysis is that in the face of a persistent and sizeable output gap, the optimal path for future policy rates signalled by the Fed would involve tightening policy later than a linear Taylor Rule would imply. By construction, this would reduce expected deviations of unemployment and inflation from target and would thus increase the likelihood of a successful forward looking monetary policy design.

   There is also a trade-off. Once the Fed starts hiking rates, it would need to go a lot faster than a linear rule implies to avoid overheating. And the Fed may even have to overshoot the policy rate target before landing back to the long-term equilibrium rate.

   We replicated the Optimal Control exercise by employing a loss function that penalises squared deviations of unemployment from NAIRU and inflation from target with an equal weight (See Statistical Appendix 1). Figure 6 shows that the rate path that our exercise produced in 2012 is broadly consistent with Yellen's own projections at the time and the path that Fed Funds rates have actually followed since. As can be seen from Figure 6 Yellen's projections at the time implied an optimal timing of the first hike in mid-2016, ahead of our own simulation of the exercise based on 2012 data. However, this is to be expected; our model replication of the 2012 exercise incorporates data revisions and ex-post output gap assessments not possible at the time.

Consistent with evidence of slower trend growth since then and higher capacity utilisation the Fed is also signalling today that the first hike may come at least 6 months earlier than what the 2012 exercise would imply as optimal.

As the Fed raises rates back towards equilibrium levels, each hike feeds back into growth, inflation and unemployment. Box 1 describes how we model the impact of Fed hikes on cyclical macro variables. In turn, modelled shifts in the underlying economy feed back into the Fed's modelled reaction function.

BOX 1

The feedback loop between policy rates and fundamentals

The level of the output gap as well as the level of slack in the economy determine the initial conditions that the Fed faces in its dilemma. To illustrate the forward rates path 4-5 years out (a period that roughly corresponds to the median cycle half-life), we also employ assumptions about the Fed's reaction function to shifts in the output gap as well as in related shifts in inflation.

To do this, we also need to model the response of growth (and the output gap) as well as the response of inflation to interest rate hikes by the Fed, which in turn feed back into the Fed's reaction function.

The most complete description of the dynamics of the US economy can be found in the FRB/US model that the Fed typically relies on. This is a macro paradigm that maps in detail the dynamics of different subcomponents of output and prices at a very granular level. We try to replicate the same dynamics captured by the Fed's FRB model in a reduced form system of equations that capture:

a) The relationship between the output gap and real forward interest rates, controlling for lagged effects and accounting for the dynamics in the relevant variables. For all intents and purposes, this equation replicates the I-S (investment/savings) curve in the economy.

b) The relationship between the output gap and the unemployment rate. This equation is often referred to as Okun's law.

c) The relationship between shifts in lagged and forward inflation and the output gap, essentially an equation that captures the dynamics of a New Keynesian Phillips curve.

d) A reaction function via which the Federal Reserve sets policy rates in response to shifts in inflation and output (and employment).

e) In a manner consistent with the relevant literature, we produce ex-ante inflation expectations using VAR-based estimates. We rely on quarterly data from 1965q1 to 2015q1.

In Statistical Appendix 2 the reader can see a detailed account of the statistical properties of our framework.

There are two key concepts that we borrow from our recently published and detailed work (Big Macro 01):

- First is the concept of the equilibrium long-term Fed Funds rate; the rate at which Fed Funds are likely to settle when the output gap closes and inflation lands at target. In broad terms, it can be thought of as the sum

of the equilibrium real rate, which we estimate to be slightly below 1%, and the level of inflation expected to be credibly delivered by an inflation targeting central bank – in the case of the Fed this can be postulated to be 2%. Overall, we impose nominal Fed Funds rates to converge to about 3% in the long run (Big Macro 01).

- Second, we use our decomposition of output between trend and cycle published in Big Macro 01, in order to obtain our output gap estimates.

Later & steeper is safer

We now have all we need to run our Fed simulations under four plausible scenarios: 1) one where economic slack today is moderate and the Fed starts raising rates earlier and slower, 2) one where there is significant slack and the Fed starts raising rates later and steeper, 3) one where slack is moderate but the fed is patient and raises rates later and steeper regardless, and finally 4) one where there is significant slack but the Fed misreads the situation and hikes earlier and slower.

