BANCO DE ESPAÑA
Eurosistema

ANALYTICAL ARTICLES
2017

The natural interest rate: concept, determinants and implications for monetary policy

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2 March 2017

This article defines the natural interest rate, analysing the concept and its role in monetary policy conduct.

Estimates of the natural interest rate place it at historically low and even negative levels. Demographics and growth, but also the recent financial crisis with weak aggregate demand, deleveraging, etc., are identified as factors related to this decline.

Lastly, the article highlights the difficulties that a natural rate of this type may pose to central banks in achieving their objectives, and it discusses potential monetary policy-related solutions, such as QE and changes in the monetary policy objective.

THE NATURAL INTEREST RATE: CONCEPT, DETERMINANTS AND IMPLICATIONS FOR MONETARY POLICY

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Introduction

The concept of the "natural interest rate" has taken on considerable significance in recent analyses and discussions on macroeconomic policy and, in particular, in the monetary policy realm, for which this notion of interest rate is a highly relevant reference. Broadly, the natural interest rate corresponds to the *real* interest rate (the nominal rate less expected inflation) that would prevail under circumstances considered as desirable from the standpoint of macroeconomic stabilisation (GDP, inflation, etc.).

Recent evidence appears to suggest that the natural rate in the main advanced economies is at historically low and even negative levels. A natural rate standing at negative levels poses notable challenges for monetary policy, linked to the difficulty central banks face in placing nominal interest rates (their main monetary policy instrument) below a specific level or effective lower bound.

This article analyses the concept of the natural interest rate and the role it plays in monetary policy conduct. It further discusses the empirical evidence on past and recent changes in the rate. Finally, it analyses the difficulties that a very low or indeed negative rate may pose to central banks' ability to attain its macroeconomic objectives, discussing possible alternatives.

The natural interest rate: definition and significance

Various definitions of the natural interest rate exist alongside one another in the economic literature, although they are all closely interrelated. One commonly used definition is that of Woodford (2003), according to which the natural interest rate is the real interest rate that would be observed in an economy in which all prices and wages were perfectly *flexible*, i.e. continuously adjusting to reflect at all times the supply and demand conditions in their respective markets. This definition is that most used in the framework of the new-Keynesian model of economic cycles and monetary policy, on which some of the modelling instruments used by central banks are based.[1] Similarly, Holston et al. (2016) define the natural rate as that which ensures that GDP is at its natural level (i.e. under flexible prices) and that inflation holds constant.[2] Finally, under the definition popularised by Summers (2014), the natural interest rate is that consistent with a situation of *full employment*.[3]

Why is the natural interest rate important? As is clear from the various foregoing notions, the natural rate represents the real interest rate for a situation considered desirable, whether this be due to price stability, full employment or a lack of rigidities preventing prices and wages from adjusting efficiently. As a result, an habitual conclusion in analyses of optimal monetary policy design is that the central bank must set the nominal interest rate (its main monetary policy instrument) so that the real interest rate draws closer to its

1 New-Keynesian models are dynamic general equilibrium models that incorporate monopolistic competition in goods and labour markets, along with nominal rigidities in prices and wages.

2 This definition is linked to that of Woodford (2003): in the basic new-Keynesian model, the real interest rate that would prevail under flexible prices (Woodford's definition) is precisely that which holds GDP at its natural level and inflation constant. See the analysis of the basic new-Keynesian model in the Box in this article.

3 Generally, *natural GDP* and *full employment* describe different situations: there may be unemployment (e.g. as a result of monopolistic margins in wages) even though prices and wages are flexible, i.e. even though GDP is at its natural level (see, for instance, Galí, 2011). But generally full employment requires flexibility of prices and wages, hence the similarity of both concepts.

natural level, as far as possible, since in this way GDP, unemployment, inflation and other variables successfully follow a welfare-maximising path.[4] Hence a real interest rate above the natural rate is usually interpreted as an indicator of a "contractionary" monetary policy stance, while the opposite situation denotes an "expansionary" monetary stance. Box 1 illustrates the importance of the natural interest rate for monetary policy conduct within the framework of the basic new-Keynesian model.

