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The Natural Rate of Interest I: Theory

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The term natural (or neutral) real interest rate refers to the equilibrium value of the real interest rate. As this equilibrium is usually conceived as a situation where inflationary or deflationary pressures have abated, the natural real interest rate is a key concept for central banks seeking to stabilize the general price level or targeting the rate of inflation. The present roundup provides a brief historical review of this concept and explains the relevance of the natural real rate for monetary policy analysis.

Wicksell's original idea

The notion of a „natural real interest rate" (NRI) originated with the Swedish economist Knut Wicksell (1898). He distinguished the „market rate of interest" (i.e. the actual value of the real interest rate) from its equilibrium value, the so-called "natural rate of interest". According to Leijonhufvud (1979), both rates being equal in equilibrium serves a double duty: it brings about monetary equilibrium, i.e. a stable price level, as well as real equilibrium, i.e. consistency between saving decisions by households and investment decisions by firms. Deviations of the market rate from the NRI lead to changes in the price level *via* Wicksell's famous „cumulative process".

Humphrey (1986) tracks the theoretical origins of cumulative process models and explains Wicksell's version as follows: if the market rate is below the NRI, investors demand funds to finance investments in excess of what savers supply. In a competitive market, the market rate would rise to eliminate investors' excess demand. However, Wicksell assumed that funds were channeled from savers to investors *via* the banking sector and not *via* a market mechanism. In other words, savers hold deposits with banks, and banks (rather than savers) provide funding to investors. The banking sector is not constrained by households' savings and can increase the supply of credit to accommodate investors' excess demand. Hence, when the natural rate is below the market rate, more (credit) money chases a constant number of goods and consequently prices rise.

According to Wicksell, the cumulative process can continue indefinitely as long as the market rate remains below the NRI and the banking sector keeps injecting credit into the economy. Consequently, the real interest rate can only equal the NRI as long as the banking sector remains "neutral" and intermediates between savers and investors without providing excess credit to the economy.

The natural rate in postwar economics

Monetarists, e.g. Friedman (1968), used the distinction between the natural rate and the market rate in order to draw a line between real and monetary forces. Friedman (1968) added Fisher's (1930) idea that the real interest rate equals the nominal interest rate corrected for inflation expectations. Furthermore, he conceived the NRI as the rate that is "ground out by the Walrasian system of general equilibrium equations" (p. 8). In particular, central banks can push market rates below the natural rate or boost employment above its Walrasian equilibrium level only by inflating the economy. Since inflation expectations would adjust, keeping employment at its lower level would require further increases in inflation, i.e. an indefinite acceleration of inflation. Friedman's conclusion was that only a rising rate of inflation could produce a deviation from the (natural) Walrasian equilibrium, a high rate could not! However, Friedman (1963) stresses the viewpoint that "inflation is always and everywhere a monetary phenomenon". As such, monetarists focused on the money supply as the chief determinant of inflation, while Wicksell's real rate gap, i.e. the difference between the natural rate and the market rate, became less important.

The neo-Wicksellian framework

The most recent literature on monetary theory and policy has returned to a Wicksellian perspective, placing the natural rate and the real rate gap again front and center into the analysis (Amato, 2005). Woodford (2003) offers the most comprehensive account of what he calls a "neo-Wicksellian" framework (a more common label for this school of thought is „New Keynesian" (see e.g. Clarida, Gali Gertler, 1999). We follow Woodford (2003) by calling this class of models "Neo-Wicksellian" in order to highlight the importance of the natural rate in this framework.). The standard neo-Wicksellian model is based on a dynamic stochastic general equilibrium (DSGE) model in the spirit of real business cycle models (Kydland and Prescott, 1982; Hansen, 1985). The standard model vintage assumes that firms are monopolistically competitive and have some leeway in setting their prices, and thereby allows including price rigidities (Gali, 2008). The natural level of output is defined as the steady state value of output (subject to stochastic shocks) under fully flexible prices and the natural rate of interest is the real rate that prevails if output is equal to its flexible price level. Given imperfect price adjustment, however, the actual level of output can depart from this benchmark. The Wicksellian flavor comes from the fact that inflationary or deflationary pressures are proportional to the real rate gap.

