3rd Place – Profesor František Vencovský Award
3. místo – Cena profesora Františka Vencovského

Interaction between Monetary and Fiscal Policy in a Small Open Economy with Autonomous Monetary Policy and Fiscal Policy Rule

*Interakce měnové a fiskální politiky v malé otevřené ekonomice v systému s autonomní měnovou politikou a fiskálním pravidlem**

DAVID PRUŠVIC**

1 Introduction

Fiscal policy, as well other economic policies, is not in the system of economic policies alone and doesn´t react quite independently. It is affected and at the same time affects other policies of the state, whether social policy (interaction in the field of social benefits or ways of motivation and labour incentives through the tax system), or the environmental policy, where for example it can determine and control the contamination level, along with other policies and their tools, way of internalization etc. There is also interaction between monetary and fiscal policy. These two fundamental "macro-policies" can influence each other or they can reduce their reciprocal actions, they can be in the position of dominant and inferiority policy. Creating economic policy mix these and surely other reasons must be well-considered in advance, particularly when the both policies are carried out by independent institutions. Then it is appropriate to decide, which one will follow the decisions of the other one or specify a space for its function that doesn't damage slightly function of the dominant policy. Fiscal policy rules could play this role.

The European Union (EU) in the Treaty establishing the European Community delegated the task of monetary policy in the area called Economic and Monetary Union (EMU) to a European Central Bank (ECB) and monetary-policy strategy to a European System of Central Banks. ECB controls reference interest rate in the countries with common currency, on the other hand fiscal policy is provided by each single member state separately. Optimal Currency Area theory considers as important so that in these countries fiscal policy might have the opportunity to respond to local asymmetric shocks, whereas monetary policy to the shocks affecting the whole single currency area. However, when economic systems are not sufficiently harmoni-

* *This paper is part of the GAČR research project no. 402/06/0187.*

** *Department of Public Finance, Faculty of Finance and Accounting, University of Economics, Prague; and Ministry of Finance of the Czech Republic.*

zed, common monetary policy can rather cause damage than help to the economy and fiscal policy won't be able to solve these non-synchronous shocks effectively.

On the contrary there are disadvantages of too autonomous fiscal policies. Firstly they can restrain effects of monetary policy and secondly problem of "free rider" could arise due to single currency and single reference interest rate. Thus there is an effort to backward this adverse consequence of non-coordinated "split" fiscal policies through a fiscal policy rule (an example of this rule in the European Union is known under the label "the Stability and Growth Pact").

The Czech Republic, as an EU member, is subordinate to the Stability and Growth Pact as well and some information and other duties against EU institutions results from it. Conversely the Czech economy is affected by central bank, which is still national economic-policy institution, however its primary objective is price stability through the Bank board agreed regime inflation targeting. The Czech National Bank is perceived as a relatively high autonomy (especially instrumental one) moreover.

Therefore it is convenient to study reaction functions of both economic-policy authorities in a small open economy and to monitor how one authority's decision about intervention effects the other authority's decision. Eventually observe when one of the policies "has to" react to the action and when just "can". These central bankers and governments "games" then have of course different impacts on the economy in the terms of output gap or inflation rate change.

The plan of the study is following. At first a model is developed, which partly follows other authors studies. Being modified by external influences the model is step by step transformed through the central banker's and fiscal authority's loss functions into the central bank's and fiscal authority's reaction functions. The process of adjustment is shown in the model of central bank's and fiscal authority's reaction functions together with the conditions under they lead to convergence and steady state and when conversely divergent. There are also discussed the influences of exogenous shocks on individual reaction functions. Final analytical chapter solves the question how the monetary policy reaction function will change, when the Czech Republic enters the Economic and Monetary Union.

2 A model construction

The basic version of this model comes out from the work of Buti, Roeger, Veld (2001). In this study we "open" it and consider influences that might be fatal for small open economies. Authors like Ball (1998) or Svensson (1998) have dealt in the model applied on open economies, mainly in the view of monetary authorities. Their pieces of knowledge are also used.

2.1 Presumptions of the model

The model is based on the following assumptions. Demand side of the economy is characterised by IS curve for the open economy, its functional record is:

$$y = \beta_B B - \beta_r \left(i - \pi^e \right) + \beta_R R + \varepsilon_1 \quad , \tag{1}$$

where:

y	symbolizes output gap, i.e. the difference between real product (Y) and its potentional level (Y^*),
B	public finance deficit, defined as the difference between government expenditures and revenues ($G - T$), or as a difference between structural budget deficit component (CAB)[1] and its cyclical part: $B = CAB - \alpha y$, where α denotes the budget deficit sensitivity to output gap ($0 < \alpha < 1$)[2],
$i - \pi^e$	expression of real interest rate as a difference between nominal and expected inflation rate (here it is considered traditional simplification , when under the condition of low nominal interest rates and expected inflation rates values it is possible to abstract from term $r\pi^e$ in expression: $i = r + \pi^e + r\pi^e$,
β_B, β_r, β_R	are appropriate coefficients, and
ε_1	represents other demand factors (especially exogenous shocks)

Modified version of the Phillips curve represents the supply side. Modelling the supply side we can start from an original Phillips curve designed by Professor Phillips (1958) on the basis of empirical tests of annual data time series of the Great Britain:

$$\frac{W_t - W_{t-1}}{W_{t-1}} = w_t = \alpha + \beta u_t^{-c} \, , \tag{2}$$

This expression Samuelson and Solow (1960) adjusted by replacing wage rate growth by inflation rate. They supposed that the inflation rate grows if the wage growth exceeds labour productivity growth at the same time:

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{W_t - W_{t-1}}{W_{t-1}} - \frac{Q_t - Q_{t-1}}{Q_{t-1}} \, , \tag{3}$$

where:

π_t	means inflation rate in time t,
P_t	price level in time t, and
Q_t	labour productivity in time t.

Friedman (1968) and Phelps (1967, 1968) Phillips curve enrichment consist in categories like natural unemployment rate (u*) and expectation π_t^e:

---

1 In this study the abbreviation "CAB" indicates the structural part of the budget deficit, not budget balance.

2 The values of budgetary sensitivities vary from 0,27 (Lithuania) to 0,65 (Denmark) in EU-25. Unweighted arithmetical mean is 0,44 in EU-25, the new EU countries (EU-10) reach on average lower budgetary sensitivity (0,36). Budgetary sensitivity of the Czech public finance was estimated as 0,37. (For details see European Commission (2005)).

$$\pi_t = \pi_t^e - \eta\left(u_t - u^*\right). \tag{4}$$

Next we extend the equation No. 4 by supply shocks (ε_2), add the difference between real and natural unemployment rate and from the Okun's law relationship

$$\left(u_t - u^*\right) = -\phi\left(\frac{Y_t - Y_t^*}{Y_t^*}\right)$$

we obtain formula No. 5[3]:

$$y_t = \beta_\pi\left(\pi_t - \pi_t^e\right) + \varepsilon_2. \tag{5}$$

By adding the change of exchange rate between two periods we receive extended Phillips curve for open economy, where β_π and γ and are coefficients implying influence of the expected inflation rate on output gap and of the import prices on the inflation rate and output gap:

$$y_t = \beta_\pi\left(\pi_t - \pi_t^e\right) + \gamma\Delta R_t + \varepsilon_2 \ . \tag{6}$$

For estimation of the fiscal authority reaction function let's simply modify equation No. 1, where we input decomposition of budget deficit to its cyclical and structural part:

$$y = \frac{1}{1-\beta_B\alpha}\left(\beta_B CAB - \beta_r\left(i - \pi^e\right) + \beta_R R + \varepsilon_1\right). \tag{7}$$

The reason of this step is a fact that we will study the effect of discretionary component of the budget deficit on output gap.