Measurement

What is the current level of the natural interest rate? Answering this question poses various difficulties derived mainly from the fact that the natural interest rate is not directly observable. As explained above, it represents the real interest rate which *would be observed* if there were full employment or if prices and wages were perfectly flexible. For this reason, economists have used various methods to extract from the data an estimate of the natural interest rate and of changes therein.

A recent method of proxying the natural interest rate is based on the estimation of dynamic stochastic general equilibrium (DSGE) models, particularly their new-Keynesian variant. Under this method, relationships between the variables based on economic theory are imposed in order to build an "ideal" economy of full employment or of flexible prices and wages. An example is the work of Del Negro et al. (2015), who estimate a DSGE model for the United States using data on interest rates, prices and various financial and activity indicators.[5]

An alternative methodology seeks to estimate the natural interest rate in the context of *semi-structural* models, i.e. econometric models whose equations are inspired on the structural equations of new-Keynesian models but which adopt a more flexible form. Compared with the aforementioned approach, this methodology imposes fewer economic restrictions constraints on data and, as a consequence, is more robust to possible errors in model specification. The seminal work in this line is that of Laubach and Williams (2003), who estimate a model of this type for the United States using GDP and inflation data and a measure of the nominal short-term interest rate. The model consists of two main equations: an aggregate demand equation according to which the gap between the observed real interest rate and the natural interest rate affects economic activity; and a Phillips curve which relates inflation to the gap between observed output and its natural level (output gap).[6]

Despite the differences between them, these two methods coincide in signalling that natural interest rates in the United States and other developed economies are at historically low, and in some cases even negative, levels. Chart 1 shows the results of Holston et al. (2016), which suggest that the natural interest rate fell gradually from the 1960s in the main advanced economic areas. Along the same lines, Fries et al. (2016) recently estimated natural interest rates for the four main euro area economies and found that they have gradually fallen to near-zero values since the onset of the 2008 crisis.

It should however be noted that measures of the natural interest rate are rather imprecise, as indicated by Laubach and Williams (2003). This uncertainty in estimating the natural interest rate also affects, to a considerable extent, the projections of its future path, as pointed out, for example, by Yellen (2015).

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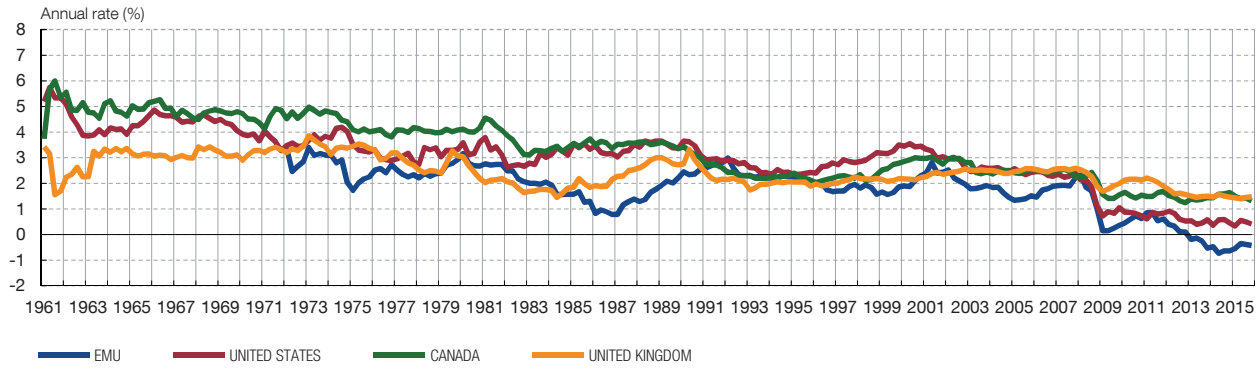
4 See, for example, Woodford (2003) and Galí (2015).