At least in theory, the natural rate provides a benchmark that allows answering questions such as "Is the monetary policy stance expansionary or contractionary?", or "Will interest rates rise or decline and if so, against which level will they converge?". While it is imperative that monetary policy makers and central banks have a measure at hand that helps answering such questions, the precise definition of the natural rate, its measurement and therefore the answers to these questions crucially depend on the specification of the theoretical model and on the respective benchmark steady state.

For instance, as shown in Woodford (2003) or Gali (2008), in closed economy models with frictionless financial markets and labor as the only input factor in production, the natural rate – defined as the equilibrium rate under perfectly flexible prices and wages – becomes a function of the representative agent's discount rate and stochastic aggregate shocks. Gertler (2002) adds capital to the production function and shows that the natural rate further depends on the level of the capital stock. Clarida, Gali and Gertler (2001, 2002) or Gali and Monacelli (2005, 2008) consider open economies that engage in trade with the rest of the world. As such,

the natural rate in their models also depends on foreign output shocks. What these and other variations have in common, however, is that the natural rate is independent of monetary policy actions. Put differently, the conditions for the flexible price equilibrium can be separated into those that pin down the real side of the economy (including the natural rate) and those that pin down the nominal side. De Fiore and Tristani (2011) show that this dichotomy breaks down when certain types of credit frictions are introduced: "This lack of dichotomy implies that the equilibrium rate of interest under flexible prices can only be computed after specifying the policy rule adopted by the monetary authorities". This impedes the use of a natural rate as the rate that prevails under fully flexible prices as an indicator for monetary policy analysis. De Fiore and Tristani therefore re-define the benchmark equilibrium to obtain a version of the natural rate that once again becomes independent of the policy regime. That is, their natural rate "(…) coincides with the real rate of return arising in an equilibrium in which the central bank is able to maintain the opportunity cost of money constant over time and all nominal frictions are absent, i.e. i) prices have always been fully flexible and are expected to remain so in the indefinite future; ii) external finance takes the form of real debt".

The natural rate and monetary policy

Wicksell's key policy lesson resonates rather well with modern concepts of monetary policy, where the rate of inflation (based on a general price index) is targeted by adjusting a short-term nominal interest rate. As Wood (2005) explains, Wicksell had a rule-based monetary policy in mind that focused on a stable price level. To stabilize the price level, the interest rate was to be adjusted to close the real rate gap, i.e. the central bank should raise rates if prices rise and *vice versa* if prices fall.

In contrast to Wicksell, Friedman preferred to conduct monetary policy in terms of money supply rules such that the rate of inflation would be pinned down by the rate of growth of the money supply. Although Friedman agreed with Wicksell that inflation could be kept in check if the central bank pegged the market rate at the level of the natural rate, he believed that the natural rate was everything else than "immutable and unchangeable" (p. 9). Hence, attempting to peg the market rate at the NRI would not lead to a determinate policy since the market rate would vary for many reasons other than policy and tracking these variations would make the money growth path inconsistent with the policy rule.

Sargent and Wallace (1975) echo Friedman's skepticism about interest rate rules. They compare classes of money-supply and interest rate rules and emphasize that only money supply rules could lead to a determinate rational expectations equilibrium. The interest rate rules considered in their analysis lead to equilibrium indeterminacy, i.e. imply multiple rather than a unique path for the price level. McCallum (1981), however, points out that the Sargent-Wallace result only applies to those rules that specify an exogenous path for the nominal interest rate. Hence, their results do not hold for feedback rules where the policy rate reacts to endogenous variables like inflation or employment.

McCallum's idea resurfaced when Taylor (1993) proposed a specific interest rate feedback rule, by now called the "Taylor rule", to describe the behavior of the US Federal Reserve's policy and further emphasized its normative significance. The rule states that central banks (should) adjust the policy rate more than one-for-one in response to deviations of inflation and output (gap) from their targeted values (so-called Taylor principle). This rule pins down a unique rational expectations equilibrium and prevents the occurrence of unstable inflation dynamics.

