Axel A Weber: The role of interest rates in theory and practice – how useful is the concept of the natural real rate of interest for monetary policy?

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1 Introduction

It is obvious that interest rates play a key role in monetary policy today. On the one hand, the instrument of most central banks is a short-term interest rate. On the other, interest rates contain important information on the current state of the economy, and the extent to which past monetary policy measures have already started to take effect. Put it differently, interest rates are important as both an input into and an output of monetary policy decisions – they are *instrument variables* as well as *indicator variables*.

Of course, there is no such thing as ‘the’ interest rate. Rather, there is a wide variety of them. Neglecting other relevant features, we have to distinguish interest rates at least with respect to their time to maturity and with respect to whether they are expressed in nominal or in real terms. Interest rates that matter for consumption and investment decisions are likely to be of longer maturity. Moreover, since economic agents ultimately benefit from the consumption of real goods, it will be real rates rather than nominal rates that they are mainly interested in.

Monetary policy directly controls nominal and very short-term rates. However, since – according to the expectation theory of the term structure – longer-term rates depend on expected future short-term rates, a central bank does have the ability to affect them by influencing private agents’ expectations. A similar argument holds for real rates. Given the level of nominal rates, real interest rates depend on expected future inflation rates. To a large extent, these depend on the degree to which the public believes monetary policy will be able to ensure price stability. Besides expected short-term interest rates and expected inflation, longer-term real rates also depend on several types of risk premia, for example inflation risk. These constitute an additional channel through which monetary policy may influence long-term real rates. Thus, monetary policy exerts both a direct effect on short-term *nominal* rates and an indirect but important effect on long-term *real* rates.

Understanding how current economic variables – such as economic activity and policy variables – interact with expected future variables is a challenge that has been featuring prominently in both academic discussion and monetary policy practice in recent years. Accordingly, the book by Michael Woodford “Interest and Prices”, which is cited frequently nowadays, characterizes the practice of central banking mainly as the management of expectations. This is an aspect of which G.L.S. Shackle was already well aware, as we shall see later.

Having said that monetary policy does have an influence on a variety of interest rates it is not clear *a priori* whether certain levels of these rates are ‘adequate’ in the sense that they represent prudent monetary policy. This brings me to my second point, the information content of interest rates. Inferring the current monetary policy stance from prevailing interest rates requires some sort of benchmark. Ideally, this would be a reference level – depending on current economic conditions – with which some particular interest rate could be compared, the difference between the two then measuring how loose or tight monetary policy is. For such a benchmark to be useful for the monetary policy decision-making process, it should satisfy certain criteria, including the following three.

- First, that benchmark rate should be based on sound *<u>theoretical foundations</u>*. This would allow a meaningful interpretation of its behaviour and the driving forces behind it.
- Second, the difference between some particular interest rate and this benchmark rate should ideally be a *<u>summary variable reflecting the overall pressure on inflation</u>*. If this is not possible, it should, at least, contain some predictive power for future inflation.
- Third, the benchmark should be *<u>readily computable from observable economic data</u>*. Ideally, this criterion includes the requirement that these data should be available with sufficient precision at the time they are needed.

Actually, there is an economic variable which is often claimed to provide such a benchmark role: the natural real rate of interest on which I will focus in this talk. I will start with Wicksell's notion of the natural rate, followed by a presentation of its definition and role in today's monetary macroeconomics. After that, I will focus on approaches to measuring the natural real rate of interest (NRI) and its usefulness for the practice of monetary policy. At the end of my remarks, I will try to judge whether the natural rate is able to satisfy all or some of the criteria I have listed.

2 Wicksell's concept of the natural rate of interest

The concept of a natural rate of interest goes back to Wicksell. He defined it as the level of the real interest rate at which prices have no tendency to move either upward or downward. The starting point of his analysis is the assumption that any movement in the price of a single good must have been caused by a mismatch between the demand for and the supply of this particular good. Accordingly, the movement of the aggregate price level must have been caused by a mismatch between aggregate demand and aggregate supply. Wicksell therefore stressed that any theory which intends to explain the overall rate of inflation must therefore be able to explain the underlying aggregate demand and supply movements.

