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Economic Commentaries

Is the Swedish monetary policy in line with the Taylor rule?[1]

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We show that monetary policy in Sweden, since the introduction of the inflation target, can be described in terms of a Taylor rule. Today's very expansionary monetary policy with a negative interest rate is in line with the Taylor rule, if one takes into account the fact that the long-term real interest rate has shown a falling trend in recent decades and is currently very low.

"Over the past two decades, research on policy rules has shown that simple rules have important robustness advantages over fully optimal or more complex rules in that they work well in a variety of models. Experience has shown that simple rules also have worked well in the real world." (Taylor and Williams (2011))

Monetary policy is often described in terms of a rule of thumb or a so-called policy rule. The Taylor rule is a simple monetary policy rule that has spread widely over the past two decades. According to this rule, the policy rate depends on inflation, resource utilisation and long-term interest rates. One reason why the Taylor rule has become popular is that it appears to be able to describe monetary policy in many countries relatively well, at least under normal economic circumstances. However, one should not expect that a simple rule will always give a good description of the monetary policy. Monetary policy decisions are based on many different factors and difficult deliberations that cannot always be captured in a simple rule.

Another reason why the Taylor rule has become popular is that it has been shown in economic models to provide good guidance on how monetary policy should be conducted under different assumptions of the functioning of the economy. This is despite that the optimal monetary policy is complex and depends on several different factors. There are thus theoretical reasons why the Taylor rule leads to a good outcome. It is therefore often used as a guideline when evaluating the monetary policy conducted, although no central bank would exactly follow a Taylor rule.

In this Economic Commentary, we show that monetary policy in Sweden has been in line with the Taylor rule, if the long-term real interest rate is allowed to vary over time, since the inflation target was introduced in 1995.[2] [3] The current very expansionary monetary policy with a negative interest rate is also in line with the Taylor rule. An important explanation for this is that the long-term real interest rate has shown a falling trend in recent decades and is very low at present. Our estimates indicate that it could be as low as −2 per cent.

The Taylor rule – a simple monetary policy rule

The Taylor rule is named after the American economist John Taylor.[4] There is no clear-cut definition of the Taylor rule in practice; it has become a collective term for various

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[2] It was decided in 1993 that the inflation target would formally begin to apply with effect from 1995.

[3] Berg et al. (2004) also find that simple Taylor rules may be in line with monetary policy in Sweden. However, they study a shorter time period, 1993–2002.

[4] See Taylor (1993).

monetary policy rules where the central bank's instrument is a short-term nominal interest rate, the so-called policy rate (or repo rate). In this study we use a Taylor rule that is described in Taylor (1993), with the difference that the long-term real interest rate is not constant, but can vary over time. According to the Taylor rule, the policy rate varies around a long-term nominal interest rate level – which can be divided into a long-term real interest rate and the inflation target – where the variations depend on how inflation relates to the inflation target and resource utilisation to the long-term level. Formally, the Taylor rule can be described with the following expression,

$$R_t = r_t^* + \pi^* + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*),$$

where R denotes the policy rate, r^* the long-term real interest rate (the raised asterisk indicates that it is the level of the long-term real interest rate) – note that the long-term level can vary over time, π inflation, π^* the long-term level of inflation, which is usually set at the central bank's inflation target, y resource utilisation and y^* the long-term level of resource utilisation. The parameters α and β state by how much the policy rate reacts to deviations of inflation from the inflation target and to deviations of resource utilisation from its long-term level, respectively.

We assume that the weight of inflation's deviation from the target, α, is 1.5, which is a standard value in many studies. The weight of resource utilisation, β, is set at 0.1. This is somewhat lower than what is common in the academic literature but on the other hand it is in line with the estimation of this parameter in the Riksbank's macromodel, Ramses. We set π^* at the Riksbank's inflation target, which is 2 per cent. A Taylor rule for the Swedish economy can then be written as,

$$R_t = r_t^* + 2 + 1{,}5(\pi_t - 2) + 0{,}1(y_t - y^*).$$

The long-term real interest rate, r^*, plays an important role for setting the policy rate. If both inflation and resource utilisation are close to their long-term levels, their impact on the policy rate will be small. The level of the policy rate will then be the level of the long-term real interest rate plus the inflation target.

Description of data

To calculate the policy rate according to the Taylor rule, we need information on inflation, resource utilisation and the long-term real interest rate. An important element of the analysis is that we take into account the uncertainty inherent in the measurement of these variables. We illustrate this uncertainty by using several different measures and with the aid of these we calculate a so-called uncertainty band for the policy rate from the Taylor rule.