The Taylor principle is usually included in neo-Wicksellian models. While zero inflation and stable prices can be achieved whenever the central bank closes the real

rate gap, the Sargent and Wallace critique still applies: by just tracking the "changeable and mutable" natural rate, one cannot pin down a unique price level path, since the natural rate is a function of purely exogenous variables. Thus, equilibrium indeterminacy resumes and a large number of possible rational expectations equilibria with varying levels of output gap and inflation arises. As Woodford (2001) or Clarida, Gali and Gertler (1999) point out, determinacy can be ensured by following the "Taylor principle". In particular, once movements in inflation trigger a more-than-one-for-one increase in the nominal interest rate, the real rate, i.e. the difference between nominal rate and expected inflation, increases and leads to a shift of households' demand from consumption today towards consumption in the future. This, in turn, stabilizes the current rate of inflation and guarantees the determinacy of a locally bounded equilibrium. It should be noted, however, that this interpretation has been subject to a fundamental critique by Cochrane (2011). He terms this "old-Keynesian stabilizing logic" (one may even better call it "old-Wicksellian stabilizing logic"). What the Taylor principle truly does, according to Cochrane, is to eliminate all equilibria which are not locally bounded, i.e. it rules out equilibria with nominal explosions such as hyperinflations. Cochrane, however, finds nothing wrong with these equilibria, as they are not in conflict with the transversality conditions used in agents' optimal decisions. According to Cochrane: "By raising rates in response to inflation, the [central bank] induces accelerating inflation or deflation, or at a minimum a large `nonlocal' movement, unless inflation today jumps to one particular value". However, "there is no economic reason why the economy should pick this unique initial value, as inflation and deflation are valid economic equilibria". As a consequence, even the Taylor principle does not help in pinning down a unique equilibrium and it leaves the model still indeterminate.

Conclusion

The natural real interest rate is an important variable in assessing the stance of monetary policy. However, the uncertainty surrounding its true functional form and its value restrains its use as a quantitative guidepost for actual policy decisions. As a consequence, any empirical assessments of the natural rate and, *a fortiori*, any implications derived from a comparison between the actual rate and an estimation of the natural rate, have to be taken with a grain of salt since it is never possible to observe / estimate the true natural rate that is associated with equilibrium in the actual economy. This should not mean that the concept of a natural rate is a useless one. But it means that the validity of any proposition such as "monetary policy is too loose since the real rate falls below the natural rate" depends on a subjective decision about the benchmark model that is used to compute the natural rate.

Literature

Amato, J.D. (2005): The Role of the Natural Rate of Interest in Monetary Policy, BIS Working Paper, 171
http://www.bis.org/publ/work171.pdf

Blume, L. and Durlauf, S. (eds.) (2008): The New Palgrave Dictionary of Economics, 2nd ed., Palgrave Macmillan.

Clarida, R., Gali, J. Gertler, M. (1999): The Science of Monetary Policy: A New Keynesian Perspective. Journal of Economic Literature, 37(4), 1661-1707.
https://www.aeaweb.org/articles?id=10.1257/jel.37.4.1661

Clarida, R., Gali, J. Gertler, M. (2001): Optimal Monetary Policy in Open versus Closed Economies: An Integrated Approach. American Economic Review, 91(2), 248-252.
https://www.aeaweb.org/articles?id=10.1257/aer.91.2.248

Clarida, R., Gali, J. Gertler, M. (2002): A simple framework for international monetary policy analysis, Journal of Monetary Economics, 49(5), 879-904.
http://www.sciencedirect.com/science/article/pii/S0304393202001289

Cochrane, J. (2011): Determinacy and Identification with Taylor Rules. Journal of Political Economy, 119(3), 565-615.
http://www.journals.uchicago.edu/doi/10.1086/660817

De Fiore, F. and Tristani, O. (2011): Credit and the Natural Rate of Interest. Journal of Money, Credit and Banking, 43, 407-440.
http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp889.pdf

Fisher, I. (1930): The Theory of Interest - As Determined by Impatience to Spend Income and Opportunity to Invest It.
http://www.econlib.org/library/YPDBooks/Fisher/fshToI.html

Friedman, M. (1963): Inflation: Causes and Consequences. Asia Publishing House: Bombay.

