Balázs Krusper and Katalin Szilágyi: How can an interest rate rule reflect real economic considerations?*

Since March 2011 the projections published by the Magyar Nemzeti Bank have been prepared using the Monetary Policy Model (MPM), in which interest rates are determined endogenously as a function of macroeconomic variables. This paper explains the characteristics of the interest rate rule of the model. First, the interest rate rule assures that monetary policy stabilises inflation over the appropriate horizon (generally approximately eight quarters), that is, it achieves medium-term price stability. Second, it takes into account the considerations of the real economy (both directly and indirectly), that is, it does not make excessive real economic sacrifices to achieve its primary objective. We demonstrate through simulations in the MPM model that monetary policy can attach more weight to real economy considerations if it broadens its horizon, that is, if it becomes forward-looking. This means that if monetary policy looks through short-term surges in inflation, then in the event of an adverse cost-push shock it need not aggravate the slowdown of the real economy to combat inflation. Moreover, this forward-looking rule which neutralises only second-round effects provides for more favourable trade-off between the objectives of inflation and the stability of the real economy than a direct increase in the weight of real economy consideration in the interest rate rule.

INTRODUCTION

Since March 2011 the projections published by the Magyar Nemzeti Bank have been prepared using an endogenous interest rate path. This means that the projection is not meant to answer the question of how the key variables would change assuming that the central bank remains passive and does not change the prevailing interest rate. Instead, we attempt to identify the interest rate path needed for inflation to develop in line with the inflation target over the time horizon relevant for monetary policy. The resulting projection assumes that the central bank 'does its job' as specified in its mandate and reacts to macroeconomic processes.

In determining the interest rate path, we need to consider that the primary objective of monetary policy is to achieve and maintain price stability, and – without jeopardising the primary objective – monetary policy also strives to smooth economic cycles, that is, it pays special attention to the output gap (the difference between actual output and its potential level). Furthermore, the central bank also takes into account financial stability, as because the efficient operation of monetary transmission requires the uninterrupted operation of the financial intermediary system.

Accordingly, the interest rate rule used in the projection assures that monetary policy stabilises inflation over the appropriate horizon (generally approximately eight quarters), that is, it attains medium-term price stability. Furthermore, it takes into account the considerations of the real economy, that is, it does not make excessive real economic sacrifices to achieve its primary objective. Finally, the interest rate rule tries to mitigate the effects of any shocks arising from the financial markets in that it directly responds to changes in the risk premium.

The paper demonstrates that the interest rate rule describing the systematic behaviour of monetary policy may take into account real economic considerations both directly and indirectly. Direct reaction means that the central bank immediately responds to any change in the output gap, thereby dampening fluctuations in the real economy. Another, less direct mechanism which is also conducive to incorporating real economy considerations is when the central bank reacts to expected medium-term inflation, or it looks through one-off changes in the price

* The views expressed in this article are those of the author(s) and do not necessarily reflect the offical view ot the Magyar Nemzeti Bank.

level that do not affect the underlying inflation rate. We have incorporated the direct reaction and both types of indirect solutions into our interest rate rule: it aims for the stabilisation of forward-looking inflation with the effects of changes in indirect taxation filtered out. We also demonstrate that broadening the horizon of monetary policy (i.e. increasing the forward-looking nature of inflation reaction) provides for better trade-off than intensifying direct real economy reactions would in cases where the two possible central bank objectives, the stabilisation of inflation and output, would require interest rate responses in opposite directions.

THE ROLE OF MONETARY POLICY AND CRITERION FOR ITS SUCCESS

Macroeconomic variables are diverted from the equilibrium path by various shocks, returning to equilibrium gradually through various adjustment mechanisms. Economic policy (including monetary policy) may help to achieve that shocks divert variables to the smallest possible degree and that they return to the equilibrium path as soon as possible after the shock. Monetary policy is successful if it can reduce the volatility of important variables, that is, if it can stabilise the economy.

The macroeconomic indicators that are of key importance for monetary policy are inflation and output. According to the Central Bank Act, the primary objective of monetary policy is to achieve and maintain price stability. In other words, the central bank is successful if it can minimise the deviation of inflation from the target. On the other hand, without jeopardising the primary objective, monetary policy also strives to smooth real economic cycles, that is, it pays special attention to the output gap.[1]

In certain cases, inflation and the output gap move in the same direction. For instance, in the event of a positive consumption shock the output gap widens while demand pressure increases inflation. In such cases, the direction of interest rate actions can be easily determined because both inflation and real economic considerations justify a rate increase: the goals of stabilising inflation and the real economy are not in conflict.

