SIMPLE GUIDELINES FOR INTEREST RATE POLICY*

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1. INTRODUCTION

Those of us working at research departments in central banks are regularly questioned on the right target for the interest rate in the inter-bank market. For many of us this is not an easy question, since the models are not unanimous and the information on the true model of the economy is insufficient. In this note we describe simple guidelines for interest rate policy compromising on the underlying model as well as on other more practical issues.

In an environment with multiple distortions where fiscal and monetary policy are decided optimally, such as Correia, Nicolini and Teles (2002), the interest rate policy is the Friedman rule, of a zero nominal interest rate. The distortions that are taken into account arise from the need to raise revenues with distortionary taxes, the inability of the government in issuing state-contingent debt, a monopolistic competitive structure, as well as nominal rigidities in the form of price setting restrictions. The application of optimal principles of taxation implies the Friedman rule. This simple policy recommendation obtained in a complex environment is nevertheless foreign to the policy discussion where the question is whether to raise or lower rates around an average rate that is low but different from zero. In this note we describe an alternative framework where the optimal recommendation is closer to the policy discussion. The recommendation can also be followed in a simple fashion with a number of practical shortcuts.

The alternative framework abstracts from important aspects of the more complete environment, including the need to raise revenue with distortionary taxes and the potential distortions resulting from the need to use money for transactions. It is a first best world where all the distortions can be eliminated. Lump sum taxes can be raised to finance government expenditures. They also finance a subsidy to production that eliminates the mark up distortion arising from monopolistic competition. In order to eliminate the distortions resulting from sticky prices, it is enough that the price level be constant over time. In this case the firms that are restricted not to change prices will charge the same price as the firms that are free to set them. Since the price level is constant over time, then the nominal interest rate fluctuates with the real interest rate around a positive average rate. The distortion caused by a positive and variable nominal interest rate is eliminated by assumption as if transactions could be performed without money.

Since the distortions associated with sticky prices are eliminated, the real interest rate in the model with sticky prices coincides with the one under flexible prices. This is the optimal target for the nominal interest rate, the real interest rate under flexible prices that moves in response to shocks, i.e. the natural rate of interest.

There are two main difficulties in conducting interest rate policy, targeting the natural rate of interest. One is to compute the target, i.e. the real interest rate that would hold under flexible prices in

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response to the shocks that hit the economy. In order to infer the behaviour of the natural rate of interest we look at the behaviour of the real interest rate on short term bonds in periods where, in the U.S., inflation was low and stable. The rationale is, as mentioned above, that in a model with sticky prices where the price level is constant over time, the price setting restrictions on firms are not binding. The equilibrium quantities and prices will be the same as under flexible prices and, therefore, so will the real interest rate.

The second difficulty is that it is well known that interest rate policy is not sufficient to pin down a single equilibrium. For each interest rate policy there are multiple equilibria. Even if global multiplicity cannot in general be excluded it is possible to use policy to generate local uniqueness. Under certain conditions, there is therefore a unique equilibrium close to a particular steady state. The conditions for local uniqueness are model dependent but there is a class of models where a sufficient condition is that the nominal interest rate respond to inflation in a particularly strong fashion.

In summary, the ingredients to conduct monetary policy in the simplified, and unfortunately not very satisfactory, framework are the estimation of the flexible price real interest rate and an active response to variations in inflation. In the theoretical model, since the objective is precisely to eliminate the distortions arising from sticky prices, inflation will not vary in equilibrium and therefore all that policy will have to do is to follow the real rate of interest under flexible prices in its movements in response to shocks. This is the Wicksellian policy named by Woodford (2003) after the Swedish economist of the turn of last century Knut Wicksell.

The note proceeds as follows: In Section 2 we describe the behaviour of a measure of the real interest rate on short term bonds in the US for the post war period. In particular we look at the correlation with the growth rate of output and detrended output. In periods of low inflation those correlations are high, so that the inference on the natural rate of interest will be based on the behaviour of those series. In Section 3 we address the issue of local determinacy and therefore the need for interest rate policy to react to inflation. In Box 1 we discuss how interest rate policy should be conducted in a model with less instruments and more distortions, that takes into account the joint decision of fiscal and monetary policy when taxes are distortionary.

