The purpose of the comparative analysis was to determine the performance of CBA in comparison with the situation where another monetary system would have ruled in Estonia.

1. Monetary rule

According to Claus-Conway-Scott (2000, p.48), the general form of the monetary policy rule, where the interest rate is the instrument, is as follows:

\[ r_t = r_{eq} + \alpha \text{GAP}_{t+i}^e + \theta (\log(y_t/y_{t-1}) - g^*) + \beta (\pi_{t+i}^e - \pi^*) \]

where \( r_t \) is the short-term nominal interest rate, \( r_{eq} \) is its equilibrium level, \( \text{GAP} \) is the policymaker’s perceived output gap, \( \log(y_t/y_{t-1}) \) is output growth, \( g^* \) is a trend growth rate (which is set equal to the true long-run average growth rate in real output), \( \pi_{t+i}^e \) is the model-consistent forecast of inflation \( i \) quarters ahead, \( \pi^* \) is the target rate of inflation and \( \alpha, \theta, \) and \( \beta \) are response coefficients.

By manipulating the response coefficients, the equation can be transformed into a range of different rules for setting monetary policy. We disregarded the targeting of economic growth from the general form of the monetary rule as it is not very frequently used in practice, and thus \( \theta \) equaled 0. Accordingly, our alternative rule for the CBA was:

\[ r_t = r_{eq} + \alpha \text{GAP}_{t+i}^e + \beta (\pi_{t+i}^e - \pi^*) \]

As the Bank of Estonia lacks the inflation as the operational target we used the long-run value of inflation as a target.

For simulations, we defined the monetary rule in three modes: (a) \( \alpha = \beta = 1 \); (b) \( \alpha = 1, \beta = 0 \); (c) \( \alpha = 0, \beta = 1 \). We also allowed forward-looking and backward-looking behavior. So \( i \) was given three values: \( i = (-1,0,1) \).

In the case of (the Estonian) CBA, the monetary authority (the Bank of Estonia) lacks both the instruments as well as the operational targets in such meaning as they are applied in the Taylor’s definition. Nevertheless, it is possible to form a rule basically similar to the typical monetary rule of the full-fledge central bank. CBA could be considered as the completely credible fixed rate regime (see Devereux-Lane (2000)). In the case of fixed exchange rate, the interest rate is determined by the UIP - uncovered interest rate parity (Benigno- Benigno (2000)). Due the basic resemblance of CBA with the fixed exchange rate regime, the monetary rule of interest rate determination or the UIP is applicable also for the CBA.

2. Policy rule and exchange rate regime

Exchange rate regimes are divided in two (a more detailed approach is not important here): fixed rate and floating rate. There is a relatively clear relation between the policy rule (with the interest rate as the instrument) and the exchange rate regime.
For floating rate, any monetary rule can be used (except UIP). The fixed rate, however, allows only one (quasy) rule - UIP. And UIP as the “monetary rule” is characteristic of only the fixed rate. That means if we want to change UIP – which was our aim in counterfactual simulation – we need to suppose that

a) the exchange rate regime will also change, or
b) we will study closed economy and leave the exchange rate regime unchanged.

The assumption about the substitution of the exchange rate regime is based on the fact that the shift in the interest rate (caused by the central bank) has to bring about a change in the exchange rate. The fixed rate regime, however, excludes the response of exchange rate by definition. UIP implies that domestic-currency interest rate is a passive reflection of devaluation expectations. There is, therefore, no room for active interest rate policy (Flood-Jeanne (2000, p.3)). Accordingly, the fixed rate does not allow any monetary rule, where the interest rate is the instrument, for inflation, etc. targeting.

In order to account for the exchange rate effect of the monetary rule which includes the interest rate as an instrument, we can use the hypothesis of introduction of a completely flexible exchange rate regime. Yet, such regime is not very popular. The managed float regime could rather be considered an alternative to fixed exchange rate and it can be realised in two ways:

1. using several rules and instruments, one of which targets the exchange rate, or
2. using one rule which includes the exchange rate as a target.