Friedman, M. (1968): The Role of Monetary Policy, The American Economic Review, 58(1), March, 1-17.
https://assets.aeaweb.org/assets/production/journals/aer/top20/58.1.1-17.pdf

Galí, J. and Monacelli, T. (2005): Monetary Policy and Exchange Rate Volatility in a Small Open Economy, Review of Economic Studies, 72(3), 707-734.
http://restud.oxfordjournals.org/content/72/3/707.short

Galí, J. and Monacelli, T. (2008): Optimal monetary and fiscal policy in a currency union. Journal of International Economics, 76(1), 116-132.
http://www.sciencedirect.com/science/article/pii/S0022199608000573

Gali, J. (2008): Monetary Policy, Inflation and the Business Cycle. Princeton University Press: Princeton.

Hansen, G. (1982): Indivisibe Labor and the Business Cycle. Journal of Monetary Economics, 16(3), 309-327.
http://www.sciencedirect.com/science/article/pii/030439328590039X

Humphrey, T. M. (1986): Cumulative Process Models from Thornton to Wicksell. Economic Review, May / June, Federal Reserve Bank of Richmond, 18-25.
https://www.richmondfed.org/-/media/richmondfedorg/publications/research/economic_review/1986/pdf/er720303.pdf

Kydland, F.E. and E.C. Prescott (1982): *Time to Build and Aggregate Fluctuations*. Econometrica, 50(6), 1345-1370.
http://www.jstor.org/stable/1913386?seq=1#page_scan_tab_contents

Leijonhufvud, A. (1979): *The Wicksell Connection – Variations on a Theme.* In: Information and Coordination – Essays in Macroeconomic Theory. Oxford University Press: Oxford. 131-202.

Leijinhufvud, A. (1987): *The Natural Rate and the Market Rate*. In: Eatwell, J., Milgate, M. and Newman, P.: The New Palgrave – Money. W.W. Norton Publishers: London.

McCallum, B. T. (1981): Price level determinacy with an interest rate policy rule and rational expectations. Journal of Monetary Economics, 8(3), 319-329.
http://www.sciencedirect.com/science/article/pii/0304393281900143

Rieth, M. (2017): The Inflation Targeting Debate. DIW Roundup, 107
https://www.diw.de/de/diw_01.c.549678.de/presse/diw_roundup/the_inflation_targeting_debate.html

Sargent, T.J. and Wallace, N. (1975): Rational Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule. Journal of Political Economy 83, 241-254.
http://www.journals.uchicago.edu/doi/abs/10.1086/260321

Smets, F. and Wouters, R. (2007): *Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach*. American Economic Review, 97(3), 586-606
https://www.aeaweb.org/articles?id=10.1257/aer.97.3.586

Svensson, L. (2010): Inflation Targeting, in Friedman, B. and Woodford, M. (2010): Handbook of Monetary Economics 3A, North Holland.

http://ac.els-cdn.com/B9780444534545000104/1-s2.0-B9780444534545000104-main.pdf?_tid=bcb1028e-d737-11e6-a2fc-00000aacb361&acdnat=1484054687_984868e6dd71bb2348fb44e6bba19844

Taylor, J. (1993): Discretion versus Policy Rules in Practive. Carnegie-Rochester Conference Series on Public Policy, 39, 195-214
http://web.stanford.edu/~johntayl/Onlinepaperscombinedbyyear/1993/Discretion_versus_Policy_Rules_in_Practice.pdf

Wood, J. (2005): *A History of Central Banking in Great Britain and the United States*. Cambridge University Press, Cambridge.

Woodford, M. (2001): The Taylor Rule and Optimal Monetary Policy. American Economic Review, 91(2), 232-237. https://www.aeaweb.org/articles?id=10.1257/aer.91.2.232

Woodford, M. (2003): Interest and Prices – Foundations of a Theory of Monetary Policy. Princeton University Press: Princeton.

ECB (2004): *The Natural Real Interest Rate in the Euro Area.* ECB Monthly Bulletin, May, 57-69.
https://www.ecb.europa.eu/pub/pdf/mobu/mb200405en.pdf

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