Figure 7 shows the paths of the two different Fed policy rules assuming a moderate level of slack. Figure 8 shows the different Fed paths for a deeper degree of capacity underutilisation and economic slack, as described above.

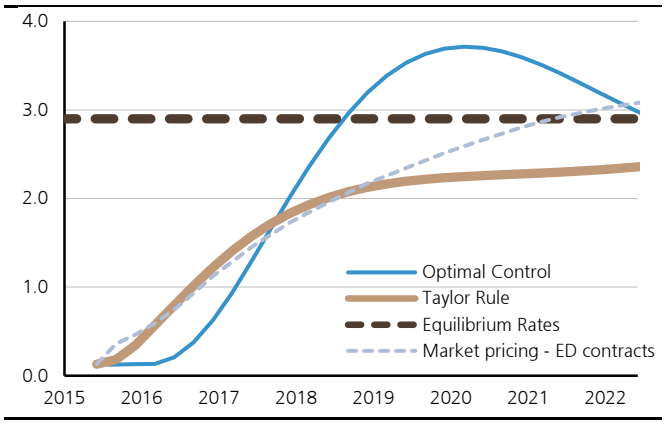
A few things become clear:

Being a bit later is safer

1. It is still "optimal" for the Fed to be patient. First, in the case of limited slack, the optimal control policy rule argues that the Fed is better off waiting until the end of the year or even the beginning of next year before hiking. In practical terms, this means that hiking too early risks declining inflation expectations and declining rates of core PCE inflation for some time (Figure 9, next page). Additionally, the Fed may then take a very long time to reach its desired level of inflation for the economy.

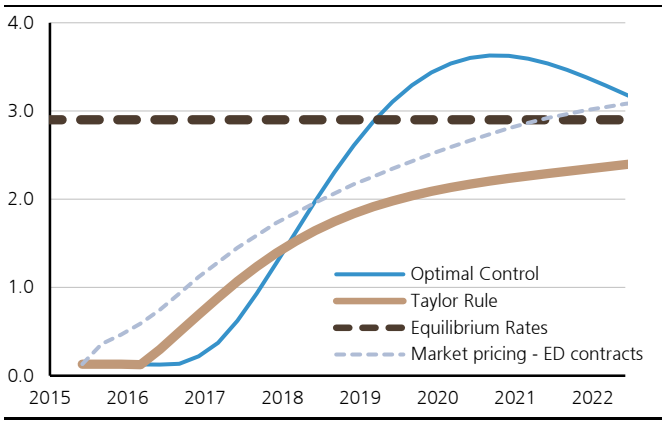
   Second, there is the risk that the Fed has underestimated the level of slack in the economy. In this case, even a linear Taylor-like rule implies that 2015 hikes are premature (Figure 8). Thus, waiting would mitigate the risk of acting too early in the event that the output gap is deeper than currently expected. In this case, the optimal hiking time may not come until late-2016.

Figure 7: Fed Funds path assuming moderate slack (output gap circa 1%)



Source: UBS, Bloomberg. Market pricing from Eurodollar futures contracts

Figure 8: Fed Funds path assuming significant slack (output gap circa 2%)



Source: UBS, Bloomberg. Market pricing from Eurodollar futures contracts

Third, early and gradual tightening raises the risk that policy rates never actually reach equilibrium levels within this cycle. Assuming moderate slack and a linear hiking path, Fed Funds are projected to reach "equilibrium levels" near 3% over a very long time horizon (Figure 7, previous page). In essence, the cost to earlier hikes is a much flatter path further out. Over such a long time window the odds of a new recession are reasonably high.

On average and across scenarios, the most likely optimal timing for the first hike is deemed to be at some point in the first half of 2016. This is consistent with recent work from the IMF (2015) on the subject.

Paying the front end is risky

2. The risk-reward in paying the front end is poor. Even in the event that there is moderate slack left in the economy and the Fed starts hiking in a steady-linear fashion, interest rate expectations embedded at the front end of the curve appear to be broadly in line with our simulations and thus they leave limited room for the Fed to surprise interest rate expectations to the upside (Figure 7, previous page).

   Instead, in the scenario that the Fed proves more dovish than the market anticipates (Figure 7 – Optimal Control Case) or in the case that the market underestimates the level of slack in the economy (Figure 8), there is a lot of room for the Fed to undershoot market expectations at the front end.

