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Instability, imprecision and inconsistent use of equilibrium real interest rate estimates ☆

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A R T I C L E I N F O

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A B S T R A C T

The debate on monetary and fiscal policy is heavily influenced by estimates of the equilibrium real interest rate. In particular, this concerns estimates derived from a simple aggregate demand and Phillips curve model with time-varying components as proposed by Laubach and Williams (2003). For example, Summers (2014a) refers to these estimates as important evidence for a secular stagnation and the need for fiscal stimulus. Yellen (2015, 2017) has made use of such estimates in order to explain and justify why the Federal Reserve has held interest rates so low for so long. First, we re-estimate the United States equilibrium rate with the methodology of Laubach and Williams (2003). Then, we build on their approach and an alternative specification to provide new estimates for the United States, Germany, the euro area and Japan. Third, we subject these estimates to a battery of sensitivity tests. Due to the great uncertainty and sensitivity that accompany these equilibrium rate estimates, the observed decline in the estimates is not a reliable indicator of a need for expansionary monetary and fiscal policy. Yet, if these estimates are employed to determine the appropriate monetary policy stance, such estimates are better used together with the consistent estimate of the level of potential output.

1. Introduction

Interest rates in leading industrial economies have been declining for about three decades. The economic recovery in the aftermath of the global financial crisis and the euro area debt crisis has been slow, while consumer price inflation remained close to zero until recently. Partly for these reasons, central banks have set near zero or negative policy rates and engaged in massive asset purchases. As a consequence, not only short- and medium-term money market rates remained either close to zero or negative, but also the rates for longer-term government bonds. In the euro area, for example, the yield curve of government bonds with an AAA-rating estimated by the European Central Bank (ECB) has at times been negative for up to ten years. Taking into account that inflation expectations are positive and surveys for longer-term inflation near two percent, the real return tends to be negative as well.

Central bankers have argued that the key reason for keeping nominal interest rates so low for so long is a decline in the equilibrium real interest rate, for which desired savings would be equal to planned investment. Monetary policy – it is said –

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needs to steer real interest rates below the equilibrium in order to stimulate aggregate demand and inflation. Former FOMC Chair Janet Yellen has referred repeatedly to equilibrium real interest rate estimates near zero percent that were obtained with a methodology proposed by Laubach and Williams (2003) (see Yellen, 2015, 2017; Williams, 2015). In particular, she has argued that FOMC policy is not deviating much from the prescriptions of Taylor-style interest rate rules if such an estimate of the equilibrium rate is used in the rules. Yellen spoke of 'headwinds' that kept the equilibrium rate low for some time, for example, the unwinding of the high debt levels of private households. She expected the equilibrium rate to move and rise to a higher level in the future. By contrast, Lawrence Summers has cited Laubach-Williams type estimates of the equilibrium real interest rate as evidence for a secular stagnation. In his view, monetary policy is unable to raise growth and a large fiscal expansion is called for (see Summers 2014a, 2014b, 2014c). In the euro area, ECB President Draghi has also referred to a global excess of desired savings over planned investment as the main driver for the low interest rate environment (Draghi, 2016). The decline in equilibrium rate estimates with the methodology of Laubach and Williams (2003) is one of the reasons given for the massive quantitative easing started at the beginning of 2015 (see Constâncio, 2016).

In this paper, we conduct a comprehensive analysis of equilibrium interest rate estimates obtained within a simple aggregate demand and Phillips curve framework for the United States, Germany, the euro area, and Japan. The associated equilibrium is best characterized as a medium-term concept. We start with a brief overview of the development of nominal and real interest rates in these four economies. Next, we employ the methodology of Laubach and Williams (2003) and a modified version similar to Garnier and Wilhelmsen (2009) to obtain new estimates of the medium-term equilibrium real interest rate for the United States. Then, we examine the sensitivity of such estimates by considering different specifications regarding technical assumptions and data series before providing estimates for the other economies. Finally, we assess to what extent such estimates are useful for assessing the appropriate stance of monetary and fiscal policy.

2. Trends in short-term nominal and real interest rates: 1965–2018

Nominal money market rates in advanced economies have trended downwards since the 1980s. Of course, nominal rates are closely linked to inflation and inflation expectations, which have to be taken into account in order to derive real rates, ex-post or ex-ante. Fig. 1 shows short-run nominal and real interest rates since 1965 and since 1970 for the euro area.

Data concerning the United States and Germany are taken from the Organisation for Economic Co-operation and Development (OECD) Main Economic Indicators database. The euro area data stems from the Area Wide Model Database (AWM) of the European Central Bank. In this database, data from individual member countries prior to the establishment of the monetary union is aggregated in order to construct counter-factual euro area time series starting from the 1970s (Fagan et al., 2001). For Japan, we employ the three months deposit rate from 1979 onwards and the spliced immediate rate before that. Both series are from the Federal Reserve Economic Data (FRED). For inflation, we use consumer price indices from the same sources. Inflation expectations are estimated as in Hamilton et al. (2015) from an autoregressive model with a rolling window. The estimation starts with a window length of ten years that is extended gradually to 20 years.

Of course, nominal rates fluctuate a lot over this period but some trends are nevertheless apparent. From 1965 to 1980, interest rates tended to increase until reaching a peak in the early 1980s. Then they declined again. The trend is especially pronounced in Japan and more pronounced in the United States and in the euro area than it is in Germany. In Japan, interest rates were highest in the 1960s. They reached a first trough around 4 percent in the 1980s. After another increase they declined towards zero percent in the 1990s. Currently, nominal interest rates remain close to zero in the euro area and in Japan. In the United States they started to rise in 2015. Since then, they have risen to a bit above 2 percent. Nominal rates are constrained from falling much below zero percent, because cash provides an investment opportunity with a nominal return of zero percent that is available to all savers. In other words, savers need not necessarily accept negative returns on savings held in bank accounts or other instruments. Of course, holding a large stock of cash comes with expenses for storage and insurance. Hence, the effective lower bound on nominal interest rates is likely to be a small negative number.

High and increasing nominal rates during the 1970s are largely explained by high and rising inflation. As inflation rates in the United States, France, Italy, and Spain exceeded those in Germany, inflation also largely explains differences in nominal rates during this period. Accounting for inflation or inflation expectations, ex-post and ex-ante real interest rates declined and were negative on several occasions during the 1970s, especially in Japan and to some extent in the United States and several European economies, except Germany.

Real interest rates increased after 1980. The increase is particularly pronounced for the ex-post real interest rate (middle panel) in the United States. The reason is that the tightening of monetary policy and subsequent disinflation during Paul Volcker's tenure as Fed Chairman initially came as a surprise to market participants. Ex-ante real interest rates (lowest panel) also increased but leveled off around 5 percent. From the mid-1990s onwards, real interest rates trended downwards. In 2009, they turned negative in the United States, the euro area and in Germany following substantial monetary easing. In Japan, the real rate turned negative right before the 1997 Asian Financial Crisis. Our estimates of ex-ante real rates exhibit relatively similar patterns to ex-post rates, because the horizon of inflation expectations estimated following Hamilton et al. (2015) is only one quarter. In the second quarter of 2018, the ex-ante real interest rate was negative in Germany and the euro area and around zero percent in the United States and Japan.

