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Taylor rules and monetary policy: a global "Great Deviation"?[1]

Policy rates have on aggregate been below the levels implied by the Taylor rule for most of the period since the early 2000s in both advanced and emerging market economies. This finding suggests that monetary policy has probably been systematically accommodative for most of the past decade. The deviation may, however, in part also reflect lower levels of equilibrium real interest rates that might introduce an upward bias in the traditional Taylor rule.

JEL classification: E43, E52, E58.

The Taylor (1993) rule is a simple monetary policy rule linking mechanically the level of the policy rate to deviations of inflation from its target and of output from its potential (the output gap). Initially proposed as a simple illustration for the United States of desirable policy rules that had emerged from the academic literature at that time, it has become a popular gauge for assessments of the monetary policy stance in both advanced economies and emerging market economies (EMEs).

From a historical perspective, the Taylor rule has been a useful yardstick for assessing monetary policy performance. Specifically, in some major advanced economies, policy rates were below the level implied by the Taylor rule, and monetary policy therefore systematically too accommodative from the perspective of this benchmark, during the "Great Inflation" of the 1970s. In contrast, policy rates were broadly consistent with the Taylor rule during the "Great Moderation" between the mid-1980s and early 2000s, a period characterised by low inflation and low macroeconomic volatility.[2]

Between the early 2000s and the outbreak of the global financial crisis, policy rates were again systematically below Taylor rule-implied rates in a number of advanced economies (eg Taylor (2007), Ahrend et al (2008)). The

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[2] For Taylor rule-based analyses of historical monetary policy performance, see, for instance, Taylor (1999) for the United States, and Nelson and Nikolov (2003) for the United Kingdom. Orphanides (2003) demonstrates that the deviation of policy rates from the Taylor rule during the 1970s can be largely explained by real-time mismeasurement of the output gap, while Nelson and Nikolov (2003) show that this factor played a less important role in the United Kingdom.

prolonged monetary accommodation suggested by this deviation has been identified as a potential causal factor in the build-up of financial imbalances before the global financial crisis, but the literature has not reached a consensus on this issue.[3] Taylor (2010, 2012) even argues that the deviation reflects another change in the policy regime, to a regime which he dubs the "Great Deviation", a conjecture that is, however, rejected by Bernanke (2010).[4]

This special feature takes up this question from a global perspective by assessing the level of policy rates prevailing since the mid-1990s through the lens of the Taylor rule. The results of the analysis show that, in advanced economies and in particular also in EMEs, policy rates were on aggregate well below the levels implied by the Taylor rule over the past decade. While lower equilibrium real interest rates may explain part of the deviation and the simplistic setup of the Taylor rule generally cautions against taking its indications too literally, this finding suggests that monetary policy has probably been systematically accommodative for most of the past decade.[5]

The remainder of this special feature is organised as follows. The first section compares the level of policy rates that prevailed in advanced economies and EMEs with the levels that result from the Taylor rule. The second section estimates policy rules empirically. In the third section we discuss possible explanations of our findings. The fourth section concludes.

The Taylor rule and global monetary policy

The Taylor (1993) rule takes the following form:

The Taylor rule links policy rates mechanically to the deviation of inflation from target and the output gap

$$i = r^* + \pi^* + 1.5\,(\pi - \pi^*) + 0.5\,y \qquad (1)$$

where i is the nominal policy rate, r^* is the long-run or equilibrium real rate of interest, π^* is the central bank's inflation objective, π is the current period inflation rate, and y is the current period output gap.

The Taylor rule implies that central banks aim at stabilising inflation around its target level and output around its potential. Positive (negative) deviations of the two variables from their target or potential level would be associated with a tightening (loosening) of monetary policy. While the

[3] Evidence presented by Taylor (2007) and Ahrend et al (2008) suggests that monetary policy was probably an important driver in the build-up of pre-crisis imbalances. Other studies, however, suggest rather that regulatory and supervisory failure and global imbalances were the main drivers (eg Merrouche and Nier (2010)).