2. THE NATURAL RATE OF INTEREST

In the theoretical model, the goal of interest rate policy is to follow the movements of the real rate of interest under flexible prices, the natural rate of interest. This unobserved series moves with shocks that are not observed, according to laws of behaviour that are also unknown. Without the aid of complex quantitative tools it would seem impossible to find a decision rule on the target for the nominal rate. However, policy makers seem to be able to take decisions based on a few indicators of the state of the economy, such as fluctuations of GDP around its trend and GDP growth.

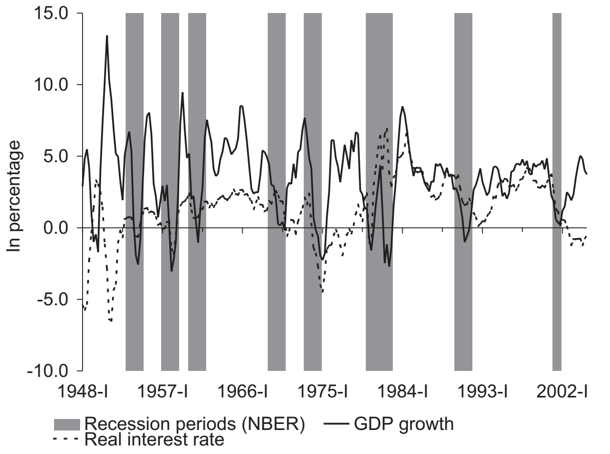
In this section we describe the behaviour of a measure of the real rate of interest for the post war US economy. We compute this using as the forecast for inflation, the previous four quarters PCE inflation. We look at the correlations with the growth rate of GDP, as well as detrended GDP. We do this for both periods of low and stable inflation and periods where it was relatively high and volatile. We are not surprised to find out that the correlations are high in the periods where inflation was low and stable.

Charts 1 and 2 plot the real interest rate at quarterly frequency against, respectively, the annualized GDP growth rate, and deviations of GDP from trend, for the post war period, 1948-2004, for the US(1). The shaded bars are the NBER recessions. If we take for instance the 1990-91 recession, the real interest rate fell down with output from a

(1) All data are in quarterly frequency. The annualized GDP growth series was computed as year-on-year rates of change of real GDP. The GDP deviations from trend series was computed in reference to a Hodrick-Prescott (HP) filter with a smoothing parameter of 1600. The real interest rate series was computed as the difference between the nominal yield on secondary market three-month Treasury Bill, and the lagged year-on-year rate of change of the Personal Consumption Expenditure (PCE) deflator. The real GDP and the PCE deflator series were extracted from the NIPA Tables of the Bureau of Economic Analysis. The nominal yield of the three-month Treasury Bill was extracted from the Board of Governors of the Federal Reserve System. This series comes in monthly frequency and so was converted into quarterly frequency through averaging.

Chart 1

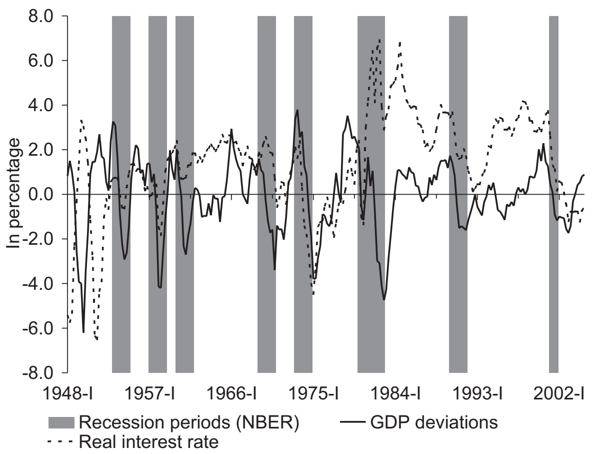
GDP GROWTH AND THE REAL INTEREST RATE



Sources: Bureau of Economic Analysis, Board of Governors of the Federal Reserve System.

Chart 2

GDP DEVIATIONS FROM HP TREND AND THE REAL INTEREST RATE



Sources: Bureau of Economic Analysis, Board of Governors of the Federal Reserve System.

level of around 4% to a level close to zero after the trough to go back up with output to a level again close to 4%, and down again with the 2001 recession (Chart 2). Other cycles exhibit the same pattern. However, as illustrated in Tables 1 and 2, the correlation between the real rate of interest and the measures of economic activity for the whole period is zero.