This brief comparison reveals that negative real interest rates already occurred before the global financial crisis and that Japan and the United States experienced negative real returns fairly often. Hence, they are not a new phenomenon. Indeed,

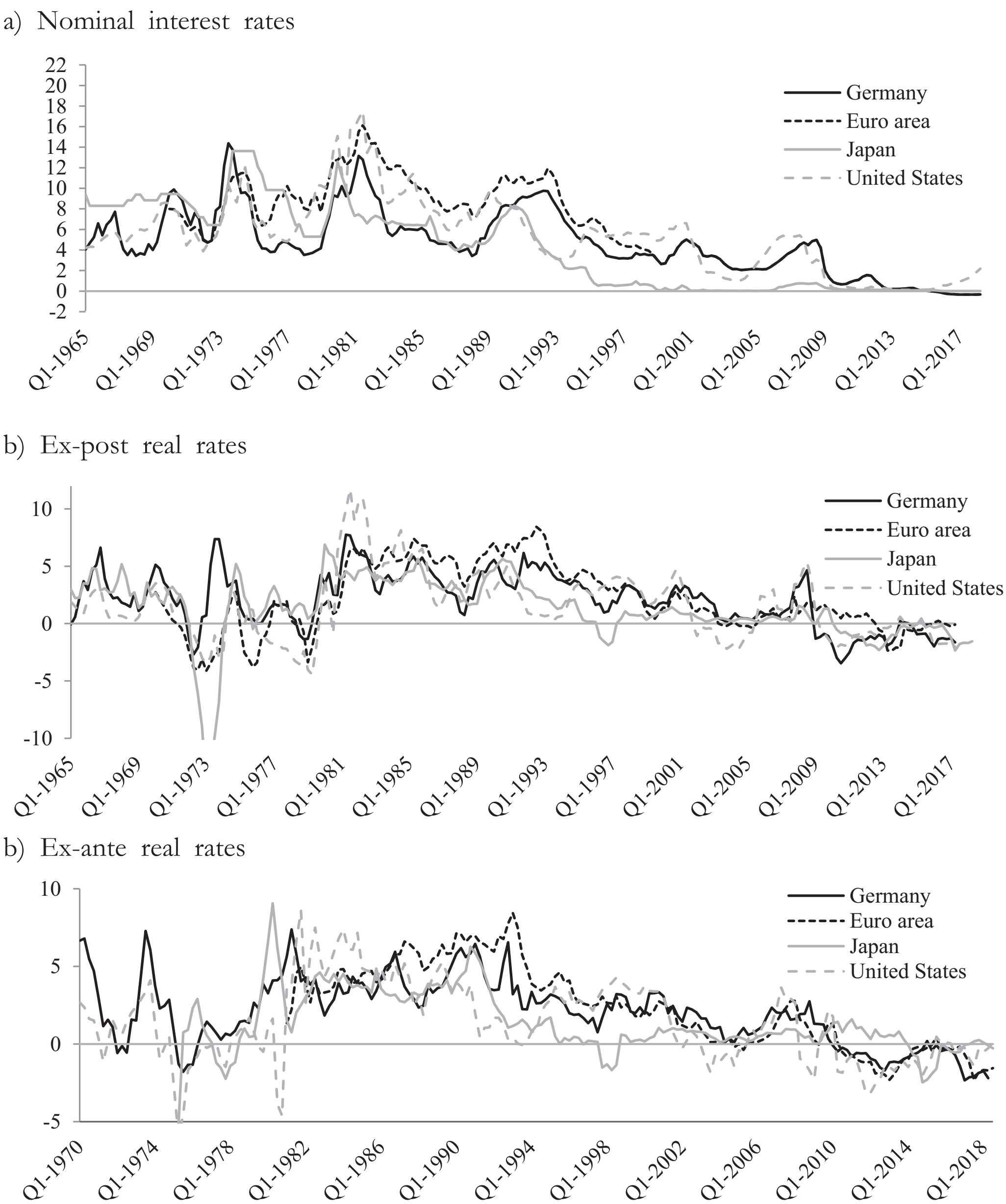

Fig. 1. Interest rates in the Germany, the euro area, Japan and the United States. **Sources:** ECB, OECD, own calculations. **Note:** Inflation for ex-post inflation rates is based on consumer prices. Inflation expectations for ex-ante interest rates are estimated as in Hamilton et al. (2015) from an autoregressive model with a rolling window. The estimation starts with a window length of ten years that is extended gradually to 20 years.

Hamilton et al. (2015) find real returns in Germany previously turned negative for a while during the 19th century and during the two world wars, also in the United States.

Fig. 2 provides estimates of trends in real interest rates using a moving average of ex-ante real rates with a window length of five years and the Hodrick-Prescott-Filter (1997). Both procedures deliver quite similar results. In the United States and Germany, real rates initially trended downwards. From about 1975 to 1980, they were negative in the United States. During the first half of the 1980s, filtered rates in the United States increased quickly to 5 percent before starting a slow decline. In Germany, the initial increase and the subsequent decline were less pronounced. Nevertheless, current filtered rates are negative for all four economies considered.

These trends in real rates could be interpreted to indicate movements in the equilibrium real rate over a medium-term horizon. However, such measures are not informed by any theoretical concept of economic equilibrium. This requires a structural model of the economy.

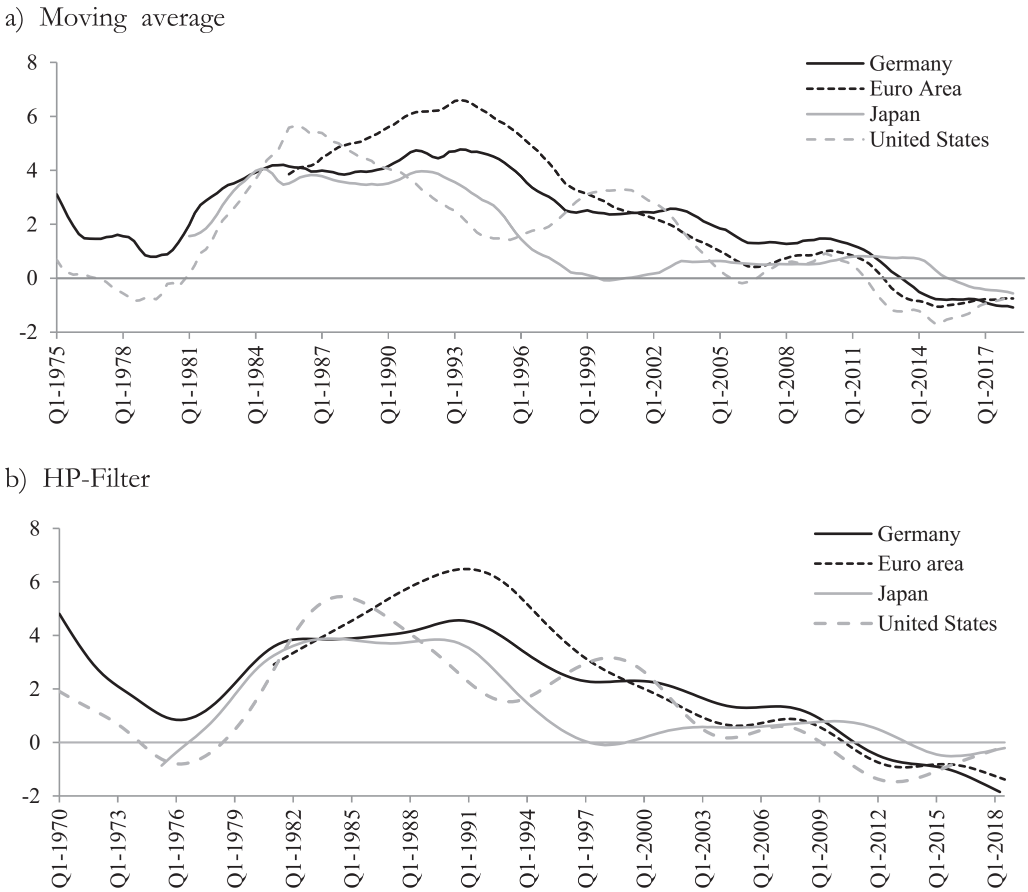

Fig. 2. Trends in ex-ante real interest rates. Note: The HP-Filter uses a smoothing parameter of 1600 and the moving average uses a five years window.