The first option will take us to an hypothesis that is difficult to rationalize. The second one, presented by Benigno-Benigno (2000) and Ball (2000) is more true to life. If we proceed from the simple Taylor-type rule, then by adding the exchange rate (e), we get

\[ r_t = r_{eq} + \alpha GAP_t^{\pi_{t+1}^{e_i}} + \beta (\pi_{t+1}^{e} - \pi^*) - \lambda (e - e^*) \]

The monetary rule under the managed float regime, where exchange rate is a target, is close to the fixed exchange rate. Therefore, instead of the fixed rate regime one could use in simulations de facto fixed rate in the form of managed float.

Nevertheless, we took the closed economy assumption as our starting point and left the rate regime unchanged in our experiments. In other words, the closed economy assumption (or one may say - simplification) has been used. In this case the interest rate shift initiated by the monetary authority does not affect the (nonexisting) trade nor financial flows. Such choice was determined by the fact that so far we have been unable to estimate neither of the effects of exchange rate in the Estonian economy. Therefore, the model used in our simulations fails to reflect the role of exchange rate in adjustments and matches the closed economy assumption rather well.

3. Information problem

In my experiments, the monetary authority is assumed to know the true structure of the economy. The monetary authority understands the formation of private agents’ expectations, and is able to use this knowledge to its advantage.

The possession of perfect information entails two things – firstly, the central bank is competent to make 100 per cent adequate decisions. Secondly, the perfect information
assumption allows to realise its decision precisely in accordance with the expectation and intentions. The reality is certainly more complex than the above simplification. Svensson and Woodford state that central bank operates under considerable uncertainty about the state of the economy and the size and nature of the disturbances that hit the economy.

Many important indicator variables for central banks are forward-looking variables, that depend on private-sector expectations of the future developments in the economy and future policy. However, these expectations in turn depend on an estimate of the current state of the economy, and that estimate in turn depends, to some extent, on observations of the current forward-looking variables. This circularity presents a considerable challenge for the estimation problem in the presence of forward-looking variables. (Svensson and Woodford (2000, p.1,2))

The assumption according to which CB has perfect information is useful also for another reason. In addition to eliminating mistakes, perfect information allows the central bank to exogenize the market interest rate (i.e. to make it perform according its discretion) which otherwise would entail a considerable endogenous component.

The exogenous interest rate is important in simulations because there is actually no opportunity to analyse different monetary rules statistically on the basis of Estonian data. Since the Bank of Estonia has never used interest rate as an instrument, it is impossible to estimate a model that would describe the direct effect of the interest rate as an instrument on macro variables \(^1\) (or the effect of the instrument on market interest rate).

If, however, we presume that the CB has perfect information, then the market interest could be considered exogenous with regard to the activities of the CB and that the market rate is completely determined by the operations of the Bank of Estonia. In such case, the market interest rate could be considered as the proxy for the CB instrument.

There is only one way to soften the assumption of perfect information in the comparative analysis of CBA and alternative monetary policies – the stochastic simulation. For the latter, the relations described in model are realised stochastically, i.e. in the simulations the decisions of the central bank do not correspond 100 per cent to perfect information, but contain also mistakes. On the other hand, stochastic simulation provides a possibility that the decisions of the CB will realise in a different way than compared with the intention of central bankers. To conclude, stochastic simulation provides a relatively realistic framework for comparative analysis of monetary rules.

4. Lucas’ critique

In his very influential article, Robert E. Lucas, Jr. (1976) raised a serious critique against econometric models that were used for policy evaluation. The relevance of the Lucas critique lies mostly in the question of how sensitive the macro economic relations are with regard to policy changes. Since the one and only economic policy regime in Estonia during the period under the consideration has been CBA, it is impossible to test the sensitivity of the macro model to economic policy on the basis of Estonian data.