For further analysis a "loss" function of fiscal policy authority must be specified. Loss functions have been occurred as minimization of the second power of difference between selected variables and their targeted or claimed values. In this respect it is often used term "central bankers' loss function" that will be discussed in the next part of this paper. Of course, it is possible to develop fiscal authority loss function, e.g. to minimize output gap and structural deficit:

$$L\left(FP\right) = \left(CAB - CAB^*\right)^2 + \Theta\left(Y - Y^*\right)^2. \tag{8}$$

Before deriving own fiscal authority loss function it is convenient, for the purpose of our study, to analyze the European Union fiscal framework briefly.

2.2 European Union fiscal framework

All EU member countries must fulfil the Stability and Growth Pact (Pact) claiming not to exceed 3% reference value, in the case of government deficit (ESA 95 methodology), and 60% of government debt to GDP ratio (the same methodology). The numerical values are

3 Equation No. 5 expresses common formula for Lucas supply curve. See e.g. Hallett, Libich (2007).

determined by Protocol No. 20 on the Excessive Deficit Procedure (annexed to the Treaty on European Union).

EU countries, especially EMU countries, use fiscal rules for security against "free rider" behaviour of their neighbour countries. Without fiscal policy restraint (specifically deficits and debts) in the areas with common monetary policy the "free rider" is able to avoid higher costs – higher interest rates – or the possibility not to borrow (markets would expect too high interest rate or nobody would be willing to lend this government). Every member of the monetary union would fall for an "international moral hazard" – i.e. expectation that other member countries, in case of "free rider" insolvency, would make lend him owed money in order to maintain monetary union. There is also worth mentioning different influence on the common interest rate from economically different powerful member countries. The influence would by higher if the borrower is economically stronger than of economically "weaker" one. Briefly, fiscal policy rule restrains overflowing of negative externality effect.

Generally fiscal rule should serve most of all as framework for politicians, that reduces their behaviour during various phases of the political cycle and thus eliminates their impact on a business cycle. This should result into the public finance and economic stabilisation.

The three and sixty per cent upper limits of the Pact can be considered only as a short flexibility rule demonstration. In the Resolution of the Amsterdam European Council on the Stability and growth pact there is another measurement of the fiscal target – "close to balance or surplus" of the government sector budget. Further since 2005 there has been statement in the Council Regulation[4] about country-difference middle-terms goals[5] effective for those countries that accepted common currency or for ERM 2 members. Specific values of middle-term budget targets vary from -1% GDP to balance or surplus budget (after deduction of temporary and one-off measures).

Another flexibility expression seems to be a duty to take a cyclical position of the economy during excessive deficit procedure into account. In the original Pact statement[6] there was a decline in annual GDP considered as an exception only if the annual real GDP decrease was at least 2%, eventually if the decrease was lower the cumulated GDP loss or the intensity of decrease was considered.

In the "new Pact" there is considered every annual real GDP decrease or accumulated loss during long time period the economy operating under the potentional product as escape clause. [7]

---

4 Council regulation 1055/2005 amending Regulation (EC) No 1466/97 on the strengthening of the surveillance of budgetary positions and the surveillance and coordination of economic policies.

5 Revision of the medium term fiscal framework is possible only if crucial structural reforms have been taken place in the observed economy, otherwise once a four years.

6 Article No. 2, Council Regulation (EC) No. 1467/97 on speeding up and clarifying the implementation of the excessive deficit.

7 Council Regulation No. 1056/2005, amending Regulation (EC) No 1467/97 of 7 July 1997 on speeding up and clarifying the implementation of the excessive deficit procedure.

Moreover in both Pact versions there are mentioned following escape clauses[8]: any unusual event that has negative impact on "government budgets financial situation" and that wasn't be able to change in any way or which was caused by "serious economic downturn" or when the European Commission finds breach of the 3% ceiling as temporary.
New version of the pact includes these additional escapes:

- adverse impact on public finance budgets caused by high cofinance of the European Union structural funds aid,
- whether the excess is temporary and deficit still remains close to 3% value,
- whether the country introduce pension system reform from PAYG scheme to fully funded (net pension reform costs can be "equivalently dissolved" during 5 years).

2.3 Derivation of the reaction functions

For simplicity we suppose that the 3% reference level value for deficit-to-GDP ratio is firstly the "entrance ticket" into excessive deficit procedure, which is ended by either deficit decrease back below 3% limit or, otherwise, by imposing the sanction (see box No. 1), secondly it is a signal towards financial markets, whose possible negative impact governments would like to avoid, and thirdly it is a short-term fiscal rule that is subject of our attention.

BOX No. 1 – Mechanism of the sanctions under the Stability and Growth Pact

Sanction mechanism is a part of the excessive deficit procedure (see table No. 1), whose basic mechanisms are described in article No. 104 of the Treaty on European Union establishment (Treaty) and closer developed in Council Regulation (EC) No. 1467/97 of 7 July 1997 on speeding up and clarifying the implementation of the excessive deficit procedure, amended by Council Regulation (EC) No. 1056/2005.

Table No. 1: Excessive deficit procedure in EU-25 (2002 – 2006)

Country	2002	2003	2004	2005	2006
Austria					
Belgium					
Cyprus	-	-			x
Czech Republic	-	-	x		
Denmark					
Estonia	-	-			
Finland					
France		x	x		
Germany	x		x		x
Greece			x	x	

8 *For various types of escape clauses see e.g. Pružvic (2005).*

Country	2002	2003	2004	2005	2006
Hungary	-	-	x	x	x
Ireland					
Italy					x
Latvia	-	-			
Lithuania	-	-			
Luxembourg					
Malta	-	-	x		
Netherland			x	x	
Poland	-	-	x		
Portugal	x				x
Slovakia	-	-	x		
Slovenia	-	-			
Spain					
Sweden					
United Kingdom			x	x	x
Total	2	1	10	4	6

Note: x denotes country where excessive deficit according to EU Council occurred; – mark for those countries that were not members of the EU in the observed year.
Source: European Commission (2006). Own adjustments.

In the paragraph No. 11 of the mentioned article No. 104 of the Treaty there are enumerated measures that EU Council can use according to its consideration (however till 4months since last EU Council call aimed at the member country to take corrective measures):

- "to require the Member State concerned to publish additional information, to be specified by the Council, before issuing bonds and securities;
- to invite the European Investment Bank to reconsider its lending policy towards the Member State concerned;
- to require the Member State concerned to make a non-interest bearing deposit of an appropriate size with the Community until the excessive deficit has, in the view of the Council, been corrected;
- to impose fines of an appropriate size."