Instead, the correlations are positive and high in periods of low and stable inflation, when we trust the behaviour of the real rate of interest to be close to the object of interest, the natural rate of interest. We divide the whole sample, 1948-2004, in a somewhat arbitrary way as shown in Chart 3. The shaded areas are the periods considered of low and stable inflation. In the periods 1953-1973 and 1983-2002 the correlations between the real interest rate and the measures of economic activity, is high (around 60%), when we take GDP growth and somewhat lower for deviations of GDP from trend (around 50%)(2). The average real rate is 1.2% for the period 1953-1973 and 2.4% for the second subperiod of low inflation. For the periods of high and volatile inflation the averages are -1.7% and 0.6%, respectively, for 1948-1952 and 1974-1982.

The high historical correlation recorded between the real interest rate and GDP growth in periods of low and stable inflation justifies an interest rate policy that targets the natural rate of interest by reacting to changes in output growth, raising the interest rate in phases of accelerating activity and lowering it otherwise. For the period 1983-2002 the correlation is higher with lagged output growth, meaning also that the interest rate is increasing while growth is decreasing before the peak of the boom. Focusing on Chart 2, it is apparent that in the later period of low and stable infla-

Table 1

CORRELATION BETWEEN GDP GROWTH AND THE REAL INTEREST RATE

	Contemporaneous	dy(t),r(t+1)	dy(t),r(t+2)
1948-2004	0.03	0.00	-0.02
1948-1958	-0.34	-0.50	-0.58
1959-1968	0.61	0.52	0.44
1969-1978	0.45	0.51	0.48
1979-1988	0.28	0.22	0.18
1989-1998	0.32	0.40	0.48
1994-2002	0.61	0.74	0.84
1953-1973	0.60	0.57	0.40
1983-2002	0.61	0.68	0.72
1983-2004	0.44	0.52	0.56

Source: Bureau of Economic Analysis, Board of Governors of the Federal Reserve System.

(2) It is interesting to note that the correlation in the calibrated real business cycle model of Prescott (1986) is 60%.

Table 2

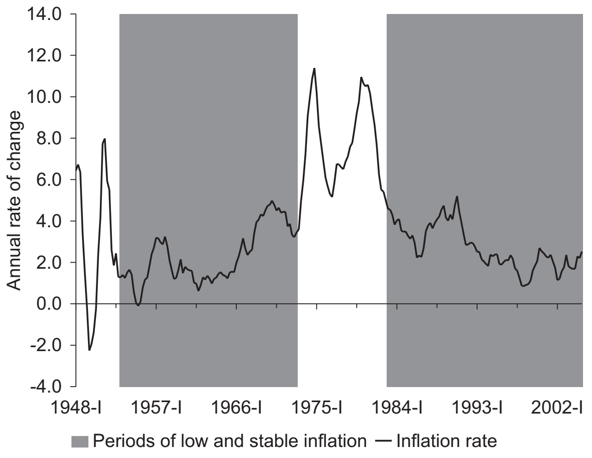
CORRELATION BETWEEN DETRENDED GDP AND THE REAL INTEREST RATE

	Contemporaneous	desv. y(t),desv. r(t+1)	desv. y(t),desv. r(t+2)
1948-2004	0.04	0.02	-0.01
1948-1958	-0.35	-0.38	-0.34
1959-1968	0.46	0.17	0.00
1969-1978	0.47	0.42	0.26
1979-1988	-0.20	-0.26	-0.30
1989-1998	0.54	0.52	0.48
1994-2002	0.52	0.45	0.35
1953-1973	0.46	0.25	0.00
1983-2002	0.40	0.33	0.22
1983-2004	0.33	0.33	0.28

Source: Bureau of Economic Analysis, Board of Governors of the Federal Reserve System.

Chart 3

PCE DEFLATOR-BASED INFLATION RATE



Source: Bureau of Economic Analysis

tion, the typical behaviour of the targeted natural rate of interest rate along the cycle is to be lowered with output to the point where it is close to zero, after the trough of the recession, followed by a rise to a level of 3 or 4% at the peak of the boom.

In the introduction we mentioned that there were two difficulties in conducting optimal interest rate policy within our framework. The first stemmed from the need to find series that can track the movements of the natural rate of interest. The GDP growth rate, or detrended output seem to fare well on that criteria. The second difficulty is related to finding a policy design that ensures a unique equilibrium. Since global uniqueness is not achievable, we will take comfort in local uniqueness. We now turn to the discussion of this latter issue and will see that it is in guaranteeing local uniqueness that there is a role for inflation in the interest rate feedback rule.