In other cases, however, considerations relevant for monetary policy would demand interest rate measures in opposite directions. This tends to happen at times of cost-push shocks. Let us consider, for instance, an oil price increase. In this case the output level declines, the output gap becomes negative temporarily while inflation rises due to the cost pressure. Monetary policy faces a trade-off: reducing inflation would require higher interest rates but this would open the negative output gap even wider. Consequently, the goals of stabilising inflation and the real economy are in conflict, that is, disinflation demands a sacrifice in the real economy. In such cases, the response of monetary policy depends on the weight attached by the policymaker to the different objectives: the stabilisation of inflation and the real economy (which in this case require monetary policy actions in opposite directions).

MODELLING MONETARY POLICY – THEORETICAL CONSIDERATIONS

If we want to model the behaviour of monetary policy, the above considerations are best captured by a loss function. The loss function contains the deviation of the target variables (inflation and output gap) from their equilibrium values. This reflects the fact that monetary policy seeks to stabilise both inflation and output along the long-term equilibrium path. The further the current value of the variables is from the equilibrium level and the longer it stays there, the greater the loss.

In addition to inflation and output gaps, the change in the nominal interest rate also tends to be included in the loss function. That is because central banks, with the exception of extreme cases, change interest rates gradually, in several steps and they try to avoid major interest rate movements that have the risk of a fast reversal. Therefore, the loss function can be expressed as follows:

$$Loss = w_1\,(\text{deviation of inflation from its target})^2 + w_2\,(\text{output gap})^2 + w_3\,(\text{interest rate change})^2 \qquad (1)$$

This formulation relies on two assumptions. First, divergence from the equilibrium level causes the same magnitude of loss for monetary policy in both directions, that is, both positive and negative deviation is costly. Second, the further a variable departs from the equilibrium level, the greater the loss. This means that if, for instance, inflation is significantly above target, a 1 percentage point additional increase has more severe consequences than a same magnitude of increase with inflation starting from a level near the target (for example because of the higher risk of expectations becoming unanchored). The same rationale applies to the real economy: in the event of a deep recession any further decline in output is more detrimental than it would be if output had been close to the potential

[1] In line with mainstream macroeconomics, we assume that monetary policy has no effect on long-term economic trends. Thus monetary policy can only stabilise the output gap, the cyclical component of the output, while it has no influence over potential output.

level. Finally, the coefficients of the variables (w_1, w_2 and w_3) express the preferences of policymakers, that is, the weight they attach to each variable.

Accordingly, monetary policy-making can be interpreted as searching for an interest rate path that minimises the value of the loss function. Consequently, we need to determine how to derive an interest rate path from the given loss function.

We have two options for this. First, the interest rate path that minimises the value of the loss function can be computed directly in the course of any projection. Among best practice central banks, only the Norwegian central bank applies this method.

The other option is to incorporate an interest rate rule in the projections that shows the reaction of monetary policy to changes in the various macroeconomic variables (e.g. expected inflation, output gap).[2] This approach is more common because the interest rate rules make it easier to understand the factors that play a key role in achieving an interest rate consistent with the projection. Consequently, the interest rate path is easier to communicate to the general public, and thus allows for more transparent monetary policy making.

The key consideration for the design of the interest rate rule is to minimise the value of the loss function. This requirement is generally satisfied if the interest rate rule contains the variables that monetary policy wishes to stabilise. Consequently, the two approaches lead to similar results. It is easy to see that the loss function can almost always be well represented with a much simpler interest rate rule.

It should be noted that the choice between the two options is fundamentally a modelling (technical) issue: a decision on the way to reflect the rule-based behaviour of monetary policy in the projection. For both options, we assume that the central bank systematically reacts to changes in the macroeconomic situation by adjusting the interest rate, that is, it is committed to rule-based behaviour. Rule-based behaviour is important so that the central bank can coordinate the expectations of economic agents and thus provide guidance in their forward-looking decisions.

MODELLING OF MONETARY POLICY – THE INTEREST RATE RULE

The following factors are considered in designing the interest rate rule:

1. **Price stability:** According to the Central Bank Act, the primary objective of the MNB is to achieve and maintain price stability. Consequently, we need an interest rate rule that stabilises inflation over the horizon of monetary policy, assuring that inflation is in line with the target.