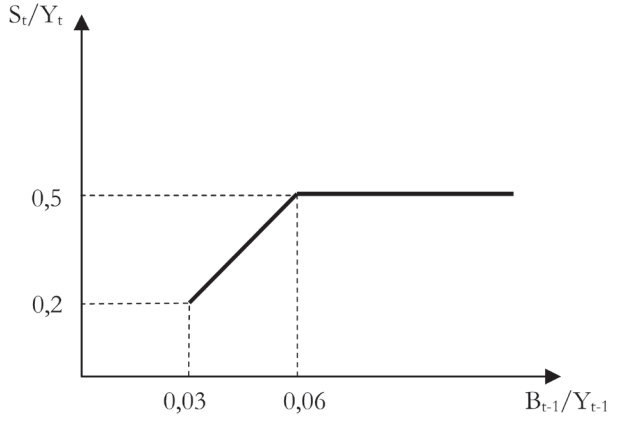
The EU Council should generally ask for non-interest bearing deposit in accordance with Council regulation (ES) No. 1467/97 (article 11).

The height of non-interest bearing deposit is then calculated as percentage of GDP, when no single sanction can exceed 0,5% GDP. The first imposed sanction equals to the sum of a fixed part (0,2% GDP) and flexible sanction part, which measures the degree of reference value exceed (deficit-to-GDP ratio in the last year, when excessive deficit occurred, is taken from 3% reference value and the difference is multiplied by coefficient 0,1). Algebraically speaking:

$$\frac{S_t}{Y_t} = \begin{cases} 0,2 + 0,1 \cdot \left(\frac{B_{t-1}}{Y_{t-1}} - 0,03 \right) \cdot 100 & pro \quad 0,03 \le \frac{B_{t-1}}{Y_{t-1}} \le 0,06 \\ 0,5 & pro \quad \frac{B_{t-1}}{Y_{t-1}} > 0,06 \end{cases}, \tag{9}$$

Picture No. 1 illustrates a development of the potential sanction (non-interest bearing deposit or fine) expressed as GDP ratio in relation to deficit-to-GDP ratio. Substituting maximal possible value of one sanction (0,5% GDP) for S_t into equation No. 9 it is obvious that the sanction corresponds to double deficit value than Stability and Growth Pact allows.

Picture No. 1: Relationship between first sanction and deficit



Source: Cabral (2001), p. 150. Own adjustments.

Next year the Council can decide after imposition of the non-interest bearing deposit sanction to tighten the sanction up as long as the member state donesn´t take adequate corrective measures according to Council requests. This additional deposit is than equal only to the flexible part, however the maximum limit is still valid. If the excessive deficit is not eliminated after two years of this kind of sanction, the Council can convert the deposit into a fine.

Only the Council can call off all above mentioned measures, if it comes to the conclusion that all necessary measures to eliminate the excessive deficit were done, however the deposit converted into the fine is not returnable.

All deposits are invested and interests, as well as fine eventually, are divided among other member countries without excessive deficit. The key for yields allocation is each member state share in total GDP of countries without excessive deficit.

There is no record in the Stability and Growth Pact history that a deposit, much less fine, was applied.

From the text above follows that governments should try to control public finance deficit (B_t) under specific reference value ($\overline{B}$), i.e. $B_t \leq \overline{B}$. Again, by reformulating overall government deficit by its cyclical and structural component we obtain $CAB_t - \alpha y_t \leq \overline{B}$, rearranging this equation we receive coveted fiscal authority loss function:

$$CAB_t \leq \overline{B} + \alpha y_t . \tag{10}$$

Thus governments should make an effort with their structural part of deficit not to exceed a sum of the reference value and cyclical deficit component.

Substituting equation No. 7 in the loss function equation (No. 10) we receive fiscal authority reaction function formula:

$$CAB \leq \overline{B} + \frac{\alpha}{1-\beta_B \alpha}\left[\beta_B CAB - \beta_r \left(i - \pi^e\right) + \beta_R R + \varepsilon_1\right], \tag{11}$$

subtracting CAB on the right equation side:

$$CAB \leq \frac{1-\beta_B \alpha}{1-2\beta_B \alpha}\overline{B} + \frac{\alpha\beta_R}{1-2\beta_B \alpha}R - \frac{\alpha\beta_r}{1-2\beta_B \alpha}\left(i - \pi^e\right) + \frac{\alpha}{1-2\beta_B \alpha}\varepsilon_1 . \tag{12}$$

Simplifying the term No. 12:

$$CAB \leq \rho\left(\frac{1}{\alpha} - \beta_B\right)\overline{B} + \rho\beta_R R - \rho\beta_r \left(i - \pi^e\right) + \rho\varepsilon_1 , \tag{13}$$

where $\rho = \frac{\alpha}{1-2\beta_B \alpha}$.

The term No. 13 is basic for fiscal authority reaction function illustration in the diagram of two instrumental variables of the economic policy: nominal interest rate and structural government budget deficit. A slope of fiscal authority reaction function is determined by fraction

$-\frac{1}{\rho\beta_r}$ and is negative if $\beta_B < \frac{1}{2\alpha}$.

The formula No. 13 shows that increment of the interest rate leads to decrease in structural budget deficit part (or to increase in structural surplus). Conversely, decline of nominal interest rate means possible raise (inequality in the term) of structural deficit component or increase of "manoeuvre" fiscal policy space. Fiscal authority reaction function also quantifies, how much lower must the structural part be to maintain deficit on its reference value (line), supposing it has reached this value, after the interest rate climbed up. An increase in a nominal interest rate by 1 p.p. must be compensated by decrease of *CAB* by

$\frac{\alpha\beta_r}{1+2\alpha\beta_B}$ units.

With similar adjustment we derive monetary authority reaction function. Our starting point is again to find the appropriate monetary policy loss function. According to literature surveys it is often defined as

$$L\left(MP\right) = \varpi_\pi \left(\pi_t - \pi^T\right)^2 + \varpi_E \left(E_t - E_{t-1}\right)^2$$

(see Mandel, Tomšík (2003), or Svensson (1999)), where ϖ_{π} and ϖ_{e} are weights expressing stress put by central bank on inflation target (π^T) or exchange rate, eventually on its change. In the economy with monetary policy strategy of targeting inflation (e.g. the Czech National Bank), we simply assume that such bank prefers to minimize gap of the inflation rate (π_t) and its targeted value (π^T):

$$L(MP) = \left(\pi_t - \pi^T\right)^2 \tag{14}$$

Having specified the loss central banker function let's start with further equation adjustments. At first we put to the equation No. 6 equation No. 7:

$$\varpi\left(\pi - \pi^e\right) + \gamma\Delta R + \varepsilon_2 = \frac{1}{1-\beta_B\alpha}\left(\beta_B CAB - \beta_r\left(i - \pi^e\right) + \beta_R R + \varepsilon_1\right) . \tag{15}$$

A follow up adjustment, interest rate subtracting to the right side and after loss function embody we receive equation No. 16:

$$i = \frac{1}{\beta_r}\left(\beta_B CAB + \varepsilon_1\right) + \frac{\left[\beta_R - \gamma\left(1-\beta_B\alpha\right)\right]R_t + \gamma\left(1-\beta_B\alpha\right)R_{t-1}}{\beta_r} + \\ + \pi^e\left(1 + \frac{\omega\left(1-\beta_B\alpha\right)}{\beta_r}\right) - \frac{1-\beta_B\alpha}{\beta_r}\left(\omega\pi^T + \varepsilon_2\right) \tag{16}$$

Making term No. 16 easier, where $\frac{1-\beta_B\alpha}{\beta_r} = \varphi$, we gain monetary policy authority reaction function:

$$i = \frac{1}{\beta_r}\left(\beta_B CAB + \varepsilon_1\right) + \left(\frac{\beta_R}{\beta_r} - \gamma\varphi\right)R_t + \gamma\varphi R_{t-1} + \pi^e\left(1 + \omega\varphi\right) - \varphi\left(\omega\pi^T + \varepsilon_2\right) \tag{17}$$

A slope of this function is positive, because $\beta_B > 0 \wedge \beta_r > 0$ that's way

$\frac{\beta_B}{\beta_r} > 0$.