[4] Specifically, Bernanke (2010) argues that the systematic deviation largely disappears when real-time output gap estimates and inflation forecasts are used in the construction of the Taylor rule benchmark. The deviation that has been identified ex post would therefore reflect real-time measurement problems with the Taylor rule's input variables rather than a change in the monetary policy regime.

[5] This assessment appears to be at odds with the observation that inflation rates have been broadly consistent with central banks' inflation targets over this period. Svensson (2012) argues that monetary policy in Sweden was probably even too tight over the past 15 years since average inflation was lower than the Riksbank's inflation target. A potential explanation for this apparent inconsistency between inflation performance and the indications of Taylor rules is that, as a consequence of credible monetary policy frameworks, globalisation and financial liberalisation, loose monetary conditions manifest themselves in a build-up of financial imbalances rather than in rising inflation (Borio and Lowe (2002), White (2006)).

calibration of the reaction coefficients by Taylor is not normative, it incorporates important properties of desirable rules from the perspective of modern macroeconomic models of the New Keynesian type.[6] In particular, an inflation reaction coefficient larger than one ensures that real interest rates respond in a stabilising way to inflationary pressures.[7]

We compute Taylor rule benchmarks for the global aggregate as well as the aggregates of advanced and emerging market economies based on quarterly data for 11 advanced economies and 17 EMEs over the period from the first quarter of 1995 to the first quarter of 2012.[8] In order to take account of the uncertainty around the measurement of the input variables, ie the inflation rate and the output gap, we pursue a "thick modelling approach" by considering all possible combinations of different measures of inflation and the output gap to obtain a range of possible Taylor rule-implied rates.

Specifically, we consider four different inflation measures: the current headline CPI inflation rate, the current GDP deflator inflation rate, the current core CPI inflation rate and the consensus forecast of CPI inflation for the next four quarters as a forward-looking inflation measure.[9] In each case, inflation is measured as the year-on-year percentage change in the respective price index. For the output gap, we consider three different statistical estimators of potential real GDP: a segmented linear trend that allows for a break in the trend in 2001,[10] a Hodrick-Prescott (HP) filter trend and an unobserved components (UC) estimator.[11] For the aggregate of advanced economies, we also use the structural output gap estimate published in the IMF *World Economic Outlook* (WEO), which is not available for the aggregate of EMEs. The output gap is measured as the percentage difference between real GDP and potential GDP. Overall, we therefore have 12 possible combinations of inflation and output gap measures for the aggregate of EMEs and 16 possible combinations for the aggregate of advanced economies.

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[6] The Taylor rule generally performs well in terms of delivering macroeconomic stability across a variety of models and is therefore more robust than model-specific optimal and more complex policy rules. See Taylor and Williams (2011) for a detailed discussion. However, it needs to be borne in mind that this robustness has emerged over a class of models where price rigidities are the only friction in the economy.

[7] In the standard New Keynesian model, this feature, which is referred to as the Taylor principle, is a sufficient but not a necessary condition for equilibrium determinacy (Woodford (2001)). This result, however, does not necessarily hold under richer model specifications, where a large inflation reaction parameter can even be destabilising (see eg Christiano et al (2011)).

[8] The aggregates are constructed based on 2005 PPP weights.

[9] This measure is constructed as a weighted average of the consensus forecast for the current year and the consensus forecast for the next year as in Gerlach et al (2011).

[10] A segmented linear trend instead of a standard linear trend was chosen since the trend governing real GDP in advanced and emerging market economies changed after 2001, so that a linear trend yielded very implausible output gap estimates.

[11] In order to mitigate the endpoint problem of trend estimation we extended the output series to the fourth quarter of 2013 using forecasts from the OECD *Economic Outlook* and JPMorgan.