Six different measures of inflation are used

Inflation is a general increase in prices of all goods and services produced in an economy. To measure inflation central banks often use a so-called cost-of-living index, even though these may be associated with certain problems. One well-known problem is that changes in relative prices between different goods affect the cost-of-living index. Large upswings or downswings in the oil price are examples of relative price changes that have a direct effect on the cost-of-living index. It is therefore common that central banks look at a measures of inflation where the direct effect of the change in the oil price has been excluded. The Riksbank, for instance, reports inflation measured as CPIFXE – which is a cost-of-living index where the direct effects of changes in energy prices, which are largely comprised of oil prices, have been excluded – in

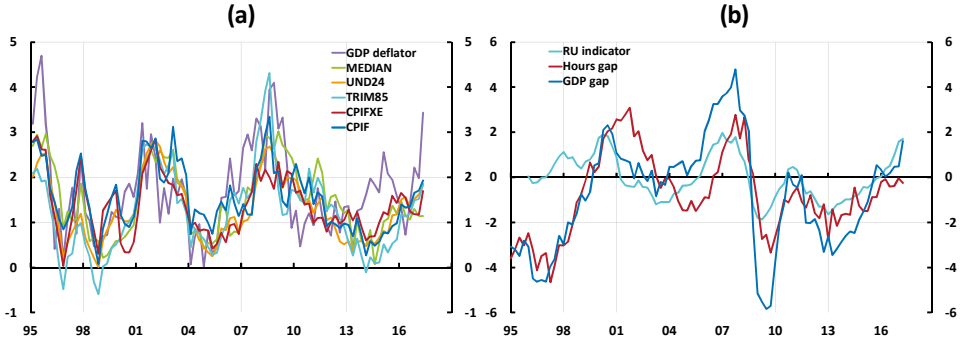
its Monetary Policy Report. Relative price changes are a natural feature of a market economy and should therefore not be confused with changes in inflation.

The most common and well-known measure of inflation in Sweden is the change in the consumer price index, CPI, which measures changes in consumer prices. However, in the Riksbank's monetary policy analysis it is the CPIF that is used in practice, that is, the CPI with a fixed interest rate, which means that one excludes the effect of changes in interest rates from the CPI.[5] The Riksbank also takes into consideration other measures of inflation, so-called underlying measures, to obtain a better picture of how inflation is developing.[6] In this study we include four different measures of underlying inflation, CPIFXE, TRIM85, UND24, and MEDIAN, in our calculations of the policy rate according to the Taylor rule.[7]

Inflation is a general upturn in all prices in the economy including prices of work, that is to say wages. This suggests that inflation is not equal to a decline in the standard of living. If the prices of all goods, services and wages rise at the same rate, there does not need to be any direct effect on the standard of living, but there can be indirect effects of an overly high inflation rate that can reduce the standard of living. This is one reason why central banks around the world are aiming to attain a low and stable rate of inflation.

The GDP deflator is a measure of inflation that includes the prices of all domestically-produced goods and services. In addition to the prices of domestically-produced consumption (private and public consumption), it includes the prices of domestically-produced investments and exports. If the GDP deflator is calculated from the income side, it is also made clear that wages are included. However, this measure is also associated with problems; it is only available on a quarterly basis and it is often revised. Unfortunately, there is no entirely satisfactory measure of inflation. Central banks generally use changes in the cost-of-living index as a measure of inflation, because they are known to the general public, they can be measured with relatively good precision and are not revised.

Figure 1. Different measure of inflation (a) and resource utilisation (b)



Note. Per cent. In Figure 1a, the CPIF is the CPI with a fixed mortgage rate. The CPIFXE is the CPIF excluding energy prices. In the measure TRIM85, 7.5 per cent of the highest and the lowest price changes in the CPI have been excluded. In UND24, the sub-groups have different weights than in the CPI, based on how much they vary. MEDIAN is the median of price changes in the CPI. In Figure 1b, the GDP gap is defined as the deviation in GDP from an estimated trend, the hours gap is defined as the deviation in the number of hours worked from an estimated trend and the RU indicator summarises a number of data from surveys and the labour market and is assumed to reflect resource utilisation in the economy.
Sources: Statistics Sweden and the Riksbank

All in all, we thus use six different measures of inflation in the analysis, CPIF, CPIFXE, TRIM85, UND24, MEDIAN and the GDP deflator. Figure 1a shows how these measures have varied

[5] The Executive Board of the Riksbank decided at its monetary policy meeting in September 2017 that the CPIF would from now on become the formal target variable for inflation.
[6] See Hansson et al. (2008) for a discussion of underlying measures of inflation.
[7] The underlying measure CPIFXE is calculated as the CPIF excluding energy prices. In the measure TRIM85, 7.5 per cent of the highest and the lowest rates of price changes in the CPI have been excluded. In UND24, the sub-groups have different weights than in the CPI, based on how much they vary. MEDIAN shows the median of price changes in the CPI.

since the inflation target was introduced. The different measures follow one another relatively well, but during certain periods of time there are marked differences.

