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1 Introduction

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- 1. ...
- 2. M ...
- 3. b ...

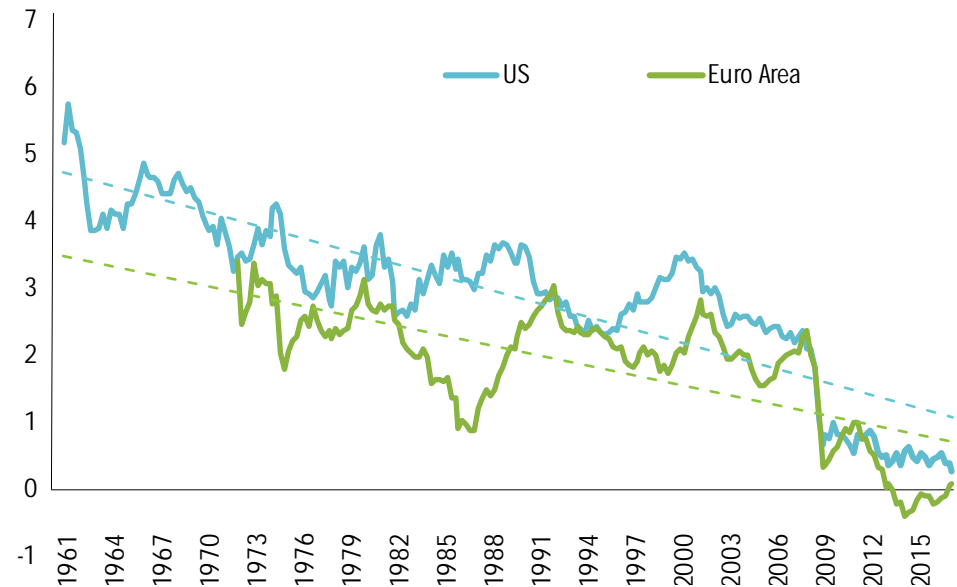
2 Challenges for monetary policy in the euro area

2.1 A potential decline of neutral interest rates

N ... 1980 (C ... 2016). A b ...

Figure 1 shows the estimates of the neutral interest rate for the US and the euro area, in percent, from 1961 to 2015. The US neutral rate (blue line) starts at approximately 5.5% in 1961 and generally declines to about 0.5% by 2015. The Euro Area neutral rate (green line) starts at approximately 3.5% in 1961 and declines to about -0.5% by 2015. Both rates show significant volatility, particularly in the late 1970s and early 1980s, and a sharp decline starting around 2008. Dashed lines represent the long-run trends for each region.

Figure 1: Estimates of the neutral interest rate for the US and the euro area, in percent



Source: By the author based on Hurn et al (2016).

A major challenge in estimating the neutral interest rate is the lack of direct data. The US Federal Reserve provides estimates of the real federal funds rate, which is often used as a proxy for the neutral rate. The ECB provides estimates of the real repo rate, which is used as a proxy for the neutral rate in the euro area. The data for the US is from 1950 to 2015, and for the euro area is from 1950 to 2015. The US data is from the FRED database, and the euro area data is from the ECB database. The data is presented in Table 1.

The neutral interest rate is a key determinant of economic growth and inflation. A higher neutral rate leads to lower inflation and lower economic growth, while a lower neutral rate leads to higher inflation and higher economic growth. The neutral rate is also a key determinant of the real exchange rate. A higher neutral rate leads to a higher real exchange rate, while a lower neutral rate leads to a lower real exchange rate. The neutral rate is also a key determinant of the real interest rate. A higher neutral rate leads to a higher real interest rate, while a lower neutral rate leads to a lower real interest rate.

Table 1: Average movements in policy rates during recessions in Germany, UK, US

Country	Time period	Average policy rate (% peak)	Average policy rate (% trough)	Average policy rate change (%)
Germany	1960-2018	5.0	2.4	-2.6
United Kingdom	1955-2018	8.7	5.8	-2.9
United States	1953-2018	8.5	3.8	-4.7