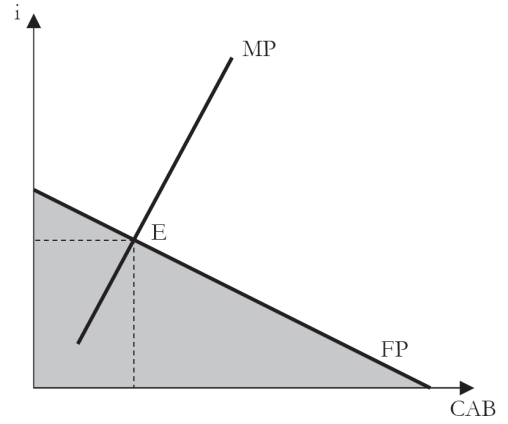
Equation No. 17 postulates that increase in structural budget deficit by one unit leads central bank to increase its interest rate by

$\frac{\beta_B}{\beta_r}$.

Central bank's reaction extent depends on the budgetary sensitivity and real interest rate sensitivity parameter.

Drawing both functions into one graph (picture No. 2) we can see positively sloped monetary policy reaction function and negatively sloped fiscal policy authority reaction function. The intersect of the both curves is an equilibrium E, which means there is no need to change a "policy" of any of the authorities, i.e. nominal interest rate and structural budget deficit of public finance as tools of the both policies are constant. Fiscal and monetary policy are in "steady state".

Picture No. 2: Fiscal and monetary policy reaction functions in a two instrumental variable graph ($\beta_B < 1/3\alpha$)

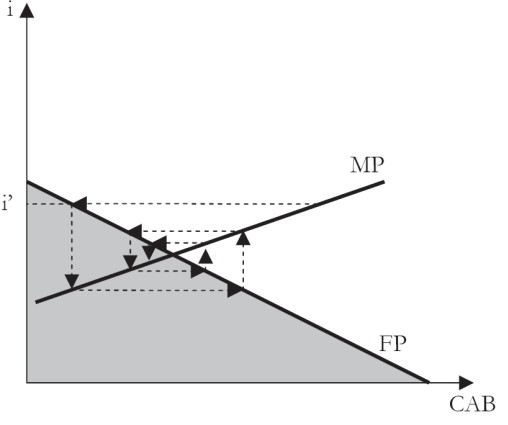


Source: Own.

3 The process of adjustment in the monetary and fiscal policy authority reaction functions model

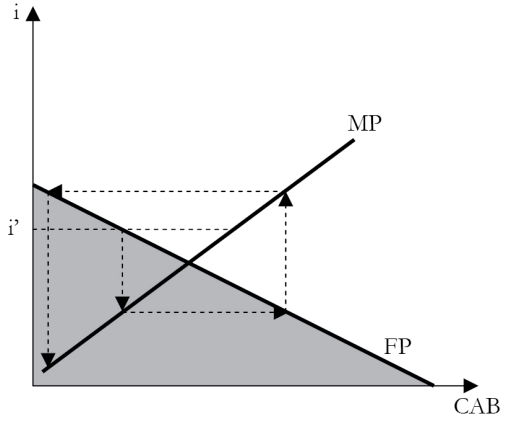
Before determination of the own adjustment process it is appropriate to compare slopes of the both reaction functions, while as we can see in picture No. 3 in this case the process of adjustment leads to the steady state point, on the other hand picture No. 4 shows the diverge process. Main difference between these two graphs is miscellaneous absolute value of the reaction function curve slopes. If the absolute value of the fiscal authority reaction function slope is higher than the monetary one, then the process converges, otherwise diverges.

Picture No. 3: Adjustment process in fiscal and monetary policy reaction functions in a two instrumental variable graph ($\beta_B < 1/3\alpha$)



Source: Own.

Picture No. 4: Adjustment process in fiscal and monetary policy reaction functions in a two instrumental variable graph ($1/3\alpha < \beta_B < 1/2\alpha$)



Source: Own.

Now let's compare the reaction functions slopes and let ask when the absolute value of the fiscal authority reaction function is higher than the monetary one:

$$\left| -\frac{1+2\alpha\beta_B}{\alpha\beta_r} \right| > \frac{\beta_B}{\beta_r} \quad . \tag{18}$$

Solving No. 18 term we achieve this result:

$$\beta_B \in \left(-\infty; \frac{1}{3\alpha} \right) \cup \left(\frac{1}{\alpha}; \infty \right) . \tag{19}$$

On the basis of empirical studies we can assume that $0 < \alpha < 1$, precisely that its value lies somewhere between one third and one half of this interval (see footnote above). The fiscal authority reaction function slope is thus higher provided that β_B parameter takes values between minus infinity and $1/3\alpha$, while in this interval the curve's slope is descending (proof:

$-\frac{1+2\alpha\beta_B}{\alpha\beta_r} < 0$, which is $\beta_B < \frac{1}{2\alpha}$,

whose value exceed the first interval value of the No. 19 term), or values between $1/\alpha$ and plus infinity, where the slope is positive (the proof is analogous with opposite inequality sign).

In the other cases, i.e. $\beta_B \in \left\langle \frac{1}{3\alpha}; \frac{1}{\alpha} \right\rangle$,

the result is divergent and whatever deflection from the steady state doesn't lead to this equilibrium again.

Let's briefly describe a hypothetical adjustment process in the picture No. 3. If central bank raises nominal interest rate above the equilibrium ones, for example because of target

overshooting expectation, government would decline the structural budget component, if limited (our case) by deficit fiscal policy rule and simultaneously if it lies on the limit border. The decrease of the structural deficit part provokes cut in nominal interest rate, which is now higher than equilibrium interest rate. Fiscal policy authority can react (the word "can" represents inequality sign in the term No. 13) by increasing structural deficit component (extension of "manoeuvre government space"). Growing structural deficit part induces in central bank's "mechanism" a need to increase interest rate being afraid of inflation rate growth; however the interest rate rise is not as robust as in the first case. The adjustment process still repeats, while "instrumental variables" values continuously approximate to i and CAB values of the steady state. There is only one point in the graph where no variable tends to change – E.

4 Exogenous variables impact

Table No. 2 sums up impacts of various exogenous variables from the model on the fiscal authority reaction functions.

Table No. 2: Exogenous variables impact on fiscal policy authority decision on structural deficit change

	ε_1	**R**	Π^E
FP	ρ	$\rho\beta_R$	$\rho\beta_r$

Note: For an increase in structural deficit component holds $\beta_B < 1/2\alpha$.
Source: Own.

There is obvious according to signs at single "shocks" from the table that exchange rate depreciation, expected inflation rate growth or exogenous positive demand shock influence public finance positively – they increase manoeuvre space for fiscal policy, eventually allow the government deficit to growth. But this conclusion is valid only if

$$\beta_B < \frac{1}{2\alpha} \ .$$

Otherwise the impact of exogenous variables is inverse.

Next there are shortly described channels, which exogenous variables change causes the fiscal policy instrumental variable change through. The real exchange rate affect through the net export – change of the real exchange rate causes multiplied change of the real product, i.e. change of the output gap that has an effect on cyclical part of public budgetary deficit. The same channel is used by demand shocks. Expected inflation rate influences the structural deficit through the real interest rate and then investments expenditures and product.