5 A similar model has been estimated by Barsky, Justiniano and Melosi (2014).

6 Other examples include Mésonnier and Renne (2007), who estimate a similar model for the euro area, and Holston, Laubach and Williams (2016), who estimate natural interest rates for the United States, the United Kingdom, the euro area and Canada.

NATURAL INTEREST RATE CHART 1



SOURCE: Holston, Laubach and Williams (2016).

Determinants and possible future developments

The abnormally low natural interest rate suggests an oversupply of savings relative to demand for investment. This net excess supply could be indicative of either an increase in the propensity to save or a decrease in agents' willingness to invest, or a combination of the two. Additionally, changes in the relative supply of low-risk assets, caused by the factors discussed below, may also have played an important role in the drop in the natural interest rate.[7]

Factors potentially behind an increase in the propensity to save include those relating to the demographic shifts experienced in many advanced economies — including the euro area — such as increased life expectancy and the falling birth rate. Thus, gradual population ageing induces people to accumulate savings during their working lives so as to be able to pay for their retirement. This may have led to an increase in demand for savings among older workers.[8] A second factor is related to recent trends in income and wealth distribution in certain countries; as a result of a decrease in the resources of lower-income individuals — who typically have a higher propensity to consume — relative to wealthier and higher-income population segments, this factor may have led to an increase in aggregate savings (see, for example, Summers, 2014). Finally, the existence of a global savings "glut" (Bernanke, 2005; Caballero et al., 2008), defined as an increase in the volume of savings in emerging economies unmatched by investment opportunities or high-quality assets, may have increased the global propensity to save.

There are also several possible reasons for the drop in the propensity to invest. First, the pessimistic outlook for *productivity growth* may have discouraged new investments. In line with this hypothesis, Gordon (2012, 2014) suggests that the potential output growth rate in the United States and other advanced economies has decreased as a result of a permanent decline in the innovation rate. This explanation follows the traditional logic of the basic new-Keynesian model, according to which the only source of variation in the natural interest rate is the productivity growth rate (see Box 1).[9] Another possible

7 Bean, Broda, Ito, and Kroszner (2015) and Rachel and Smith (2015) review the causes and consequences of persistently low real interest rates.

8 For a theoretical analysis of this issue, see Eggertsson and Mehrotra (2014). For a structural analysis of how demographic changes may have affected real interest rates in the United States, see Gagnon, Johannsen and López-Salido (2016).

9 Holston, Laubach, and Williams (2016) provide evidence to support this thesis showing that the synchronised drop in the natural interest rate in the United States and other advanced economies seems to be due to an across-the-board slowdown in productivity growth.

explanation is the relative decline in prices of capital goods observed in many advanced economies, which has led to a downward trend in total spending on productive capital despite greater demand for these goods (Karabarbounis and Neiman, 2012). This could have also prompted a decline in the demand for funds to finance this investment.

Importantly, some factors associated with the Great Recession may have strengthened these medium-term trends. For example, heightened uncertainty associated with the crisis has led to households increasing their savings and to companies accumulating liquid assets. Under this hypothesis, while this uncertainty persists, companies will remain reluctant to make new investments to expand their capacity given their concern that there will be insufficient demand for their products. Additionally, the sharp deleveraging under way in many developed economies has contributed forcefully to generating excess savings and causing a persistent drop in the natural rate. Eggertsson and Mehrotra (2014) use a new-Keynesian model with overlapping generations to formalise the idea of how a shock causing temporary deleveraging can lead to a permanently low — or even negative — natural interest rate.[10] Jimeno (2015) uses a variant of this model to show how the interplay between the effects of the Great Recession and longer-term trends — population ageing and slower productivity growth — can amplify the downward pressure on the natural interest rate, particularly in economies with high levels of public debt such as those of Europe.