2. **Real economic considerations:** In certain cases, the immediate stabilisation of inflation would require major real economic sacrifices; therefore, the rule must also take into account the output gap (directly and/or indirectly).

3. **Financial stability considerations:** Dysfunctions in the financial intermediary system have severe macroeconomic consequences; therefore, monetary policy must strive to prevent such occurrences. We present this by making the rule consider any temporary increase in the risk premium.

4. **Theoretical preferences of policymakers:** When the considerations of the stabilisation of inflation and the real economy are in conflict, the weights attached to the various considerations need to reflect the preferences of policymakers.

As the first step of designing the interest rate rule, we need to specify the scope of variables that monetary policy will react to. Then, in the next step we need to set the size of the reaction.

Interest rate rules in international practice

Table 1 shows the variables included in the interest rate rules of the projection models used by best practice central banks and various international organisations.

The review of international practices offers important lessons. First, inflation is always included in the interest rate rule. The central banks reviewed use a total inflation indicator (rather than inflation net of tax changes) while experience shows that interest rate policy tends not to

[2] As the interest rate rule describes the response of monetary policy to changes in variables, it is also called a monetary policy reaction function.

Table 1
Variables in the interest rate rule – international outlook

	Central bank / International organization	Variables in the interest rate rule			
		Inflation		Output gap	Financial stability
		Horizon (quaters)	Price index		
1	Canada	4	total inflation	yes	–
2	Czech Republic	4	total inflation	–	–
3	Norway	0	total inflation	yes	interest rate gap
4	Sweden	0	total inflation	yes	real exchange rate
5	New Zealand	0	components of inflation*	–	–
6	United Kingdom	0	total inflation	yes	–
7	ECB	0	total inflation	yes	–
8	IMF	3	total inflation	yes	–
9	European Comission	0	total inflation	yes	–
10	**Hungary**	**4**	**inflation excluding indirect taxes**	**yes**	**cyclical component of the risk premium**

** Differentiates between the inflation of traded and non-traded goods.*

respond to indirect tax rate changes.[3] Furthermore, with the exception of New Zealand,[4] they do not differentiate between components of inflation, that is, they react to changes in core inflation and non-core inflation with the same force.

The second lesson: monetary policy takes into account real economic considerations. However, central banks use different methods for this purpose. The most common solution is to directly include the output gap in the interest rate rule (e.g. Norway, Sweden, United Kingdom, ECB, European Commission). Another possibility is to extend the horizon of forward-looking inflation: the more forward-looking the inflation monetary policy reacts to, the more it looks through the direct price increasing effects of shocks and, implicitly, the more it takes into account the considerations of the real economy (e.g. Czech Republic). This is because the medium-term inflation outlook is affected by the demand environment rather than by one-off cost-push shocks. Finally, another factor increasing the weight of real economic considerations is the keener reaction of monetary policy to the component of inflation that moves closely together with the output gap (e.g. the inflation of non-traded goods such as in New Zealand). As the solutions are substantively similar, they can also be combined, which is the route chosen by Canada or the IMF.

Interest rate rule in the MPM model

The same considerations were taken into account in designing the MPM model.[5] The interest rate rule contains the interest rate of the previous period (R_{t-1}), the long-term neutral rate of interest ($\bar{R}_t$), the expected deviation of inflation from its target ($\hat{\pi}_{t+4}$), the output gap ($\hat{Y}_t$) and the deviation of the risk premium from its long-term value ($\widehat{PREM}_t$):

$$R_t = \delta_1 R_{t-1} + (1-\delta_1)[\bar{R}_t + \\ + \delta_2 \hat{\pi}_{t+4} + \delta_3 \hat{Y}_t + \delta_4 \widehat{PREM}_t] \qquad (2)$$

As in most examples, monetary policy responds to changes in the price index of the total consumer basket in our case as well. However, as indirect tax rates in Hungary have been subject to countless changes in recent years, this aspect is worth incorporating explicitly. Consequently, the interest rate rule contains a price index net of indirect tax rate changes.

