Is Our Model Breaking Up? A Macro-econometric Analysis of EU Enlargement and Its Implications to East Asian Economic Cooperation

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Abstract

For decades, European integration has been viewed as a model of regional economic cooperation by East Asian economies. However, the failure of French and Dutch referendums on European Constitution in 2005 not only reveals the problems of the model, but also suggests that the speed of European integration may be slowed down. Moreover, this trend goes against the advice of some economists who believe that the EMU should accept Central and Eastern European countries (CEECs) as soon as possible, considering the theory of endogeneity and the experience of the ERM crisis in the 1990s. The purposes of the research are: (1) to see whether the EMU and CEECs can be better off if the EU authorities still insist on gradual convergence of Maastricht criteria; (2) to explore the possibility of ERM II crisis caused by CEECs' participation in the EMU. On the basis of current development and studies of dynamic game, I will establish and simulate a European macro-econometric model with the data of Czech Republic, Poland, and Hungary. The simulation results indicate that at this moment only Czech Republic is qualified to cooperate with the ECB before entering the EMU. By means of cooperation, Czech Republic and the ECB can effectively decrease their bilateral nominal interest rate differentials and thereof decrease the risk of suffering from substantial capital flows when becoming a member of the EMU. The analysis of this research is preliminary but may be helpful in predicting the consequences of EU enlargement and in considering future policy on East Asian economic integration.

1. Introduction

For decades, European integration has been viewed as a model of regional economic cooperation by East Asian economies. Whether or not a common market can be achieved in East Asia within the next decade, the consequences of the ERM II after EU enlargement will give ASEAN+3 and the great Chinese Economic Area a lesson as to their steps toward further exchange rate and monetary cooperation. However, the failure of French and Dutch referendums on European Constitution in 2005 not only reveals the problems of the model, but also suggests that the speed of European integration may be slowed down. Moreover, this trend goes against the advice of some economists who believe that the EMU should accept Central and Eastern European countries (CEECs) as soon as possible, considering the theory of endogeneity and the experience of the ERM crisis in the 1990s. The purposes of the research are: (1) to see whether the EMU and CEECs can be better off if the EU authorities still insist on gradual convergence of Maastricht criteria; (2) to explore the possibility of ERM II crisis caused by CEECs' participation in the EMU.

The Nice Summit in 2000 confirmed the EU's commitment to a speedy eastward enlargement. In 2004 ten CEECs were invited to be members of the EU[1]. The current development so far implies many CEECs are likely to enter the ERM II, then to adopt a central parity for their currencies against the euro. That is, on the one hand, the new members will have a strong desire to gain entry to the EMU as soon as

[1] Three Baltic countries, Poland, Hungary, Czech Republic, Slovenia, Slovakia, Romania, and Bulgaria. In 2005 Romania and Bulgaria still are candidate members.

possible, in order to become a part of Europe's zone of monetary stability and to enjoy the lower interest rates. On the other hand, official readings of the European Treaty by the European Council, ECOFIN, the ECB and the European Commission (e.g., EU Commisson, 2000; ECOFIN, 2000, 2001; European Council, 2000) regard unilateral euroization – the unilateral adoption of the euro as legal tender by a CEEC – as a non-permissible option. In other word, the combination of full capital mobility and a requirement to participate in ERM II may entail an interim period in which CEECs face enhance vulnerability to capital flows before the eventual safety of monetary union is available. This may bring the danger of currency crisis if the capital flows are reversed (Temperton, 2000; Begg et al., 2003).

Are the EU officials wrong? Is an enlarged euro zone consisting of twelve current EMU members and ten CEECs an optimum currency area? The answer can be positive even if we go back to the conventional OCA theory and Maastricht critera. Figures 1 and 2 compare the degree of openness and correlation of demand and supply shocks of CEECs and other EU members. We find that most CEECs are at least as open toward the EU as other EU members (De Grauwe, 2003; European Commisson, 2001; World Bank, 2002). And some CEECs, such as Poland, Hungary, Romania, and Estonia, have positive correlations of demand and supply with the euro area. Table 1 shows the progress of CEECs in per-capita GDP, inflation, fiscal situation, and money growth. Many indicators of CEECs are close to the standard of Maastricht critera. Moreover, empirical studies (e.g., Eichengreen, 1990; Neumann and von Hagen, 1991; Bayoumi and Eichengreen, 1993; De Grauwe and Vanhaverbeke, 1993) show that the EMU is still established, though the current euro area consisting of 12 members is not an OCA.

[Insert Table 1 and Figures 1 and 2 here]

It seems that the EU officials still insist on Maastricht criteria of gradual convergence. Can't the dangerous combination of high capital mobility and an intermediate exchange rate peg be avoided without unilateral euroization? According to the theory of endogeneity (e.g., Frankel and Rose, 1998; De Grauwe and Mongelli, 2005), there are two options remain if the best choice is ruled out: One is to adopt a very hard peg such as a euro-based currency board.[2] Note that tight fiscal discipline is a prerequisite of this strategy because of the Balassa-Samuelson effect: the productivity growth of CEECs' export sectors will cause the real exchange rate appreciation, which cannot be interpreted as an inflation problem of lacking fiscal and monetary discipline.

The alternative option is a soft peg combining a full use of the exchange rate band of the ERM II with frequent and timely adjustments of the central parity. Under this strategy, monetary policies of the CEECs should coordinate with the ECB. Prudent fiscal policies are important under this strategy as well.

This work mainly focuses on the third (also the easiest) option mentioned above. That is, I will study whether CEECs-ECB policy coordination, under the presumption of ERM II and Maastricht criteria, can benefit the whole EU and help CEECs go through the transitional period. I will also look at the interest rate differentials between CEECs and the euro area — an indicator of measuring the

[2] Mundell (1999) supports this approach.

short-term capital flows. A number of works make a comparison between the ERM crisis in the 1990s and ERM II (e.g., Buiter et al., 1998; Eichengreen, 2000; De Grauwe, 1997), predict the future of the latter in a descriptive way, and then make policy suggestions for the EU, ECB, and CEECs (e.g., Eichengreen, 2002; Frensch, 2001; Begg et al., 2002; Begg et al., 2003; Borowski, Brzoza-Brzezina, and Szpunar, 2002; De Grauwe, 2003; Gavriiski, 1999; Issing et al, 2001; Mundell, 1999). The literature in this field is still growing, but more efforts are needed to predict the outcomes of the EU enlargement. In this paper, a dynamic game approach (Petit, 1990; Başar and Olsder, 1999; Dockner et al., 2000; McKibbin, 1997; Turnovsky, 2000) is adopted to study the interaction among CEECs, ECB, and the new group by financial ministers of the euro area (EURO-X). A series of publications collected in Buiter and Marston (1985) provide a comprehensive analysis of the problems that emerge in such dynamic games. From 1999 onwards, the EMU provides a realistic scenario for the use of this method. Recent works, such as Levine and Brociner (1994), Douven and Plasmans (1996a, b), Engwerda, van Aarle, and Plasmans (1999, 2002), van Aarle, Engwerda, Plasmans and Weeren (2001), van Aarle, Engwerda, and Plasmans (2000, 2002), Habor, Neck, and McKibbin (2001), and Di Bartolomeo and Plasmans (2001), explore the convergence issues of the EMU.

This paper is structured as follows. Section 2 presents and explains my modeling. Section 3 shows how I derive the different macroeconomic and international financial outcomes if CEECs and the EMU are in either a non-cooperative or a cooperative situation. Here I assume that the non-cooperative situation would cause an impending ERM II crisis. Section 4 combines the theories and the empirics

presented in sections 2 and 3 to make a simulation study in which we get an initial idea about the outcome of the ERM II in the future. Section 5 concludes our findings of this paper.

2. Establishing a Theoretical Framework

In view of the current institutional and economic development of the EU, I will offer analysis under the following assumptions,

1. I focus on the interaction among CEECs, EURO-X, and the ECB, and simplify the roles of the United States and Japan in this area. My reason is that the EU-15 are still the main economic partners of CEECs.

2. I simulate five possible game scenarios as follows: (1) non-cooperation (NC), (2) full cooperation (FC), (3) CEECs-ECB coalition, (4) CEECs-EURO-X coalition, and (5) EURO-X-ECB coalition. As mentioned above, the purpose of this work is to evaluate whether CEECs-ECB policy coordination, under the presumption of ERM II and Maastricht criteria, can benefit the whole EU and be helpful to CEECs in passing through the transitional period. Note that recently EURO-X has rejected the fiscal disciplines of Stability and Growth Pact, which conflicts with price stability held by ECB. That is, if CEECs-EURO-X is feasible, the main goal of CEECs will not be price stability but economic growth.

3. Under the ERM II arrangement (pegging to euro), CEECs can cooperate with the ECB and

EURO-X without loosing their national currencies. In theory exchange rate is a non-controlled variable (e.g., Petit, 1990). This means that it cannot be the main policy tool of a CEEC.