Other hypotheses link the low natural interest rate to an increased preference for safe assets and a simultaneous reduction in their supply. These forces caused downward pressure on the yield on these assets — by increasing their price — and the opposite effect on the yield on high-risk assets. First, demand for safe assets has increased as a result of several factors, such as greater uncertainty or stronger demand from institutional investors and, in particular, from central banks, either for the accumulation of reserves as a buffer against currency crises, particularly in the case of emerging economies, or as part of asset purchase programmes implemented more recently by various advanced-economy central banks, such as the ECB, US Federal Reserve, or the central banks of Japan and the United Kingdom. Moreover, in recent years there has been a contraction in the supply of safe assets, mainly due to the effects of the 2008 financial crisis and the European sovereign debt crisis that followed in its wake. These crises heightened the perception of the risk associated with certain types of financial assets, such as synthetic assets or some countries' government debt. Caballero and Farhi (2014) show how episodes of scarcity of safe assets can cause the natural interest rate to drop significantly.

Overall, the literature suggests various hypotheses to explain how the desired level of savings has increased relative to desired investment and the resulting estimated drop in natural rates. Nevertheless, there is no consensus as to whether this is a permanent or temporary phenomenon, with effects that will eventually — albeit slowly — dissipate. Advocates of the view that it is permanent argue that the drop in the natural rate is a symptom of a "secular stagnation", in which demand is systematically depressed (Summers, 2014). For their part, advocates of the view that it is temporary claim that it is merely a consequence of the *debt supercycle* and that, once the deleveraging process is over, the natural rate should bounce back (Rogoff, 2015). This question is still being

10 In Eggertsson and Mehrotra's model, households borrow when they are young and save when they are old. If a deleveraging shock makes lenders borrow less in the present, these households will have more savings in the future, as they will have less debt to repay. This mechanism causes the present natural interest rate to drop as a result of the increased future supply of funds.

debated. The answer, which will require more theoretical and empirical research, will have significant consequences, including implications for monetary policy, as will be discussed below.

Implications for monetary policy

As noted in the second section, monetary policy may manage to stabilise inflation if the real interest rate reproduces, insofar as is possible, the behaviour of the natural interest rate. As seen in the third and fourth sections, the available estimates suggest that the natural interest rate currently stands at historically low, possibly negative, levels, and an analysis of its determinants suggests that this situation may persist for some time. To achieve sufficiently low real interest rates, a combination of sufficiently high inflation expectations and low nominal interest rates is required. This combination may be difficult for the monetary authority to achieve in certain situations.

The main problem associated with negative natural interest rates is that nominal interest rates are subject to a minimum value, in certain cases negative but not far from zero, known as the effective lower bound (ELB). Below this level, economic agents prefer to keep their savings in the form of banknotes rather than deposit them in banks and have to pay interest. For this reason, the level of the ELB is related to the effective cost of storing cash in the form of banknotes (security, handling and other costs) and is not known precisely.[11] Although various central banks have reduced some of their key policy rates (e.g. the bank reserve rate) below zero in recent years, very few have reduced them below -50 basis points. This suggests that key policy rates in most developed economies are very near their effective lower bound.

This constraint on the conduct of monetary policy may reduce its effectiveness. For example, if a recession causes the natural interest rate to fall significantly and the downward revision of nominal interest rates hits its lower bound, the real interest rate will remain above the natural interest rate, and the monetary policy stance will thus be contractionary despite the low nominal interest rates. This will raise unemployment and deflationary pressure, which will in turn lead to a fall in agents' inflation expectations.[12] Any fall in expected inflation in turn generates an increase in the real interest rate which further heightens the contractionary nature of monetary policy, thereby aggravating the recessionary and deflationary trends. Theoretical studies suggest that, once the nominal interest rate falls to its ELB, the economy may become 'trapped' in this vicious circle of deflation and near-zero or negative nominal interest rates.[13] The macroeconomic setting of the euro area in recent years, characterised by very low or even negative nominal interest rates and persistently below-target inflation, features certain similarities to the scenario described (see Banco de España, 2015).[14]

The literature suggests various solutions for this "liquidity trap". The first is to increase agents' inflation expectations. One way of doing this is for the central bank to publish indications of the future course of monetary policy (forward guidance) in which it commits

11 See Martínez and Millaruelo (2016).

12 This fall in inflation expectations may be magnified if medium- and long-term inflation expectations are *unanchored* with respect to the monetary authority's inflation target.