Considerations of the real economy are presented in the interest rate rule of the model through three channels. First, the output gap is included directly. Second, we filter out from inflation the effects of tax changes; monetary policy does not react to those. Finally, the interest rate depends on the inflation rate projected four quarters

[3] For more detail, see Felcser (2013).
[4] In New Zealand monetary policy places more emphasis on the inflation of non-traded goods. This is because New-Zealand is a commodity exporter, and thus global commodity prices have a direct and strong effect on the total price index.
[5] For the detailed description of the MPM model see Szilágyi et al. (2013).

ahead rather than the current rate. This indirectly captures the behaviour that monetary policy responds only to the second-round effects of price-level-increasing shocks.

CALIBRATION OF THE INTEREST RATE RULE

Next, we explain how we calibrated the interest rate rule in light of the above considerations. We focus on the choice between the possible ways of taking real economic considerations into account. The answer to that question depends on the characteristics of the economy concerned and the size and frequency of economic shocks; there is no single right choice.

To answer the question, we performed a simulation to establish the volatility of inflation and of the output gap with different interest rate rules if the Hungarian economy is subjected to shocks that are shown to be typical based on historical evidence.[6] As the objective of monetary policy is to stabilise these two variables, the interest rate rules that keep both inflation and the output gap low are considered to be good.

Chart 1 illustrates how the various interest rate rules can be judged in this framework. The dots in the chart show the volatility of inflation and of the output gap under the given interest rate rule. The horizontal axis shows the standard deviation of the output gap. In other words, the further left the result is positioned, the more successfully monetary policy stabilised the real economy. The vertical axis denotes the standard deviation of inflation. Monetary policy is successful in stabilising inflation if its variance is low, that is, it occupies a lower position in our chart.

This approach is helpful in assessing the cost-benefit tradeoffs determined by the various interest rate rules. For instance, in Chart 1 the rule that takes us to point (A)[7] is clearly better than Rule (B) because it is more successful in stabilising both inflation and the real economy. By contrast, the choice between Rule (A) and Rule (C) is not that clear: the latter is better at reducing the volatility of the output gap, but this has a cost in terms of inflation. We face the same trade-off between Rule (A) and Rule (D) but the extent is different: relative to Rule (C), the same real economic benefit has a much higher inflation cost. Consequently, if we have to choose from among these four rules, then

1. we can exclude Rule (B) as Rule (A) is better in every respect;
2. we can also exclude Rule (D) as Rule (C) allows for better trade-off relative to (A) than (D) does;
3. the choice between (a) and (C) depends on the preferences of policymakers.

In our international benchmarking we have seen that the most common interest rate rules include real-time inflation and the output gap. Therefore, we chose such a rule as our starting point. Chart 2 shows the extent that this interest rate rule stabilises inflation and the output gap.

Chart 1
Valuation framework for the interest rate rules

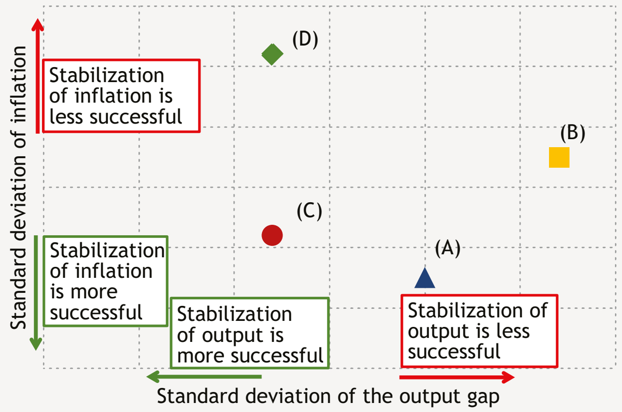
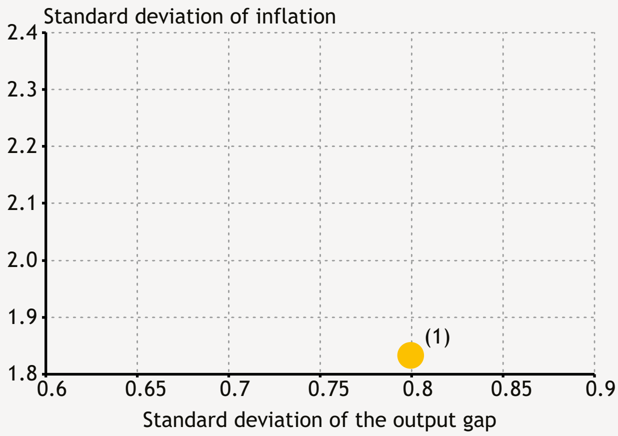


Chart 2
The stabilisation performance of the interest rate rule – real-time inflation and direct output gap reaction



[6] In the simulation, we simultaneously used demand, supply and financial shocks. We drew the shocks from a normal distribution with zero average. The variance of the corresponding distribution is identical with the historical variance of the shock concerned.