A second important aspect of Wicksell's theory is related to the role of money and credit. He did not doubt that money growth is a necessary condition for inflation, but his approach is based on the endogeneity of money – in other words, money is not exogenous. Here, the banking system plays the crucial role: By extending credit to firms and households it determines the growth rate of money and thereby aggregate demand.

Key to the understanding of this connection is Wicksell's 'cumulative process'. Banks setting 'too low' an interest rate trigger a high credit demand from investors because, given the relatively low interest rate costs, they have a high expected return. Owing to the prevailing very large degree of flexibility in the banking sector, banks can satisfy this higher loan demand, which results in an increase in money growth and a higher demand for investment goods. This tends to increase the price level of investment goods and the competitive wages in the investment goods sector, causing expenditures and the overall price level to rise. This is how Shackle describes the next steps in Wicksell's cumulative process: *"The cost of production per physical unit of goods will be rising month by month, but the price of goods per unit will be rising as fast, will be keeping ahead, and the persisting gap per unit will invite an ever-larger output"*.[1] The cumulative process of strong money creation by a highly flexible banking system and a higher aggregate price level does not end until the banks have raised the interest rate sufficiently. Here, 'sufficiently' means that the interest rate – which is set by the banks – should be raised to the level at which the overall demand for goods equals their supply – that is, the interest rate at which prices remain constant. Wicksell referred to this interest rate level as the 'natural rate of interest'.

Shackle was certainly right when in the foreword to the English translation by Stephen Frowen of Wicksell's "Value, Capital and Rent" in 1953 he compared the contribution to economic theory made by Wicksell's concept of a natural rate of interest to that made by the steam locomotive in the built-up of modern societies.[2] But, with the benefit of hindsight, we now know that Shackle was a little too pessimistic when he predicted that the natural rate could become as obsolete as the steam locomotive. Modern monetary theory – as embodied in the latest generation of New-Keynesian macroeconomic models, for example – proves that the opposite is true. It is not by accident that Michael Woodford's textbook – which became sort of a standard work in modern monetary theory – carries the title "Interest and Prices" - the English translation of the title of Wicksell's book *'Geldzins und Güterpreise'*.

3 The natural rate of interest in modern macroeconomic theory

In order to highlight the key role of the natural interest rate concept in modern monetary theory, it is useful to recapitulate briefly the core structure of New-Keynesian models which form the workhorse of

[1] Shackle, (1972),p. 336.

[2] Shackle (1954).

today's monetary policy analysis.[3] Basically, such models add various forms of nominal rigidities to the features of the real-business-cycle paradigm which is based on the notion of dynamically optimising agents in a world characterised by stochastic shocks. One of the key elements is the assumption of rational expectations: Agents fully take into account the specifics of the model world they inhabit and the consequences of today's actions for the future. In particular, they bear in mind how the monetary authority is likely to react to macroeconomic developments, and this, in turn, influences their own actions in the here and now.

Models in this micro-based paradigm render it possible to analyse the outcomes of policy changes without running into the Lucas critique. Moreover, such models can highlight and quantify the ability of monetary policy to influence private sector expectations which are key to a proper understanding of the effects of monetary policy. Based on this view, as I mentioned before the practice of modern central banking has frequently been described as being, to a large extent, the management of private expectations. This is an aspect of monetary policy which was already stressed by Shackle in his 1949 article on "The nature of interest rates." Describing a situation in which the central bank tries to bring interest rates down he states that [p. 115] "*a consensus of market opinion can be swung, by words and deeds of the monetary authority or its masters"*.