4. Fiscal expenditure and nominal interest rate are main economic instruments of a CEEC. Besides, the ECB and EURO-X respectively decide monetary and fiscal policies of the euro area. Note that EURO-X is not a supra-national institution like the ECB, but a meeting of financial ministers in the euro area. However, the members of EURO-X now take the same position that fiscal policies must be more active to boost economic growth and thereof prevent euroscepticism. This kind of viewpoint is also supported by some economists.[3] Due to the above theory and fact, I simply assume EURO-X can be a mechanism of fiscal policy coordination.

According to assumption 1, I create a two-economy model which consists of three players — a CEEC, the ECB, and EURO-X. The structural-form model is based on the empirical work of Merlevede et al (2003) for CEECs, which extends the conventional Mundell-Fleming open-economy framework. All variables are expressed in natural logarithms, except for the interest rate and the unemployment rate, which are in percentages. Most importantly, all variables denote deviations from their long-term equilibrium (balanced growth path), which is normalized to zero. Equations (1), (2), and (3) define the economic structure of a CEEC, and (4) simplify the modeling of the large-scale economies, such as the EMU, the U.S., and Japan.

[3] De Grauwe (2003, chapter 9) derives an equation according to government budget constraint: $d=b\times g$. It means that fiscal deficit over GDP (d) should be equal to debt balance over GDP (b) multiple rate of economic growth (g). In other words, d=3%

$$c(t) = \alpha_1 y_d(t) - \alpha_2 (r(t) - \dot{p}_c(t)) \tag{1a}$$

$$i(t) = \beta_1 y(t) - \beta_2 (r(t) - \dot{p}(t)) \tag{1b}$$

$$x(t) = \gamma_1 s(t) + \gamma_2 y_{EMU}(t) + \gamma_3 WTR(t) - \gamma_4 (p(t) - p_{EMU}(t)) \tag{1c}$$

$$z(t) = -\delta_1 s(t) + \delta_2 y\ (t) - \delta_3 (e(t) + p_{EMU}(t)), \tag{1d}$$

$$p(t) = \phi_1 w(t) + \phi_2 (e(t) + p_{EMU}(t)) + \phi_3 (y(t) - \bar{y}), \tag{2a}$$

$$p_c(t) = \kappa_1 p(t) + \kappa_2 (e(t) + p_{EMU}(t)), \tag{2b}$$

$$w(t) = \lambda_1 p_c(t) + \lambda_2 (y(t) - n(t)) - \lambda_3 u(t) - \lambda_4 (p_c(t) - p(t)), \tag{2c}$$

$$n(t) = -\mu_1 (w(t) - p(t)) + \mu_2 y(t) + \mu_3 s(t), \tag{2d}$$

$$u(t) \equiv n_s(t) - n(t), \tag{2e}$$

$$s(t) \equiv e(t) + p_{EMU}(t) - p(t), \tag{3a}$$

$$y^S(t) := w + n, \tag{3b}$$

$$y_d(t) := y(t) - T(t), \tag{3c}$$

$$y_i(t) = \sum_{j \in \bar{N}/i} \sigma_{ij} s_{ij}(t) + \sum_{j \in \bar{N}/i} \varsigma_{ij} y_j(t) + o_i g_i(t) - \beta_i (r_i - \dot{p}_i) \qquad (\bar{N} := EMU, US, JP), \tag{4a}$$

$$\dot{p}_i(t) = \xi_i y_i(t), \qquad p_i(0) = p_i^0 \qquad i := EMU, US, JP, \tag{4b}$$

$$\dot{p}_{cEMU}(t) = \omega_1 \dot{p}_{EMU}(t) + \omega_2 (\dot{e}_{EMUUS}(t) + \dot{p}_{US}(t)) + \omega_3 (\dot{e}_{EMUJP}(t) + \dot{p}_{JP}(t)), \tag{4c}$$

Equation (1a) gives real private consumption, *c*, as a function of the real interest rate ($r - \dot{p}_c$) defined by perfect myopic foresight, and p_c the consumer price level, and y_d real disposal income. p denotes the domestic output price level. In (1b) real private investment *i*, is assume to be a function of the real interest rate and real output *y*. Real exports *x* in (1c) depend on the real euro exchange rate,

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and *b*=60% in Maastricht critera are based on the assumption of 5% economic growth, which is not consistent with the current situation of the euro area.

which serves in the analysis as a proxy of competitiveness versus the euro area, s, real output y_{EMU}, world trade WTR, and the terms of trade with the euro area, p-p_{EMU}. Real import z in (1d) depend on the real euro exchange rate, real output and import price level, e+$p_{EMU,}$, where $p_{EMU,}$ denotes the price level of the euro area and e the euro exchange rate. Direct linkages between a CEEC and the euro area are modeled in the export and import functions through the effects of real output, price level, and exchange rate of the euro area. Output prices, consumer prices, the exchange rate and the interest rate are directly affected by the adjustment of the euro area. Four points are worth mentioning. First, equations (1a) to (1d) plus the exogenous government consumption and investment, g, form the IS curve. Second, according to assumption 3, nominal exchange rate of a CEEC with respect to euro, e, still exists. That is, e is equal to zero if the CEEC is accepted to be a member of the EMU. Third, (1c) minus (1d) is the trade balance which can be an indicator of the current account under the pegging system.

Equations (2a) to (2e) describe supply side of a CEEC. In (2a) the domestic output price level is a non-decreasing function of domestic factor costs, approximated by the nominal wage and import prices. The effect of demand-pull inflation is measured by the output gap, the deviation of gross domestic product from its equilibrium ($y - \bar{y}$). Consumer prices in (2b) are defined as a weighted basket of domestic prices and prices of EU imports. Nominal wages in (2c) are assumed to depend positively on consumer prices, according to the price-indexing elasticity λ_1, and labor productivity y-n, and negatively on the overall terms of trade, p_c-p, and on the unemployment rate (Phillips curve) in (2e), defined as the difference between the exogenous labor force n_s, and total employment n. Three factors

explain labor demand in (2d): the real wage rate, real output, and the real euro exchange rate. The former two are assumed to have a positive effect on labor demand and the latter one a negative effect.

Equations (3a) to (3c) are definitions of some variables in (1) and (2): (3a) defines the bilateral real exchange rate of a CEEC with respect to euro. Aggregate supply y^s can be simplified as values of labor output. The disposal income y_d is equal to income minus tax T. In other word, the fiscal situation of a CEEC can be shown by g-T.

On the basis of Engwerda, van Aarle, and Plasmans (2002), equations (4a) to (4c) describe the structures of large economies, such as the U.S., Japan, and the euro area. These equations extend the conventional Mundell-Fleming open-economy framework, which is simplified but is still consistent with equations (1) to (3). For instance, (4a) helps analyze the roles of the exchange rate, price convergence, and international impact on the euro area. The euro area has an impact on a CEEC, but not vice-versa. The other two economic powers, Japan and the EMU, have impact on China and Taiwan, but not vice-versa. Moreover, we assume China has impact on Taiwan, but not vice versa. Furthermore, (4b) also derives from conventional Phillips curve, and (4c) implies consumer price inflation in the euro area also is a weighted basket of domestic and foreign inflation.

Equations (1) to (4) can be reduced to an output equation of a CEEC

$$y_i(t) = D_i^T x(t), \tag{5}$$

where D_i^T is the vector of the parameters in the reduced-form model. And $x^T = \begin{pmatrix} s & g & r & v \end{pmatrix}$, where

$s \in \Re^{1\times 2}$, $g \in \Re^{1\times 2}$, $r \in \Re^{1\times 2}$, and $v \in \Re^{1\times 13}$. v is a vector included seven exogenous variables. In other word, variables of country *i* appear in the output of country *j* at the same time (though some parameters equal to zero), because a close economic link has been formed among countries. It is clear that the external influence still transmits from the EMU to the CEEC country according to the above assumptions.

Now we can get the derivatives of the real exchange rates with respect to time

$$\dot{s}_{ij}(t) = \dot{e}_{ij}(t) - \dot{p}_i(t) + \dot{p}_j(t), \tag{6}$$

By substituting (5) into (6), it can be rewritten as

$$\begin{aligned} &\dot{s}_{ij}(t) = \phi^T x(t) \qquad \phi \in \Re^{19} \qquad i \neq j \\ &s_{ij}(0) = s_{ij}^0 \end{aligned}, \tag{7}$$

where ϕ^T is a vector of parameters. The dynamics of the model in (7) are then represented by two simultaneous first-order linear differential equations with national fiscal deficits and interest rates as controlled variables, and real exchange rates, nominal cross exchange rate changes, and others as state variables.