Following Taylor (1993), we link the calibration of the equilibrium real interest rate to the estimates of trend output growth, which can be motivated by standard consumption theory.[12] Specifically, we set in each inflation-output gap combination the long-run level of the real interest rate equal to the respective estimate of the trend growth rate of real GDP. This means that r^* varies over time in those specifications where the HP gap, the UC gap or the IMF WEO output gap are used. For the construction of the global and regional aggregates of the central banks' inflation objective π^*, we use official inflation target or goal levels when available.[13] For countries that do not have an official inflation target, we use the sample average of the respective inflation measure in the case of advanced economies, and the HP filter trend in the case of EMEs.

Long-run real interest rates are assumed to be linked to trend output growth

The results reveal that the systematic deviation of policy rates from the Taylor rule since the early 2000s that has been identified by previous studies for some advanced economies is a global phenomenon. While policy rates were consistent with the levels implied by the Taylor rule up until the early years of the new millennium, a systematic deviation emerged thereafter. Since 2003, global policy rates have almost always been below the levels indicated by Taylor rules (Graph 1, left-hand panel). Only during the Great Recession of 2009 were policy rates briefly inside the Taylor rule range. After 2009, as policy rates remained low while the global economy recovered, the gap opened up again. Reflecting the recent weakening of the global economy in the wake of the European sovereign debt crisis, however, the deviation narrowed somewhat in the first quarter of 2012.

Global policy rates have on aggregate been below Taylor rule benchmarks since the early 2000s

A look at global regions reveals that the result is mainly driven by the EMEs (Graph 1, right-hand panel). There, the deviation has averaged about 4.5 percentage points since 2003. At the end of the sample period, ie the beginning of 2012, the difference was around 3.5 percentage points. In the advanced economies, policy rates have been below the range of Taylor rule rates since around 2001, but the deviation is smaller, on average less than 2 percentage points (Graph 1, centre panel). In the Great Recession, the Taylor rule would on average have suggested negative policy rates for a short period of time, but actual policy rates were still well inside the range. In 2011, the spectrum of Taylor rates shifted back to positive levels and policy rates have been at the lower bound of the range since then.

The deviation is particularly pronounced in EMEs

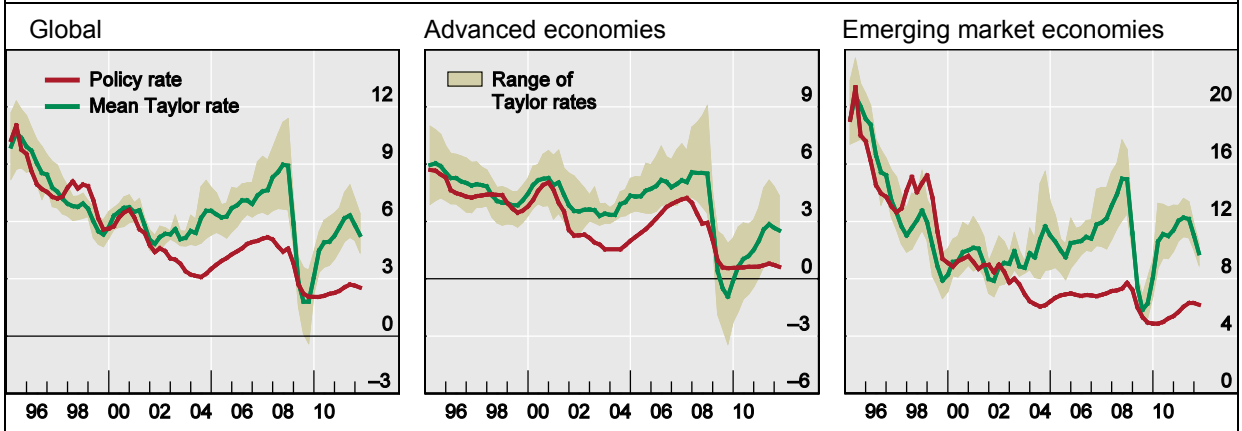
The finding that policy rates in advanced economies might currently be slightly too low compared to the levels implied by the Taylor rule may appear

[12] See Laubach and Williams (2003), who also present evidence that the natural real interest rate in the United States is indeed closely linked to trend output growth. However, they also find that estimates of the natural rate level are surrounded by a very high degree of uncertainty.