The structure of the basic New-Keynesian model can be easily represented by three equations characterising the dynamics of the interest rate, output and inflation. The first equation can be related to the supply side, the second to aggregate demand, and the third specifies monetary policy behaviour. The equation representing aggregate supply captures the price-setting behaviour of firms, resulting from profit-maximisation under the obstacle of some sort of nominal price rigidity. Owing to this rigidity, firms have to take into account the expected development of prices in the next period when setting their prices today. In its most basic form, this equation is known as the "New-Keynesian Phillips curve" which expresses current inflation π_t as a function of currently expected inflation for the next period $E_t(\pi_{t+1})$ and the current output gap x_t:[4]

$$\pi_t = \beta \cdot E_t(\pi_{t+1}) + \kappa \cdot x_t. \qquad (1)$$

The latter stands for the amount of slack in the goods market and is defined as the difference between actual output and its natural level, that is, the production level which would prevail in the hypothetical situation of fully flexible prices.

The demand equation ('IS curve') is based on the assumption that households optimise their whole consumption stream over the present and the future. This leads to an expression relating the current output gap to the currently expected output gap of the next period $E_t(x_{t+1})$ and an interest rate gap:

$$x_t = E_t(x_{t+1}) - \sigma^{-1} \cdot (i_t - E_t(\pi_{t+1}) - r_t^*) \qquad (2)$$

The natural real rate of interest comes in at this stage: the interest rate gap is the difference between the actual ex ante real interest rate $i_t - E_t(\pi_{t+1})$ and the natural real rate of interest r_t^*. This variable turns out to be a key variable for the design of monetary policy in this class of models. Within the New-Keynesian paradigm it is defined as the one-period equilibrium real rate of return that would prevail in the hypothetical equilibrium with completely flexible prices, that is, in the absence of nominal price rigidities. As is evident from the demand equation the situation where current and expected output is at its flexible-price level is accompanied by the actual real interest rate being equal to its natural counterpart and thus by a closed interest rate gap.

The natural rate of interest is influenced solely by real factors such as productivity growth, movements in government expenditure, the growth of the workforce, the tax structure, and the time preference of households. As a consequence, the natural rate is not constant over time but mirrors the dynamics of all those driving forces. Accordingly, it is subject to short- and long-run fluctuations.[5] As for the absolute level of the natural real rate, one cannot state that a high or low level does *per se* represent a state of the economy which is desirable or not. It simply reflects its driving forces which themselves

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3 See Clarida, Gali Gertler (1999), Gali (2003) and Woodford (2003).

4 The parameter β denotes the subjective discount rate of private households, κ incorporates the degree of nominal price rigidity and σ (in equation (2)) governs households' intertemporal elasticity of substitution.

5 An example of the dependency of the natural rate on structural changes has been pointed out by Charles Bean recently, see Bean (2004). He stresses that global demographic change would lead to a lower natural rate not only in the new steady state but also along the transition path.

could, in principle, be gauged as being favourable or not. For instance, an increase in the natural rate may be induced by a rise in productivity growth but may also be rooted in the need to finance larger social security deficits.[6]

For monetary policy purposes, the indicator quality of the natural rate for inflation is of special interest. To this end, what matters is the level of the actual real interest rate *compared* with the natural rate of interest. Again, this is illustrated most clearly within the baseline New-Keynesian model. An actual real interest rate below the natural level – that is, a negative interest rate gap – implies a positive value of the output gap which tends to increase inflation. If, for instance, an expected permanent future increase in productivity induces agents to expect higher income in the future, they will try to smooth consumption by already raising their consumption level in the present. In a flexible price equilibrium, the natural real interest rate would rise, increasing current desired savings in order to equate the current consumption level and current natural output again. However, if the actual real interest rate does not rise sufficiently, there will be a negative interest rate gap, which increases the current output gap – that is, stimulates the economy too much – which in turn leads to inflationary pressure.[7]

Interestingly, in these models the current inflation rate can be expressed solely as a sum of current and expected future interest rate gaps. In this sense, the sequence of interest gaps is a sufficient statistic for the determinants of inflation. This is close to the story told by Wicksell. Indeed, it may be interpreted as a forward-looking variant of the Wicksellian analysis outlined above.[8] However, at this point the New-Keynesian paradigm also differs from Wicksell's theory in one crucial aspect: while Wicksell viewed inflation as being a disequilibrium phenomenon, inflation in the New-Keynesian model is an equilibrium phenomenon. In the latter case, all markets clear each period and all variables are consistent with the optimality conditions of forward-looking households and firms.