3. Different concepts of equilibrium interest rates

The idea of an equilibrium interest rate goes back to Wicksell (1898). In simple terms, the equilibrium interest rate is the real rate that is consistent with constant prices and for which GDP, in the long run, is equal to its potential level. If a central bank pursues a positive inflation target, the equilibrium rate ensues when inflation is permanently at its target rate. Wicksell suggested that the level of the natural rate of interest changes over time and, for example, depends on factor productivity and the availability of productive factors.

Concepts of equilibrium that are employed to estimate equilibrium interest rates differ according to their time perspective. The long-run equilibrium rate obtains once all fluctuations due to cyclical and other temporary factors have died out. It is closely tied to the economic growth rate in steady state, that is, long-run potential growth. The influential Taylor (1993) interest rate rule makes use of a long-term equilibrium rate as a key reference point for central bank rate setting. Taylor (1993) sets it close to trend growth from 1984 to 1992, which he computed at 2.2 percent. Average GDP growth during the last twenty years was 2.3 percent and with an average of 1.7 percent, it remained close to 2 percent even during the last ten years, despite the recession of 2008/09.

The relationship between the equilibrium real interest rate and economic growth can be derived theoretically from a neoclassical growth model in which prices are flexible (Ljungqvist and Sargent, 2004). In such a model, the equilibrium real rate follows from the consumption Euler equation, which characterizes optimal consumption and saving decisions. This equilibrium interest rate depends on the same technological factors that drive long-run economic growth. In addition, it is influenced by behavioral parameters that characterize the time preference and savings propensity of households, and by fiscal policy.

New Keynesian macroeconomic models with sticky prices feature a short-run equilibrium rate. It is the rate that would prevail if the price level were flexible (Woodford, 2003). The actual real interest rate deviates from this short-run equilibrium rate due to wage and price rigidities. The short-run equilibrium rate is often referred to as the "natural rate of interest" (Barsky et al., 2014; Cúrdia et al., 2015). It is influenced by all economic shocks and highly volatile. Consequently, it is not surprising that estimates of such a short-run equilibrium interest rate during the Great Recession were for the most part negative. Within such New Keynesian models, monetary policy can be used to bring the actual interest rate in line with the short-run equilibrium rate. Technically, this real interest rate would result from a monetary policy that solely aims at moving actual GDP to the value that would be realized if prices were fully flexible. This natural rate does not correspond to the long-run equilibrium rate that appears as a reference point in the Taylor rule. Rather, it is best understood as a prescription for setting the central bank rate that central banks could implement in lieu of a simple policy rule such as the Taylor rule. It is a rather complex policy rule that requires solving a complete structural macroeconomic model taking into account many different economic shocks.

By contrast, the equilibrium concept of Laubach and Williams (2003) (LW03 in the following) focuses on the medium-run and is tied less stringently to a structural model. It is meant to consider different factors that influence the equilibrium rate and change only slowly. The authors employ a simple Keynesian-style macroeconomic model augmented with various unobserved and time-varying components. An aggregate demand curve establishes a relationship between the deviation of the actual real interest rate from the equilibrium real rate and the output gap, that is, the deviation of actual GDP from its unobserved potential. A Phillips curve is used to link changes in the inflation rate to the output gap and various other factors including changes in oil and import prices. The equilibrium real interest rate is unobservable and varies over time. It depends on the growth rate of potential output and a number of other unobservable factors which are meant to capture what Yellen (2015, 2017) has termed 'headwinds'.

4. The econometric methodology of Laubach and Williams (2003)

4.1. The model

The simple macroeconomic model of LW03 consists of the following elements. An aggregate demand equation is given by

$$y_t = a_{y,1}y_{t-1} + a_{y,2}y_{t-2} + \frac{a_r}{2}\sum_{j=1}^{2}\left(r_{t-j} - r^*_{t-j}\right) + \epsilon_{1,t}, \tag{1}$$

where y_t is the output gap and r_t denotes the real interest rate. The current output gap is determined by two lags of itself and the average of lagged deviations of the actual real interest rate from the equilibrium real interest rate r^*_t.

The second equation used is a Phillips curve. It links the current inflation rate π_t to the output gap in the previous period, to a weighted average of past inflation rates and the relative fluctuations of oil and import prices (π^I_t and π^O_{t-1}):

$$\pi_t = B_\pi(L)\pi_{t-1} + b_y y_{t-1} + b_I\left(\pi^I_t - \pi_t\right) + b_O\left(\pi^O_{t-1} - \pi_{t-1}\right) + \epsilon_{2,t} \tag{2}$$

The third relationship is reminiscent of the neo-classical growth model that links the equilibrium real rate to the potential growth rate and behavioral parameters governing intertemporal utility maximization of households, ($r = \frac{1}{\sigma}g_c + \theta$), where r stands for the real interest rate, g_c stands for growth of per-capita consumption, σ stands for the intertemporal elasticity of substitution of consumption, and θ stands for the time preference. Accordingly, LW03 use the following equation to link three unobservables, the equilibrium real interest rate, the potential growth rate and a third unobservable variable, z_t:

$$r^*_t = cg_t + z_t \tag{3}$$

z_t is meant to capture factors like changes in the rate of time preference of households or trends in fiscal policy. In the following, we employ Yellen's term 'headwinds' to refer to these unobservable factors that cause medium-run fluctuations in the equilibrium real interest rate of this simple macroeconomic model. There will be different assumptions governing the law of motion of these 'headwinds'. In the original specification of LW03, the 'headwinds' follow a random walk:

$$z_t = D_z(L)z_{t-1} + \epsilon_{3,t} \tag{4}$$

The level of potential output and the growth rate of potential output are also modelled as random walks:

$$y^*_t = y^*_{t-1} + g_{t-1} + \epsilon_{4,t} \tag{5}$$

$$g_t = g_{t-1} + \epsilon_{5,t} \tag{6}$$

LW03 employ the Kalman filter to estimate this model over time. Besides the equations given above, the estimation also requires assumptions concerning the structure of measurement errors regarding unobservables. In order to estimate these signal-to-noise ratios consistently, LW03 rely on the procedure of Stock and Watson (1998). The signal-to-noise ratios govern the proportion of fluctuations attributed to the level and the trend of potential output, as well as the proportion of fluctuations attributed to the 'headwinds' and the output gap.

4.2. The estimation procedure

The model is estimated in three steps. First, a simpler model is estimated, in which the real rate gap in the aggregate demand curve is omitted and trend growth is constant. This model is used to determine the signal-to-noise ratio for trend growth, ω_g, by translating the likelihood of a break in the trend into a parameter (Stock and Watson, 1998). In a second step, the model is estimated with this parameter and with constant 'headwinds' in order to determine the signal-to-noise ratio of the latter, ω_z. Finally, all other parameters of the model are estimated by means of a maximum-likelihood procedure. Standard errors are computed using a Monte-Carlo-Simulation and consider both filter and parameter uncertainty (Hamilton, 1986).[1]

4.3. An alternative specification emphasized by Garnier and Wilhelmsen (2009)

The LW03 specification exhibits two problems in applications to Germany, the euro area, and Japan. First, estimating inflation expectations reduces the number of observations available to estimate the model, which matters for these other economies with shorter data samples. Second, the random walk assumption for the 'headwinds' variable z_t leads to very unstable results. While Laubach and Williams (2003) included a specification with stationary 'headwinds' in the robustness checks, they did not compare stability. By contrast, Mésonnier and Renne (2007) and Garnier and Wilhelmsen (2009) emphasized that the estimation results are more stable if the 'headwinds' variable z_t is assumed to follow a stationary process. Furthermore, the results obtained under this assumption are more easily interpretable than those obtained under the random walk assumption. Hence, we estimate the model for Germany, the euro area, and Japan under the assumption of stationary 'headwinds' and use ex-post real interest rates instead of ex-ante real interest rates. Due to the similarity of this alternative specification with the one in Garnier and Wilhelmsen (2009), we refer to it as GW09.