[13] We construct implicit target levels for all inflation measures by adding to the inflation target the average difference between the respective inflation measure and the targeted inflation measure over the sample period. For instance, when the inflation target refers to the CPI, we construct the implicit target for GDP deflator inflation by adding the average difference over the sample between the GDP deflator inflation rate and the headline CPI inflation rate to the inflation target level.

The Taylor rule and policy rates[1]

In per cent



The Taylor rates are calculated as $i = r^* + \pi^* + 1.5(\pi - \pi^*) + 0.5y$, where π is a measure of inflation, y is a measure of the output gap, π^* is the inflation target and r^* is the long-run level of the real interest rate. We compute Taylor rates for all combinations of four measures of inflation (headline, core, GDP deflator and consensus headline forecasts) and measures of the output gap obtained from three different statistical ways to compute potential output (HP filter, segmented linear trend and unobserved components). For the advanced economies, we also use the structural output gap estimate from the IMF WEO. In each case, the long-run real interest rate is set equal to the trend output growth rate as estimated by the trend filter used to construct the respective output gap measure. π^* is set equal to the official inflation target or goal levels when available. Implicit target levels for the inflation measures to which the official inflation target does not refer are constructed by adding the average difference over the sample period between the respective inflation measure and the targeted inflation measure to the official inflation target. For countries that do not have an official inflation target, we use the sample average of the respective inflation measure in the case of advanced economies, and the inflation trend obtained from an HP filter in the case of emerging market economies. For the consensus CPI inflation forecast we use the same target level as for the actual CPI inflation rate. The graph shows the range and the mean of the Taylor rate of all inflation-output gap combinations.

[1] Weighted average based on 2005 PPP weights. "Global" comprises the economies listed here. Advanced economies: Australia, Canada, Denmark, the euro area, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the United States. Emerging market economies: Argentina, Brazil, China, Chinese Taipei, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, Poland, Singapore, South Africa and Thailand.

Sources: IMF, *International Financial Statistics* and *World Economic Outlook*; Bloomberg; CEIC; © Consensus Economics; Datastream; national data; authors' calculations. Graph 1

implausible given the perceived large degree of economic slack in these economies. This finding does indeed depend somewhat on the calibration of the Taylor rule parameters, specifically on the choice of the weight of the output reaction. In order to illustrate this point, we replicate the analysis with an alternative calibration of the Taylor rule considered by Taylor (1999). The only difference from the original calibration is a larger output reaction coefficient, which is twice as large as in the original calibration (ie equal to 1.0). This larger output weight, however, does not fundamentally alter the Taylor rule's assessment of the evolution of the global monetary policy stance over the past decade (Graph 2). The main difference is that, for the aggregate of advanced economies, the range shifts down for the period since the Great Recession, indicating negative policy rates for a longer period and putting policy rates well inside the Taylor rule range at the end of the sample period.