Table No. 3 presents, what level and direction of change of the nominal interest rate is caused by exogenous factors in central bank reaction function.

Table No. 3: Exogenous variables impact on monetary policy authority decision on nominal interest rate

	ε_1	ε_2	R_T	R_{T-1}	Π^e
MP	$\frac{\beta_B}{\beta_r}$	$-\varphi$	$\frac{\beta_R}{\beta_r}-\gamma\varphi$	$\gamma\varphi$	$1-\varphi\omega$
Valid for	always	$\beta_B < \frac{1}{\alpha}$	$\beta_B > \frac{1}{\alpha}\left(1-\frac{\beta_R}{\gamma}\right)$	$\beta_B < \frac{1}{\alpha}$	$\beta_B > 1-\frac{\beta_r}{\omega\alpha}$

Note: Positive value means increase in nominal interest rate; negative its decline, however always under the valid condition in the last row of the table.
Source: Own.

The negative supply shock means nominal interest rate growth as we can see in the table, identically depreciation of the exchange rate in the last period (influence of imported goods prices), holding

$$\beta_B < \frac{1}{\alpha} \ .$$

But at the current real exchange rate and expected inflation rate there is a complication, because of too many unknown parameters that don´t allow precisely to determine the direction of change. A real impact is not obvious. Appreciation of the current real exchange rate would reduce nominal interest rate, if

$$\beta_B > \frac{1}{\alpha}\left(1-\frac{\beta_R}{\gamma}\right) \ .$$

Similarly smaller inflation expectation would have the same direction of change if

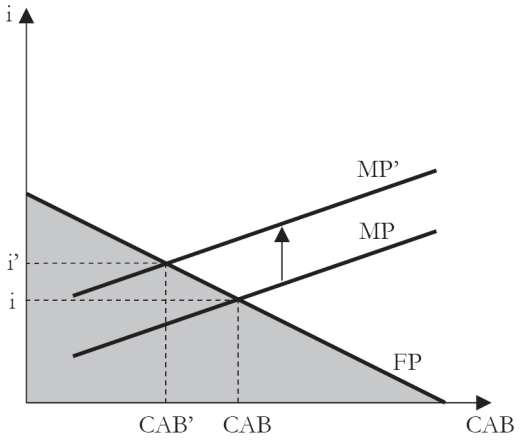
$$\beta_B > 1-\frac{\beta_r}{\omega\alpha} \ .$$

On the other hand the demand shock seems to be least problematic, because $\beta_B > 0 \wedge \beta_r > 0$ then

$$\frac{\beta_B}{\beta_r} > 0 \ .$$

Negative demand shock would press central bank to decline nominal interest rate, whereas positive one to raise it.

Picture No. 5: Negative supply shock in fiscal and monetary policy reaction functions in a two instrumental variable graph ($\beta_B < 1/3\alpha$)



Source: Own.

It is possible to summarize that all exogenous variables affecting fiscal reaction function and supply shock and real exchange rate from previous period affecting monetary policy authority reaction function have the direction of variable change indicated by corresponding sign always, when the fiscal policy reaction function curve is negatively sloped.

5 Interaction between common monetary and national fiscal policy

After the entrance into the Economic and monetary union the economy obtains except common currency common monetary as well. Article No. 2 of the Treaty on European Union establishment among others defines that "The Community shall have as its task … to promote … sustainable and non-inflationary growth…". Monetary policy is then closer specified in the Head VII. of the Treaty ("Economic and monetary policy"), chapter II. ("Monetary policy"), article No. 105, paragraph 1 says that "the primary objective of the ESCB shall be to maintain price stability. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Community…". The Governing Council of the European Central Bank approved price stability criteria: "Price stability shall be defined as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%" (ECB (1998)). In 2003 Governing Council monetary policy strategy reconfirmed and added a request to "maintain inflation rates close to 2% over the medium term" (ECB (2003)).

Putting aside main pillars of the ECB monetary-policy strategy and its tools let's discuss targeted aggregate HICP. Harmonised index of consumer prices is a Laspeyer's kind which compares prices of constant consumer basket in time. Harmonisation of various national consumer price indices has unified internationally different product groups or representative products and their weights. HICP for the whole euro zone is then calculated as a sum of the weighted HICP, where weights are member country´s final monetary expenditures of households to total euro zone final monetary households' expenditures ratios:

$$\pi_{EUR} = \sum_{i=1}^{n} \frac{C_i}{\sum_{i=1}^{n} C_i} \pi_i \ , \qquad (20)$$

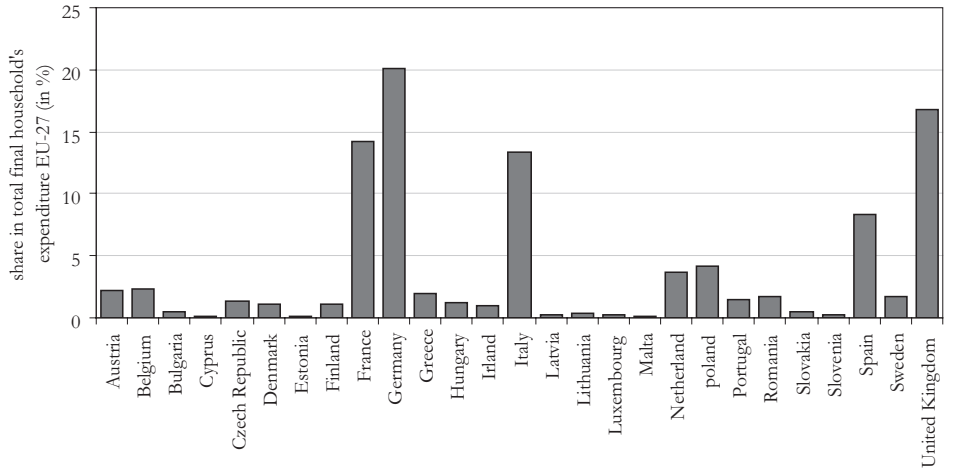
where:

π_{EUR} is harmonised consumer prices index in the euro zone,
π_i harmonised consumer prices index in the i-th euro zone's economy,
C_i final monetary households' expenditures of the i-th euro zone's economy,
n number of countries in the euro zone.

Next two pictures display the European Union weights in HICP calculated for the whole EU-27 and for EU-13 plus the Czech Republic (note: weights relates to 2006). The Czech Republic participates in total EU-27 HICP with only 1,31% (see picture No. 6). The highest shares belongs to German economy (20,1%), then the United Kingdom (16,7%), France (14,2%) and Italy (13,3%); lowest shares to Estonia, Lithuania, Latvia and "island states" Cyprus and Malta. This picture also shows that EU-27 can be separated into 2 groups – those that affect total HICP noticeably and those that have only insignificant influence. Realizing high correlation between final consumption expenditure ratio and shares in total EU-27 GDP (coefficient of correlation: 0,99), final partitions are not surprise.