[7] Hereinafter we call this Rule (A).

Chart 3
Changing the interest rate rule – different coefficients of the output gap

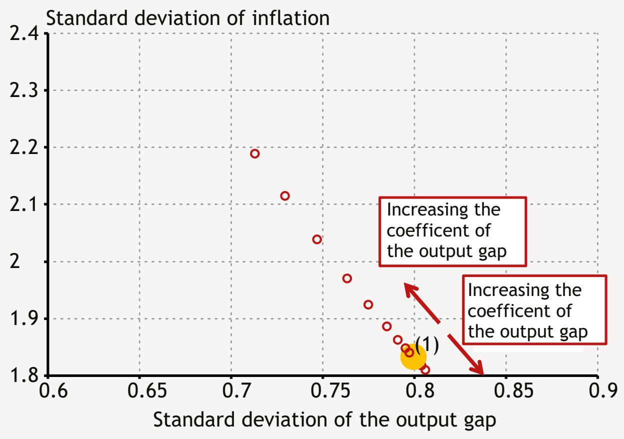


Chart 3 illustrates the outcome of changing the coefficient of the output gap. We can see that the higher the coefficient, the more successful monetary policy becomes at stabilising the real economy, but this comes at a substantial cost in terms of inflation. Reducing the coefficient moves us in the opposite direction.

Next, we examined the consequences of a stronger monetary response to changes in core inflation. As core inflation and the output gap show a closer co-movement than other items outside core inflation, this also increases the weight of real economic considerations implicitly. Chart 4 shows that we face a trade-off in this case as well: if the real economy becomes more stable, the volatility of inflation increases.

Chart 4
Changing the interest rate rule – stronger reaction to core inflation

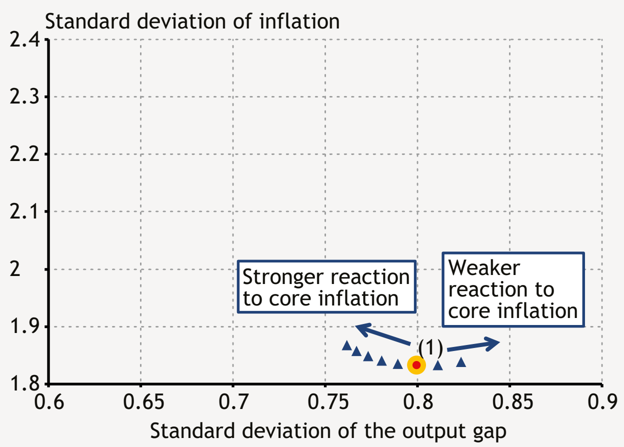
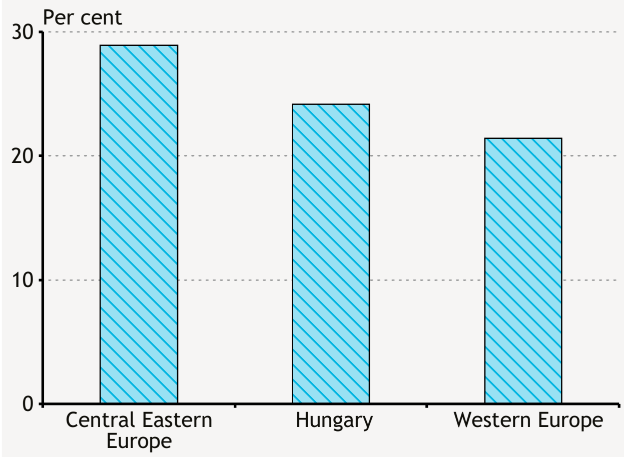


Chart 5
Weight of cost sensitive products in inflation

(average of 2002–2012)



Note: We classified Bulgaria, the Czech Republic, Estonia, Poland, Latvia, Lithuania, Hungary, Romania, Slovakia, Hungary and Romania in Eastern Central Europe. The category of Western Europe includes the other EU Member States.
Source: Authors' calculations on the basis of Eurostat data.