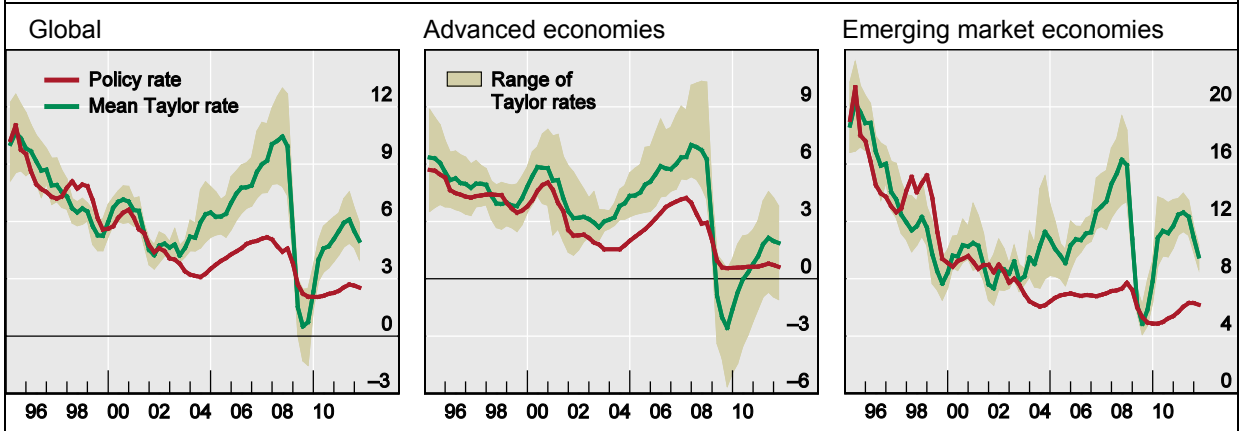
Estimated policy rules

Estimated policy rules show that the deviation of policy rates from the Taylor rule reflects …

To understand in what way policy rate setting has deviated from the Taylor rule since the early 2000s, we estimate empirically the parameters of simple policy rules for the aggregates of the group of advanced economies and the group of

The Taylor (1999) rule and policy rates[1]

In per cent



The Taylor rates are calculated as $i = r^* + \pi^* + 1.5(\pi - \pi^*) + 1.0y$, where π is a measure of inflation, y is a measure of the output gap, π^* is the inflation target and r^* is the long-run level of the real interest rate. We compute Taylor rates for all possible combinations of different inflation and output gap measures The inflation and output gap measures used and details on the construction of r^* and π^* are provided in the note to Graph 1.

[1] Weighted average based on 2005 PPP weights. See Graph 1 for a definition of the aggregates.

Sources: IMF, *International Financial Statistics* and *World Economic Outlook*; Bloomberg; CEIC; © Consensus Economics; Datastream; national data; authors' calculations. Graph 2

EMEs. The specification of the empirical policy rule is given by:

$$i = \rho i_{-1} + (1-\rho)\{\alpha + \beta_\pi(\pi - \pi^*) + \beta_y\, y\} + \varepsilon \qquad (2)$$

The specification includes a lagged interest rate term, thus allowing for interest rate smoothing. This implies a gradual adjustment of policy rates to their benchmark level, which includes the same arguments as the original Taylor rule. The constant in the empirical policy rule corresponds to the sum of the long-run real interest rate and the inflation objective in equation (1), ie $\alpha = r^* + \pi^*$. We can therefore back out the implicit estimated long-run real interest rate by subtracting the target inflation rate from the estimated constant.[14] Finally, ε is the error term.

A thick modelling approach is also applied in the estimation of the policy rules. Specifically, we estimate equation (2) by non-linear least squares (NLLS) for all possible inflation-output gap combinations.[15] The sample period for the EMEs is the first quarter of 2001 to the first quarter of 2012. For the advanced economy aggregate, the sample period ends in the fourth quarter of 2008 due to the binding of the effective lower bound of interest rates in the core advanced economies since early 2009.

… average real interest rates that were well below average output growth …

The results reveal that empirical policy rules deviate from the Taylor rule primarily in the level of the implicit long-run real interest rate. The range of estimated implicit long-run real rates is well below the trend rate of real GDP growth (Graph 3), consistent with the average levels of ex post real interest

[14] Since π^* varies over time, r^* also varies over time. For ease of exposition, we report the range of the sample averages of the time-varying r^*.