\(^1\) See models listed in Svensson - Woodford (2000, p.13)
Empirical studies of stability regarding the policy regime have rendered ambivalent results. Hallsten (2000) notes that studies that have analysed how a regime shift affects the inflation process, that is, how important the Lucas critique is in practice, have come to different results. In Fuhrer (1995) it is shown, using several different methods, that the Phillips curve for the United States has remained stable during the period 1960 to 1993, despite a shift in the monetary policy regime in 1979. Fuhrer argues that the shift in policy behaviour perhaps was not important enough to derail the empirical performance of the Phillips curve. In economies that recover from hyperinflation, on the other hand, Sargent (1981) finds evidence of a break in the Phillips curve relation. Sargent and Söderström (2000, p.19) claim that Lucas critique fails only in stable environment.

As we know, the Estonian economy was in the transition stage in the analysed period (whatever the definition of the transition be). Transition brings about structural changes and accordingly instability. Following Sargent and Söderström it means that expectations and macro model have to be dependent on the policy regime. Thus we can presume that it is highly probable that our model estimated on macro data is open to Lucas critique. However, it should be stressed that the current study with the simulation of reduced-type model is the first (and therefore naïve) stage in quantitative analysis of monetary policy in Estonia. Needless to say that we have aim of deepening our analysis through the construction and use of the Estonian specific general equilibrium class model.

5. Simulation of alternative monetary policy rules

Let us evaluate the performance of monetary rule in the conventional way - by quadratic loss function. We use the following specification of loss function

\[
\min L = \sum_{t=1}^{N} \omega_y (GAP_t)^2 + \omega_\pi (\pi_t - \pi_{eq_t})^2 + \omega_r D(\pi_t)^2
\]

where \(D(\pi_t)\) is the difference of interest rate; \(\pi_t - \pi_{eq_t}\) is the deviation of inflation from its long-run value; \(\omega_y, \omega_\pi\) and \(\omega_r\) are the weights of output gap, inflation variability and interest rate difference; \(N\) – number of observations.

The higher the value of loss function, the wider the variation of targeted variables (from target) and the less effective the specific rule in reaching targets.

The loss function used contains targets with the equal weights (\(\omega_y = \omega_\pi = \omega_r = 1\)). Such simplification makes the comparative analysis of monetary rules considerably easier since the

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2 The reason why the Lucas critique which importance in theory is commonly accepted has little empirical support lies according to Linde (2000) in low power of test used to detect the applicability of the Lucas critique. The results of examination of properties of super exogeneity test, which is conventional tool, suggest that this test is not capable of detecting the relevance of Lucas critique in practice in small samples.

3 In the conventional sense, transitional economy means (post)socialist economy which is developing from a centrally planned system into market economy. Estonia seems to have almost completed such a transition. However, Estonia still remains a transitional economy – in the sense of accession to the European Union (transition into EU).

4 If the interest rate is an instrument, it could not be the target at same time of course. Anyway it is widely accepted that the CB should consider in his operations also the variability of interest rate. So, the difference of interest rate is usually included in the loss function to smooth the path of interest rate in achieving the operational targets (see Isard - Laxton - Eliasson (1999)).
problematical estimation of weights could be excluded. This, though, need not be the most appropriate solution because the output gap is an unobservable variable. Claus-Conway-Scott (2000, p.46) stress that as the noise in the output gap measure increases relative to the signal on the level of excess demand or supply in the economy, it becomes optimal for policymakers to put less weight on the output gap and more weight on inflation when assessing the state of the economy. In practice, central banks do seem to attenuate their policy responses to the output gap in comparison to the optimal response suggested by economic models.

The historical simulations show that the following performed better
a) unrealistic monetary rules that relied on the variables of the current period, which are actually non-existent (as statistics are produced with a due lag);
b) rules that target only one variable – either output gap or inflation.

Whereas it appears that targeting output gap causes the interest rate volatility to increase drastically. This is due to the fact that output gap makes up approximately ¾ of the loss function (i.e. total variation of gap, inflation and interest rate). The rest of the total variation is divided more or less equally between inflation and interest rate.

It appears that if we use interest rate for smoothening the gap, then the interest rate variation becomes similar to gap (actual) hypervariation. The reason for that is straightforward. The CBA simulations showed that due the openness of the Estonian economy, the output gap depends mostly on foreign demand and the role of domestic demand is marginal. Therefore the smoothing of gap (i.e. domestic demand) through interest rate requires irrational growth of interest rate variability.