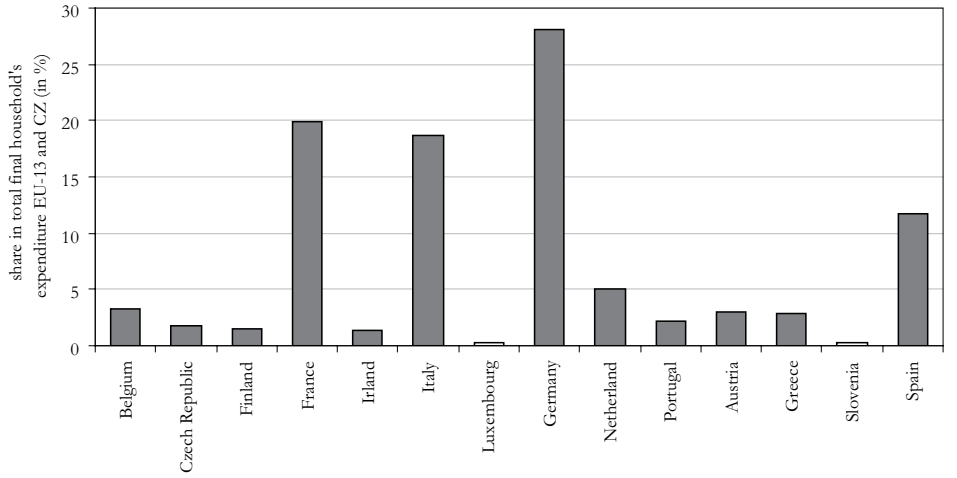
Second picture (No. 7) shows the hypothetical Czech Republic share in euro zone HICP, if the Czech Republic had already participated in the common currency project in 2006. Nor in this case the influence of the Czech inflation rate measured by HICP is high (1,8%). This short analysis can be finalized by partial conclusion about Czech inflation rate taken into account by the European central bank's reference interest rate. The Czech Republic can't expect considerable ECB reaction on domestic inflation development after enter the Economic and monetary union. Instead, reference interest rate will be conformed to inflationary and economic development in the largest and economically strongest euro zone economies.

Picture No. 6: The EU member countries HICP shares in the EU-27 total (2006)



Source: European Commission (2007). Own calculations and adjustments.

Picture No. 7: The EU-13 euro zone member countries´ and the Czech Republic's HICP shares in the euro area plus (2006)



Source: European Commission (2007). Own calculations and adjustments.

Now we can come to derive the European Central Bank loss function formula:

$$L(ECB) = \left(\pi_{EUR} - \pi^{T}\right)^{2}, \tag{21}$$

substituting π_{EUR} for decomposition of the Harmonised index of consumer prices and special expression of inflation rate in the Czech Republic:

$$L(ECB) = \left(\left(\sum_{i=1}^{n-1} \frac{C_i}{\sum_{i=1}^{n} C_i} \pi_i + \frac{C_{CZ}}{\sum_{i=1}^{n} C_i} \pi_{CZ} \right) - 2 \right)^{2} . \tag{22}$$

Thanks to the first derivation of the ECB loss function (equation No. 22) we find out minimum of this function and by expressing the Czech inflation rate we receive No. 23 term:

$$\pi_{CZ} = \left(2 - \sum_{i=1}^{n-1} \frac{C_i}{\sum_{i=1}^{n} C_i} \pi_i \right) \frac{\sum_{i=1}^{n} C_i}{C_{CZ}} . \tag{23}$$

This is again the initial expression for the construction of common monetary authority reaction function. Progress is similar to No. 16 term derivation. But in the first place we

have to distinguish national effects from other euro zone member countries effects (ε_3) on the European reference interest rate:

$$i_{EUR} = \frac{\beta_B}{\beta_r}\frac{Y_{CZ}}{\sum_{i=1}^{n} Y_i} CAB_{CZ} + \frac{1}{\beta_r}\frac{Y_{CZ}}{\sum_{i=1}^{n} Y_i}\varepsilon_1 + \left(\frac{\beta_R}{\beta_r} - \gamma\varphi\right)\frac{X_{CZ}}{\sum_{i=1}^{n} X_i} R_t + \gamma\varphi\frac{X_{CZ}}{\sum_{i=1}^{n} X_i} R_{t-1} +$$

$$+\left(1+\omega\varphi\right)\frac{C_{CZ}}{\sum_{i=1}^{n} C_i}\pi^e_{CZ} - \varphi\omega\left(2 - \sum_{i=1}^{n-1}\frac{C_i}{\sum_{i=1}^{n} C_i}\pi_i\right)\frac{\sum_{i=1}^{n} C_i}{C_{CZ}} + \varphi\frac{Y_{CZ}}{\sum_{i=1}^{n} Y_i}\varepsilon_2 + \varepsilon_3 \qquad (24)$$

We suppose in the ECB's reaction function equation from the „Czech economy view" that its reaction on government sector deficit/surplus is given by the size of the economy, the same assumption we have introduced at demand and supply shocks (ε1 and ε2). The exchange rate of each economy is weighted by its share in the euro zone total export to non-euro zone member countries. And the inflation rate, as well as the expected inflation rate, is according to mechanism of the HICP calculation weighted by their final monetary household consumption expenditure shares in the euro zone total. For simplicity we have concentrated the influences of the other euro area member countries variables including their weights into one summary variable ε3, because they are not a primary subject of our interest.

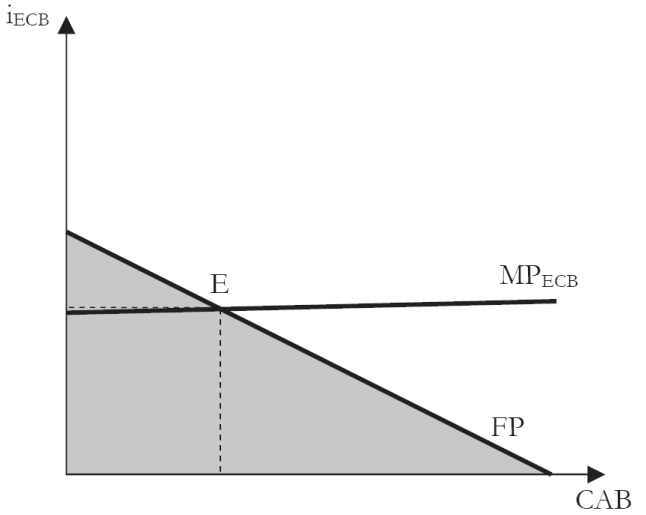
5.1 Interaction of current monetary policy and national fiscal policy in a two instrumental variables model

Drawing derived ECB's reaction function, converted into a relationship of euro zone reference interest value and the Czech national macroeconomic aggregates, together with the Czech national fiscal policy authority into two instrumental variables graph we obtain a similar picture to the interaction between national fiscal and national monetary policy one. At the first sight there is significant difference in the European monetary authority reaction function slope, which is much flatter than in the picture No. 2, because

$$Y_{CZ} < \sum_{i=1}^{n} Y_i ,$$

i.e. the Czech GDP to euro zone GDP ratio is lower than 1. Generally the higher the country's share in euro zone GDP total, the more intensive European Central Bank reaction on the changes in public finance balance of the specific economy will be. If for example this share of the Czech economy equals to less than 1% (in EU-27) or 1,3% (in EU-13 plus Czech Republic), it can't be expected more powerful reaction from the ECB. That's way common monetary authority reaction curve is drawn as nearly parallel to x axis in the picture No. 8.