4.4. The data

In order to estimate the equilibrium real rate for the United States economy, we extend the original dataset of LW03 using time series from the FRED up to the second quarter of 2018. Gross national income (GNI) and the shadow rate, which are both employed in the sensitiveness analysis are taken from FRED and Wu and Xia (2016), respectively. Inflation expectations are estimated using an autoregressive process with a lag length of 20 years.

For Germany, we use the consumer price index, the real gross domestic product (GDP), and the three-month money market rate from the OECD Main Economic Indicator database. For oil- and import prices, we rely on data from the German Federal Statistical Office.

With regard to the euro area, we make use of the AWM database, which aggregates the time series of member countries prior to monetary union. This data covers the period from 1970 to 2014. Additionally, we cover the period from 1965 to 1970 with inflation and interest rates series from Cour-Thimann et al. (2006) and create an aggregate GDP ourselves. Using data from the OECD database, we update the time series up to the second quarter of 2018. Oil and import price data does not cover the period from 1965 to 1970.

For Japan, we use GDP data from the Cabinet Office and interest rates as well as inflation from FRED. We use 3-month rates from 1979 onwards and spliced immediate rates before. Import prices cover all commodities and are taken from the Bank of Japan. Oil import prices for Japan are approximated with global oil prices.

5. Empirical results for the United States

5.1. Estimates of the equilibrium real interest rate

Fig. 3 reports the estimates obtained from the baseline specification of LW03. The dashed line refers to the estimates from a one-sided estimation, whereas the solid line refers to the estimates from a smoothed, that is, two-sided estimation. One-sided estimates are closer to what could be obtained in real-time. In this case, the estimation of the unobservable variables only makes use of past and current but not future data. Yet, the parameters of the model are first estimated over the full sample period. The two-sided estimation uses the full data set both for determining the parameters of the model, as well as for estimating the unobserved variables.

Until the end of the 1970s, the estimated medium-run equilibrium real interest rate fluctuates around 5 percent. Thereafter, it slowly declines towards a level of 2 percent in 1996. Following a brief period with an increase, it decreases further throughout the 2000s. With the recession of 2008/09, the equilibrium rate estimate suddenly drops to 0.5 percent. In the second quarter of 2013 and the first quarter of 2014, the rate is very close to but below zero percent. Then it increases again and reaches 0.6 percent by the second quarter of 2018. The estimated signal to noise ratios, ω_g and ω_z, are 0.0197 and 0.0382.

Fig. 4 plots the other unobservable variables in the estimated model. The output gap fluctuates strongly. The lowest value is reached in the early 1980s. Due to the recession of 2008/09, the output gap declines to −1.4 percent. The output gap estimated under the baseline specification returns to positive territory by the fourth quarter of 2010. By the second quarter of 2018 it reaches 2.1 percent.

[1] To replicate the estimation of Laubach and Williams (2003) we use their original GAUSS code.

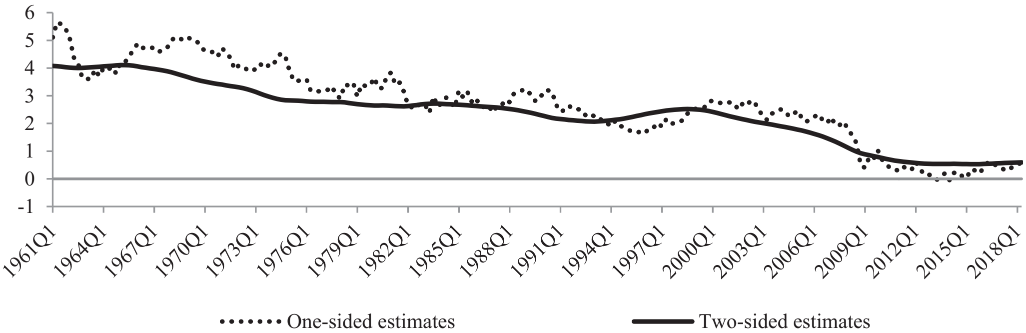

Fig. 3. Estimates of the medium-term equilibrium real interest rate in the United States.

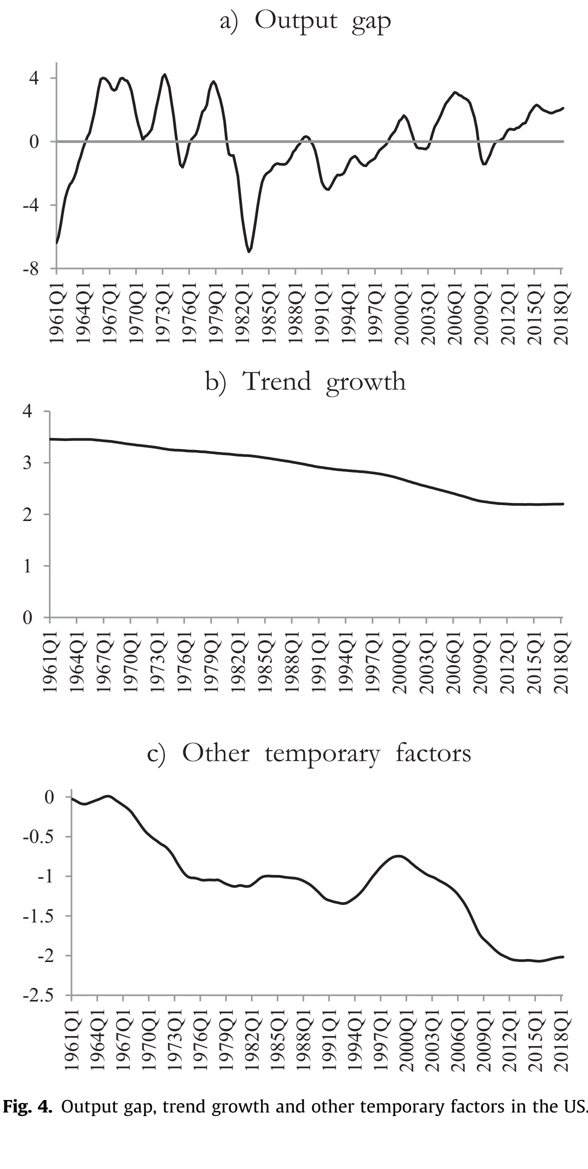

Fig. 4. Output gap, trend growth and other temporary factors in the US.

Trend growth declines from around 3.5 percent at the beginning of the 1960s to around 2.3 percent in 2009 and has remained at this level since then. Thus, changes in trend growth contribute to the decline in the equilibrium rate estimates. Yet, the ‘headwinds’ variable, which is meant to capture all other temporary components, has a larger impact. It takes on negative values over the full sample period. From the mid-1970s to about 2005, it reduces the equilibrium rate estimates by about 1 percentage point. But then, it declines to −2 percent. Yellen (2015) associates this decline with "tighter underwriting standards and restricted access to some forms of credit; the need for households to reduce their debt burdens; contractionary fiscal policy at all levels of government after the initial effects of the fiscal stimulus package had passed; and elevated uncertainty about the economic outlook that made firms hesitant to invest and hire, and households reluctant to buy houses, cars, and other discretionary goods." Indeed, after 2007 the government debt to GDP ratio as well as economic policy uncertainty as measured by Baker et al. (2016) increased substantially. This correlates with the reduction in the estimated 'headwinds', z_t.