13 See Benhabib, Schmitt-Grohé and Uribe (2001), Eggertsson and Mehrotra (2014)

14 An additional problem of negative nominal interest rates is their impact on financial stability. Negative nominal rates act as a tax on commercial bank reserves deposited at the central bank. This effect is even greater in financial systems where, as in Spain, many bank assets (such as mortgage loans) are remunerated at variable interest rates, which amplifies the impact of negative rates. If banks cannot reduce below zero the rate at which they remunerate customers' deposits, a policy of bank reserves remunerated at negative rates exerts downward pressure on banks' profits and thus, *ceteris paribus*, on their solvency.

to applying a relatively lax monetary policy stance for a given period of time. A credible announcement of this nature normally induces expectations of higher inflation in the future, which in turn will produce a fall in real interest rates during the recession, making it easier to exit from it.[15] Obviously, the effect of this measure depends crucially on whether agents question the central bank's willingness to tolerate inflation in the future or its ability to generate it.

A second alternative is quantitative easing (QE). The interest rate controlled by the central bank is a nominal short-term rate. However, agents' economic decisions usually depend on longer term rates. The idea behind QE programmes is that the central bank should purchase assets, such as public or private debt, in order to reduce long-term interest rates when short-term rates are already close to the ELB.[16] Investors replace the assets acquired by the monetary authority (such as medium/long-term government bonds) with others that have a similar duration and level of risk (such as new loans to households and firms), which leads to a fall in the return on such assets ("portfolio rebalancing effect").[17] Also, by purchasing long-term assets the central bank signals its commitment to keeping interest rates low for a prolonged period, since otherwise it would incur losses on its asset portfolio ("signalling effect").[18] This second channel can be thought of as an enhanced version of "forward guidance", which was discussed above.

Apart from these measures, which have been implemented by a large number of central banks in recent years, including the ECB, there are two alternative approaches that have received a certain amount of attention from analysts and experts. These are increasing the inflation target and switching from inflation targeting to price level targeting. Neither of these two approaches, the basic features of which are set out below, has been put into practice by any central bank, but their discussion has generated an interesting theoretical debate.

Most central banks in developed economies operate with an explicit or implicit mandate to keep inflation at around a given numerical target. For example the Eurosystem has an inflation target of "below, but close to, 2%". This target typically "anchors" agents' long-term inflation expectations. The problem is that, if inflation expectations are at 2% and the natural interest rate is close to zero, the average nominal interest rate will be 2%, so that the scope for interest rate reductions in the event of a recession will be exactly two percentage points. However, if the inflation target is raised to 4% and agents are confident this target will be achieved, the scope for downward movement in the nominal interest rate would increase to 4 pp.[19] That said, an increase in the inflation target and, therefore, in the average level of inflation, involves costs that are well documented in the literature, including the distortion of relative prices and the erosion of the real value of cash.

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15 See Eggertsson and Woodford (2003). Arce, Hurtado and Thomas (2016) study the impact of announcements of this type in an asymmetrical monetary union where some countries with high levels of private debt are threatened by recession.

16 See Banco de España (2016).

17 This channel typically requires the existence of some type of financial friction to ensure that the prices of assets depend on supply and demand rather than solely on the discounted flow of future receipts. See for example Gertler and Karadi (2011) or Chen, Cúrdia and Ferrero (2012).

18 A rise in short-term interest rates would lead to a fall in the market price of long-term assets, which would generate losses on the central bank's balance sheet at market prices. Although a central bank is not a profit-making institution and can even operate when the market value of its assets is below that of its liabilities (negative capital), this is not a desirable situation.