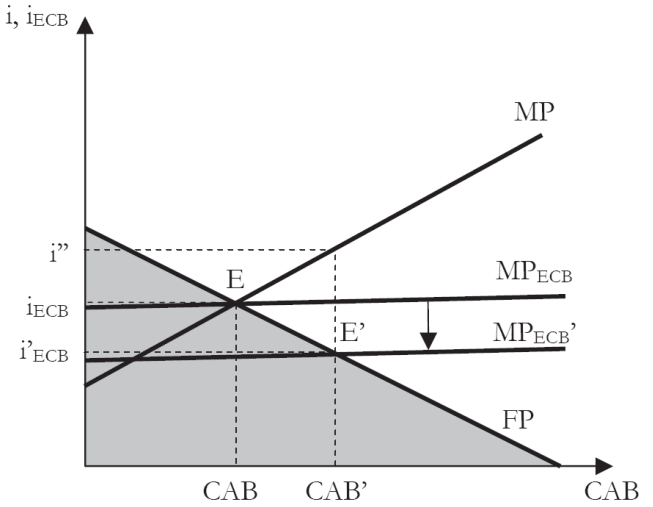
Picture No. 8: National fiscal and common monetary policy reaction functions in a two instrumental variable graph in a small economy ($\beta_B < 1/3\alpha$)



Source: Own.

If the central bank doesn't follow conditions in the small economies, it is necessary either their business cycle to be sufficiently harmonised with the largest economies or the fiscal policy must have sufficient space for business cycle corrections. Even though loosen "leading-reins" of the national fiscal policy is twofold. Let's imagine small open economy as a part of a monetary union. Common monetary policy authority decides on the basis of large economies fiscal positions assessment to decrease reference interest rate. This in our graph of one national and the second supranational reaction function causes a shift of common monetary authority reaction function curve down. Next suppose that monetary policy is effective and that reference interest rate decrease leads to the drop of the market interest rate in the monetary union. Under the "ordinal" circumstances, when the monetary policy is just national not supranational and would target only the domestic inflation rate, the interest rate wouldn't decline. New (lower) interest rate thus enables governments to increase their deficit due to reduction of the debt service costs. In the former graph the central bank would raise interest rate till i" as a reaction on the higher deficit (CAB') and gradually, through the adjustment process described above, the instrumental variables values would tend into the original steady state E. But in the case of supranational common monetary authority the new equilibrium point is E', which allows, thanks to i', all governments to increase their deficits just because they are part of the monetary union. Our case, illustrated in picture No. 9, has the advantage that this possible "free rider" problem of the small economies is reduced by introduced fiscal policy rule and supposing governments strictly keep in line it the risk of inappropriate deficit behaviour of the fiscal authorities is limited.

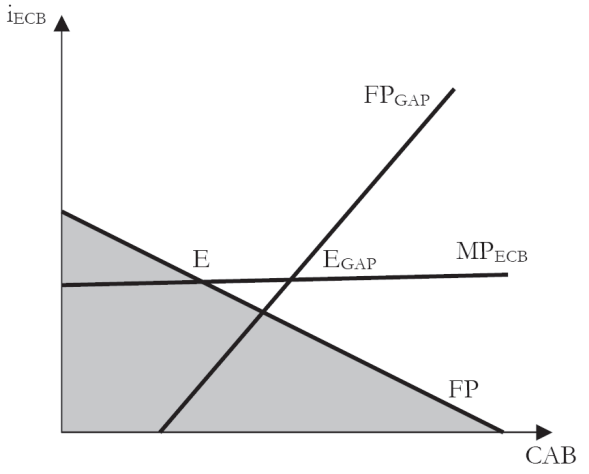
Picture No. 9: Impact of large economies´ government deficits decrease in monetary union in a graph of two instrumental variables of national fiscal authority reaction function and common monetary policy authority reaction function ($\beta_B < 1/3\alpha$)



Source: Own.

Also it is possible to illustrate the situation without fiscal rule. The last picture (No. 10) indicates possible development of the fiscal authority reaction function, if the authority reacts on the output gap deviation (this case in detail analyses the already mentioned study of Buti, Roeger, Veld (2001)) and is not restricted by a fiscal policy rule (FP_{GAP}). For the comparison purpose we let drawn the original fiscal policy reaction function (note: the development of the curves is only illustrative). We would like to demonstrate the fact that without a rule restraint fiscal policy in a small economy can reach by the nearly constant (or independent on the domestic market economy development) interest rates the sizeable deficit volumes without credit sources becoming more expensive.

Picture No. 10: Graph of the national fiscal authority output gap reaction function, the national fiscal authority reaction function with a fiscal rule and the common monetary authority reaction function in a small economy



Source: Own.

6 Conclusion

This study was a view of the world of interaction between two "non-crown economic policy queens" – fiscal and monetary policy. For study of their interaction we developed model for open economies, because we wanted to describe the Czech economy features better, and that illustrates reactions of each authority based on their loss functions. In the case of monetary authority there is an effort of the central banker to minimize the difference between the true inflation rate and the targeted one (loss function was chosen according to monetary policy regime of the Czech National Bank). The government, on the other hand, must in our model follow the rules of the Stability and Growth Pact. Taking into account especially the short-run, its loss function can be determined as an attempt not to exceed maximal 3% reference value given by the Stability and Growth Pact. We suppose that government uses structural deficit component as a tool.

Derived curves of the fiscal and monetary policy reaction functions were illustrated in the graph of the instrumental variables (i.e. structural deficit and nominal interest rate), where was shown under what condition the adjustment process will converge or diverge. It was demonstrated that the explanation lays in the comparison of the authority reaction functions slopes – if the absolute value of the fiscal authority reaction function is higher than the monetary one, the process will converge, in all other case diverge. Thanks to reaction functions coefficients we could calculate intervals giving answers where the absolute value of fiscal reaction function slope is higher or lower.

Also exogenous variables from the reaction functions have an important impact. In the graph of the two instrumental variables we could demonstrate their impact as a shift

of the curve. The fiscal reaction function exogenous variables impact specified by the concrete sign is valid when the fiscal reaction function curve is negatively sloped. Similar conclusion is drawn on the supply shocks and the previous period exchange rate, which both affect monetary authority reaction function. Negative demand shock cuts down the nominal interest rate and on the contrary. The direction of other exogenous factors impact can't be simply identified without knowledge of all parameters.

After enter the Economic and monetary union the Czech Republic will have to accept, except the common currency, the common monetary policy as well, which means to take over the reference interest rate determinated for the whole zone. Even if the monetary policy strategy of the common monetary policy performed by the European Central Bank is also based on inflation targeting, closely specified as maintaining of the year-to-year harmonised index of consumer prices below but close to 2%, it can't be expected that the intensity of ECB reaction on any another development taking place only in the Czech economy will have the same intensity as nowadays. The common monetary policy reaction function curve thus becomes nearly horizontal in the graph of two instrumental variables, i.e. nearly insensitive to changes in the Czech public finance. Next this kind of economy can profit by the interest rate decline in such an union. These two arguments are justification for a fiscal policy rule introduction that partly reduces the problems of "free rider" and moral hazardous of the economies.

However, the interaction between fiscal and monetary policy is effective just at that time, when authorities' reaction functions or authorities' loss functions are effectively followed. Without the rules observation, reaction function changes itself and equilibrium variable values including the process of adjustment become different.

Abstract

The study discusses central bank's and government's behaviour in a small open economy with a strong autonomous monetary policy and fiscal policy restricted by fiscal policy rule.