5.2. High uncertainty and sensitivity of United States estimates

Laubach and Williams (2003) note that their estimates are characterized by a substantial degree of uncertainty. Yet, this uncertainty is not mentioned in the influential policy contributions of Summers (2014a, 2014b, 2014c) and Yellen (2015, 2017). In our estimation, the average standard error amounts to over 2 percentage points. Fig. 5 shows 68 percent and 95 percent confidence bands. These bands are very wide, yet still do not reflect the full extent of uncertainty. Specifically, these standard errors neglect the uncertainty of the estimated signal-to-noise ratios and the greater uncertainty associated with more recent estimates. For example, the standard error of the estimate for the first period is 1.5 percentage points, while the standard error of the estimate for the most recent period is 4.5 percentage points.

Clark and Kozicki (2005) already documented that different models lead to very different equilibrium rate estimates and that real-time estimates are strongly influenced by data revisions. For this reason, we conduct a detailed sensitivity study. This investigation shows that estimates with the Laubach-Williams methodology change substantially when technical assumptions of the econometric procedure are modified and when other data series are used. Some of these variations were also reported in LW03.

Since the possibility of zero or even negative equilibrium rates gained substantial prominence in the policy debate in 2014 and 2015,[2] we start by comparing estimates from three years ago, that is end of 2015, with current estimates. Accordingly, Fig. 6 **(upper panel)** shows one-sided as well as two-sided equilibrium-rate estimates based on the 2015 data vintage that ends 2015Q2 and estimates based on the 2018 data vintage that ends 2018Q2. Furthermore, Fig. 6 **(lower panel)** compares the following variants of two-side estimates: (i) estimates based on gross national income (GNI) instead of GDP; (ii) estimates based on the above-mentioned alternative specification GW09; (iii) estimates using the shadow rate; and (iv) estimates using the shadow rate but with a linear trend instead of a segmented linear trend as the starting value for the estimation.

5.2.1. Data updates and revisions

The estimates of the equilibrium real rate are very sensitive to data revisions and updates. While the one-sided estimate for 2014/15 based on 2015 data was negative between −0.4 and 0 percent, it has moved up in positive territory on the basis of 2018 data. Apparently, LW-equilibrium rate estimates increased along with data revisions and policy tightening. The average equilibrium rate from the two-sided estimation between 2008 and 2011 is 0.8 percent when estimated in 2018, but it was only 0.4 percent when estimated in 2015 on the basis of the 2015 data vintage. Both data revisions and additional data can affect model parameters and consequently result in very different estimates of the equilibrium real rate. Importantly, the estimated signal-to-noise ratio for the headwinds, ω_z, is very different for the two estimations. It is higher when estimated in 2015 (0.0428 instead of 0.0382) and results in a larger negative contribution of the headwinds compared to the estimation in 2018.

5.2.2. GNI instead of GDP

Williams (2014) replaced GDP with GNI. GNI includes all income of United States residents and businesses, regardless of where it is produced. It excludes income earned by non-residents. For large economies such as the United States, differences between GDP and GNI are relatively minor. Still, using GNI instead of GDP in the estimation has a substantial impact on the results. With GNI the signal-to-noise ratios change and attribute a stronger impact on the equilibrium real interest rate to the headwinds variable. As a result, the equilibrium rate estimate exhibits a somewhat greater decline after the recession of 2008/09. It falls to about 0.3 percent by the second quarter of 2018. Yet, the difference between using GDP and GNI is much smaller than was suggested in Williams (2014). The equilibrium real rate estimate for 2015 based on the 2015 data vintage with GNI, however, replicates the larger decline found in Williams (2014). With the 2015 data vintage, even the two-sided estimates come out as low as −1 percent. Thus, the difference between the two-sided estimates for the first quarter of 2015 from the estimation with the 2015 data vintage versus the 2018 data vintage is larger than one percentage point.

[2] This was due in particular to the contributions by Summers (2014a,b,c), Yellen (2015) and Williams (2014). Other, possibly influential commentary included Krugman (2014).

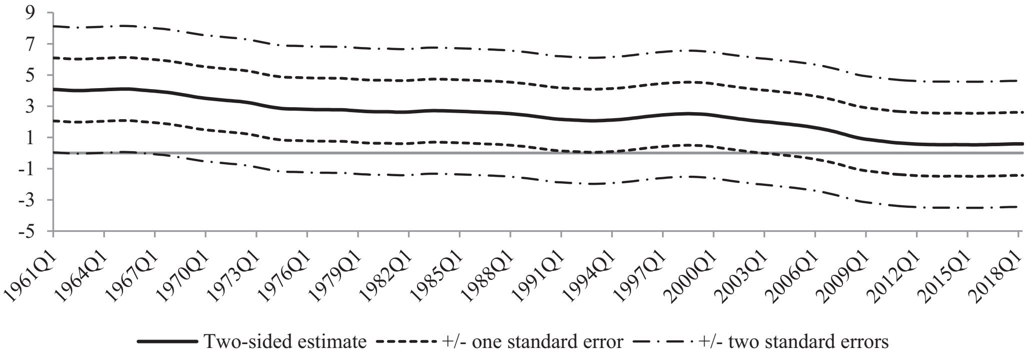

Fig. 5. Standard errors of the two-sided estimates for the United States.