Assume that the authority of a CEEC control their policy instruments such as to minimize the following quadratic loss function, which feature the domestic inflation, output, and policy instruments

$$\underset{g,r}{Min} J_{CEEC} = \underset{g,r}{Min} \frac{1}{2}\int_{t_0}^{\infty} \{\chi_1(\dot{p}_{cCEEC}(t))^2 + \chi_2(y_{CEEC}(t))^2 + \chi_3(g_{CEEC}(t))^2 + \chi_4(r_{CEEC}(t))^2\} e^{-\theta(t-t_0)} dt, \tag{8}$$

in which θ denotes the rate of time preference and χ represents preference weights that are attached to

the stabilization of variables, respectively. A quadratic form loss function including inflation and economic growth is a conventional way in economic analysis (e.g., Obstfeld, 1996). But according to Maastricht criteria, a CEEC should also stabilize its fiscal expenditure and nominal interest rate, which not only are instruments but also are policy goals. Theil (1964) argues that the use of these instruments may, by itself, produce positive or negative changes in social welfare. Besides, these instruments as well as the policy targets normally have preferred value. The introduction of the policy instruments into the objective function can therefore be considered as a device to impose some kind of constraint on the control variables, while avoiding the introduction of specific bounds on the controls which may complicate the mathematical computation of the optimal control solution and may give rise to bang-bang controls.[4] In simulation analysis of the next section, I will compute the values of the loss functions with conventional and Maastricht settings respectively, and then do a sensitivity analysis by changing the values of the preference weights.

According to assumption 4, EURO-X cares about inflation and economic growth of the euro area, and use fiscal expenditure as its main instrument.

$$\underset{g_{EMU}}{Min} J_{EURO\text{–}X} = \underset{g_{EURO\text{–}X}}{Min} \frac{1}{2}\int_{t_0}^{\infty} \{\pi_1 (\dot{p}_{cEMU}(t))^2 + \pi_2 (y_{EMU}(t))^2 + \pi_3 (g_{EURO\text{–}X}(t))^2\} e^{-\theta(t-t_0)} dt \,, \quad (9)$$

in which π represents preference weights. Note that the value of π_3 must be smaller because EURO-X rejects the fiscal disciplines of Stability and Growth Pact.

[4] Petit (1990), pp.147-48.

The loss function of the ECB is similar to that of EURO-X but stresses on price stability. It means η_1 should be larger than π_1

$$\underset{r_{EMU}}{Min}\ J_{ECB} = \underset{r_{EMU}}{Min}\ \frac{1}{2}\int_{t_0}^{\infty}\{\eta_1(\dot{p}_{cEMU}(t))^2 + \eta_2(y_{EMU}(t))^2 + \eta_3(r_{EMU}(t))^2\}e^{-\theta(t-t_0)}dt\ , \quad (10a)$$

However, according to my literature review and assumption 2, economic policy coordination between a CEEC and the ECB can be an option if unilateral euroization is impossible. That is, the ECB should invite some CEECs to participate in decision making and take their macroeconomic situations into account as early as possible

$$\underset{r_{EMU}}{MinJ_{ECB}} = \underset{r_{EMU}}{Min}\frac{1}{2}\int_{t_0}^{\infty}\{\eta_1(\dot{p}_{cEMU}(t))^2 + \eta_2(y_{EMU}(t))^2 + \eta_3(r_{EMU}(t))^2 + \eta_4(\dot{p}_{cCEEC}(t))^2 + \eta_5(y_{CEEC}(t))^2\}e^{-\theta(t-t_0)}dt, \quad (10b)$$

Considering the economic gap and the priority of the euro area, the preference weights (η_4 and η_5) and bargaining power (see the next section) of a CEEC should be much smaller than those of the euro area.

Substitute (5) into (8), (9), and (10), and let $t_0=0$, all loss functions can be shown as (11)

$$J_i = \frac{1}{2}\int_0^{\infty}\{x^T(t)M_i\,x(t)\}\,e^{-\theta t}dt \quad i := \text{CEECs, EURO-X, ECB,} \qquad (11)$$

where $M_i \in \Re^{19\times 19}$.

3. Policy Designs in the Non-cooperation, Full Cooperation, and Partial Coalition

In the case of non-cooperation (NC), each country and ECB minimize their loss functions (6)

independently with respect to the dynamic laws of motion (5) of the system. Here we assume that NC is close to the current situation of the EMU and EU enlargement. Besides, it can be treated as a benchmark that is useful in comparing with the rest of the possible outcomes, such as full cooperation and partial coalition (e.g., a cooperative EMU vs. non-cooperative CEEC countries).

$$\begin{aligned} &Min \quad J_i \qquad i = CEEC, EURO-X, ECB \\ &s.t. \quad \dot{s}_j(t) = As_j(t) + Bu_1(t) + Cu_2(t) \qquad j = CEEC, EMU \\ &s_j(0) = s_j^0 \end{aligned} \tag{12}$$

where s_i^T, u_1^T, and u_2^T are 1×2、1×4、1×13 vectors of real exchange rates, policy instruments, and non-controlled variables, respectively. And A、B、C are matrices of parameters.

Two main different approaches to bargaining have been proposed in the literature: One is the strategic approach, where a dynamic bargaining process is explicitly described and where the negotiation between players takes place in the context of a non-cooperative game (Rubinstein, 1982). The other is the axiomatic approach, which goes back to Nash (1950, 1953) and where, unlike the strategic approach, no bargaining process is considered. This approach is therefore static in nature and describes a solution rather than a bargaining process. Here I try to model the possible cooperative outcome by the axiomatic approach to decide the standard coalitional Nash equilibrium (CNE). The CNE can be characterized by two properties:

Profitability property: The losses in the coalition must be lower than or equal to the non-cooperative losses for all economy members of the coalition.

Stability property: (a) internal stability: the loss of each economy member of the coalition must be lower than or equal to the loss that the same economy member faces when it decides to leave the coalition and the other economy members of the coalition do not change their strategies; (b) external stability: the loss of each economy of non-member of the coalition must be lower than the loss that the same economy faces when it decides to join the coalition.

Note that changing the combination of these two properties can make different assumptions. For example, exclusive membership (Bloch, 1997), which implies that each member of an existing coalition can block the entrance of a new possible member, can be described by the profitability and the internal stability properties. And the profitability can explain only the coalition unanimity, which assumes that the whole coalition collapses when one of its members defects.

We establish a two-stage game as follows. In the first stage a CEEC, EURO-X, and ECB or two of them decide whether they want to have a full cooperation or a bilateral coalition. Next the cooperative mechanism will face various economic shocks. And the three players will coordinate their policy instruments to minimize their joint loss function. The full cooperation can be solved by the following open-loop Nash equilibrium.

$$J_{FC} = \sum_i \tau_i J_i , \quad \sum_i \tau_i = 1, \quad i:=CEECs,\ EURO\text{-}X,\ ECB, \tag{13}$$

where τ measures not only bargaining powers between countries but also the degree of "sacrifice. τ is 1/3 (1/2) if we assume three (two) players can have a fair negotiation.

Minimize the joint loss function

$$J_{FC} = \frac{1}{2}\int_0^{\infty}\{x^T(t)M_{FC}\,x(t)\}e^{-\theta t}dt\ , \tag{14}$$

where $M_{FC} = \sum_i \tau_i M_i$ 。

The steps to find the non-cooperation and full cooperative Nash solutions are shown in Appendices 1 and 2.

4. Numerical Simulation

We do the simulations on the basis of the CEECs' macro-econometric study by Merlevede, Plasmans, and van Aarle (2003). The main points of their work are as follows. They transform the continuous model of the equations (1) to (4) as the discrete form, and then estimate economic behaviors of CEECs by an error correction mechanism (ECM) and seeming unrelated regressions (SURs). Here we define the mode in a discrete time and go to a different notation.

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{k=1}^{K}\beta_k x_{k,t-1} + \sum_{k=1}^{K}\sum_{l=0}^{L_k}\delta_{k_l}\Delta x_{x_k,t-l} + \sum_{m=1}^{M}\gamma_m \Delta y_{t-m} + \varepsilon_t\ , \tag{15}$$

where *y* represents the left-hand side variable (e.g., real consumption and investment in equation (1)) and *x* represents all right-hand side variables except the lagged left-hand side term and the differenced terms of all relevant lags of *y*, and the first differenced terms of all lags of *x*. ε is a white noise error term. The main source of the data is International Financial Statistics published by IMF. Most variables are from 1994.I to 2001.IV, and are seasonally adjusted by Census X12.

Table 2 summarizes the short-run and long-run elasticities of Czech Republic, Hungary, and Poland — the three selected CEECs by this research. The reasons why I choose the three countries are that for a long time they have had free trade with the rest of the world, the largest economic scales in the CEECs (see Table 1), and had outstanding macroeconomic performance. Besides, I estimate the structure of the euro area by transforming equation (4) to (15) and using the same database, and also calibrate the values of policy preference weights of the loss functions according to some studies (e.g., van Aarle, Engwerda, and Plasmans, 2002). All parameters are reported in Table 2 and become the baseline values of my simulation.

The details of CEECs' economic structures can be found in Merlevede, Plasmans, and van Aarle (2003). I briefly report the results in Table2. First, a lot of variables are not different from zero at 10% level. Second, on the demand side, all α_1 are significant, which explains the impact of disposal income on real private consumption. Third, on the supply side, import price (ϕ_2) and demand gap (ϕ_3) have impacts on domestic price, which in turn increases consumer price (κ_1). With the growth of labor productivity (λ_1 and λ_2), per-capita nominal wage thereof increases. Fourth, real exchange rate (γ_1) and terms of trade(γ_4) can explain the growth of export, and high import price (δ_3) decreases import.