Difficult to measure resource utilisation

Resource utilisation can be measured in several different ways, which indicates that there is some uncertainty on how it should be measured. We use three different measures that are also published in the Riksbank's Monetary Policy Report, i.e., the GDP gap, the hours gap and the RU indicator. The GDP gap measures the deviation in GDP from an estimated trend, while the hours gap measures the deviation in the number of hours worked from an estimated trend. The RU indicator summarises a large amount of survey and labour market data and is assumed to reflect resource utilisation in the economy. Figure 1b shows how the three measures have varied during the period since the inflation target was introduced. During certain time periods, the different measures may differ fairly substantially.

The long-term real interest rate is unobservable

The Riksbank steers a short risk-free nominal interest rate – the so-called policy rate – which in turn affects interest rates with longer maturities faced by households and companies. The nominal interest rate may have some impact on demand in the economy, but the real interest rate probably plays a more important role – that is, the interest rate obtained when inflation has been subtracted from the nominal interest rate. Monetary policy is considered to be able to affect the real interest rate in the short term, but in the longer term it is probably determined by other factors. These factors can be the trend growth in the economy, households' valuation of consumption today in relation to the future, demographic developments and real interest rates abroad. In a world with free capital movement, it may be difficult for a small open economy like Sweden to have real interest rates that deviate too much from those in other countries. In recent decades, real interest rates around the world have shown a falling trend, which has also affected real interest rates in Sweden.

According to the Taylor rule, the policy rate is related to the long-term level of the real interest rate. Unfortunately, it is not possible to observe this and there is no consensus on how it should be calculated. A common assumption in many studies is that it is constant over time. This is often the case in economic models and it is also in line with how Taylor (1993) estimated the long-term level. However, this can be a problematic assumption in many situations, since it is likely that when structural changes occur in the economy the long-term interest rate may also be affected. We therefore assume that the long-term real interest rate may vary over time in our calculations and that it will roughly follow the trend in the real interest rate.

To calculate the long-term real interest rate, we use a relatively simple method proposed by James Bullard, head of the Federal Reserve Bank of St. Louis.[8] This method is based on the Fisher equation, that is,

$$r_t = R_t - E_t\pi_{t+1},$$

where E denotes the expectation operator.

So, to calculate the real interest rate we need to know the expected inflation rate during the time to maturity. We calculate both so-called *ex ante* real interest rates, where we use inflation expectations from money market participants, and so-called e*x post* real interest rates, which are based on actual inflation outcomes. In these calculations we use CPIF, CPIFXE, TRIM85, UND24, MEDIAN and the GDP deflator as measures of inflation.

The maturity of the nominal interest rate, R, should be at least as long as the time that monetary policy affects real interest rates. However, it should not be too long, as interest rates

[8] See Bullard (2016).

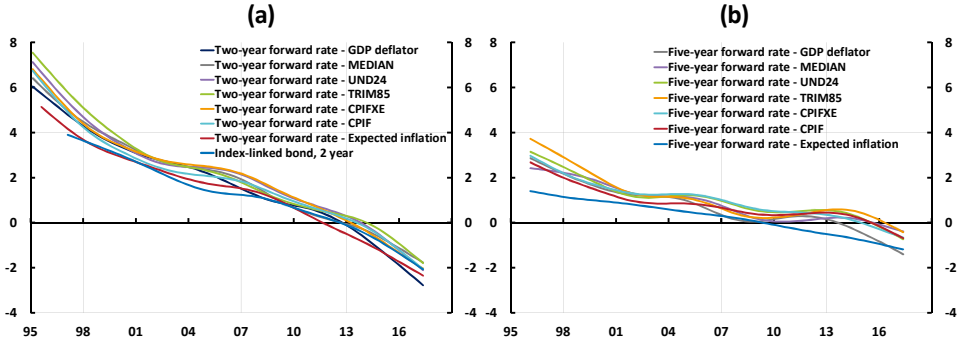
with longer maturities contain a term premium that may be difficult to exclude. The interest rate that the central bank relates to should also be a risk-free rate. Bullard suggests that the effect of monetary policy on the real interest rate lasts a few quarters and he therefore uses the yield on a nominal government bond with a maturity of one year minus expected inflation as a measure of the real interest rate.