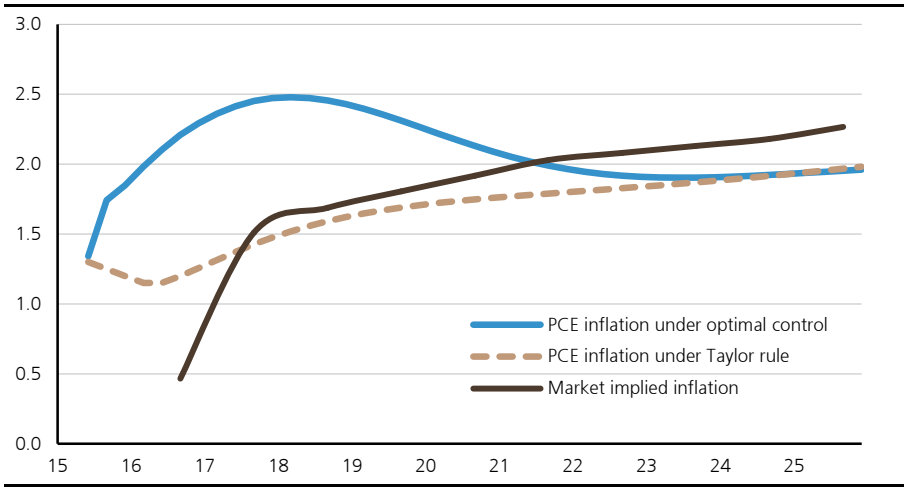
If the Fed gets going early, then you should too (in the long and intermediate tenors)…

3. The earlier the hikes, the better the opportunity to buy USTs in long and intermediate tenors. As we show in our analysis, even if one assumes that most of the slack has disappeared from the US economy, an early and steady rise in rates will result in a much flatter Fed path 3-5yrs out. There may even be room to receive intermediate tenors depending on the Fed's hiking patterns. Of course, this result is even more pronounced in the event that slack is larger.

…but if the Fed takes its time, expect the curve to steepen

4. The later the hikes, the steeper the curve. A more dovish Fed mitigates some of the risks stemming from economic uncertainty as discussed above. There is a clear trade-off as our simulations show. At some point in 2016, it will have ample room to catch up to the upside. At the same time, the later the hikes come, the more likely the need for the Fed to raise rates above the equilibrium level (an event of overshooting of policy rates) to arrest overheating dynamics.

Figure 9: Later & steeper reduces risk of further disinflation / increases chance that 2% inflation will be achieved earlier (assumes moderate slack)



Source: UBS, Haver Analytics, Bloomberg, Reuters Eikon.

In this case, steepening will occur both as a function of lower realised rates in the 1-2 year horizon AND as a function of higher rates 3-5yrs down the line.

5. Fed's path will also have an impact on 5y5y forward rates. In Big Macro 01 we have estimated the Fed's terminal rate slightly below 3%. The level of 5y swap rates 5yrs forward that are broadly consistent with this terminal rate range between 2.6% and 3.8%. Broadly speaking, 5y5y forward swaps are trading slightly below the mid-point of that range. But the Fed's decisions are likely to affect which end of that range the market will trade.

   To have a higher chance of reaching the 3% (terminal) policy rate within this timeframe (5-10yrs from now), the Fed would need to hike later and steeper. In contrast, early hikes increase the odds that the Fed fails to reach a 3% terminal rate within this timeframe. In this case, 5y5y rates will likely trade at levels consistent with the low end of our valuation range described in Big Macro 01. And likely at levels below current market pricing.

Early and steady doesn't necessarily get you to your destination

How and by how much could the market be wrong?