Composed model thus fully corresponds to the Czech reality, where the Czech National Bank's independency is evaluated as a very strong one, its monetary-policy regime is inflation targeting and Czech public finance, or the General Government Sector's finance (according to the system of national accounts ESA 95), must follow fiscal policy rules of the Stability and Growth Pact. It simply claims deficits not to exceed the 3% level of GDP and public debt should remain below the 60% of GDP limit. Because the Czech economy is not confronted with the "excessive debt" problem and it seems it won't be for a few years, the analysis focuses an attention especially on deficit limit criteria. The last part of the study is denoted to the common monetary policy and individual fiscal policy problematic, again from the small open economy point of view.

The study could contribute to solution of the question, what fiscal policy should be practiced before and after the Economic and Monetary Union entrance.

Keywords

Fiscal Policy, Monetary Policy, Fiscal Policy Rule, Monetary Policy Rule, Interaction, Open Economy, Inflation Targeting

JEL classification / JEL klasifikace
E52, E58, E61, E62

Souhrn
Studie se zabývá chováním centrální banky a vlády v malé otevřené ekonomice s výrazně autonomní měnovou politikou a fiskální politikou omezenou fiskálním pravidlem. Sestavený model tak plně koresponduje s českou realitou, kdy nezávislost České národní banky je hodnocena jako poměrně vysoká, jejím měnově-politickým režimem je cílování inflace, a české veřejné rozpočty, respektive finance sektoru vládních institucí, v terminologii systému národních účtů, podléhají fiskálním pravidlům Paktu stability a růstu, jenž ve zjednodušené formě požaduje vyvarovat se nadměrným deficitům stanoveným na úrovni 3 % HDP a nepřekročit hodnotu dluhové kvóty ve výši 60 %. Protože česká soustava veřejných financí není v současné době konfrontována problémem překročení referenční hodnoty podílu dluhu na HDP a zřejmě několik let nebude, soustřeďuje se analýza zejména na kritérium deficitní. Poslední část je věnována problematice interakce společné měnové politiky Hospodářské a měnové unie a individuální politiky fiskální, opět z pohledu malé ekonomiky.

Výstup studie může přispět k řešení otázky, jakou fiskální politiku provádět před a po vstupu do Hospodářské a měnové unie, ve které Evropská centrální banka plní pro všechny členské státy shodnou měnově-politickou úlohu.

Klíčová slova
Fiskální politika, měnová politika, fiskální pravidlo, monetární pravidlo, koordinace, otevřená ekonomika, cílování inflace

Kontaktní adresa / Contact address
Ing. David Prušvic
Katedra veřejných financí, Fakulta financí a účetnictví, Vysoká škola ekonomická v Praze, a Výzkumný ústav práce a sociálních věcí.
(e-mail: prusvicd@vse.cz)

Ing. David Prušvic
Je absolventem oboru Hospodářská politika a správa na Fakultě národohospodářské VŠE v Praze. Od roku 2004 je studentem doktorského studia oboru Finance na katedře veřejných financí Fakulty financí a účetnictví Vysoké školy ekonomické v Praze. Do července t. r. působil jako výzkumný pracovník v odboru příjmové a mzdové politiky ve Výzkumném ústavu práce a sociálních věcí. V současné době pracuje jako analytik na MF ČR, odbor finanční politiky, odd. makroekonomických predikcí.

References
BALL, L. (1998): *Policy Rules for Open Economies.* Cambridge, NBER 1998, WP. No. 6760, 30 p.
BUTI, M., ROEGER, W., VELD, J. (2001): *Monetary and Fiscal Policy Interactions under a Stability Pact.* EUI Working Paper ECO No. 2001/8.
CABRAL, A. J. (2001): *Main Aspects of the Working of the Stability and Growth Pact.* In: BRUNILA, A., BUTI, M., FRANCO, D. ed.: The stability and growth pact the architecture of fiscal policy in EMU, Basingstoke, Palgrave 2001, p. 139 – 157.

Council Regulation (EC) No 1056/2005, amending Regulation (EC) No 1467/97 of 7 July 1997 on speeding up and clarifying the implementation of the excessive deficit procedure.
Council Regulation (EC) No 1467/97 on speeding up and clarifying the implementation of the excessive deficit procedure.
Council Regulation 1055/2005 amending Regulation (EC) No 1466/97 on the strengthening of the surveillance of budgetary positions and the surveillance and coordination of economic policies.
Council Regulation 1466/97 on the strengthening of the surveillance of budgetary positions and the surveillance and coordination of economic policies.
Ecb (1998): A stability-oriented monetary policy strategy for the ESCB. Rada guvernérů ECB, 13. října 1998.
Ecb (2003): The ECB's monetary policy strategy. Rada guvernérů ECB, 8. května 2003.
European Commission (2005): New and Updated Budgetary Sensitivities for the EU Budgetary Surveillance. Brussels, European Commission, Directorate General, Economic and Financial Affairs, 30. September 2005.
European Commission (2006): Ongoing procedures under article 104 of the Treaty (Excessive Deficit Procedure). [On-line], 26.9.2006, [cit. 18.3.2007], <http://ec.europa.eu/economy_ finance/about/activities/sgp/old_sgp/procedures_en.htm>.
European Commission (2007): Eurostat Database. [On-line], 28.2.2007, [cit. 11.6.2007], <http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=EU_MAIN_TREE&depth=1>.
FRIEDMAN, M. (1968): *The role of monetary policy.* American Economic Review, Vol. 58, 1968, p. 1-17.
HALLETT, A. H., LIBICH, J. (2007): *Fiscal-Monetary Interactions: The Effect of Fiscal Restraint and Public Monitoring on Central Bank credibility.* CEPR 2007, 19 p.
IZÁK, V. (2005): *Fiskální politika.* Praha, Nakladatelství Oeconomica 2005, 210 p.
MANDEL, M., TOMŠÍK, V. (2003): *Monetární ekonomie v malé otevřené ekonomice.* Praha, Management Press 2003, 287 p.
PHELPS, E. S. (1967): *Phillips Curves, Expectations of Inflation and Optimal Unemployment over Time.* Economica, New Series, Vol. 34, No. 135, Aug. 1967, p. 254-281.
PHELPS, E. S. (1968): *Money-Wage Dynamics and Labour-Market Equilibrium.* The Journal of Political Economy, Vol. 76, No. 4, Part 2: Issues in Monetary Research, Jul. - Aug. 1968, p. 678-711.
PHILLIPS, A. W. (1958): *The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957 Economica, New Series, Vol. 25, No. 100, Nov. 1958, p. 283-299.*
PRUŠVIC, D. (2005): *Fiskální pravidla versus pravidla Paktu stability a růstu.* In: Theoretical and Practical Aspects of Public Finance. Praha, Vysoká škola ekonomická v Praze 2005, p. 38.
Resolution of the Amsterdam European Council on the Stability and Growth Pact.
SAMUELSON, P. A., SOLOW, R. M. (1960): *Analytical Aspects of Anti-Inflation Policy. American Economic Review, Vol. 50, No. 2, 1960, p. 177-194.*
SVENSSON, L. E. O. (1998): *Open-Economy Inflation Targeting.* Stockholm, Institute for International Economic Studies, Stockholm University 1998, 53 p.
SVENSSON, L .E. O. (1999): *Inflation Targeting as a Monetary Policy Rule.* Journal of Monetary Economics, June 1999, 43, p. 607-654.
The Treaty on European Union and of the Treaty of the Establishing the European Community.