4 Monetary policy and the natural rate of interest in theory

Since there is no trade-off between output and inflation stabilisation in the theoretical model presented so far, the prescription for stability-oriented monetary policy is straightforward: measure the currently prevailing natural real rate of interest, and equate the one-period interest rate – which is the monetary policy instrument – with that number. If an inflation rate different from zero is viewed as desirable, the resulting interest rate should simply be increased by that amount. For expositional clarity, I will assume a zero inflation objective in the following theoretical remarks.[9]

The key role which the natural rate plays with regard to the inflation process in the described basic New-Keynesian model thus renders monetary policy a simple task: Although there are a variety of real shocks that influence inflation, the central bank only has to care about the movements in the natural rate through which the shocks are channelled. However, in this benchmark New-Keynesian model, too, the described policy would have the problem that it is merely *consistent* with the equilibrium outcome of price stability but does not necessarily *create* it. The problem is that it permits the occurrence of other less desirable equilibria with fluctuating inflation and output gaps. This is why monetary policy must also commit to react sufficiently strongly to endogenous variables such as the deviations of the output gap and inflation from their target values. Thus – assuming a zero inflation objective – the monetary policy reaction function in this theoretical model would set the short-term interest rate as

$$i_t = r_t^* + g_1 . x_t + g_2 . \pi_t, \qquad (3)$$

where r_t^* denotes the natural real rate of interest. If the monetary policy authority credibly commits to follow the natural rate *and* to react to unfavourable situations, these situations will never occur at all. Thus, following the above rule not only supports the equilibrium of full stabilisation but pins it down as the only possible one.

We should further note that a simple Taylor rule of the form

6 See ECB (2004).

7 See Amato92005).

8 See Woodford (2003) p. 279.

9 For the analysis of monetary policy in the simple model with and without cost-push shocks, see Gali (2002).

$$i_t = c + g_1 . x_t + g_2 . \pi_t, \quad (4)$$

which does not follow the variations in the natural rate of interest would generally not be able to generate full stabilisation. To illustrate this, assume for the moment that monetary policy can nevertheless commit to (4) and at the same time completely stabilize output and inflation. In this case, the nominal interest rate and expected inflation would be constant over time. However, since the natural real rate of interest moves due to exogenous factors, the resulting interest rate gap varies. But according to demand equation (2) this would be incompatible with the assumed complete stabilisation of the output gap. This line of reasoning shows that the simple policy rule (4) is not capable of implementing complete stabilisation unless the natural rate is constant.

Unlike in the simple model considered so far, monetary policy will in general not be able to guarantee full stabilisation at all times. One important factor that generates a trade-off between output and inflation stabilisation is the presence of cost-push shocks. These appear as an additional disturbance term in the Phillips curve,

$$\pi_t = \beta \cdot E_t(\pi_{t+1}) + \kappa \cdot x_t + e_t. \quad (1a)$$

Thus, a cost-push shock constitutes an additional driving force to inflation beyond those effects that operate via the output gap. The presence of such shocks can arise from time-varying market power of firms, from time-varying distortionary consumption or wage taxation, or from time-varying wage-mark-ups in imperfectly competitive labour markets.[10] In contrast to the earlier example, where all inflationary pressures had been due to real shocks – manifested in movements of the natural rate – the central bank will now face a trade-off between output-gap and inflation stabilisation. If a cost push shock arises, the monetary authority may raise the interest rate to counterbalance the effect on inflation. This, however, now comes at the cost of generating a negative output gap. In this case, the weights that the central bank attaches to both targets come into play. In theory, this is typically represented by a loss function that increases in squared deviations of the output level and inflation from target.[11]

The policymaker seeks to minimize this loss function, taking the functioning of the economy as a constraint. In the presence of cost-push shocks, it is immediately evident that – contrary to the model without cost-push shocks – a vanished interest rate gap does not imply price stability. What the optimal policy looks like in this case depends, in particular, on whether or not the policymaker can credibly commit to future actions or – in the language of the "time inconsistency" literature – whether monetary policy is conducted under discretion or commitment. In any case, given the existence of cost-push shocks, a policy that merely traces the path of the natural rate is not optimal. Rather, optimal policy will have to take into account both: movements in the natural rate and the nature of additional cost-push shocks which are not manifested in the natural rate.