[Insert Table 2 here]

4.1 The values of the loss functions under different scenarios

At first, I simulate a non-cooperation game in which a CEEC, EURO-X, and ECB will minimize

their loss functions when encountering the following shocks:

1. Price level of the euro area increases by 5% with respect to the price levels of the other economies. That is, the shock is from the euro area to the CEEC.

2. The price level of the euro decreases by 5% with respect to the price levels of the other economies. In addition, euro appreciates by 15% with respect to U.S. dollar and yen. And the CEEC's unemployment rate increases by 5%. That is, negative shocks happen in the euro area and the CEEC at the same time.

According to assumption 2 and the principles of CNE, the goal of this paper can be achieved through making a comparison between the benchmark (non-cooperation game) and various cooperation and coalitional scenarios. That is, whether the EMU and CEECs can be better off and whether ERM II crisis can happen will be considered.

Some limitations on the simulation also need to be mentioned. In particular the likeliness that many parameters in the macroeconomic relations of CEECs have been subjected to changes over the sample due to the large and fundamental changes in the institutional and economic structures in these countries. Although perfect foresight and the structural form I adopt should be helpful in improving the modeling (Taylor, 1993; Stanley, 2000), the Lucas critique (Lucas, 1976) would imply that we cannot necessarily take for granted that the structural parameters of the economy remain unaffected by a regime switch from a non-cooperative scenario to a coalitional situation. Besides, the methodology of this

paper is different from the so-called new open-economy macroeconomics (NOEM), which stresses on micro-foundations and elaborates stock-flow interactions in private, public and external asset accumulations. Such models, on the other hand, typically rely on calibration rather than complete estimation like our small and traditional macroeconomic model.

Using Matlab, I write a simulation program to compute the loss functions under different economic shocks and cooperative scenarios. Tables 3, 4, and 5 (or 6, 7, and 8) are the results when Czech Republic, Hungary, and Poland are faced with the first (or the second) shock under different scenarios. Note that I assume there are two possibilities of the ECB's loss functions, which are represented by equations (10a) and (10b) respectively. The values put in parentheses are computed according to (10b). The values marked with asterisks mean that they are consistent with the profitability property of the CNE.[5]

[Insert Tables 2, 3, 4, 5, 6, 7, 8 here]

According to the profitability property of the CNE, for instance, full cooperation (FC) can be profitable if the loss functions of the three players are lower than those of them in non-cooperation (NC). Then we check whether FC is stable according to stability property. As mentioned before, other principles such as exclusive membership or unanimity are also available.

[5]If matrix *M* shown in Appendix 1 has more than two positive eigenvalues multiple equilibria arise, whereas if this matrix has less than two positive eigenvalues no equilibrium exists (for more details see Engwerda, 1998). I only concentrate on one case if multiple equilibria exist.

However, the results from Tables 3 to 8 are basically the same — no cooperative mechanism can be a CNE. Note that my simulation here uses the baseline values in Table 2. A sensitivity analysis by changing bargaining powers and policy preference weights is necessary.

4.2 Sensitivity analysis

From now on I will do a sensitivity analysis for Tables 6, 7, and 8. This is because the results of the two shocks shown in Tables 3 to 8 are similar, and the second shock is closer to the current situation in the EU. First of all, the bargaining powers of CEECs should be less than those of the ECB and EURO-X. The results shown in Tables 9, 10, and 11 are based on the extreme asymmetry of bargaining powers — τ of the CEEC is equal to zero in all cooperative scenarios. However, we still cannot get a CNE here. The main reason is that the values of the CEEC's loss function become bigger than those in non-cooperation. In other words, it will not be a good choice for a CEEC to participate in a cooperative mechanism which is fully dominated by the euro area.

[Insert Tables 9, 10, 11 here]

Next, the bargaining asymmetry will not be as extreme as the above. In FC, we adjust τ of a CEEC to 1/25, since there are 12 national central bankers and 12 financial prime ministers in the ECB and EURO-X respectively. For the same reason, τ of a CEEC is 1/13 in either CEEC-ECB or CEEC-EURO-X coalition. This is of course a simplified assumption which does not take the voting

system of the ECB into account.[6]

Besides, the symmetry of policy preferences is also changed according to assumptions 2 and 4. Here we assume that the ECB and CEECs stress on price stability, and EURO-X prefers economic stability. New preference weights are shown in the note of Tables 12, 13, and 14.

From the fourth column of Table 12, I find that Czech Rep.-ECB can be a CNE if the ECB's loss function is (10b). That is, under the assumptions of asymmetric bargaining powers and policy preferences as well as an EU-wide loss function of the ECB, Czech Republic can be a member of ERM II before becoming a formal member of the EMU.

[Insert Tables 12, 13, 14 here]

Finally, with the loss functions in equations (8), (9), and (10), I follow the conventional way to set quadratic loss functions which include only inflation or economic growth. Here I assume that price stability is the only objective of the ECB and CEECs, so all variables except inflation rates in equations (8), (10a), and (10b) are skipped. For the same reasons, the loss function of EURO-X includes both inflation and output of the euro area. The simulation results are shown in Tables 15, 16, and 17, which also indicate that Czech Republic can cooperate with the ECB in making policies before entering the EMU.

[6] The Governing Council of the ECB consists of six members of the Executive Board and governors of the twelve national central banks. That is, the governors of the national central banks hold a clear majority of the seats, which is indeed too decentralized, see De Grauwe, 2003; Issing et al., 2001.

[Insert Tables 15, 16, 17 here]

4.3 Interest rate differentials

One purpose of the research is to explore the possibility of ERM II crisis caused by CEECs' participation in the EMU. Both interest rate differentials and trade balances are the main indicators I use to measure the pressure of the balance of payment crisis under a pegging system. I draw six graphs of the two indicators in Figure 3 according to Czech Rep.-ECB coalition, which is the only CNE in my simulation.

[Insert Figure 3 here]

Figures 3 (a) to (c) are the bilateral interest rate differentials between Czech Republic and the euro area simulated in NC, Czech Republic-ECB coalition in Table 12 and Table 15 respectively. Figures 3 (d) to (f) are the trade accounts of Czech Republic in the same scenarios. By intuition, the nominal interest rate of Czech Republic should be higher than that of the euro area. Figures 3 (a) to (c) indicate that the bilateral coalition is indeed helpful in stabilizing interest rate differentials, which will alleviate short-term capital flows. However, the effect of the trade account is not obvious — Figures 3 (d) to (f) do not show clear evidence that the coalition can stabilize the trade deficit of Czech Republic resulting from deflation of the euro area.

5. Concluding Remarks

The purpose of this work is to know whether CEECs-ECB policy coordination, under the presumption of ERM II and Maastricht criteria, can benefit the whole EU and help CEECs go through the transitional period. By doing so, I also look at the interest rate differentials between CEECs and the euro area — an indicator of measuring the short-term capital flows. The model and information provided by this analysis are very preliminary, but may be helpful in considering the future of EU enlargement. The important results of this research can be summarized as follows:

First, among Czech Republic, Hungary, and Poland, only Czech Republic-ECB coordination can be a CNE under the assumption of an EU-wide ECB. This result is not satisfying but is still consistent with the theory of endogeneity.

Second, Czech Republic-ECB coordination can also efficiently decrease bilateral interest rate differentials. It can be helpful to Czech Republic in avoiding short-term capital flows during the transitional period.

Third, the reason why EURO-X is unable to cooperate with the ECB and CEECs can be that their national interests conflict with one another. This is consistent with the results of French and Dutch referendums on the EU constitution, which reveal the skeptic attitude held by western Europeans toward EU enlargement. On the other hand, EURO-X has rejected the strict fiscal disciplines of Stability and Growth Pact, which may harm price stability of the euro area expected by the ECB.

The future research may need to deal with some factors if following the framework of this paper, and one will be the so-called Balassa-Samuelson effect (e.g., Begg et al., 2003). That is, the main cause of CEECs' inflation which goes against Maastricht criteria is not undisciplined fiscal and monetary policies but be expansion of the export sectors. To analyze this issue, we need to improve our price settings by including the productivity of CEECs' trading sectors so that the Balassa-Samuelson effect under different cooperative scenarios can be evaluated. Put different, if policy cooperation with the ECB can alleviate CEECs' inflation pressure caused by export expansion, it will be easier for a CEEC to live up to Maastricht criteria.

To conclude, can we learn something from the experience of EU enlargement? The feasibility of Czech Rep.-ECB coalition indicates that the main problem of deepening regional economic and monetary cooperation will not be economic gaps, but conflicts of national interests (e.g., tradeoff between price stability and short-run business cycles). This is also an important issue of future ASEAN+3 and the so-called "Chinese Economic Area."