Finally, the third option is to increase the forward-looking nature of inflation foresight. If monetary policy takes into account the expected future inflation rate, it looks through the direct price level increasing effects of shocks and responds only to second-round effects. This method may be useful if the economy is often hit by cost-push shocks and these shocks have a strong impact on inflation. In the case of Hungary, the inflation components that are driven by costs[8] have a larger weight than in Western European countries (Chart 5). Accordingly, we can expect that it may be expedient to make the inflation reaction forward looking.

As indicated in Chart 6, the rule that looks one or two quarters ahead performs better in terms of stabilising both inflation and the output gap than the reference rule. Any further extension of the horizon has inflation costs, which continue increasing and at a certain point both inflation and real economic performance start to deteriorate.

If we compare the three changes presented above, we can decide which one offers more potential to reflect real economic considerations in the interest rate rule. Chart 7 shows that if the horizon of the inflation reaction is changed, the stabilisation of the output gap is much more successful, while its inflation cost is much smaller than in the case of the adjustment of the coefficient or weight of core inflation. In the projection, we use interest rate rule (2) because any more expansion of the horizon (an upward

[8] Food, petrol and market energy.

Chart 6
Changing the interest rate rule – more forward-looking inflation reaction

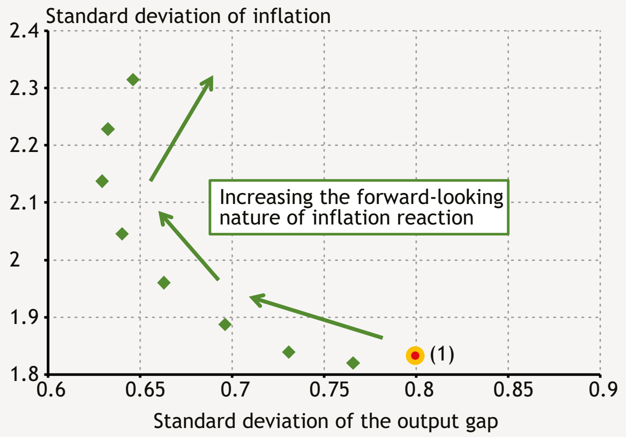
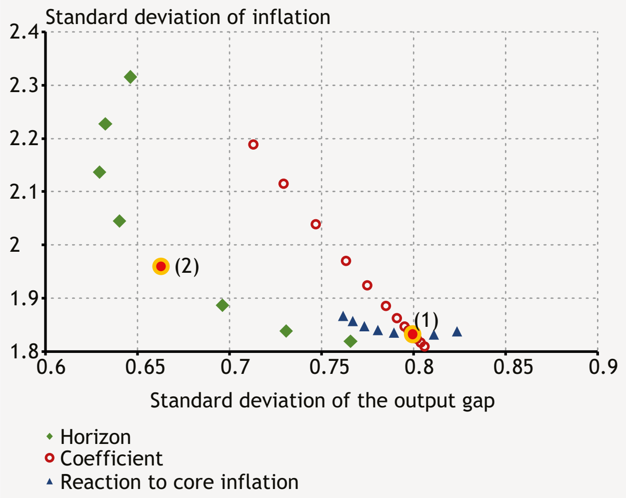


Chart 7
Comparison of the various adjustments



(1) Interest rate rule containing concurrent inflation reaction.
(2) Interest rate rule in the MPM model.

move in the green diamonds) would incur significant inflation costs. The figure also reveals that this rule takes best account of the considerations of inflation and stabilisation of the real economy.

CONCLUSIONS

The projections published by the MNB take into account the systematic behaviour of monetary policy, which we incorporate in the projections through the interest rate rule of the MPM model. Based on the review of the interest rate rules used by other central banks (and international institutions) for projection and/or policy analysis, we can conclude that the modelling of monetary policy is consistent with international best practice.

The interest rate path included in the projection relies on a rule that stabilises inflation on the horizon of monetary policy, while also taking into account of real economic and financial stability considerations. Considerations of the real economy are reflected through three channels. First, the output gap is included directly in the interest rate rule. Second, monetary policy takes into account inflation net of tax changes. Third, the interest rate depends on the inflation rate projected rather than the real-time rate. The latter two factors are conducive to indirectly incorporating real economic considerations. The analysis we conducted indicates that increasing the weight of real economic considerations would incur significant inflation costs, irrespective of whether it is achieved by increasing the direct real economic reaction or the forward-looking nature of the model.

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