5 Monetary policy and the natural rate of interest in practice

In light of the discussed theoretical considerations, the natural rate of interest could in principle play an important role in the conduct of monetary policy. And at least conceptually its measurement would be straightforward: identify its real driving forces, get to know in what way the NRI is affected by each of them, and finally measure their values. Obviously, all of these three steps imply considerable obstacles. Step one requires an exhaustive enumeration of all those real factors that are potentially important. Step two requires a precise knowledge of how these factors affect the real rate, thus requiring some sort of a very exact economic model. Finally, step three requires a measurement of variables which are themselves partly unobservable, such as the time discounting rate of private households. Therefore, the natural rate has to be estimated indirectly based on current and past observations of directly observable economic data, making use of a more or less detailed model prescribing the interactions of the NRI with these variables.

However, policymakers intending to make use of the natural rate are in an even less comfortable position than econometricians conducting ex post analyses for estimating the NRI at a given point in

[10] See Benigno and Woodford (2004), Walsh (2003) or Woodford (2003).

[11] More elaborated optimising models based on utility-maximising agents even allow choosing this loss function so that it represents the utility stream of private agents, which in turn makes meaningful welfare analyses of different policies possible.

history. Econometricians can use current, past, and future observations to make inferences about the NRI, while policymakers have only past and current data at their disposal. Moreover, past and current data may also be affected by data revisions, this so-called ‘real-time data problem’ being, in itself, a significant obstacle to monetary policy analysis on its own.

5.1 Estimating the natural rate of interest

For estimating the NRI, a number of different methods have been established in the literature. Unfortunately, they lead to a wide range of different results.[12] Such variability across estimation methods poses an additional problem besides the one of uncertainty surrounding any statistical estimate. As we shall see below, dealing with these uncertainties in an appropriate manner is a real challenge for monetary policy – a challenge which is both discussed in the current academic literature and debated in the context of policymaking in practice. The various approaches to estimating the NRI in the literature can be grouped into the following three categories: (1) univariate filtering approaches, (2) structural econometric models with the NRI as a latent variable, and (3) fully-fledged equilibrium models with microeconomic foundations. In my following remarks, I will sketch the nature of these methods and comment on their advantages and drawbacks.

One approach to estimating the NRI is based on simply using realised real rates. The idea supporting this *modus operandi*, is that in the long run – that is, after all shocks have washed out – the actual real rate should have converged to its natural counterpart. If moving averages of actual real rates are taken over the typical length of a business cycle, the resulting number may be interpreted as being close to the natural rate. Since the method uses actual real rates it already inherits the arbitrariness of measuring them: one has to decide between ex ante and ex post measures of inflation and on the type of price index used. Additionally, one has to decide the window width over which the sequence of means is computed. Since all these choices will have an influence on the level of the estimated natural real rate, different variants of this approach can result in quite different point estimates of the NRI.

The NRIs resulting from such moving average estimations typically constitute a fairly smooth time series. However, this stands in contrast to the characterising features of the ‘true’ natural rate outlined above, because – theoretically - it can in fact exhibit strong variations corresponding to the size and dynamics of the real shocks it depends on. In general, methods based on averaging will by their very nature translate a *de facto* abrupt persistent upward change in the NRI into a smooth phase of transition. This drawback remains even if the averaging method is refined, as is the case, for example, in methods that filter out low-frequent components from the real rate.[13]

Alternatively, the literature also employs econometric models which explicitly specify the dynamics of the natural rate as an exogenous stochastic process. This approach is – on the one hand – based on exogenous shocks and – on the other – on the assumption about certain structural relations between observable variables and the NRI.[14] These structural equations may contain quite general formulations of inflation and output dynamics based on economic theory. Typically, they nest a variety of specifications from both specific theories and *ad hoc* assumptions. For instance, an inflation equation may nest a forward-looking Phillips curve that would result from particular assumptions of a micro-founded equilibrium model – as mentioned above – but would also contain lagged inflation and real activity in order to take account of some degree of backward-lookingness that is present in the data. Here, the key idea is that the NRI – which, by its very nature, is unobservable – may be filtered out from observable data on the basis of the model’s implications for the interaction between the NRI and these observable variables. This filtering technique is more efficient if it is two-sided, that is, if it uses not just past and current data, but also future data. However, since policymakers are confined to one-sided filtering, this real-time problem tends to reduce the usefulness of this method.