However, there is no consensus in the literature on how long monetary policy may influence real interest rates. Many argue that monetary policy affects the real interest rate for longer than a year. We share this assessment and therefore use forward rates on Swedish government bonds with a maturity of two and five years. The forward rate on the five-year government bond is moreover adjusted for a term premium.[9] To obtain a measure of the long-term real interest rate we calculate a so-called HP trend.[10] Our assessment of the long-term real interest rate is in other words the HP trend in the real interest rate.

Figure 2a shows the long-term real interest rate two years ahead since the inflation target was introduced. The long-term real interest rate has fallen from around 6–8 per cent in the middle of the 1990s to around −2 per cent today. The long-term real interest rate five years ahead is also showing a falling trend, although not so steep, see Figure 2b. At the beginning of the period, the long-term real interest rate is around 2.5–3.5 per cent, while it is currently between −0.5 and −1.5 per cent according to this measure.

The Riksbank assessed in a box article in the Monetary Policy Report in February 2017 that the real interest rate could be expected to be between 0.5 and 2.0 per cent five to ten years from now, but that it will be much lower in the coming years.[11] An estimate of the trend in the real interest rate using the Riksbank's macro model Ramses implies that the long-term level of the real interest rate at the end of 2016 was around −1.5 per cent, which is in line with our estimates. [12]

Figure 2. Long-term real interest rate (HP trend) two years ahead (a) and five years ahead (b)



Note. Per cent. The long-term real interest rate is calculated as the HP trend (lambda = 1600) for the real interest rate two years ahead (the forward rate for a two-year government bond minus inflation) and five years ahead (the forward rate for a five-year government bond adjusted for the term premium and minus inflation). Expected inflation is expectations among money market participants two respectively five years ahead.
Sources: Own calculations, Macrobond, Statistics Sweden, TNS Sifo Prospera and the Riksbank

Swedish monetary policy in line with the Taylor rule

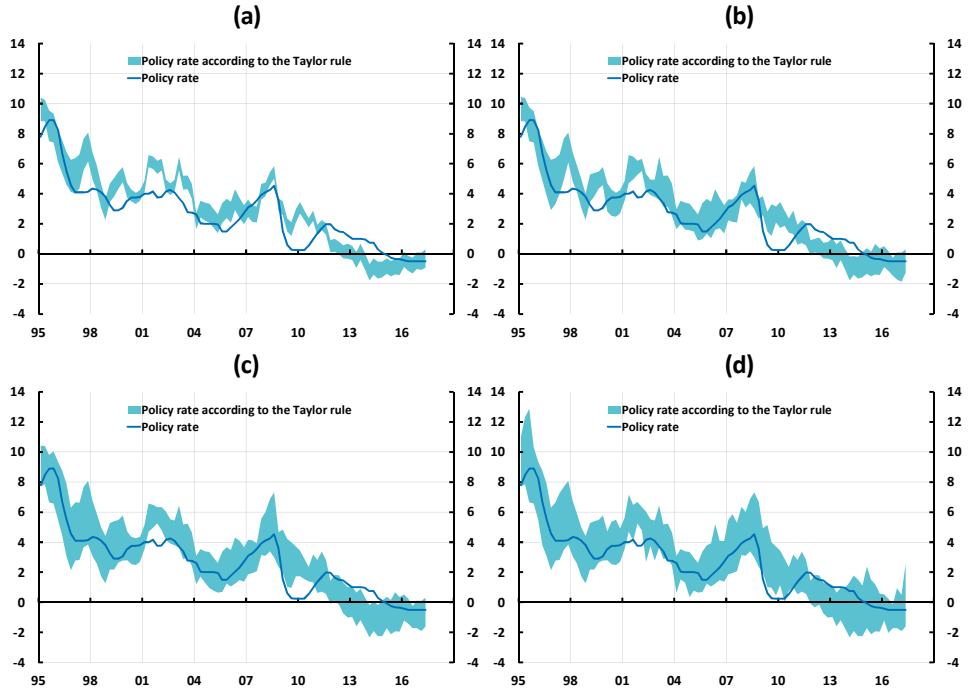
One of the difficulties in calculating the policy rate according to the Taylor rule is, as we have discussed, the uncertainty inherent in the different measures of inflation, resource utilisation