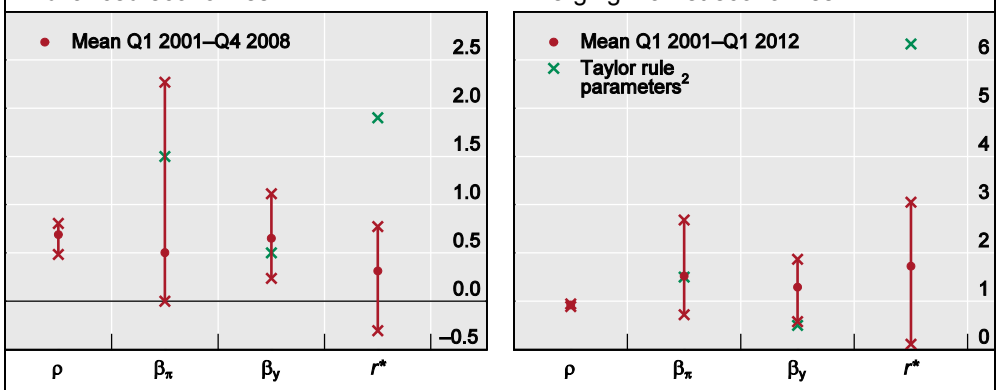
[15] Inflation and output gap reaction coefficients are restricted to be positive in order to rule out implausible coefficient values.

rates that prevailed over the sample period. This finding does not, however, constitute evidence that equilibrium real interest rates are in fact lower. It is rather a mechanical reflection of the systematic negative deviation of policy rates from Taylor rule-implied rates documented in the previous section. A lower constant term, and hence a lower estimated long-run real interest rate level, than assumed in the Taylor rule is needed in order to obtain a policy rule that is consistent with the actual path of policy rates.

The estimated inflation reaction parameter is on average fully consistent with the value of 1.5 in the Taylor rule in the EMEs but, with a mean estimate of 0.5, is well below that value in the advanced economies. However, the range of the estimated inflation response parameters in the latter group of countries is rather wide and includes the value of the Taylor rule. Therefore, rather than indicating a genuine violation of the Taylor principle, this finding may just be a reflection of central banks' success in keeping inflation low and stable over the sample period. In the absence of major movements in inflation, the reaction of policy rates to this variable might simply have become more difficult to pin down with any great precision.[16]

The estimated response of policy rates to the output gap is very close to the Taylor rule parameter value of 0.5 for the aggregate of advanced economies. For the EME aggregate, the estimated reaction parameter is

Estimated policy rule parameters[1]



[1] Parameter estimates from the empirical policy rule $i = \rho i_{-1} + (1-\rho)\{\alpha + \beta_\pi(\pi - \pi^*) + \beta_y y\} + \varepsilon$, where i is the policy rate, π is a measure of inflation, y is a measure of the output gap, π^* is the inflation target, α is the regression constant and ε is an error term. The equation is estimated by non-linear least squares for all possible combinations of different inflation and output gap measures. The inflation and output gap measures used and details on the construction of the inflation target measure π^* are provided in the note to Graph 1. The sample period is Q1 2001–Q1 2012 for the aggregate of emerging market economies and Q1 2001–Q1 2008 for the aggregate of advanced economies. The inflation and output gap reaction coefficients, β_π and β_y, are restricted to be positive. The long-run real interest rate r^* is computed by subtracting the inflation target rate π^* from the regression constant α, and then taking the sample average. The graph shows the mean and the range of the estimated policy rule parameters. [2] Following Taylor (1993), the benchmark inflation coefficient equals 1.5, the benchmark output gap coefficient equals 0.5 and the benchmark long-run interest rate equals the average real GDP growth rate over each sample.