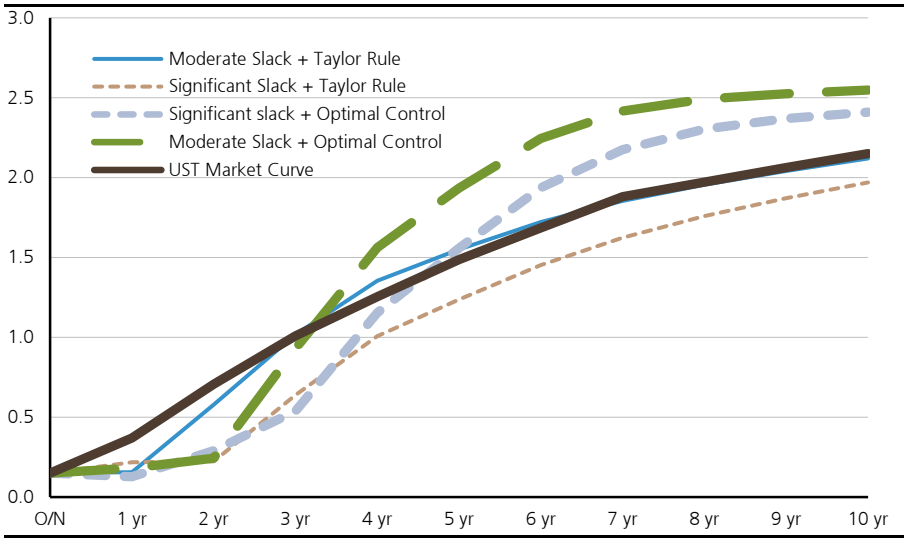
Putting it all together, the market is pricing moderate slack and a Fed led by the Taylor rule

What economic scenario does the US yield curve reflect and where are the opportunities? We follow two simple steps to transform our simulations into different outcomes for the US curve. First, we compound the implied path for Fed Funds rates over time. Second, we use standard estimates of term premia (see Adrian, Crump and Moench, 2013) to translate the compounded implied Fed Funds rates into bond yields of different maturities (Figure 10).

By and large, the market today reflects expectations of moderate slack in the US economy and an earlier but gradual (linear) tightening path by the Fed. In Figure 11, our relevant scenario fits very close the current shape of the UST curve (assuming stable term premia). There are three ways the market could be wrong:

a) The market could be right on the Fed's reaction function but it may underestimate the level of slack in the economy. If that is the case, we could see a parallel shift lower in the US curve of 30-40bps in 1-5y tenors and 15-25bps in 5-10y tenors.

Figure 10: The scenarios that the US curve is pricing and the ones it is not



Source: UBS, Bloomberg

b) The market may be right in thinking that there is moderate slack in the US economy but the Fed may surprise expectations by tightening later and steeper. In this case the curve's shape should be significantly steeper from current levels (by more than 100bps); 2y tenors feature the most downside in yields – of up to 45bps. But in contrast, one should expect 5-10y yields to rise significantly by 45-55bps (even despite the near term disappointment in Fed tightening expectations).

c) Finally, the market could be wrong about both; slack could be ample and the Fed could also prove a lot more patient than US interest rate forwards imply. Again, the net result is curve steepening but by a less aggressive 70bps (compared to b). 2 and 3yr yields would could decline by about 45bps, while 10y yields can rise vs current levels but by less than 30bps.

Overall, there is very little upside in paying front end rates in our simulations, if anything, and all-else equal, the risk is that front end yields either decline or realize 30bps to 45bps below current levels.

The risks for 10y rates are more symmetric. We could observe a sell-off of up to 50bps but only if the Fed proves to be quite a bit more patient in raising rates, than currently expected.

Intermediate tenors are the trickiest point of the curve, with outcomes ranging from 25bps lower to 45bps higher depending on the level of slack and the Fed's reaction function.

Where we could be wrong.

Several ways we could be wrong

We discussed two economic scenarios that make moderate assumptions about the prevailing level of slack in the US economy. We did not discuss tail outcomes. But crucially, those outcomes are symmetric to our scenarios. The probability that the US economy is running significant capacity constraints at the moment is non zero (in line with trends in the short-term unemployment rate). But equally, there is a non-zero probability that the output gap may prove to be deeper than we estimate (in line with the levels of core PCE inflation and the slow rates of growth outside the US, as well as the tighter US financial conditions).

Our assessments are also based on standard estimates of US term premia, which are at the moment quite suppressed. Similarly to our term premia discussion in Big Macro 01, the curve can sell-off by more than what our analysis shows, should the Fed shift towards policy tightening via active balance sheet shrinkage beyond market expectations based on Fed communications. See our US Economics' detailed analysis of balance sheet risks in "The Problem with a Big Balance Sheet".

Finally, like in any modelling exercise, the underlying macro relationships in the economy may be changing in ways that econometric frameworks cannot possibly capture yet. For that reason we will be updating our framework over regular timeframes to pick up early signals of structural shifts.

And what if the Fed gets it wrong?