Appendix 1 The basic algorithm to derive the non-cooperative game solutions

The basic algorithm is mainly based on Engwerda, van Aarle and Plasmans (1999) and van Aarle, Engwerda and Plasmans (2000). It is described by the following steps:

1. Factorize matrices $M_i \in \Re^{19\times 19}$

$$M_i = \begin{pmatrix} Q_i & P_{1i} & P_{2i} & P_{3i} & P_{4i} & P_{5i} & P_{6i} & L_{1i} & L_{2i} & L_{3i} & \cdots & L_{4i} \\ P_{1i}^T & R_{1i} & K_{1i} & K_{2i} & K_{3i} & K_{4i} & K_{5i} & K_{6i} & K_{7i} & K_{8i} & & \vdots \\ P_{2i}^T & K_{1i}^T & R_{2i} & N_{1i} & N_{2i} & N_{3i} & N_{4i} & N_{5i} & N_{6i} & N_{7i} & & \\ P_{3i}^T & K_{2i}^T & N_{1i}^T & R_{3i} & H_{1i} & H_{2i} & H_{3i} & H_{4i} & H_{5i} & H_{6i} & & \\ P_{4i}^T & K_{3i}^T & N_{2i}^T & H_{1i}^T & R_{4i} & T_{1i} & T_{2i} & T_{3i} & T_{4i} & T_{5i} & & \\ P_{5i}^T & K_{4i}^T & N_{3i}^T & H_{2i}^T & T_{1i}^T & R_{5i} & F_{1i} & F_{2i} & F_{3i} & F_{4i} & & \\ P_{6i}^T & K_{5i}^T & N_{4i}^T & H_{3i}^T & T_{2i}^T & F_{1i}^T & R_{6i} & V_{1i} & V_{2i} & V_{3i} & & \\ L_{1i}^T & K_{6i}^T & N_{5i}^T & H_{4i}^T & T_{3i}^T & F_{2i}^T & V_{1i}^T & R_{7i} & W_{1i} & W_{2i} & & \\ L_{2i}^T & K_{7i}^T & N_{6i}^T & H_{5i}^T & T_{4i}^T & F_{3i}^T & V_{2i}^T & W_{1i}^T & R_{8i} & O_{1i} & & \\ L_{3i}^T & K_{8i}^T & N_{7i}^T & H_{6i}^T & T_{5i}^T & F_{4i}^T & V_{3i}^T & W_{2i}^T & O_{1i}^T & R_{9i} & & \\ \vdots & & & & & & & & & & \ddots & \\ L_{4i}^T & \cdots & & & & & & & & & & R_{10i} \end{pmatrix},$$

where subscript $i \in \{CEEC, EURO\text{-}X, ECB\}$, $Q_i \in \Re^{2\times 2}$, $P_{ji}, L_{ji} \in \Re^{2\times 1}$.

2. Computing the following matrices:

$$G := \begin{pmatrix} R_{1i} & K_{1i} & K_{2i} & K_{3i} \\ K_{1i}^T & R_{2i} & N_{1i} & N_{2i} \\ K_{2i}^T & N_{1i}^T & R_{3i} & H_{1i} \\ K_{3i}^T & N_{2i}^T & H_{1i}^T & R_{4i} \end{pmatrix},$$

$$H_1 := \begin{pmatrix} -A & 0 & 0 & 0 \\ M_{CEEC}(1:2,1:2) & A^T & 0 & 0 \\ M_{EURO-X}(1:2,1:2) & 0 & A^T & 0 \\ M_{ECB}(1:2,1:2) & 0 & 0 & A^T \end{pmatrix},$$

$$H_2 := \begin{pmatrix} B \\ P_{ji} \end{pmatrix},$$

$$H_3 := \begin{pmatrix} P_{1CEEC} & B_1^T & 0 & 0 & 0 & 0 \\ P_{2EURO-X} & 0 & B_2^T & 0 & 0 & 0 \\ P_{3CEEC} & B_3^T & 0 & 0 & 0 & 0 \\ P_{4ECB} & 0 & 0 & 0 & 0 & B_4^T \end{pmatrix},$$

$$M = H_1 + H_2 G^{-1} H_3 ,$$

where M_i *(1:2, 1:2)* means the first and second columns and rows of the matrix *M*, respectively.

3. Take three positive eigenvalues of *M* and the corresponding eigenvectors v_i to write the following expression:

$$\begin{pmatrix} X \\ Y_1 \\ Y_2 \\ Y_3 \end{pmatrix} := \begin{pmatrix} v_1 & v_2 \end{pmatrix} := z \in \Re^{8\times 2},$$

from which we can derive the optimal controls:

$$\begin{bmatrix} g_{CEEC}(t) \\ g_{EURO-X}(t) \\ r_{CEEC}(t) \\ r_{ECB}(t) \end{bmatrix} = -G^{-1} \begin{bmatrix} P_{1CEEC}^T + B_1^T CL_1 \\ P_{2EURO-X}^T + B_2^T CL_2 \\ P_{3CEEC}^T + B_3^T CL_1 \\ P_{4ECB}^T + B_4^T CL_3 \end{bmatrix} s(t) := CLs ,$$

where $CL_i := Y_i\ X^{-1}$. If matrix *M* has more than three positive eigenvalues multiple equilibria arise, whereas if this matrix has less than three positives eigenvalues no equilibrium exists (for more details see Engwerda, 1998).

4. Rewrite the loss functions of the countries and the dynamics of the model as

$$J_i = \frac{1}{2}\int_0^\infty [(IC\ )\ M_i\ (IC^T)]dt\ ,$$

$$\dot{s}\ = (A + BCL)s := A_{CL}s\ ,$$

So the problem can be written as

$$J_i = q_0^T Z_i\ q_0\ ,$$

where Z_i can solve the following Lyapunov equation

$$A_{CL}^T Z_i + Z_i\ A_{CL} + \frac{1}{2}[(IC)M_i\ (IC)^T] = 0$$

Appendix 2 Cooperative game solutions

The unique equilibrium strategies can be obtained by the following steps. First, factorize matrix M_{FC} by removing uncontrolled variables

$$M_{FC} = \begin{bmatrix} Q & W \\ W^T & X \end{bmatrix},$$

where *Q* is a 2x2 matrix, *W* a 2x4 vector containing instrumental variables, and *X* a 4x4 matrix

containing instrumental variables.

Second, following Lancaster and Rodman (1995) and van Aarle, Engwerda and Plasmans (2002), we calculate the Hamiltonian matrix

$$Ham = \begin{bmatrix} -(A - BX^{-1}W^T) & BX^{-1}B^T \\ Q - WX^{-1}W^T & (A - BX^{-1}W^T)^T \end{bmatrix},$$

After we determine two positive eigenvalues of *Ham* and its corresponding eigenvector, the equilibrium strategies can be

$$\begin{bmatrix} g_{CEEC}(t) \\ g_{EURO-X}(t) \\ r_{CEEC}(t) \\ r_{ECB}(t) \end{bmatrix} = -X^{-1}(W^T + B^T\Gamma)s(t) \quad = H_{FC}s(t),$$

where

$$\begin{pmatrix} X \\ Y_1 \end{pmatrix} := \begin{pmatrix} v_1 & v_2 \end{pmatrix} := z \in \Re^{4\times 2},$$

and $\Gamma := Y_1 X^{-1}$. The solution of a partial coalition game is similar to the above steps. See van Aarle, Engwerda and Plasmans (2002) and Yeh and Plasmans (2002) for the details.

Reference

van Aarle, B., J. Engwerda, and J. Plasmans (2000), "Macroeconomic Policy Interaction under EMU: A Dynamic game approach," *Open Economies Review*, 12, 29-60.

van Aarle, B., J. Engwerda, and J. Plasmans (2002), "Monetary and Fiscal Policy Interaction in the EMU: A Dynamic Game Approach," *Annals of Operations Research*, 109*,* 229-264.

van Aarle, B., J. Engwerda, J. Plasmans, and A. Weeren (2001), "Macroeconomic Policy Interaction under EMU: A Dynamic Game Approach," *Open Economies Review*, 12, 29-60.

Başar, T. and G.J. Olsder (1999), *Dynamic Noncooperative Game Theory*, 2nd ed., New York: Academic Press.

Bayoumi, T. and B. Eichengreen (1993), "Shocking Aspects of European Monetary Integration," in F. Torres and F. Giavazzi (eds.), *Adjustment and Growth in the European Monetary Union*, London: CEPR and CUP.

Begg, D., F. Canova, P. De Grauwe, A. Fat, and P.Lane (2002), *Surviving the Slowdown: Monitoring the European Central Bank No. 4*, London: CEPR.

Begg, D., B. Eichengreen, L. Halpern, J. von Hagen, C. Wyplosz (2003), "Sustainable Regimes of Capital Movements in Accession Countries," *CEPR Policy Paper* 10.

Bloch, F. (1997), "Noncooperative Models of Coalition Formation in Games with Spillovers," in C. Carraro and D. Siniscalco (eds.), *New Directions in the Economic Theory of the Environment*, Cambridge: Cambridge University Press.

Borowski, J, M. Brzoza-Brzezina, and P. Szpunar (2002), "Exchange Rate Regimes and Poland's Participation in ERM II," ECB Workshop Exchange Rate Issues in Accession Countries, 2002.10.21.