19 See Blanchard , Dell'Ariccia and Mauro (2010).

The second measure is to replace the inflation target by a target for the price level. Under price-level targeting (PLT) the central bank adjusts interest rates with the aim of achieving a pre-announced path for prices: for example, trend growth of 2% per annum. The difference with respect to the current operational framework, based on inflation targets, is that, if inflation in a given year is below 2% and therefore the price level falls below its target path, the central bank would have to tolerate inflation at above 2% in the future in order to ensure that the price level returns to its target path. Thus, PLT amounts to a type of "forward guidance" on the future path of inflation, which requires a high degree of commitment by the central bank.

Conclusions

The evidence available suggests that the natural interest rate has declined over the past few decades, whereby recently it has dropped to historically low – or even negative — rates in some of the main advanced economies. This decline seems to have been due to a combination of supply- and demand-side factors, which have been amplified by the effects of the Great Recession. A context of low natural interest rates poses significant challenges for monetary policy, given that it is difficult for central banks to reduce nominal interest rates below a certain threshold, thus making it necessary to introduce unconventional monetary policy measures.

Importantly, although monetary policy can mitigate the effects of low natural interest rates, it cannot, in principle, alter this rate directly. A combination of structural measures to boost productivity growth and of fiscal measures to stimulate global aggregate demand and support long-term economic growth is necessary to reverse the drop in the natural rate.

2.3.2017.

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To illustrate the role of the natural real interest rate in monetary policy conduct, it can be helpful to use the basic new-Keynesian model, a dynamic general equilibrium model characterised, among other things, by the existence of price stickiness. After linearisation, the model can be summed up in the following equations:

$$\pi_t = \kappa (\gamma_t - \gamma_t^n) + \beta E_t \pi_{t+1},$$

$$\gamma_t - \gamma_t^n = E_t (\gamma_{t+1} - \gamma_{t+1}^n) - \sigma \left(\underbrace{i_t - E_t \pi_{t+1}}_{r_t} - r_t^n \right),$$

where γ_t is GDP (in logarithms), i_t is the nominal interest rate, π_t is the inflation rate and E_t represents expectations of a given variable. An important concept in this model is what is termed the natural equilibrium. This is defined as the equilibrium observed if prices are perfectly flexible and is denoted in the equations by the superscript 'n'. In particular, r_t^n represents the natural real interest rate. Thus, on the basis of the first equation, known as the new-Keynesian Phillips curve, current inflation is determined by the gap between current GDP and its natural level (the output gap) and future inflation expectations. According to the second equation, known as the IS curve, the output gap depends in turn on its expected future value and on the gap between the current (r_t) and natural real interest rates. Lastly, in the basic model the natural rate is determined by

$$r_t^n = \rho + \sigma^{-1} E_t g_{t+1},$$

where ρ is agents' discount rate and g_t is the rate of productivity growth. Thus, the only source of cyclical change in the natural rate would be variations in productivity growth.

Optimal monetary policy. As Woodford (2003) and Galí (2015) explain, in this model, desirable monetary policy from the standpoint of social welfare is one that completely stabilises both the GDP gap and inflation: $\gamma_t - \gamma_t^n = \pi_t = 0$. As the equations above show, the central bank can achieve this objective provided it manages to keep the real interest rate equal to its natural level at all times, or, in other words, when the nominal interest rate (which is the one it controls directly) is equal to the real natural rate plus expected inflation: $i_t = r_t^n + E_t \pi_{t+1}$.

T*he lower bound on the interest rate.* If the natural interest rate is sufficiently low, and given inflation expectations, the nominal interest rate that would be needed to stabilise GDP and inflation may fall below the effective lower bound, i.e. the level below which the nominal rate cannot drop. For simplicity, we assume that this lower bound is zero. When the nominal rate reaches zero, the real rate is $r_t = - E_t \pi_{t+1}$. Thus, if inflation expectations are not sufficiently high, the real interest rate may prove to be too high relative to its natural level ($r_t > r_t^n$). This in turn causes GDP to drop below its natural level ($\gamma_t < \gamma_t^n$), resulting in deflation ($\pi_t < 0$). Thus, the interaction between an extremely low natural interest rate and the lower bound on the nominal rate may pose an obstacle to monetary policy conduct.