The aforementioned econometric approaches specify a fairly general structure of the dynamics of key economic variables that interact with the NRI. Alternatively, one may use more specific general equilibrium models of the economy, which are usually based on explicit microeconomic foundations.

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12 See in particular the survey in Crespo Cuaresma, Gnan and Ritzberger-Grünwald (2005).

13 These problems are analogous to those encountered when estimating potential output. Filtering low-frequency components from a series of actual output does not in general lead to a time series that shares the characteristics of the theoretical concept of potential output.

14 See e.g., Laubach and Williams (2003) and Mesonnier and Renne (2004).

For the euro area, the model by Smets and Wouters (2003), for instance, has gained some popularity as a tool for monetary policy analysis. Such a model makes it possible to emulate the hypothetical flexible-price path of the economy, that is, the sequence of equilibria in which all real variables are at their natural levels. This counterfactual exercise allows us to derive the natural rate of interest. Usage of an estimated equilibrium model also makes it possible to track and interpret the very sources of its variation, such as shocks to technology, government spending, or a change in the tax system.[15]

Moreover, structural equilibrium models direct attention to the role that specific key variables may play in identifying the relative natural rate movements. As outlined above, inflation may be represented by the sum of future expected natural real interest rates. But an immediate proxy for the expected natural real interest rate is even less available than it is for the current natural real rate. However, exploiting the logic of forward-looking models, these important future developments may be inferred from observations available in real time. For instance, in variants of the New-Keynesian model, presented in Andres, Lopez-Salido and Nelson (2004), portfolio adjustment costs lead to a forward-looking specification of money demand. This, in turn, implies that current real balances are linked not only to current income and interest rates but also to the sum of expected future values of the NRI and interest rate gaps. In other words, if their model is true, money contains valuable information on future natural real rates. For policymakers, this a crucial point: Given the real-time data problems with which they are confronted, looking at monetary developments may be useful for learning about the current (and future) state of the economy even in the New-Keynesian world which, at first sight, has no such role for money to offer. And this point is to some extent also related to Wicksell's theory, where an interest rate gap has direct implications for credit and money growth. I will come back later to the issue of monetary indicators' usefulness.

However, deriving the natural rate of interest from structural models is accompanied by the risk that the underlying narrow view of economic interactions may not be an adequate representation of reality. Basing estimates of the NRI on a distorted picture of real-world interactions would then lead to a distorted estimate of the NRI. Obviously, this shows that the use of the concept of the natural rate of interest for policymaking comes with the problems of model and data uncertainty.

5.2 Monetary policy guided by estimates of the natural rate of interest

From the foregoing remarks it should come as no surprise that point estimates of the natural rate of interest vary immensely across methods. Again, it is important to note that this variation across estimation approaches prevails in addition to the statistical uncertainty surrounding every point estimate for any given model on which it is based. For the euro area since 1999, a synopsis in a paper by Crespo Cuaresma, Gnan, and Ritzberger-Grünwald (2005) shows that estimated paths of the NRI differ considerably in terms of their levels, the range that they cover over time, and their smoothness.