[9] The term premium is excluded using a method described in De Rezende (2017). The interest rates on both the two-year and five-year government bonds are so-called forward rates, that is, interest rates in two and five years' time.
[10] See Kydland and Prescott (1990) for a discussion of the so-called HP filter used to calculate an HP trend. In our calculations, lambda in the HP filter is set to 1600.
[11] The article reports an interval for the nominal interest rate between 2.5 and 4 per cent. To obtain an interval for the real interest rate we have subtracted the Riksbank's inflation target of 2 per cent.
[12] See Strid and Bonomolo (2017).

and the long-term real interest rate. To take this into account, we calculate an uncertainty band for the policy rate that includes several different measures of these three variables.

Figure 3a shows the actual policy rate since the inflation target was introduced, together with an uncertainty band for the policy rate calculated from the Taylor rule. In this calculation inflation is measured with the CPIF. It is thus implicitly assumed in this calculation that inflation can be measured exactly with the CPIF. The width of the uncertainty band thus depends on the different measures of resource utilisation and the long-term real interest rate. The measures of resource utilisation are shown in Figure 1b and the measures of the long-term real interest rates, calculated from the real interest rate two years ahead, are shown in Figure 2a.

Figure 3. Actual policy rate and policy rate according to the Taylor rule with an uncertainty band. The long-term real interest rate in the Taylor rule is calculated using the real interest rate two years ahead.



Note. Per cent. In Figure 3a, the uncertainty band shows the difference between the highest and lowest policy rate according to the Taylor rule when all combinations of the different measures of resource utilisation and the long-term real interest rate have been included and inflation is measured with the CPIF. Figure 3b also includes the CPIFXE as a measure of inflation. Figure 3c also includes TRIM85, UND24 and MEDIAN as measures of inflation. Figure 3d in addition to the other measures also includes the GDP deflator as a measure of inflation.
Sources: Own calculations, Macrobond, Statistics Sweden and the Riksbank

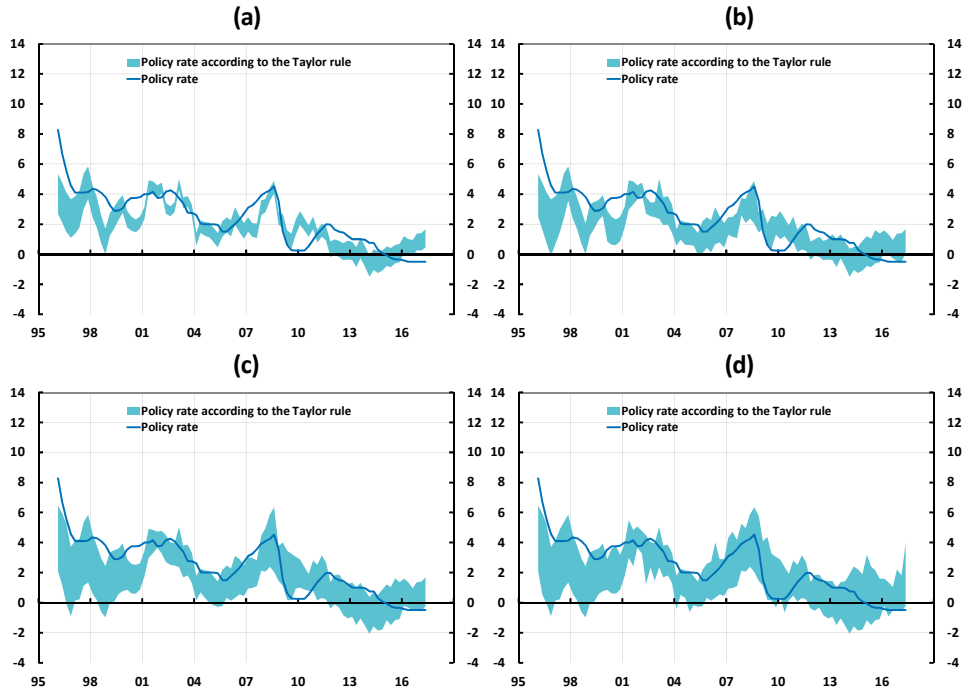
The overall picture is that the Riksbank's policy rate is largely in line with the policy rate from the Taylor rule, although there are deviations during certain episodes.[13] During a large part of the 2000s the policy rate was close to the lower edge of the band, or even slightly under. During the financial crisis 2008–2009 the Riksbank cut the policy rate more than would have been justified by the Taylor rule. However, this does not necessarily mean that monetary policy was wrongly conducted. The Taylor rule is expected to provide good guidance on how monetary policy should be conducted in normal times. But in times of financial stress, it is reasonable to