Buiter, W. and R. C. Marston, eds. (1985), *International Economic Policy Coordination*, Cambridge: Cambridge University Press.

Buiter, W. H., G. Corsetti, and P. Pesenti, (1998), *Financial Markets and European Monetary Cooperation: The Lesson of the 1992-93 Exchange Rate Mechanism*, Cambridge: Cambridge University Press.

De Grauwe, P. (1997), *The Economics of Monetary Integration*, 3rd ed., New York: Oxford University Press.

De Grauwe, P. (2003), *The Economics of Monetary Union*, 5th ed., New York: Oxford University Press.

De Grauwe, P and W. Vanhaverbeke (1993), "Exchange Rate Experiences of Small EMS Countries. The Cases of Belgium, Denmark and the Netherlands," in V. Argy and P. De Grauwe (eds.), *Choosing an Exchange Rate Regime*, Washington: International Monetary Fund.

De Grauwe, P. and F.P. Mongelli (2005), "Endogeneities of Optimum Currency Area: What Brings Countries Sharing a Single Currency Closer Together?" *ECB Working Paper* 468.

Di Bartolomeo, G. and J.E.J. Plasmans (2001), "Endogenous Coliation Formation and Stabilization Policies in a Monetary Union," Discussion Paper, UFSIA-RUCA, University of Antwerp.

Dockner, E., S. Jorgenson, N. van Long, and G. Sorger (2000), *Differential Games in Economics and Management Science*, Cambridge: Cambridge University Press.

Douven, R.C. and J.E.J. Plasmans (1996a), "Convergence and Coordination in the EU: A Dynamic Game Approach," *Control Eng. Practice*, 5 (4), 561-566.

Douven, R.C. and J. E. J. Plasmans (1996b), "SLIM: A Small Linear Interdependent Model of Eight EU-member States, the USA and Japan," *Economic Modelling*, 13, 185-233.

ECOFIN Council (2000), "ECOFIN Council Conclusions on Exchange Rate Strategies for Accession Countries," Brussels, November 7.

ECOFIN Council (2001), "Exchange Rate Aspects of Enlargement," *European Economy 1, Supplement C*, 1-3.

Eichengreen, B. (1990), "Is Europe an Optimum Currency Area?" *CEPR Discussion Paper* 478.

Eichengreen, B. (2000), "The EMS Crisis in Retrospect," *NBER Working Paper* 8035.

Eichengreen, B. (2002), "The Enlargement Challenge: Can Monetary be Made to Work in an EU of 25 Members?" Fifth Annual David Finch Lecture at the University of Melbourne, 2002.2.20.

Engwerda, J. (1998), Computational aspects of the open-loop Nash equilibrium in linear quadratic games," *Journal of Economic Dynamics and Control* 22 (8-9), 1487-1506.

Engwerda, J., B. van Aarle, and J. Plasmans (1999), "The (In)finite Horizon Open-loop Nash LQ Game: An Application to the EMU," *Annals of Operations Research*, 88, 251-73.

Engwerda, J., B. van Aarle, and J. Plasmans (2002), "Cooperative and Non-cooperative Fiscal Stabilisation Policies in the EMU," *Journal of Economic Dynamics and Control*, 26 (3), 451-81.

European Commission (2000), "Exchange Rate Strategies for EU Candidate Countries," ECFIN/521/2000-EN, Brussels.

European Commission (2001), *European Economy*, Brussels.

European Council (2000), "Presidency Conclusion," Nice Council meeting December 7-9 2000 (http://ue.eu.int/en/info/eurocouncil/index.htm).

Frankel, J. and A.K. Rose (1998), "The Endogeneity of the Optimum Currency Area Criteria," *Economic Journal*, 108 (441), 1009-1025.

Frensch, R. (2001), "Some Perspectives on Currency Relations between EMU and Central and Eastern European EU Accession Countries," *Economic System* 25 (3).

Gavriiski, S (1999), "Currency Boards and EMU – A Bulgarian Perspective," seminar on the Accession Process organised by the ECB and the Bank of Finland, Helsinki, November 10-12, 1999.

Habor, G., R. Neck, and W.J. McKibbin (2001), "Monetary and Fiscal Policy Rules in the European Economic and Monetary Union: A Simulation Analysis," presented in the Conference of The European Macroeconomy: Integration, Employment and Policy Coordination, Antwerp, Belgium.

Issing, O. et al. (2001), *Monetary Policy in the Euro Area: Strategy and Decision-Making at the European Central Bank*, Cambridge: Cambridge University Press.

Korhonen, I. and J. Fidrmuc (2001), "Similarity of Supply and Demand Shocks between the Euro Area and the Accession Countries," *Focus on Transition*, Austrian National Bank 2.

Lancaster, P. and L. Rodman (1995), *Algebraic Riccati Equations*, Oxford: Clarendon Press.

Lucas, R. E. (1976), "Econometric policy evaluation: A critique," in R.E. Lucas (ed.), *Studies in Business-Cycle Theory*, Cambridge: The MIT Press, 104-30.

Levine, P.L., and A. Brociner (1994), "Fiscal Policy Coordination and EMU: A Dynamic Game Approach," *Journal of Economic Dynamics and Control*, 18 (3-4), 699-729.

McKibbin, W.J., (1997), "Empirical Evidence on International Economic Policy Coordination," in M. Fratianni et al. (eds.), *Hand book of Comparative Economic Policies (Vol 5): Macroeconomic Policy in Open Economies*, Westport: Greenwood Press, 148-76.

Merlevede, B., J. Plamsmans and B. van Aarle (2002), "A Small Macro-econometric Model of EU-accession Countries," *Open Economies Review* 14 (3), 221-250.

Mundell, R. (1999), "The Euro and the Stability of the International Monetary System," Conference the Euro as a Stabilizer in the International Economic System, Luxembourg, December 3-4.

Nash, J.F. (1950), "The Bargaining Problem," *Econometrica*, 18, 155-62.

Nash, J.F. (1953), "Two-person Cooperative Game," *Econometrica*, 21, 128-40.

Neumann, M. and J. von Hagen (1991), "Real Exchange Rates within and between Currency Area: How Far Away is EMU?" Discussion Paper, Indiana University.

Obstfeld, M. (1996), "Model of Currency Crises with Self-fulfilling Features," *European Economic Review* 40, 1037-47.

Petit, M. L. (1990), *Control Theory and Dynamic Games in Economic Policy Analysis*, Cambridge: Cambridge University Press.

Rubinstein, A. (1982), "Perfect Equilibrium in a Bargaining Model," *Econometrica*, 50, 97-109.

Stanley, T.D. (2000), "An Empirical Critique of the Lucas Critique," *Journal of Socio-Economics* 29, 91-107.

Taylor, J.B. (1993), *Macroeconomic Policy in a World Economy*, New York: W.W. Norton & Company.

Temperton, P. (2000), *The Euro,* Taipei: Huan-yu (in Chinese).

Theil, H. (1964), *Optimal Decision Rules for Government and Industry*, Holland: North-Holland.

Turnovsky, S., (2000), *Methods of Macroeconomic Dynamics*, Cambridge: The MIT Press. Chapter 3.

World Bank (2002), *World Development Indicators*, Washington: World Bank.

Table 1 Macroeconomic indicators of the CEECs (years 2001 and 2004)

	CZE	HUN	POL	EST	LVA	LTU	ROM	SVK	SVN	BUL
GDP (Mil. euros)	86,265	80,331	195,206	8,893	11,064	17,926	58,535	33,119	25,895	19,459
Per-capita GDP	65.0[f]	56.4[f]	43.2[f]	46.1[f]	39.9[f]	44.0[f]	28.8[f]	49.4[f]	72.0[f]	28.4[f]
(% EU-15 average)	(57.2)	(51.0)	(39.7)	(42.2)	(33.3)	(37.6)	(25.2)	(47.6)	(68.8)	(28.0)
Inflation rate	2.6	6.8	3.6	3.0	6.2	1.1	11.9	7.4	3.7	6.1
	(4.7)	(8.8)	(5.5)	(5.8)	(2.4)	(1.3)	(34.5)	(7.3)	(8.4)	(7.4)
Fiscal deficit	-3.4	-6.4	--	--	-1.1	--	--	-2.6	-1.5	0.7*
(% GDP)	(-5.7)	(-3.3)	(-6.0)	(-0.4)	(-1.8)	(-1.7)	(-3.5)	(-3.9)	(-1.2)	(-0.9)
Public debt	37.4	57.6	43.6	4.9	14.4	19.7	21.8	43.6	29.4	46.2
(% GDP)	(19.5)	(53.2)	(44.5)	(5.7)	(13.8)	(29.1)	(29.8)	(34.2)	(23.3)	(71.5)
Current account	-6.1*	-9.0*	-2.0*	-13.2*	-8.2*	-6.9*	-5.7*	-0.9*	-0.4*	-8.5*
bal. (% GDP)	(-4.7)	(-2.3)	(-3.9)	(-6.5)	(-10.0)	(-5.8)	(-6.1)	(-8.9)	(-0.4)	(-6.7)
Money growth	4.4	9.0	6.9	15.8	26.7	18.2*	40.1	9.7*	7.6	24.0
	(6.0)	(15.8)	(8.7)	(21.2)	(29.0)	(21.4)	(46.2)	(7.8)	(30.4)	(24.8)

Note: Most data are in year 2004, but the data in parentheses are in year 2001. Superscript f means forecasts; * means data in year 2003; -- means the data have not been available.