Therefore, the natural question arises as to whether the concept of the NRI can be useful to monetary policymakers in practice. For illustration, let us consider again the most basic New-Keynesian model without any output/inflation trade-offs. Here, policymakers can completely stabilise the path of inflation and output: they set the nominal interest rate equal to the natural real rate of interest plus their inflation objective. They commit to react to inflation and output gap fluctuations, but these would never occur in equilibrium. However, if the natural rate is not measured precisely and is simply replaced by its estimate in the above rule, then *"estimation error becomes policy error, and stabilization policy becomes destabilizing*".[16]

One therefore has to explore what the optimal monetary policy looks like in the presence of measurement uncertainties concerning the natural rate. This is one instance of the general question of how monetary policy should act in presence of uncertainty about the state of the economy and this issue currently constitutes a very active research area. Under specific assumptions the apparently comfortable principle of 'certainty equivalence' prevails: optimal policy should react to its best estimate of a state variable in exactly the same way as it should react if this variable were precisely observable. It is immediately clear that even in this 'straightforward' case, every policy that comes in the form of a 'simple rule' loses that property of simplicity: reacting to the 'best estimate' of any state variable

[15] See also Neiss and Nelson (2001). In their DSGE model, it is particularly interesting to see that the response of the NRI to a technology shock depends crucially on the specification of capital adjustment.

[16] Jonathan A. Parker in a comment on Orphanides and Williams (2002).

usually implies conducting a one-sided filtering exercise, yielding a state estimate which is a function of all current and past observables. Moreover, this approach is conditional on two crucial requirements: first, the central banker has to know the structure of the data-generating process for the NRI in order to come up with the best estimate. And second, this best estimate will typically depend on the degree of mismeasurement of the NRI which, in general, is not precisely known either. Thus, in trying to react appropriately to state uncertainty, uncertainty kicks in on another level, posing an even greater challenge.

If model uncertainty or uncertainty about the degree of mismeasurement prevails, policymakers are well advised to go for a strategy that is robust to misconceptions of the true economic mechanism or the degree of NRI mismeasurement. That is, a policy that performs acceptably under a variety of possible model structures should be preferred to one that is optimal in one specific environment but would lead to disastrous outcomes if another setting prevailed. One way to tackle this issue is the Bayesian approach, where the policymaker has to assign a subjective probability distribution over the class of possible models prevailing.[17] Of course, doing so requires an *a priori* decision about the set of models considered within the exercise. Note that this problem is closely related to G.L.S Shackle's work on uncertainty: coming up with a sensible set of models – relevant for decisions affecting the future – may not be accomplishable: there are always „fresh kaleidic shift(s) of the environment"[18], thus, those models that are potentially adequate to describe the economic characteristics of the future may not be imaginable today.

Model uncertainty in the sense of an unknown degree of mismeasurement of the natural rate[19] is the subject of Orphanides and Williams (2002): they show that the welfare cost of underestimating the degree of mismeasurement of the natural rate of interest[20] exceeds the cost of overestimating it. Put differently, a policy that is optimal for the case of low measurement uncertainty would induce large welfare losses if measurement uncertainty is, in fact, high, but would bring about only moderate losses in efficiency in the converse case. Accordingly, the robust policy rule puts little weight on the estimate of the natural rate. In the extreme, robust optimal policy would ignore it completely and go for a policy rule that relies on first differences of observed variables rather than the relevant gaps.[21]

6 Summing up and looking ahead

This example illustrates that on top of all those statistical measurement problems the question of how to react optimally to an estimate of the natural rate may be an even more intricate problem. So at the end of the day, what can we make of the concept of the natural real rate of interest for the practice of monetary policy?

To answer this question, let me come back to the properties for an ideal benchmark indicator of the monetary policy stance, which I listed at the beginning.

First, concerning *theoretical foundations*, the natural real rate of interest – with an already long tradition in economic theory – plays a key role in modern rational-expectations models of monetary macroeconomics and stands on sound analytical ground. It is a tool for thinking about the monetary transmission process. This is because the determinants of the natural rate of interest – for example changes in preferences, advances in production technology and variations in government spending – all have an effect on output fluctuations and inflation. Thus, the natural rate of interest subsumes all these real shocks into a single number that – when compared with the actual real rate – provides an indicator for the stance of monetary policy.

Second, even within the limits of the theoretical framework, the corresponding interest rate gap is not a sufficient *summary variable reflecting the overall pressure on inflation* in the sense that it captures all

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[17] See Angeloni, Smets and Weber (1999) and the references therein concerning the problem of monetary policy making under uncertainty with special reference to ECB policy.