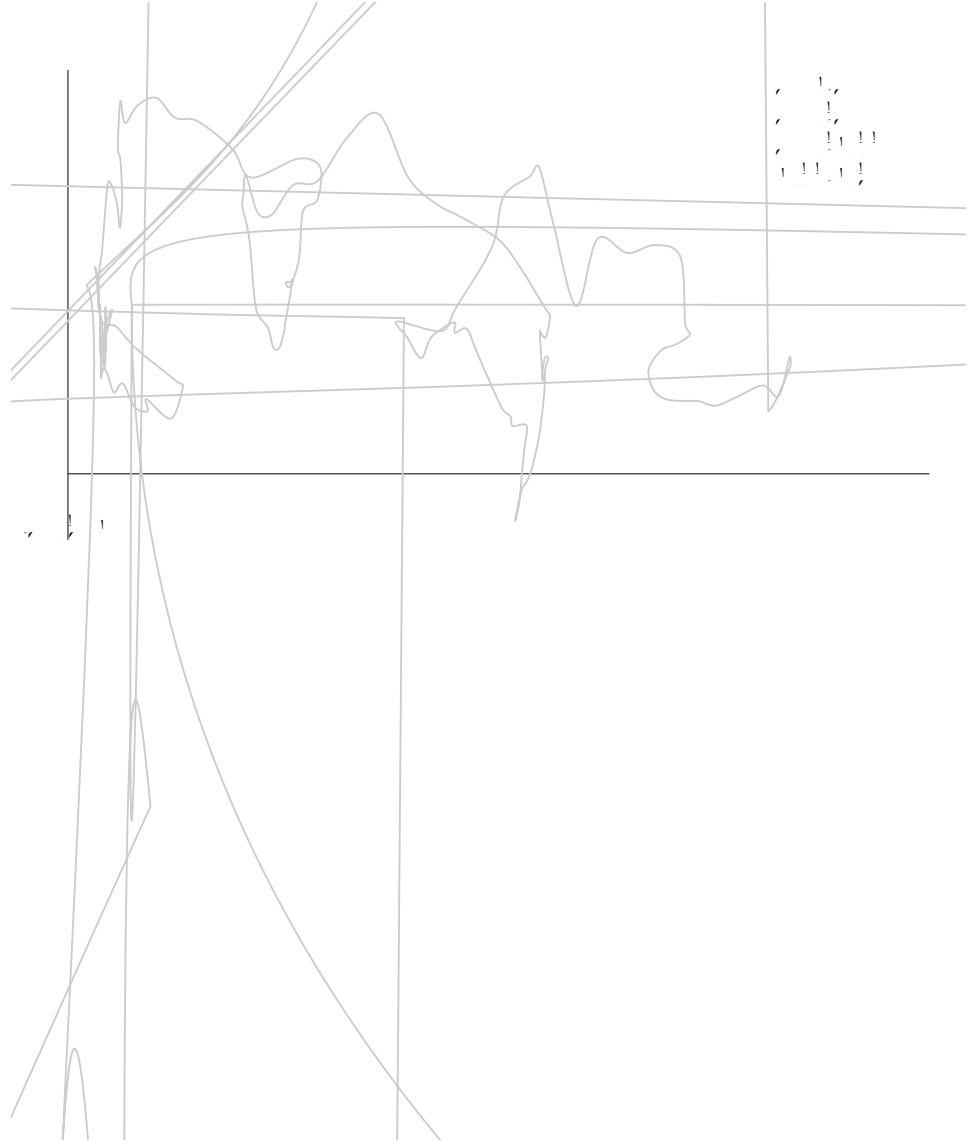
Source: Bry and Moore (2014), Deutsche Bundesbank, Bank of England, FRED, NBER, Bureau of Economic Analysis, OECD Compendio, Fitch IBCA, and Fitch Ratings.

2.2 A potential flattening of the Phillips Curve

The Phillips Curve (PC) is a key relationship in macroeconomics, linking inflation to output. It is typically written as $\pi_t = \pi_t^e + \alpha(y_t - y_t^*)$, where π_t is inflation, π_t^e is expected inflation, α is a parameter, and $y_t - y_t^*$ is the output gap. The Phillips Curve is often derived from the New Keynesian model, which assumes that firms have imperfectly elastic prices. In this model, the Phillips Curve is derived from the first-order conditions of firms, and it is shown that the Phillips Curve is downward sloping. The Phillips Curve is a key relationship in macroeconomics, linking inflation to output. It is typically written as $\pi_t = \pi_t^e + \alpha(y_t - y_t^*)$, where π_t is inflation, π_t^e is expected inflation, α is a parameter, and $y_t - y_t^*$ is the output gap. The Phillips Curve is often derived from the New Keynesian model, which assumes that firms have imperfectly elastic prices. In this model, the Phillips Curve is derived from the first-order conditions of firms, and it is shown that the Phillips Curve is downward sloping. The Phillips Curve is a key relationship in macroeconomics, linking inflation to output. It is typically written as $\pi_t = \pi_t^e + \alpha(y_t - y_t^*)$, where π_t is inflation, π_t^e is expected inflation, α is a parameter, and $y_t - y_t^*$ is the output gap. The Phillips Curve is often derived from the New Keynesian model, which assumes that firms have imperfectly elastic prices. In this model, the Phillips Curve is derived from the first-order conditions of firms, and it is shown that the Phillips Curve is downward sloping.

b, the average rate of quarterly inflation over the period 1970:1-2018:4 is 4.5%. This is consistent with the long-run equilibrium rate of inflation being 4.5%.