Source: EUROSTAT (http://www.europa.eu.int/comm/eurostat/, 2005.5.17); IFS CD-ROM, 2005.3.

Table 2 Baseline values in the simulation

Demand	**Czech Rep.**	**Hungary**	**Poland**
α_1	0.4756	0.3208	0.5243
α_2	0	1.2892	0.2041
	$\overline{R}^2$ =0.52	$\overline{R}^2$ =0.68	$\overline{R}^2$ =0.74
β_1	0	0	3.4650
β_2	0	0.7847	0
	$\overline{R}^2$ =0.43	$\overline{R}^2$ =0.41	$\overline{R}^2$ =0.90
Prices and labor market	**Czech Rep.**	**Hungary**	**Poland**
φ_1	0.1530	0	0.1644
φ_2	0.2028	0.3266	0.5353
φ_3	0.1225	0.0767	0.1031
	$\overline{R}^2$ =0.51	$\overline{R}^2$ =0.67	$\overline{R}^2$ =0.88
κ_1	1.1163	0.3795	0.5288
κ_2	0.1257	0	0
	$\overline{R}^2$ =0.49	$\overline{R}^2$ =0.80	$\overline{R}^2$ =0.95
λ_1	0.6600	0.6849	1.5258
λ_2	0.2148	0.1518	0.4383
λ_3	0.0003	0	0.0002
λ_4	0.7774	0	0
	$\overline{R}^2$ =0.60	$\overline{R}^2$ =0.45	$\overline{R}^2$ =0.42
μ_1	0.0390	0.1309	0.0457
μ_2	0	0.4341	0.0376
μ_3	0	0.3904	0
	$\overline{R}^2$ =0.76	$\overline{R}^2$ =0.89	$\overline{R}^2$ =0.53
Trade accounts	**Czech Rep.**	**Hungary**	**Poland**
γ_1	0.5763	0.9568	4.1185
γ_2	0	0	1.4597
γ_3	0.9178	0	1.6275
γ_4	1.4262	0.9464	0.3612
	$\overline{R}^2$ =0.38	$\overline{R}^2$ =0.38	$\overline{R}^2$ =0.60
δ_1	4.9713	0	0
δ_2	0	0.4823	0
δ_3	5.1971	0.9532	0.9334
	$\overline{R}^2$ =0.41	$\overline{R}^2$ =0.47	$\overline{R}^2$ =0.32
Weights (loss functions)	**Czech Rep.**	**Hungary**	**Poland**
$\dot{p}_c$	2	2	2
y	5	5	5
g	2.5	2.5	2.5
r	2.5	2.5	2.5

Note: (1) Values of the long-run and short-run elasticities are based on Merlevede, Plasmans, and van Aarle (2003); (2) The estimation results of the euro area are as follows:σ_1=0, σ_2=0.0587, ς_1=0.1771, ς_2=0, o=0.0091, β=0.8661 (adj. R^2=0.89), ξ=0.1663 (adj. R^2=0.95), ω_1=0.2025, ω_2=0, ω_3=0.0356 (adj. R^2=0.72)。Values of the U.S.'s and Japan's ξ are 0.2014 (adj. R^2=0.84) 與 0 (adj. R^2=0.03)), respectively. The data source is IFS CD-ROM, 2005.3; (3) Values of structural parameters are set to be 10^{-20} in order to avoid the problem of singular matrix if they are insignificant in 1%, 5%, or 10% level; (4) Values of the preference weights are based on van Aarle, Engwerda, and Plasmans (2002).

Table 3 The loss functions of Czech Republic, Euro-X, and the ECB (P_{EMU} increases by 5%)

Regime / Country	NC	FC	Czech - EURO-X	Czech - ECB	EURO-X- ECB
Czech	0.0777	0.1661	0.0712*	0.0767*	0.0777*
	(0.0777)	(0.1649)	(--)	(--)	(0.0728*)
EURO-X	1.95e-09	0.0019	0.0027	6.78e-05	1.95e-09*
	(4.93e-08)	(0.0020)	(--)	(--)	(0.0016)
ECB	8.19e-10	0.0012	0.0016	7.17e-05	8.20e-10
	(0.0732)	(0.1662)	(--)	(--)	(0.0708*)

Table 4 The loss functions of Hungary, Euro-X, and the ECB (P_{EMU} increases by 5%)

Regime / Country	NC	FC	Hungary - EURO-X	Hungary - ECB	EURO-X- ECB
Hungary	8.92e-04	--	8.87e-04*	7.59e-04*	0.2898
	(8.92e-04)	(--)	(8.88e-04*)	(7.63e-04*)	(--)
EURO-X	1.95e-09	--	1.53e-05	0.0073	2.12e-09
	(2.05e-09)	(--)	(1.14e-05)	(0.0074)	(--)
ECB	8.26e-10	--	9.38e-06	0.0044	3.19e-10*
	(8.67e-04)	(--)	(8.71e-04)	(0.0052)	(--)

Table 5 The loss functions of Poland, Euro-X, and the ECB (P_{EMU} increases by 5%r)

Regime / Country	NC	FC	Poland - EURO-X	Poland - ECB	EURO-X- ECB
Poland	9.59e-04	9.42e-04*	7.58e-04*	2.41e-05*	0.0035
	(9.59e-04)	(9.42e-04*)	(6.69e-04*)	(3.76e-05*)	(1.1045)
EURO-X	1.97e-09	1.19e-04	7.77e-04	0.0061	2.05e-09
	(2.35e-09)	(1.78e-04)	(2.02e-04)	(0.0054)	(0.0052)
ECB	9.85e-10	7.19e-05	0.2249	0.0037	4.07e-10*
	(8.43e-04)	(0.0010)	(7.18e-04*)	(0.0033)	(0.0464)

Note: (1) Columns identify policy regimes, which include non-cooperation (NC), full cooperation (FC), and three bilateral coalitions by a CEEC, EURO-X, and the ECB; (2) Rows 2 to 4 indicate the policy-makers' optimal losses (divided by 10^6); (3) values in parenthesis are computed according to equation (10b). The rest values are based on equation (10a). The values with asterisks are consistent with the profitability condition of CNE; (4) – means no equilibrium exists because of insufficient positive eigenvalues; (5) each player's bargaining power (τ) is assumed to be 1/3 in FC and 1/2 in bilateral coaltions, respectively.

Table 6 The loss functions of Czech Republic, Euro-X, and the ECB (P_{EMU} decreases by 5%)

Regime / Country	NC	FC	Czech - EURO-X	Czech - ECB	EURO-X- ECB
Czech	0.0782	0.1664	0.0712*	0.0801	0.0782*
	(0.0782)	(0.1652)	(--)	(--)	(0.0728*)
EURO-X	7.82e-09	0.0023	0.0032	2.66e-04	7.81e-09*
	(8.23e-09)	(0.0024)	(--)	(--)	(0.0020)
ECB	3.04e-09	0.0014	0.0019	2.02e-04	3.05e-09
	(0.0735)	(0.1666)	(--)	(--)	(0.0710*)

Table 7 The loss functions of Hungary, Euro-X, and the ECB (P_{EMU} decreases by 5%)

Regime / Country	NC	FC	Hungary - EURO-X	Hungary - ECB	EURO-X- ECB
Hungary	8.97e-04	--	8.89e-04*	7.57e-04*	0.3247
	(8.97e-04)	(--)	(8.93e-04*)	(7.62e-04*)	(--)
EURO-X	7.82e-09	--	4.33e-05	0.0085	8.49e-09
	(7.39e-09)	(--)	(1.14e-05)	(0.0086)	(--)
ECB	3.03e-09	--	2.54e-05	0.0051	1.27e-09*
	(8.70e-04)	(--)	(8.74e-04)	(0.0059)	(--)

Table 8 The loss functions of Poland, Euro-X, and the ECB (P_{EMU} decreases by 5%)

Regime / Country	NC	FC	Poland - EURO-X	Poland - ECB	EURO-X- ECB
Poland	0.0011	0.0010*	8.96e-04*	2.02e-05*	0.0042
	(0.0011)	(0.0010*)	(7.55e-04*)	(4.14e-05*)	(1.0341)
EURO-X	7.83e-09	1.62e-04	6.25e-04	0.0076	8.73e-09
	(6.88e-09)	(2.38e-04)	(2.02e-04)	(0.0057)	(0.0048)
ECB	2.77e-09	9.60e-05	0.4600	0.0045	1.05e-09*
	(9.30e-04)	(0.0011)	(7.89e-04*)	(0.0055)	(0.0445)

Note: P_{EMU} decreases by 5% with respect to other economies, euro depreciates by 15% with respect to U.S. dollar and yen, and unemployment rate of a CEEC increase 5%. The rest settings are the same as those in Tables 3, 4, and 5.