3. TARGETING THE NATURAL RATE OF INTEREST: LOCAL UNIQUENESS

In the simplified framework all that interest rate policy has to do in equilibrium is to track the natural rate of interest. Without knowledge of the underlying shocks and the true model of the economy that would reveal the equilibrium rate associated with a particular history of shocks, the knowledge of the historic correlations between output and the real interest rate can be useful. In the previous section we have documented that in periods of low and stable inflation, and thus in periods, where we trust, the real rate of interest was the natural rate, the one under flexible prices, the correlation is positive and high.

Tracking the real interest rate in this manner is a necessary condition to confirm a path of low and stable inflation which is the optimal equilibrium path in this set up. It is not sufficient. Every interest rate policy generates multiple paths, possibly converging to a steady state. When there is a single path converging to a steady state, while all the other equilibrium paths do not, we say that there is local determinacy. It is little comfort that, within a multiplicity of equilibrium paths, there may be a single path converging to a steady state. Still there is a huge literature on conditions for local determinacy. In a class of models, those conditions are that the response of the nominal interest rate to inflation be positive and high. Out of equilibrium variations in inflation require a response in the nominal interest rate that has to be higher than the variation itself. The intuition is straightforward. Let us consider the following linear approximation to the Fisherian equation in a deterministic model

$$i_{t+1} = r_{t+1} + \pi_{t+1}$$

where i_{t+1} is the nominal interest rate between period t and $t+1$, r_{t+1} is the real interest rate and π_{t+1} is the inflation rate. If interest rate policy is described by the following rule

$$i_{t+1} = r_{t+1} + \alpha\pi_t$$

where $\alpha > 1$, then the resulting equilibrium dynamic equation is

$$\pi_{t+1} = \alpha\pi_t$$

There are two types of solution of this equation. Either

$$\pi_t = 0,$$

or π_t is explosive when it starts from any other point. In this case the equilibrium with zero inflation is locally determinate. Notice that the policy rule is such that the interest rate responds to realized inflation rather than a forecast of inflation. If that was the case the equilibrium equation would be

$$\pi_{t+1} = \alpha\pi_{t+1},$$

so that, for $\alpha \neq 1$, the forecast of inflation would be pinned down but not current inflation.

When $\pi_t = 0$, in equilibrium, policy is conducted so that

$$i_{t+1} = r_{t+1},$$

implying that it is necessary to identify the real rate of equilibrium under flexile prices in order to be able to target zero inflation. For this reason we looked at the behaviour of the real interest rate when the frictions resulting from sticky prices were made redundant by restricting attention to periods of low and stable inflation.

4. CONCLUDING REMARKS

In a world with very low and stable inflation, firms that are restricted in the setting of prices and unrestricted firms charge the same prices. Sticky price restrictions are not binding. In that world the real interest rate is the natural rate of interest, the one that would hold under flexible prices. In order to infer the behaviour or the natural rate of interest we identify time periods for the post-war US economy where inflation was low and stable and compute the correlation of the nominal interest rate with measures of economic activity.

We observe that the correlation between the real interest rate and fluctuations in GDP is high for periods of low inflation, contrary to the figure for the whole period, where it is close to zero. If the task of interest rate policy is to track the natural rate of interest, thus ensuring a stable price level, then it is justifiable to follow the principle of raising the interest rate with output in booms and lowering it in recessions around a low average positive rate. The interest rate should also react to inflation as a means of guaranteeing local uniqueness of equilibrium.

Unfortunately, in deriving the goal of policy to be the target of the natural rate of interest we have abstracted from important issues in what concerns the underlying framework. In particular we have ignored the need to raise revenue with distortionary taxes and the welfare cost of the money demand distortions. We have also followed a simplistic approach to the estimation of the natural rate of interest. Also, local uniqueness of equilibria is little comfort when it may be associated with global indeterminacy (see Benhabib, Schmitt-Grohe and Uribe, 2001). Finally, we have assumed that the nominal rigidity is due to sticky prices and have not considered the possibility of other sources of distortions, such as sticky wages or segmented asset markets.