Figure 2: Phillips Curves (x-axis quarterly unemployment in percent, y-axis year-on-year quarterly inflation in percent)



Source: Based on OECD.

2.3 The interaction between price stability and financial stability

The interaction between price stability and financial stability is a complex issue. In a world of perfect capital markets, a central bank can achieve its target rate of inflation without affecting the real economy. However, in a world of imperfect capital markets, a central bank's actions can have significant real effects. For example, a central bank's attempt to reduce inflation by increasing the real interest rate can lead to a recession and financial instability.

Financial stability is a key concern for central banks. A central bank's actions to maintain price stability can have significant effects on financial stability. For example, a central bank's attempt to reduce inflation by increasing the real interest rate can lead to a recession and financial instability.

b) $\{a^n b^m \mid n \geq 1, m \geq 1\}$ is not a regular language. We can prove this using the Pumping Lemma. Assume it is regular. Then there exists a pumping length p . Consider the string $s = a^p b^p$. According to the Pumping Lemma, s can be written as xy^kz for some $k \geq 1$, where $|x| \leq p$, $|y| \geq 1$, and $|z| \geq 1$. Since $|x| \leq p$, x contains only a 's. Similarly, since $|z| \geq 1$ and $|x| \leq p$, z contains only b 's. Therefore, y must contain both a 's and b 's. Let $y = a^i b^j$ where $i \geq 1$ and $j \geq 1$. Now, pump y once, resulting in $s' = xy^2z = a^{p+i} b^{p+j}$. This string is not in the language because the number of a 's is not equal to the number of b 's. This contradicts the Pumping Lemma. Hence, the language is not regular.

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$b = a - ab \Rightarrow U_a = a - ab$, $U_b = a - ab$
 H $\frac{U_a}{U_b} = 1$ $\Rightarrow a - ab = a - ab$
 $a = a - ab$
 $ab = 0$

4 What is the possible evolution of the ECB's monetary framework?

4.1 Adjusting the definition of price stability to increase flexibility

T $\frac{U_a}{U_b} = \frac{a - ab}{a - ab}$ ECB' $a = a - ab$ $U_a = a - ab$ $U_b = a - ab$
 T $\frac{U_a}{U_b} = 1$ $\Rightarrow a - ab = a - ab$ $\Rightarrow ab = 0$

T $\frac{U_a}{U_b} = \frac{a - ab}{a - ab}$ $U_a = a - ab$ $U_b = a - ab$ $\Rightarrow ab = 0$

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b $a - ab$ $U_a = a - ab$ $U_b = a - ab$ $\Rightarrow ab = 0$

$\frac{1}{2} \frac{d}{dt} \ln \left(\frac{a}{b} \right) = \frac{1}{2} \left(\frac{1}{a} \frac{da}{dt} - \frac{1}{b} \frac{db}{dt} \right)$

4.2 What should the ECB do if price stability and financial stability diverge?

The ECB has been faced with a dilemma since the 2008 financial crisis. A key objective is price stability, as defined in the Maastricht Treaty (1992), which states that the ECB shall maintain price stability. However, the ECB also has a responsibility to ensure the stability of the financial system. This has led to a tension between the two objectives, particularly in the context of the Eurozone.

The ECB's primary mandate is price stability, which is defined as a long-term average inflation rate of 2%. However, the ECB has also been concerned with financial stability, particularly in the context of the Eurozone. The ECB has been faced with a dilemma since the 2008 financial crisis, where price stability and financial stability have diverged. The ECB has been forced to choose between maintaining price stability and ensuring financial stability.

The ECB's response to this dilemma has been to focus on price stability, while also providing support to the financial system. This has been done through various measures, such as the Outright Monetary Transactions (OMT) program, which allows the ECB to purchase government bonds of Eurozone countries to ensure the smooth functioning of the banking system.

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$a^2 + ab + b^2$ 是 $(a+b)^2$ 的因式。设 $(a+b)^2 - (a^2 + ab + b^2) = k$ ，
 $a^2 + 2ab + b^2 - (a^2 + ab + b^2) = k$ ，
 $ab = k$ 。因为 a, b 是正整数，所以 k 也是正整数。又 $k = ab$ ，
 $(a+b)^2 - (a^2 + ab + b^2) = ab$ ，
 $a^2 + 2ab + b^2 - a^2 - ab - b^2 = ab$ ，
 $ab = ab$ 。所以 $(a+b)^2 - (a^2 + ab + b^2) = ab$ 。
 因为 $(a+b)^2 - (a^2 + ab + b^2) = ab$ ，
 $(a+b)^2 = a^2 + ab + b^2 + ab$ ，
 $(a+b)^2 = a^2 + 2ab + b^2$ 。所以 $(a+b)^2 = a^2 + 2ab + b^2$ 。
 所以 $(a+b)^2 - (a^2 + ab + b^2) = ab$ 。

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