Credibility losses potentially loom on both sides of the policy coin

So far we have described outcomes in which the Fed reacts to data developments in a manner consistent with standard frameworks, which are highly comparable to its own. But the Fed could still act driven by considerations that these frameworks do not directly capture. More specifically, there is intense debate on whether the Fed's zero interest rate policy is endangering long-run financial stability.

Our models argue that it is optimal for the Fed to wait further until uncertainty has declined and capacity constraints have become more evident. But waiting for longer and then overshooting policy rates may result in significant market volatility – both during the waiting time (boosting pro-cyclical assets), but also during the hiking time (as overvaluations that may have occurred during waiting time violently unwind). Our (and the Fed's) modelling work is not built to capture the effects that volatility in broad financial condition shifts may have on real activity.

This is one of the considerations that may, in part, inform a Fed decision to raise rates early but in a very protracted fashion. But, as it becomes clear from the discussion above, such a decision involves risk. In what follows, we try to quantify the risks and derive market implications.

We create a macro scenario where slack is currently moderate (OG of about 1%) and the Fed raises rates by 100bps in the next 12 months, irrespective of incoming macro information, at a pace of one hike per quarter. These hikes feed through to the economy. After this mini hiking cycle is done, we re-run our simulations.

As Figure 11 shows, an optimal control framework implies that stable rates or even rate cuts may actually need to be delivered in the aftermath until mid/late 2017, in order to once again put the output gap back on a narrowing track.

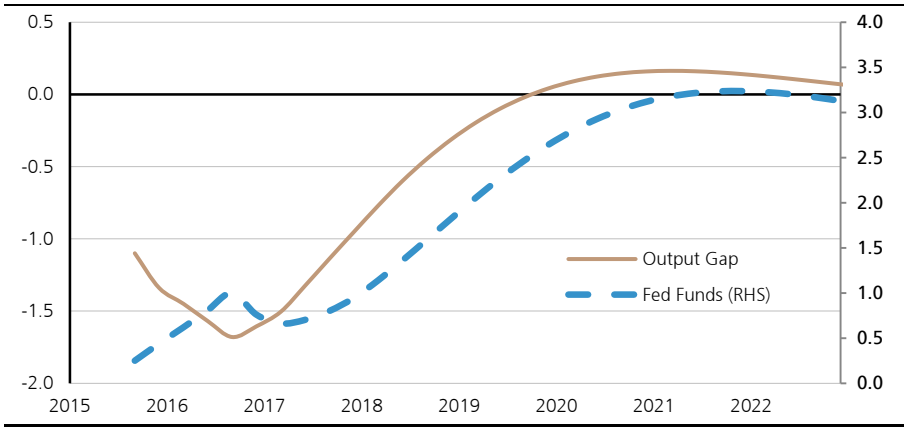
These simulations are highly stylized and need to be viewed with caution. Nevertheless, an overarching point transpires; there are risks to tightening early and the fine-tuning that the Fed needs to do should be careful and in sync with data developments.

Conclusion

In terms of market strategy, our findings suggest the risk-reward in paying front-end (e.g., 2-3y) rates is poor. In fact there may be room to receive and harvest 30-45bps of carry. Instead, the risk-reward for 10y rates is more balanced. 10y yields could settle about 50bps above current levels if the Fed refrains from hiking until H12016 (and then steeply catches up).

In contrast, the earlier and more frontloaded the hikes, the higher the odds that intermediate and long-end bonds rally outright (and curves flatten).

Figure 11: There are policy risks to tightening too early



Source: UBS calculations

Statistical Appendices

Summary

The models we employ are designed as smaller, adapted versions of the FRB/US model. They contain equations that represent a New Keynesian Phillips curve, with lagged and forward inflation and the output gap, an IS curve, with lagged output and the real ex ante Federal Funds rate, an equation for, the so called, Okun's law linking the unemployment gap with the output gap and a linear monetary rule with lags of the federal funds rate, the output gap and inflation (alternatively, a standard Taylor rule). We estimate our equations using quarterly data from 1965q1 to 2015q2, and we proxy inflation expectations using VAR-based estimates; our estimated parameters are in close agreement to values appearing in the literature. We have experimented with model consistent and VAR-based expectations and all reported results are using the first kind of expectations. Baseline values, which are needed for the solution of models with rational expectations, are generated by a VAR model which imposes convergence to the long-run values for the output gap, inflation and the Federal Funds rate. Given these baseline values we generate baseline values for the unemployment gap, which are also needed for the simulations. We have considered two types of estimates for the output gap, one coming from a mini-supply side model, of our own construction, similar to the one used by the FRB/US supply side model and another one coming from a rolling window averaging methodology -- results on the use of these two measures in the optimal control (OC) experiments are qualitatively similar. The unemployment gap we employ is based on our computations for Okun's law. Our OC simulations use the same constraints as those used by the FRB/US model and the zero lower bound conditions is imposed throughout. The model with the Taylor rule is simulated without reference to the OC constraints, although it obeys the long-run restrictions we require for the output gap, inflation and the Federal Funds rate.