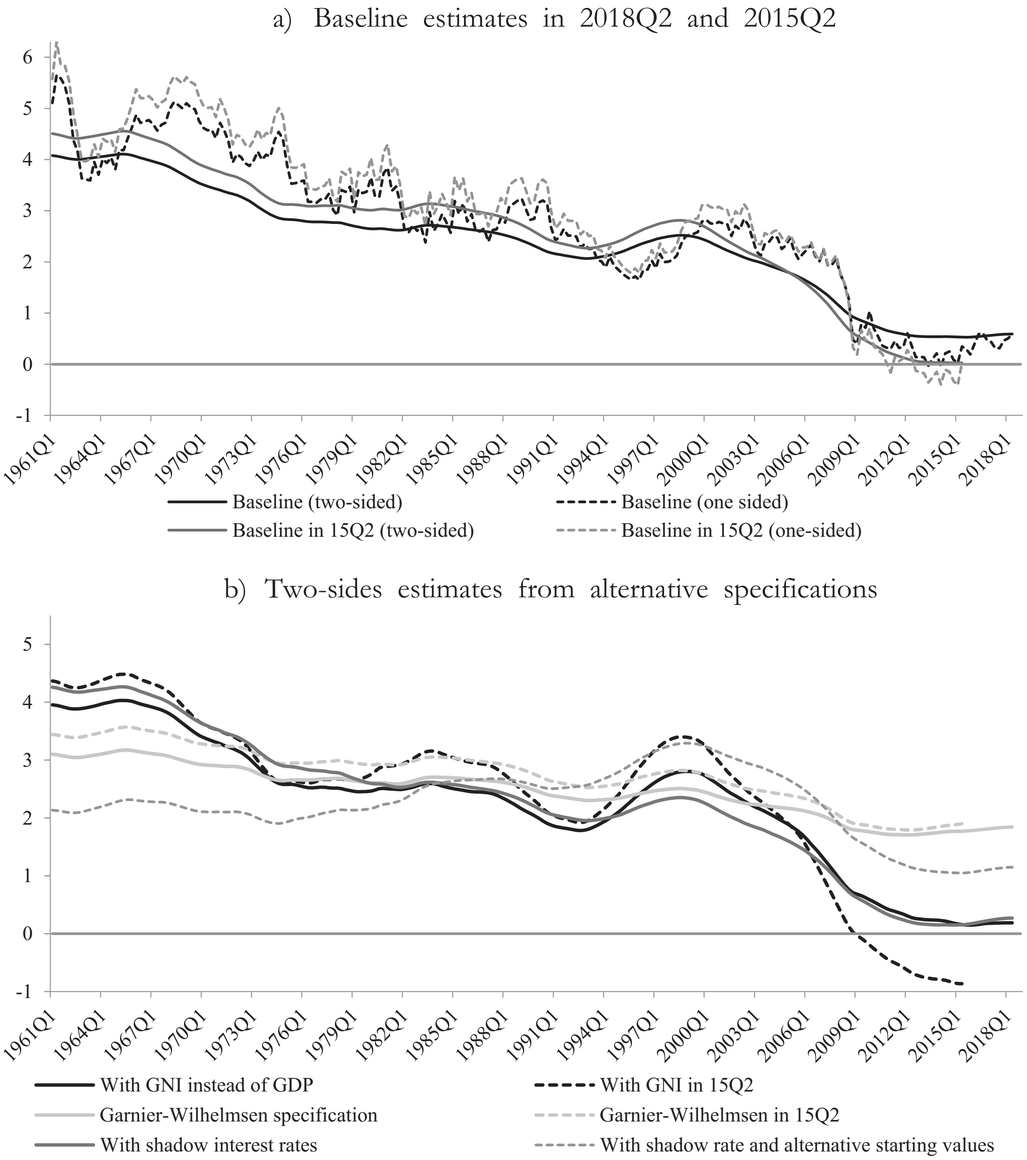

Fig. 6. Sensitivity Analysis: United States equilibrium rate estimates.

5.2.3. Alternative specification as in Garnier and Wilhelmsen (2009)

To estimate the specification of GW09, we use the same signal-to-noise ratios as in the baseline specification. The resulting estimates change much less over time. The estimated equilibrium real interest rate in the second quarter of 2018 is 1.8 percent and thus considerably higher than the 0.6 percent estimate of the baseline specification.

5.2.4. Shadow rate

The sample period comprises several years of near-zero nominal interest rates. To some extent, the effective lower bound on nominal interest rates may have been binding during this period. Furthermore, quantitative easing contributed to monetary policy accommodation beyond what was visible in short-term nominal market rates. To account for this in the estimation, we use the shadow rate of Wu and Xia (2016) as interest rate measure. Using the shadow rate lowers the estimated equilibrium rate. However, the difference is not larger than when switching from GDP to GNI. For the last quarter of 2018, the estimate based on the shadow rate is with 0.3 percent half as high as the baseline estimate.

However, using the shadow rate does not render the estimation more stable. Starting values are seemingly innocuous specification parameters, yet are found to matter for the results. Laubach and Williams (2003) use a segmented linear trend to define starting values for potential output. As an alternative, we consider a simple linear trend. The resulting equilibrium real rate estimates deviate substantially. At the beginning of the estimation period, the rate is lower and the declining trend during the 1960s and 1990s vanishes. At the end of the period, the estimate using the shadow rate and the alternative starting values for potential trend is with 1.1 percent nearly twice as high as the estimate from the baseline specification.

5.3. United States output gap: LW-methodology versus Congressional Budget Office estimates

A natural question to ask is how the output gap estimates obtained together with the equilibrium rate estimates compare to the probably most-widely known estimate for the United States, that is, the Congressional Budget Office (CBO) estimate. As shown in Fig. 7, the estimates obtained with different specifications of the LW methodology move almost in lockstep with the CBO's estimate between 1961 and 2002. As a result of this long period of fairly similar behavior, there is overall a high degree of correlation. The correlation of the different output gaps with the output gap measured by the CBO gap varies between 0.62 for the GW09 specification and 0.72 for the GNI specification (the correlation is 0.69 for the baseline specification and 0.68 using the shadow rate).

Yet, from 2003 onwards a large gap opens up between the CBO estimate and the LW estimates. The CBO output gap is a bit below −2 percent in 2003, while the estimates with the LW-methodology are near zero. The difference increases further following the recession of 2008/09, when the CBO output gap reaches a trough below −6 percent. The LW estimates are mostly close to −2 percent at that time, except for the GNI-based estimate for which it is close to −4 percent. It takes until 2018 for the CBO output gap to close. By contrast, the different LW-estimates imply that the gap is already closed by 2012. In 2018, all estimates of different specifications of the LW-methodology are near 2 percent.

Clearly, the decline in equilibrium real interest rate estimates since 2009 that is indicated by the LW-methodology is not consistent with the CBO estimate of the output gap. Rather, output gap estimates that are consistent with the estimated decline in the equilibrium real interest rate indicate a smaller output gap in the recession. Furthermore, this gap closes by 2012 and by 2018 GDP is about 2 percent above the equilibrium level that would be consistent with the equilibrium real rate estimate according to the LW methodology.

5.4. Using the equilibrium rate estimates in the Taylor rule

As noted previously, former FOMC Chair Janet Yellen has referred to estimates of the equilibrium real interest rate with the Laubach-Williams methodology (Yellen, 2015, 2017) in order to argue that the Fed's policy stance does not deviate much from the prescriptions of the Taylor rule. Specifically, she used an LW03 estimate of the medium-run equilibrium rate of 0 percent to replace the long-run estimate of 2 percent in the original Taylor rule. As a result, interest rate prescriptions shifted down by about 2 percentage points.

As a measure of inflation Janet Yellen used the personal consumption expenditures (PCE) prices excluding food and energy prices, as we do in our analysis. With regard to the output gap, she multiplied the deviation of the current unemployment rate from the long-run natural unemployment rate with an Okun's law factor of two in order to obtain an estimate of the long-run output gap. This long-run unemployment-based output gap is fairly similar to the CBO output gap but even lower during the recession of 2008/09. In 2009, it drops below −10 percent, whereas the CBO output gap is around −6.5 percent.[3] It is hence inconsistent with the medium-run equilibrium rate estimate of the Laubach-Williams methodology. Instead, it would be consistent to use the LW estimates of the equilibrium rate and the output gap together in the Taylor rule. Fig. 8 compares the Yellen-Taylor Rule from Yellen (2015) with the consistent version.

The Yellen-Taylor rule declines to about −4 percent in the course of the recession of 2008/09. Yet, a consistent version of the rule – that uses both the equilibrium real interest rate and the output gap estimate from the LW method – implies substantially higher interest rate prescriptions. These prescriptions only decline towards −0.6 percent in 2010 and return

[3] In the second quarter of 2018, however, it is one percentage point more positive than the CBO estimate (1.3 percent vs. 0.3 percent).

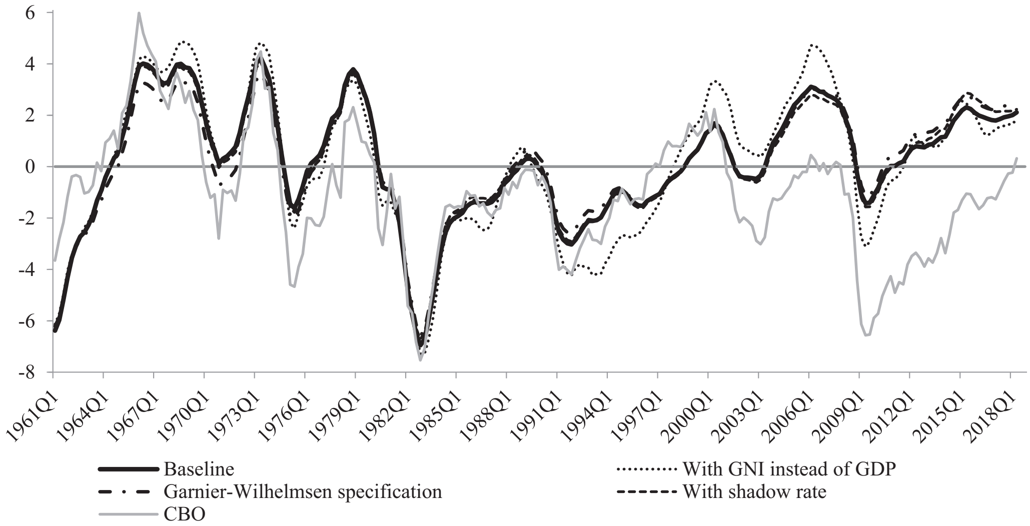

Fig. 7. Output gaps from different specifications and CBO.