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Box: OPTIMAL FISCAL AND MONETARY POLICY

In this box we describe optimal policy in the environment in Correia, Nicolini and Teles (2004)[(1)]. In this environment there is underlying uncertainty resulting from shocks to technology and public expenditure. The agents are households, firms that are monopolistic competitive and set prices in a staggered manner as in Calvo (1983), and a government. The households have preferences over final consumption goods and leisure. The consumption goods are a composite of differentiated goods produced by the different firms with labour. Money is used for transactions. The government must finance revenues with distortionary taxes on consumption and labor income as well as a profit tax and is not able to issue state-contingent debt.

There are multiple sources of distortions in the economy. The unavailability of lump sum taxes makes it necessary for the government to raise revenue with consumption and labour income taxes creating wedges in the marginal choice between consumption and leisure. Since the firms are monopolistic competitive, prices are set with a mark up over marginal cost which is also a source of inefficiency. The fact that firms face different restrictions on the timing of price changes may create a relative price distortion since firms that are otherwise identical may charge different prices. This is a productive inefficiency since production would take place inside the production possibilities frontier. A positive nominal interest rate distorts the demand for money inducing agents to spend productive resources on transactions. Finally, the inability of the government to issue state-contingent debt may also add to the welfare cost of distortionary taxation, since it may limit the capacity of the government to deal with uncertainty in expenditure and revenue.

In this complex environment where there is a trade-off between different distortions, it is feasible and optimal to eliminate every distortion except for the necessary wedges in the decision of consumption and leisure arising from the absence of lump sum taxes. The mark up distortion is eliminated with the revenue from the profit tax. The money demand distortion is eliminated with the Friedman rule. The distortions associated with price stickiness are dealt with a policy that promotes the stability of the price level net of consumption taxes (producer price level). The elimination of these distortions is consistent with the policy aim of achieving productive efficiency according to the principle in Diamond and Mirrlees (1971) that even in a second best environment productive efficiency is optimal. This is compatible with the Friedman rule since the optimal use of consumption taxes allows the price level gross of consumption taxes (consumer price level) to change according to fluctuations in the real interest rate. Consumption taxes also allow to replicate real state-contingent debt with ex-post volatility of the price level gross of consumption taxes.

More precisely, the rationale for the optimality of the Friedman rule is the following: The nominal interest rate is the price charged on the use of money. In case it is higher than the production cost of money then it includes a tax on money. The usual assumption on the production cost is that it is negligible, so that whenever the nominal interest rate is positive we say that money is being taxed. There are two good reasons to set the nominal interest rate equal to zero. While final goods in general should be taxed that is not the case with intermediate goods. Taxation of intermediate goods creates inefficiencies in production that should be avoided. Money is obviously not a final good but, rather, an intermediate good that is useful to perform transactions. For this reason money should not be taxed. But there is an even stronger reason to charge a very low price on money. Money is a good that has a very low cost of production. The cost in producing coins or bank notes is not zero but it is very low. Even if the proportionate tax on money was positive and very high, when applied to a very low cost of production, the resulting price charged for the use of money would also be very low[(2)]. This is the second reason not to tax money.

The policy of a zero nominal interest rate is consistent with the principles of optimal taxation from another angle. In particular, it is consistent with no price dispersion across firms that only differ on the price setting restric-

(1) *See also Siu (2004), Schmitt-Grohe and Uribe (2004), Benigno and Woodford (2003), Chari, Christiano and Kehoe (1991) and Lucas and Stokey (1983).*

(2) *Since the nominal interest rate (i_t) is the price of money, it can be written as a function of the production cost of money (γ) and the proportionate tax rate on money (τ_t^m) as: $i_t = \gamma(1+\tau_t^m)$. For γ arbitrarily close to zero, a positive i_t entails an arbitrarily large τ_t^m.*

tions. For this it is necessary that the producer price level be stable. If the price level is stable, then firms that are not able to set prices will charge the same price as the unrestricted firms. A stable producer price level is optimal according, again, to the principle that, even in a second best world, it is not desirable to create distortions in production.

When the nominal interest rate is zero, since the real interest rate fluctuates around a positive average, and because the nominal interest rate is roughly equal to the real rate plus expected inflation (gross of taxes), it must be the case that expected inflation is different from zero and fluctuates with the shocks. With consumption taxes the movements in the inflation rate can be captured by policy movements in those taxes still keeping the producer price level constant.