Statistical Appendix 1

A short introduction to Optimal Control (OC) for monetary policy

Economic policy design requires a variety of inputs, most of which are based on the precepts of economic theory and corresponding econometric methodologies. The OC methodology is no different but focuses on how variables interact among themselves in obtaining a desired path for the policy variable(s) that the policy makers have under their direct influence.

Thus, let us assume that the policy variable in question – the nominal Federal Funds rate – is denoted by i(t), inflation is denoted by π(t), unemployment is denoted by u(t) and there is a vector of other variables (which include the three variables above as well) denoted by x(t). There is a parametrized structural model denoted by M[x(t),E{x(t+1)|t}, θ], where θ is a vector of parameters and E{x(t+1|t)} denotes components with forward looking expectations. This model contains our structural equations (Phillips curve, IS curve, Okun's law, monetary policy reaction function).

The policy maker wants to set the present (and possibly future values) of i(t) such as to satisfy a policy objective. One such popular objective is inflation stabilization and a way to achieve this is to consider a rule (a policy function) R of the form:

$$i(t) = R[i(t-1), \pi(t), E\{\pi(t+1)|t\}, o(t), E\{o(t+1)|t\}, \psi] \quad (A1.1)$$

so that the value of the policy variable is a function of past rates, and current/future inflation and current/future output gap o(t) and a vector of policy parameters ψ. The well-known "Taylor rule" is of this form. However, there is a potential drawback with the use of this type of policy function: it does not provide for "policy commitment" in the future and is subject to fluctuations not necessarily related to the long-term goals of monetary policy. Furthermore, there is a possibility that the rule is miss-specified and/or not jointly estimated with the other equations of the model M[x(t),E{x(t+1)|t}, θ] (in which case the estimates for ψ would not be a function of estimates for θ, i.e. $\psi \neq \psi(\theta)$).

Thus, instead of considering a policy function of this form, the policy maker may opt to "design" a forward looking experiment whereas the policy variable is set not just for its present value but also for its future values so as a specific economic outcome is realized in the model's values. This outcome is related to some desired future values that some "target variables" attain, and these values are known/set by the policy maker. In our experiment we follow the Fed's approach which is to consider as target variables the triplet τ(t) = [i(t),π(t),u(t)-u*(t)], u*(t) being structural unemployment, and to set them according to a rule that tries to minimize a weighted sum of squares of deviations of the values of these variables from their targets, over a sufficiently long period in the future. Suppose, for simplicity, that the target values are fixed at 2% for inflation, 0% for the unemployment gap and (about) 0% for the difference in the Federal Funds rate, i.e. $i(t) \approx i(t-1)$ (the latter condition imposed so as not to have sudden changes in the conduct of monetary policy). Let T denote the number of future periods over which the policy maker wants to apply its control, let i(T) denote the vector of all values of the policy variable and denote by D[i(T)] the following sum of squares:

$$D[i(T)] = [(i(2)-i(1))+(\pi(2)-2)+(u(2)-u^*(2))]2 + \ldots + [(i(T)-i(T-1))+(\pi(T)-2)+(u(T)-u^*(T))]2 \quad (A1.1)$$

Then, the OC experiment is an attempt to find the "optimal" sequence i*(T) so that D[i(T)] is minimized subject to the model M[x(t),E{x(t+1)|t}, θ], or equivalently:

$$i^*(T) = \text{argmin } i(T) \{ D[i(T)] \mid M[x(t),E\{x(t+1)|t\}, \theta] \} \quad \text{(A1.2)}$$

It should be clear from the structure of the above optimization problem that it may not have a closed form solution since, in order to solve it, we require some form of estimates for future expectations over the course of the simulation (over the T periods). Furthermore, note that the solution of the OC problem depends on the structure of the model and the values of the parameters; if these are "incorrectly" specified (model) estimated (parameters) then the results of the OC problem would be "biased".