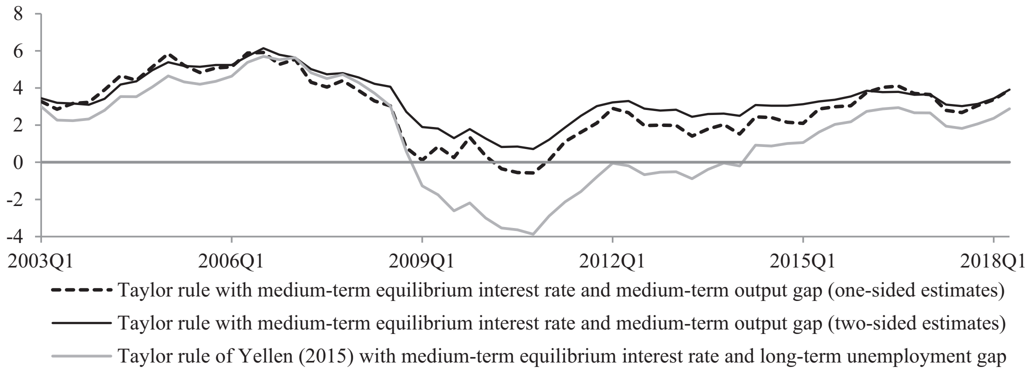

Fig. 8. Taylor rule with LW equilibrium rate estimates.

to positive territory after only three quarters. If the smoothed estimates are used, the rate prescriptions are even a bit higher. Hence, the consistent version of the Taylor rule with the LW estimates of the equilibrium rate does not provide an argument for a prolonged period of very low interest rates and quantitative easing. They have called for a tightening of the Federal Reserve's policy stance well before this tightening started and they suggest to continue with this tightening process.

The reason why the LW estimate of the output does not decline as much as the CBO estimate or Yellen's unemployment-based estimate in the course of the recession of 2008/09 is as follows. A reduction in the estimate of the potential growth rate implies a lower equilibrium rate estimate but also a lower level of potential output. Alternatively, if the CBO or Yellen estimates of the output gap are considered more sensible, that would be a reason to call into doubt the usefulness of the LW estimate of the real-equilibrium interest rate.

6. Empirical results for Germany, the euro area, and Japan

When applying the LW method to data for Germany, the euro area, and Japan, we encountered difficulties in achieving convergence of the estimation. Estimates turned out to be unstable and very sensitive to starting values. Estimates for the euro area were not economically sensible. By contrast, using the simplified estimation procedure from Garnier and Wilhelmsen (2009), we obtain more stable and more plausible results, though they remain very sensitive to the estimation period.

We estimate the equilibrium real interest rate for Germany, the euro area, and Japan from 1965 onwards. While time series start later than for the United States, the simplified specification allows estimating the rate from the first data point onwards because it does not require a separate estimation of inflation expectations. The signal-to-noise ratios are taken from Garnier and Wilhelmsen (2009), i.e. $\omega_g = 0.081$ and $\omega_z = 0.064$, and assumed to be the same for Germany, the euro area, and

Japan. Fig. 9 reports the estimation results. The one-sided estimates are reported in panel (a) and the two-sided estimates in panel (b).

From 1965 to 1975, one-sided estimates of the real equilibrium interest rate in Germany fluctuate between 1.7 percent and 3.5 percent, two-sided estimates between 2.5 percent and 3.2 percent. Subsequently, there is a long phase during which the estimates decrease slowly from over 3 percent at the beginning of the 1970s to below 2 percent in the late 1990s. Following German re-unification, the estimates increase again to nearly 3 percent. From the second half of the 1990s onwards, however, they decrease steadily. In 2004, the one-sided estimate declines briefly below 1 percent. Prior to the financial crisis it rises again, but with the recession the one-sided estimate drops from 1.4 percent in the first quarter of 2008 to 0.2 percent in the first quarter of 2009. Importantly, both types of estimates remain positive and recover subsequently. The latest estimate for the second quarter of 2018 is 0.9 percent.

For the euro area, the estimated equilibrium real interest rate fluctuates initially around 4.5 percent. Then it declines fairly steadily to below 2 percent. In the first half of the 1980s it lies below the rate estimated for Germany. In the early 1990s, estimates rise to over 3 percent. Prior to the global financial crisis they are around 2 percent. The drop in 2008 is much more pronounced than with German data. The one-sided estimate falls from 2.4 percent in the first quarter of 2008 to slightly below zero in the second quarter of 2009. The two-sided estimate does not drop below zero. The estimate rebounds until 2011 before declining again during the European sovereign debt crisis. From 2013 onwards, however, the estimated equilibrium rate increases quickly reaching a value of 1.6 percent in the second quarter of 2018, which is a good bit higher than with German data.

Equilibrium real interest rate estimates for Japan are quite a bit lower than for Germany and the euro area. Between 1965 and 1975 they hover around 1.5 percent. Estimates then decline to around 0.6 percent in the mid-1980s. After a mild upturn