[13] One objection one can make is that the long-term real interest rate has been calculated using data from the entire time period. This means that when the policy rate is calculated according to the Taylor rule, the Riksbank is assumed to have more information on the long-term level (or trend) than it was actually possible to have in real time when making the policy rate decisions. On the other hand, the fact that the actual policy rate is in line with the Taylor rule can be interpreted that the Riksbank, despite having had incomplete information on the trend in the real interest rate, has made pretty good assessments of the long-term real interest rate at its monetary policy meetings.

also take into account the risks of a financial crisis or to try to alleviate the effects if one has already arisen. This is not captured in our specification of the Taylor rule, since it does not include any financial variables. During the period from the end of 2011 to around 2015 the Riksbank's policy rate was somewhat higher than advocated by the Taylor rule. At the beginning of this period, the Riksbank also received criticism from several commentators, in line with the Taylor rule, that it was conducting an overly tight monetary policy.

The period after 2015 is particularly interesting, since it is characterised by a very expansionary monetary policy with a negative policy rate. However, this is also in line with the Taylor rule. The main reason for this is the falling trend in the real interest rate in recent decades. This has led to the long-term real interest rate being very low. Our calculations indicate that it currently could be as low as −2 per cent.

Figure 4. Actual policy rate and policy rate according to the Taylor rule with an uncertainty band. The long-term real interest rate in the Taylor rule is calculated using the real interest rate five years ahead.



Note. Per cent. In Figure 4a, the uncertainty band shows the difference between the highest and lowest policy rate according to the Taylor rule when all combinations of the different measures of resource utilisation and the long-term real interest rate have been included and inflation is measured with the CPIF. Figure 4b also includes the CPIFXE as a measure of inflation. Figure 4c also includes TRIM85, UND24 and MEDIAN as measures of inflation. Figure 4d in addition to the other measures also includes the GDP deflator as a measure of inflation.
Sources: Own calculations, Macrobond, Statistics Sweden and the Riksbank

In Figures 3b–3d we also take into account the uncertainty in the measure of inflation. The uncertainty band for the policy rate thus becomes wider and the probability that the policy rate will be within the band becomes higher. In Figure 3b a further measure of inflation, the CPIFXE, is included. This is a measure that is common in the monetary policy discussion and it is regularly shown in the Monetary Policy Report. As expected, the band becomes somewhat wider, but the conclusions from Figure 3a do not change significantly. A further three measures are included in Figure 3c – TRIM85, UND24 and MEDIAN – together with the CPIF and the CPIFXE for the calculation of the uncertainty band. The Riksbank's policy rate then lies within the band, with the exception of a couple of individual years. When the GDP deflator is

also included among the measures of inflation, the deviation in the policy rate from the uncertainty band becomes entirely marginal, see Figure 3d.

In Figures 4a–4d the long-term real interest rate in the Taylor rule is calculated using the real interest rate five years ahead. If we compare Figure 4a with Figure 3a, we can observe that the fit of the policy rate to the Taylor rule is somewhat poorer in Figure 4a, particularly at the beginning and end of the period. The current expansionary monetary policy with a negative policy rate does not lie within the uncertainty band in this case. The main reason for this is that the long-term real interest rate measured five years ahead is not as low as the one two years ahead. But if we take into account the uncertainty in the measures of inflation, the negative policy rate is largely within the uncertainty band, albeit at the lower edge, see Figures 4b–4d.

Closing comments

We have shown that monetary policy in Sweden, since the introduction of the inflation target in 1995, can be described in terms of a Taylor rule. Two important elements in the analysis have been to take into account (i) the uncertainty in the measures of inflation, resource utilisation and the long-term real interest rate, and (ii) we allow the long-term real interest rate to vary over time. The second assumption is the main explanation why the current very expansionary monetary policy with a negative policy rate is also in line with the Taylor rule. The long-term real interest rate, both in Sweden and abroad, has shown a falling trend in recent decades and is currently very low.

An important question for monetary policy in the coming years is probably how the long-term real interest rate will develop. Will the low levels persist, or will the real interest rate begin to rise? An interesting discussion of how global demographic developments may have contributed to the falling trend in the real interest rate in recent decades and how this trend may be reversed in the future is provided by Goodhart and Pradhan (2017).

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