The historical simulation showed that only the targeting of inflation could have been hypothetically competitive with CBA – provided that the central bank does not make mistakes, etc.

As noted above, stochastic simulation makes the comparative analysis of monetary rules somewhat more realistic. In stochastic simulation, the interaction described by the model is realized stochastically. Stochastic simulation proves CBA - out of the more realistic options - to be the most suitable for Estonian economy. The advantage of CBA comes from the lowest variation of the interest rate. In the case of other monetary rules, interest rate must vary considerably in order to be able to smooth targeted variable. At the same time, however, the growth of interest rate variation does not counterbalance the decrease in targeted variability.

Although the result – the advantage of CBA – could be guessed intuitively, the reasoning is not in accordance with the views expressed in economic literature. Characteristic to the fixed rate, and accordingly also to CBA, is wider variation of interest rate as compared to other exchange rate regimes (i.e. monetary rules). Interest rate variation results from the fact that in fixed regime there is no adjustment mechanism that derives from exchange rate changes. Adjustment occurs through interest rate changes. In the case of floating rate, however, it is the exchange rate that accounts for the adaptation and therefore interest rate variation is marginal.

5 Stochastic simulation involves solving the model a number of times, each time adding a pseudo-random shock to each equation, and drawing a new set of shocks for each replication. The average of the resulting simulations is a measure of the expected value of the solution.
The reason for the difference lies most probably in the fact that the model used in simulations is actually a model of closed economy as the trade as well as financial flows are exogenous. Since the effect of (actual) exchange rate is not yet discovered in Estonia, the exchange rate stays out of the modeled of adjustment and the adaptation takes place only through interest rate under each monetary rule. This would mean that the conclusions of model simulations cannot be interpreted in the conventional context of exchange rate regime analysis.

6. Conclusions

The simulations show that CBA is the optimal monetary rule for Estonia. The main conclusion of the deterministic simulation of shocks is that shocks adjust to the long-run path and the Estonian currency board is sustainable. The stochastic simulation proves CBA to be the most suitable option for the Estonian economy.

The advantage of CBA derives from the flexibility of the Estonian economy. The flexibility, in turn, stems from the liberalization and openness. Yet it is a one-sided conclusion since it only reflects the short-term effect. In fact, CBA relevantly relates to the long-term aspect as well. The flexibility, liberal organization and openness of the Estonian economy are the results of introduction of CBA (and the reforms initiated thereby). The structure of our economy is endogenous to monetary rule: CBA is most suitable because Estonia has developed a favourable environment for CBA through structural and institutional reforms.

References

Kokkuvõte

ALTERNATIIVSETE POLIITIKA REEGLITE KONTRAFAKTUAALNE SIMULATSIOON EESTIS

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Komparatiivse analüüsi eesmärgiks on selgitada, kuidas toimib valuutakomitee (VK) vörreldes situatsiooniga, mil Eestis kehtiks muu monetaarne süsteem. Hinang konkreetse monetaarsüsteemi efektiivsusele anti sihifunktsooni põhjal, mis peegeldas fundamentaalsest näitajate variatsioonist. Valuutakomitee alternatiivina vaadeldi intressimäära sisuldavat monetaarreeglit, mille üldisest formuleeringust jäeti välja praktikas vähelevinud majanduskasu eesmärgistamine.


VK sobivus tuleneb Eesti majanduse avatusest ja fleksibiilsusest. Samas on taoline järeldus mõneti ühekõlgne, sest see peegeldab vaid lühiajalist efekti. Tegelikult seondub VKga tähelepanuväärsel viisil just pikaajaline aspekt. Majanduse avatus ja fleksibiilus on VK juurutamise (ning sellest tulenevate reformide) järelemeid. Nii on majanduse struktuur
monetaarreegli suhtes endogeenne: VK sobib seetõttu, et struktuursete ning institutsionaalsete reformidega on Eestis kujundatud VK toimeks sobiv keskkond.