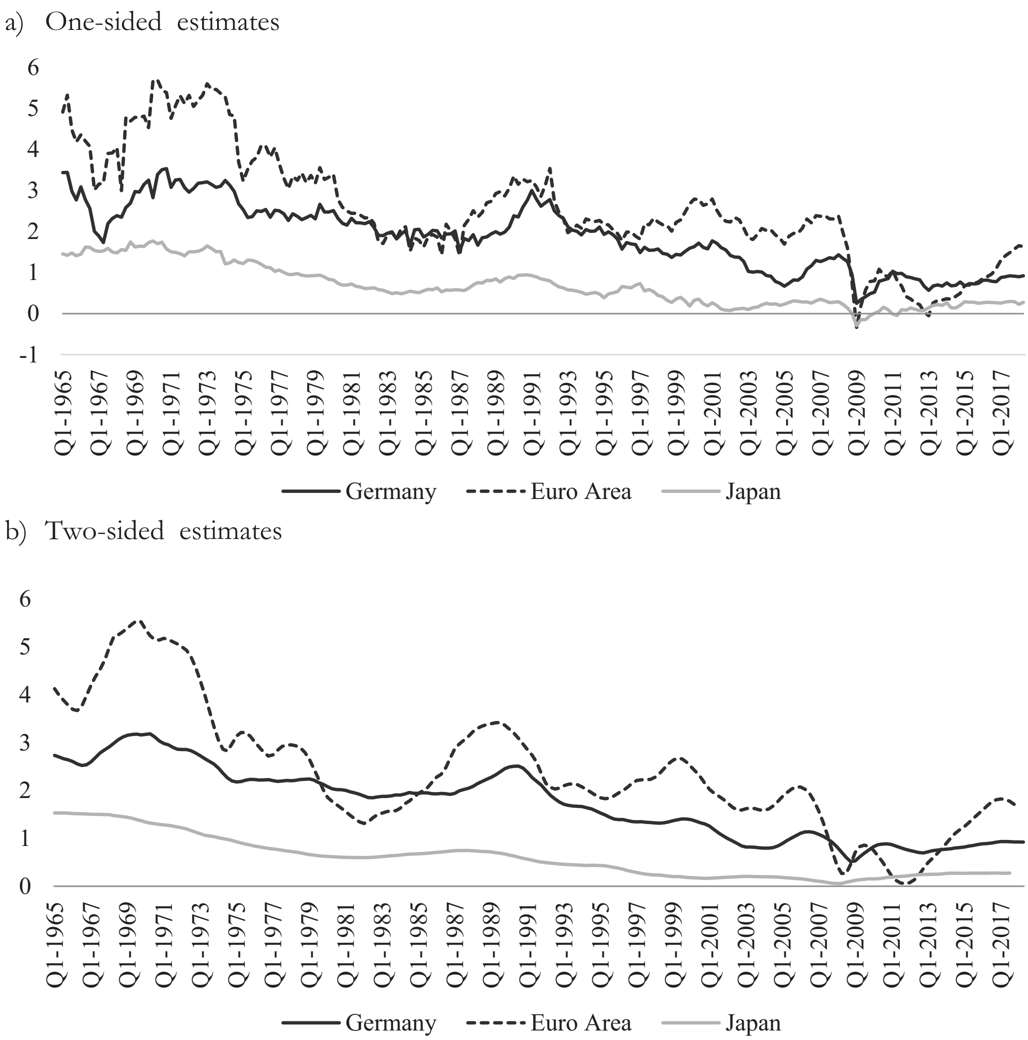

Fig. 9. Estimates of the medium-run equilibrium rate in Germany, the Euro Area and Japan (Garnier-Wilhelmsen specification).

in the late 1980s, they decrease again. The financial crisis has only a small effect on the equilibrium rate estimates in Japan. With 0.3 percent, the estimated rate for the second quarter of 2018 is lower than that of Germany or the euro area.

All these estimates and comparisons over time and across economies need to be interpreted very cautiously. The degree of uncertainty is very high just as in the case of the United States estimates. With 3.5 percentage points the average standard error in Germany is even a bit larger than for the United States estimates. In addition, filtering uncertainty is crucial and makes more recent estimates very unreliable. In the most recent period, the standard error is 6.7 percentage points. With 2.7 percentage points the average standard error in Japan is similar. In the euro area, it is only 1.2 percentage points but the standard error for the last observation is also twice as high. In addition, the estimates for Germany, the euro area, and Japan are not robust to changing the estimation period or the starting values. As for the United States, a wide range of estimates can be produced.

7. Conclusions

Equilibrium real interest rate estimates obtained with the Laubach-Williams (2003) method and related approaches have had substantial influence on the monetary policy debate. Yet, our empirical investigation and sensitivity analyses have delivered the following findings:

First, the estimates reported by Laubach and Williams (2003) and Williams (2014, 2015) for the United States can be replicated and updated without major difficulties when using the original specification and code of Laubach and Williams. Given the nature of the simple model that is used to identify the equilibrium rate, it is best considered a medium-run concept. The estimates obtained with the baseline specification tend to decrease during the last decades and decline to zero percent in the course of the financial crisis.

Second, the estimates with United States data are associated with a very high degree of uncertainty. Moreover, our sensitivity analyses show that relatively small and technical changes of the econometric specifications or the data series result in economically relevant changes in the estimates. Thus, these estimates are extremely imprecise and may well be biased. The reason for this sensitivity to small changes in the econometric specification is most likely due to the attempt to estimate several unobservable variables at the same time. These are the medium-term equilibrium real interest rate, the level of potential output, the growth rate of potential output, and another unobservable variable that is capturing other factors that affect the equilibrium rate in the medium-term. The unobservable variables mostly depend on temporary and permanent shocks. It is therefore necessary to make assumptions to what degree forecast errors are due to temporary or permanent factors. If the parameters on which this decomposition depends, i.e. the signal-to-noise ratios, change even a little, equilibrium rate estimates often change a lot. Besides, the methodology requires very long data series to lead to at least somewhat stable results. To be fair, Laubach and Williams (2003) took note of the high degree of uncertainty and sensitivity of their estimates. We find that in spite of an additional 15 years of data, these features of the equilibrium rate estimates remain unchanged.

Third, applying the baseline specification of Laubach and Williams to data for Germany, the euro area, and Japan yields even more discouraging results. For the most part, the length of available data samples is too short to obtain sensible and reliable estimates. We obtain more plausible results based on a modification of the econometric specification proposed by Garnier and Wilhelmsen (2009). It simplifies and restricts the modelling of unobserved factors other than the potential growth rate that influence the equilibrium rate. These factors represent what Yellen (2015) refers to as 'headwinds'. In the course of the financial crisis and recession, our estimates for Germany and the euro area drop as well. Yet, they remain mostly positive. For the second quarter the estimates are 0.9 percent and 1.6 percent, respectively. Importantly, however, these estimates are also very imprecise and very sensitive to small changes in the econometric specification.

Fourth, our findings were first circulated in a German language working paper (Beyer and Wieland, 2015) and an English language summary in GCEE (2015). Since then, Holston et al. (2017) have also provided estimates for the euro area along with estimates for the United Kingdom and Canada. Their specification differs in several ways from the baseline specification in Laubach and Williams (2003). The effect of trend growth on the equilibrium real rate is not estimated anymore. Instead it is restricted to unity. It would be considerably higher otherwise. Second, there are constraints on the estimated coefficients. Third, the estimation of inflation expectations is different. Nevertheless, the estimates remain very imprecise and highly sensitive.

With regard to the debate on monetary policy in a low rate environment and secular stagnation, we draw the following conclusions:

First, the decline in medium-run equilibrium rate estimates is much too uncertain and too sensitive to fairly arbitrary technical assumptions, to be used as the key argument for determining the appropriate monetary policy stance as in Yellen (2015, 2017). Indeed, others have speculated that, by keeping interest so low for so long, the Fed may have actually have caused low long-term interest rates rather than responding to them (Gavin, 2018). From the perspective of our empirical findings, it is sensible that the tightening narrative of the Chairman Powell relies less on estimates of the equilibrium real interest rates and unobservable 'headwinds'. Similarly, estimates with the LW methodology do not provide reliable evidence for a secular stagnation as suggested in Summers (2014a, 2014b, 2014c). These highly influential contributions to the debate on monetary and fiscal policy fail to highlight appropriately the imprecise nature of these estimates. Furthermore, there are a number of possibilities for omitted variable bias as noted by Taylor and Wieland (2016) and Cukierman (2016). These include structural factors reducing trend growth and potential, monetary policy deviations leading to low interest rates and the impact of financial stability concerns on policy and the economy.

Second, the Taylor (1993) rule uses a long-run equilibrium rate in order to determine the appropriate level of monetary policy rates. Estimates of such a long-run equilibrium rate have not declined as much as the medium run concept from Laubach and Williams (see Taylor and Wieland, 2016). Even so, if one wishes to use the LW03 estimate of the medium-run equilibrium rate in Taylor-style monetary policy rules, it is important to employ it together with the consistent medium-run output gap. When this is done, the Taylor-rule interest rate prescription is higher than with a long-run output gap as in Yellen (2015, 2017). The reason is that the medium-run equilibrium rate of near zero percent implies that output is near potential.

Third, the high degree of uncertainty about the equilibrium rate suggests that it is worthwhile considering policy rules, which do not require information on the equilibrium rate. This is true, for example, for simple first-difference interest rate rules as considered by Orphanides and Wieland (2013). Such rules appear to perform well in model simulations with noisy estimates of the equilibrium real interest rate according to Orphanides and Williams (2009). With regard to level rules, such as for example the Taylor (1993) rule, it is best to use an estimate of long-run equilibrium rate because these estimates are more precise and have not declined as much as the medium-run rate estimates.

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