In our analysis we have closely followed the general literature on monetary policy making, especially with regards to model specification, and have adapted the much larger FRB/US macroeconomic model to a smaller scale that can reproduce most of its larger sibling behavior. Solutions for the OC problem were implemented using the same algorithms as in the FRB/US model. We explain more about our model in Statistical Appendix 2.

Statistical Appendix 2

A small macroeconomic model for the US

The FRB/US model is a very large model, with many equations and identities, which provides a very thorough mapping of the US economy into a usable policy tool. The model is freely available with its database, the latter not in real time, and it combines many of the literature's suggestions and caveats. There is also a mini-literature from the model's authors that deals with various experiments with it and/or with smaller variants of it. Our main concern was to find that model size that would be both sufficiently "large" to capture the proposed policy dynamics by the Fed and that would provide parameter estimates that would be economically reasonable and close to the literature.

A closer look to the FRB/US model shows us that necessary model ingredients include the following: the output gap, the unemployment gap, inflation and the Federal Funds rate. These four variables contain the essence of monetary policy making and are subject to evolution paths which contain future expectations – a vital component of modern macroeconomic thinking. There is of course not one model, or equation specification, that is globally agreed upon but there is sufficient consensus on what the ingredients and general structure of these equations should be. We build upon this consensus our four main equations. To start off, we require a Phillips curve, linking inflation with past and future inflation a measure of economic activity – in our case the output gap, see equation (A2.1) below. Next, we require an equation linking economic activity with monetary policy making (the Federal Funds rate) and inflation, here future inflation. This is an IS curve that links economic activity with the ex-ante real Federal Funds rate, see equation (A2.2) below. Next, we need a version for Okun's law, so as to link the output gap with the unemployment gap. Here we followed a two-step approach. First, we estimated a dynamic relationship between the unemployment gap and the output gap and then computed the implied long-term coefficient among the two variables and imposed the resulting relationship on our simulations; see equations (A2.3a) and (A2.3b). This is required because we need to maintain consistency on the projected paths of output and unemployment (e.g. when one rises the other must fall). Finally, we need a monetary policy reaction function. Here we have many options among which way this should be modeled. We opted for an unrestricted specification linking current rates with past rates and current and past inflation and output gap, see equation (A2.4). Our results are robust to different reaction functions and for the sake of simplicity we maintained the unrestricted specification throughout. Our equations, which form the model M[x(t),E{x(t+1)|t}, θ] of Appendix 1, follow.

$$\pi(t) = f\pi[o(t), \pi(t), \pi(t-1), E\{\pi(t+1)|t\}, \pi^*(t), \theta\pi] + \varepsilon\pi(t) \quad \text{(A2.1)}$$

$$o(t) = fo[o(t-1), i(t)- E\{\pi(t+1)|t\}, \theta o] + \varepsilon o(t) \quad \text{(A2.2)}$$

$$u(t)-u^*(t) = fu[u(t-1)-u^*(t-1), o(t), o(t-1), \theta u] + \varepsilon u(t) \quad \text{(A2.3a)}$$

$$u(t)-u^*(t) = -\gamma(\theta u)o(t) \quad \text{(A2.3b)}$$

$$i(t) = fi[i(t-1), o(t), o(t-1), \pi(t), \theta i] + \varepsilon i(t) \quad \text{(A2.4)}$$

In the above presentation we denote by $\varepsilon g(t)$ the unobservable error term for the g variable and, similarly, for the vector of parameters θg. The parameter $\gamma(\theta u)$ is a function of the parameter vector θu. The variables are as follows:

π(t) – inflation

π*(t) – target inflation

o(t) – output gap

u(t) – observed unemployment

u*(t) – structural unemployment (unobserved)

i(t) – Federal Funds rate

and, collectively, we have that x(t) = [π(t), π*(t), o(t), u(t), u*(t), i(t)] and similarly θ = [θπ, θo, θu, θi], that form the model M[x(t),E{x(t+1)|t}, θ].

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**Big Macro 01 refers to:*
Fiotakis, T., Waldman, D. and Kontopoulos, Y. 2015. Global Macro Strategy – Big Macro 01: Are Low US Yields Here to Stay? UBS Global Research https://neo.ubs.com/shared/d1MMftBWnJzyoa8

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