[18] Shackle (1972), p. 240.

[19] Thus, compared to the latter considerations, model uncertainty in a quite narrow sense.

[20] They are concerned with both the natural rate of interest and the natural rate of unemployment.

[21] Orphanides and Williams even propose a policy rule that completely dismisses any reliance on natural rate concepts. See, however, the comment by J. A. Parker who claims that within non-simple rules estimates of the natural rates can be fruitfully exploited.

possible determinants of price changes. Rather, cost-push shocks provide a source of inflation which is important for monetary policymakers to know, but which is not mirrored by the natural rate of interest.

Third, the natural rate of interest is not *readily computable from observable economic data*. On the contrary, its measurement is affected by severe problems. In addition to the usual statistical estimation uncertainty, estimated NRIs differ widely across estimation approaches. The more simplistic the approach one follows, the farther away one will move from a theoretically founded notion of the NRI. This problem is less severe if a detailed theoretical model is used for estimation. In this case, however, the problem of model uncertainty becomes pivotal.

Thus, I think one can safely conclude that the natural rate cannot be a surrogate for a detailed analysis of the real and monetary forces relevant for the identification of risks to price stability. As we have seen, even within the simple New-Keynesian model with cost-push shocks, the natural real rate of interest or the corresponding real interest rate gap alone is not a sufficient measure of the monetary policy stance.

Moreover, it is far from certain what role the natural rate may play in models outside the New-Keynesian paradigm. This point is particularly relevant with respect to models that aim to capture the longer-run perspective between monetary developments and inflation. Such models could represent natural complements to models of short-run fluctuations – such as those of the New-Keynesian type – in the toolbox of policymakers. These are an essential device for judging the medium to long-term risks to price stability. More generally, an anchoring of inflation expectations in the long run requires that any analysis of the real side – in which natural rate considerations take place – is complemented by an analysis of monetary and credit development. This is one line of reasoning that stands behind the two-pillar strategy of the Eurosystem, which takes account of short to medium run inflationary pressures within its economic analysis as well as of medium to long-run risks to price stability within its monetary analysis.

However, I think further active research on the role of the natural rate for monetary policy and its measurement is certainly worthwhile. Theoretical considerations along the lines of Wicksell's cumulative process or of the New-Keynesian paradigm have demonstrated that the natural rate may be key to understanding the factors that drive inflation. And since policymakers cannot afford to discard such information, they should certainly keep an eye on it. However, one cannot judge the usefulness of the natural rate of interest for monetary policy purposes without taking into account the serious problems that accompany its measurement and estimation. As has been pointed out, these problems are severe and comprise a considerable degree of data as well as model uncertainty. Seen from this perspective, it may be worthwhile to examine in more detail what information content the real-time estimates of the natural rate of interest from various empirical approaches – or more precisely the implied real interest rate gaps – have for future inflation. This exercise would move away a bit from the question of what measure provides an estimate that is as close as possible to the 'true' natural rate, and would move towards the question of which is the most informative empirical measure based on natural rate considerations for inflation in the medium run.[22] Finally, within the very active theoretical literature on optimal monetary policy under uncertainty, there remains the relevant question of what to do with the – up to now very imprecise – estimates of the natural rate of interest.

Conclusion

Coming back to the title of this lecture "The role of interest rates in theory and practice - How useful is the concept of the natural real rate of interest for monetary policy?" I would like to conclude by answering this question. I think that the concept of the natural rate of interest is of importance for modern monetary theory and that it is proving to be very useful in organising one's thoughts about the working of the economy and the effects of monetary policy. Thinking again of Shackle's likening of Wicksell's natural rate of interest to the steam locomotive I would say that the modern theoretical version of this concept is indeed a high-speed train. However, the degree to which this theoretical concept can be transferred to the sphere of practical monetary policy is, as yet, uncertain.

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22 Neiss and Nelson (2001) find that a real interest rate gap based on an estimated DSGE model has explanatory power for future inflation in the UK.