Sources: IMF, *International Financial Statistics* and *World Economic Outlook*; Bloomberg; CEIC; © Consensus Economics; Datastream; national data; authors' calculations. Graph 3

[16] This explanation is similar to the one that has been put forward for the disappearance of the money growth inflation link implied by the quantity theory (see eg De Grauwe and Polan (2005)).

higher, with a mean value of 1.3. However, this finding does not necessarily imply a higher preference for output stabilisation in this group of countries, since the policy rule parameters reflect, from a conceptual point of view, not only the central bank's preferences but also the structural determinants of the transmission mechanism.[17]

… and a high degree of interest rate smoothing

Finally, in line with the previous literature, we find that interest rate smoothing plays an important role in policy rate setting. The smoothing parameter ρ is very tightly estimated with a mean value of around 0.7 in the advanced economies and around 0.9 in the EMEs. This implies that policy rates adjust very slowly to their benchmark level. The persistent deviation of policy rates from the Taylor rule documented in the previous section might therefore in part reflect the effect of interest rate smoothing. This cannot, however, explain why policy rates on various occasions over the sample did not display any adjustment towards the Taylor rule benchmark or even moved in the opposite direction.

The global deviation from the Taylor rule: potential explanations

The global deviation from the Taylor rule could be driven by …

What explains the global deviation of policy rates from the Taylor rule? A possible explanation is the systematic influence of factors other than the dynamics of inflation and output in policy rate setting, specifically of concerns about financial instability and about destabilising capital flow and exchange rate movements.[18]

… an asymmetric monetary policy response over the financial cycle in some countries …

Concerns about the macroeconomic tail risks associated with financial instability offer a potential explanation for the deviation of policy rates from Taylor rates in the group of advanced economies. The view that prevailed in some core advanced economy central banks over the past decade was that monetary policy should mitigate the fallout of financial busts, but should respond to financial booms only if they are associated with perceived risks to the inflation objective. Advanced economy policy rates did indeed fall strongly and rapidly in the wake of the two financial busts since 2000 and rose only slowly or not at all during the following recovery (Graph 1, centre panel). This suggests that an asymmetric response pattern over the financial cycle might have been present, a notion that is also supported by formal empirical evidence (Borio and Lowe (2004) and Ravn (2011)).[19] With inflation rates firmly anchored to central banks' inflation goals over this period, this could have driven down nominal and real interest rates and thereby opened a wedge between policy rates and Taylor rule-implied rates.

[17] See Hayo and Hofmann (2006) for an applied discussion of this issue in the context of a comparison of output reaction coefficients in estimated Bundesbank and ECB policy rules.

[18] Hannoun (2012) refers to these two factors as "financial dominance" and "exchange rate dominance".

[19] Conceptually, a systematic, though symmetric, response of policy rates to financial factors can be rationalised based on models with financial frictions. For instance, in the model of Cúrdia and Woodford (2009) a credit spread measure enters the optimal policy rule as an additional argument. Policy rates would therefore be higher than implied by the classical Taylor rule during financial booms when credit spreads are below normal, and lower during financial busts when credit spreads are above normal.

… combined with global behavioural monetary policy spillover effects

Concerns about unwelcome capital flows and exchange rate movements may in turn have transmitted low interest rates in core advanced economies to EMEs and other advanced economies. Out of such concerns, central banks may aim to avoid large and volatile interest rate differentials so that their policy rates become implicitly tied to those prevailing in core advanced economies.[20] The empirical relevance of this point is underpinned eg by Gray (2012) and Goldman Sachs (2012), who find that US interest rates are an important argument in estimated policy rules of both advanced economies and EMEs. Through this channel, the downward trend in core advanced economies' policy rates might have exerted downward pressure on policy rates around the globe, driving down real interest rates and alienating policy rates from the levels suggested by domestic inflation and output developments through the Taylor rule.

The deviation may in part also reflect lower equilibrium real interest rates

The indication that monetary policy has been systematically too accommodative over the past decade from the perspective of the Taylor rule would, however, be partly qualified if equilibrium real interest rates were indeed lower than trend real output growth. While the low average level of ex post real interest rates since early 2000 might merely be a reflection of systematically accommodative monetary policy, there are also a number of factors that might have pushed down equilibrium real rates over this period. Low long-run real rates may in part reflect secular demographic trends, specifically the influence of the baby boomer generation on asset markets (Takáts (2010)). Also, high saving rates and underdeveloped financial markets in EMEs may have given rise to a global asset shortage that has lowered equilibrium real interest rates worldwide (Caballero et al (2008)). Another potential factor is a possible increase in the perceived riskiness of capital assets in the wake of the recurrent asset price booms and busts since the late 1990s. Such higher "capital price risk" could drive long-run risk-free real interest rate levels well below trend output growth (Abel et al (1989)). However, while all these factors may have lowered equilibrium real interest rates, there is no evidence at hand to assess their quantitative impact.

Finally, there are a number of specific considerations that might explain in part the deviation of policy rates from the Taylor rule over the more recent period. The negative shocks that have buffeted the global economy over the past four years may have temporarily lowered equilibrium or "natural" real interest rates below their low-frequency component that is linked to trend output growth.[21] Moreover, the binding of the zero lower bound during the Great Recession in some economies might have created a cumulative shortfall of monetary accommodation over this period. This would make the case for

[20] Gray (2012) explores the mechanics of such behavioural monetary policy spillover effects across borders in a simple open economy rational expectations model. From a conceptual point of view, a systematic reaction to exchange rate misalignments and foreign demand conditions would be part of an optimal monetary policy rule in open economy models with incomplete exchange rate pass-through and incomplete asset markets (Corsetti et al (2010)).

[21] From the perspective of New Keynesian macro models, the equilibrium or "natural" real interest rate in the Taylor rule should also include a high-frequency component reflecting the real economic shocks hitting the economy (Woodford (2001)).

keeping policy rates below the levels implied by conventional monetary policy rules until the shortfall is made up for (Reifschneider and Williams (2000)).

Conclusions

The analysis in this special feature suggests that, from the perspective of the Taylor rule, monetary policy has on aggregate been systematically accommodative globally since the early 2000s. A candidate explanation for the potential global accommodative bias in monetary policy is the combination of two factors: an asymmetric reaction of monetary policy to the different stages of the financial cycle in core advanced economies, and global behavioural monetary policy spillovers through resistance to undesired capital flows and exchange rate movements in other countries, especially in EMEs. This would suggest that central banks need to reconsider their monetary policy frameworks with a view to ensuring symmetry in the conduct of monetary policy over the financial cycle and to better internalise the externalities associated with global monetary policy spillovers (Borio (2011)).

At the same time, it is important to bear in mind the limitations and pitfalls of Taylor rule-based analysis. First, the indications of Taylor rules should be taken with caution as they involve assumptions about unobservable concepts which might be wrong and hence misleading. Specifically, the indication that monetary policy has been systematically too accommodative might in part reflect a drop in equilibrium real interest rates. Second, the traditional Taylor rule might not adequately capture the factors that are relevant for macroeconomic stability and hence for monetary policy. In particular, financial stability risks and their macroeconomic implications are not appropriately captured. As a consequence, the Taylor rule is likely to have a downward bias during financial booms and an upward bias during financial busts.[22] Finally, Taylor rules do not capture the role of other monetary policy instruments. Specifically, changes in reserve requirements, which play an important role in some EMEs, and central banks' balance sheet policies are not taken into account. Total assets held by central banks have roughly quadrupled over the past decade and stood at approximately $18 trillion at the beginning of 2012, or roughly 30% of global GDP. This is likely to have further eased monetary policy, eg by lowering long-term interest rates and mitigating exchange rate appreciation,[23] so that the global monetary policy stance over the sample period was probably more accommodative than indicated by the level of policy rates.

[22] The Taylor rule might also have a downward bias in the bust emanating from potential adverse side effects of prolonged low levels of interest rates. See BIS (2012) for a more detailed discussion of these side effects.

[23] For an overview and new evidence of the effect of central bank bond purchase programmes on long-term government bond yields, see Meaning and Zhu (2011). Gambacorta et al (2012) present evidence that the expansionary balance sheet policies adopted by advanced economy central banks in response to the global financial crisis had significant macroeconomic effects.

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