Table 9 Sensitivity analysis (Table 6)

Regime / Country	NC	FC	Czech - EURO-X	Czech- ECB
Czech	0.0782	0.2144	0.2143	0.2144
	(0.0782)	(0.2144)	(0.2118)	(1.51e+05)
EURO-X	7.82e-09	1.98e-08	7.82e-09*	2.00e-08
	(8.23e-09)	(1.98e-08)	(9.67e-06)	(15.1106)
ECB	3.04e-09	1.98e-08	3.23e-09	2.00e-08
	(0.0735)	(0.2144)	(0.3659)	(9.1482)

Table 10 Sensitivity analysis (Table 7)

Regime / Country	NC	FC	Hungary - EURO-X	Hungary- ECB
Hungary	8.97e-04	0.0019	0.0019	0.0019
	(8.97e-04)	(--)	(--)	(9.44e-04)
EURO-X	7.82e-09	1.98e-08	7.82e-09*	1.97e-08
	(7.39e-09)	(--)	(--)	(1.20e-06)
ECB	3.03e-09	1.98e-08	3.23e-09	1.97e-08
	(8.70e-04)	(--)	(--)	(7.66e-04*)

Table 11 Sensitivity analysis (Table 8)

Regime / Country	NC	FC	Poland - EURO-X	Poland- ECB
Poland	0.0011	0.0013	0.0013	0.0013
	(0.0011)	(--)	(0.0013)	(--)
EURO-X	7.83e-09	1.98e-08	7.82e-09*	1.97e-08
	(6.88e-09)	(--)	(6.67e-09*)	(--)
ECB	2.77e-09	1.98e-08	3.23e-09	1.97e-08
	(9.30e-04)	(--)	(0.0013)	(--)

Note: Sensitivity analysis for Tables 6, 7, and 8 by setting a CEEC's τ is equal to zero.

Table 12 Sensitivity analysis (Table 6)

Regime / Country	NC	FC	Czech - EURO-X	Czech- ECB	NC
Czech	0.0245	0.0391	0.0229*	0.0253	0.0245*
	(0.0245)	(0.0383)	(0.0232*)	(0.0200*)	(0.0212*)
EURO-X	4.11e-09	3.03e-04	3.46e-04	7.89e-05	6.89e-09
	(6.75e-10)	(4.45e-04)	(2.19e-04)	(2.02e-04)	(0.0013)
ECB	1.68e-10	4.79e-05	5.48e-05	4.39e-05	1.18e-09
	(0.0224)	(0.0384)	(0.0213*)	(0.0132*)	(0.0199*)

Table 13 Sensitivity analysis (Table 7)

Regime / Country	NC	FC	Hungary - EURO-X	Hungary - ECB	EURO-X- ECB
Hungary	2.44e-04	3.84e-04	2.43e-04*	1.44e-04*	0.0972
	(2.44e-04)	(--)	(2.43e-04*)	(1.55e-04*)	(0.0474)
EURO-X	4.11e-09	6.49e-07	1.12e-06	0.0037	4.14e-09
	(3.96e-09)	(--)	(1.33e-07)	(0.0060)	(8.24e-05)
ECB	1.67e-10	9.42e-08	1.66e-07	5.91e-04	1.24e-10*
	(2.31e-04)	(--)	(2.31e-04*)	(0.0011)	(0.0385)

Table 14 Sensitivity analysis (Table 8)

Regime / Country	NC	FC	Poland - EURO-X	Poland - ECB	EURO-X- ECB
Poland	2.48e-04	2.54e-04	2.40e-04*	--	0.0036
	(2.48e-04)	(--)	(2.40e-04*)	(3.49e-05*)	(3.15e-04)
EURO-X	4.12e-09	7.01e-07	1.70e-06	--	4.13e-09
	(4.10e-09)	(--)	(1.70e-06)	(0.0051)	(1.01e-06)
ECB	1.48e-10	1.02e-07	2.56e-07	--	1.36e-10*
	(2.41e-04)	(--)	(2.33e-04*)	(8.17e-04)	(2.34e-04*)

Note: (1) Sensitivity analysis for Tables 6, 7, and 8 by setting a CEEC's τ is equal to 1/25 in FC and 1/13 in bilateral coalitions, respectively; (2) asymmetric policy preferences, that is, $\chi_1=5$, $\chi_2=1$, $\chi_3=2.5$, $\chi_4=2.5$, $\pi_1=2$, $\pi_2=5$, $\pi_3=1$, $\eta_1=5$, $\eta_2=1$, $\eta_3=2.5$, $\eta_4=5$, $\eta_5=1$.

Table 15 Sensitivity analysis (Table 6)

Regime / Country	NC	FC	Czech - EURO-X	Czech- ECB	NC
Czech	1.86e-04	--	1.85e-04*	--	1.86e-04*
	(1.86e-04)	(--)	(1.85e-04*)	(1.54e-04*)	(1.84e-04*)
EURO-X	5.19e-11	--	1.90e-06	--	5.19e-11*
	(4.16e-11)	(--)	(1.90e-06)	(1.60e-04)	(9.85e-06)
ECB	4.13e-16	--	5.92e-09	--	1.43e-13
	(1.71e-04)	(--)	(1.79e-04)	(1.25e-04*)	(1.68e-04*)

Table 16 Sensitivity analysis (Table 7)

Regime / Country	NC	FC	Hungary - EURO-X	Hungary - ECB	EURO-X- ECB
Hungary	2.00e-06	3.86e-06	2.00e-06*	3.28e-06	7.37e-04
	(2.00e-06)	(--)	(2.00e-06*)	(3.89e-06)	(0.0019)
EURO-X	5.19e-11	1.75e-08	1.09e-10	0.0031	5.19e-11*
	(8.58e-12)	(--)	(1.07e-10)	(0.0041)	(1.26e-05)
ECB	4.10e-16	5.49e-11	1.63e-13	9.84e-06	6.12e-15
	(2.10e-06)	(--)	(1.92e-06*)	(1.49e-05)	(0.0015)

Table 17 Sensitivity analysis (Table 8)

Regime / Country	NC	FC	Poland - EURO-X	Poland - ECB	EURO-X- ECB
Poland	2.33e-06	--	5.37e-07*	--	1.46e-05
	(2.33e-06)	(2.60e-06)	(2.33e-06*)	(2.27e-05)	(1.82e-05)
EURO-X	5.19e-11	--	1.00e-06	--	5.19e-11*
	(4.84e-11)	(4.61e-09)	(2.67e-10)	(0.0038)	(5.60e-08)
ECB	3.51e-16	--	0.0089	--	6.07e-15
	(2.17e-06)	(2.60e-06)	(2.17e-06*)	(1.65e-05)	(3.60e-06)

Note: Sensitivity analysis for Tables 6, 7, and 8 by setting the policy preference weights are close to zero, except χ_1=5, π_1=2, π_2=5, η_1=5, η_4=1. The rest settings are the same as those in Tables 12, 13, and 14.

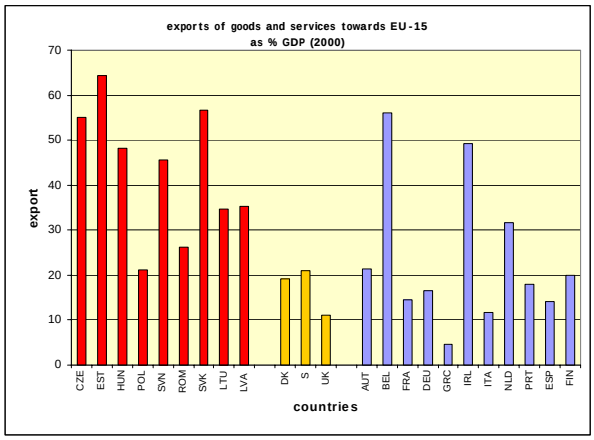

Figure 1 Exports of goods and services towards EU-15 as % of GDP in 2000

Source: De Grauwe (2003)

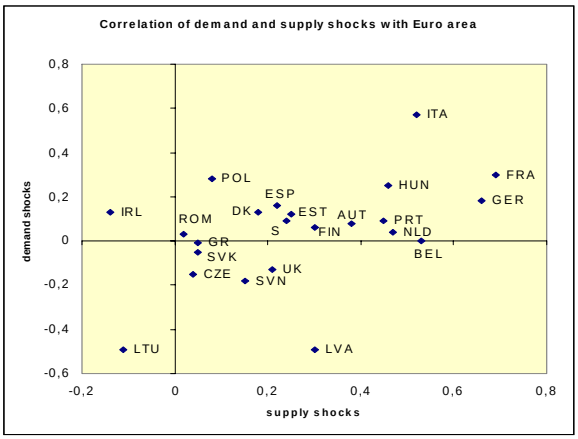

Figure 2 Correlatioin of demand and supply shocks with the euro area

Source: Korhonen and Fidrmuc (2001)

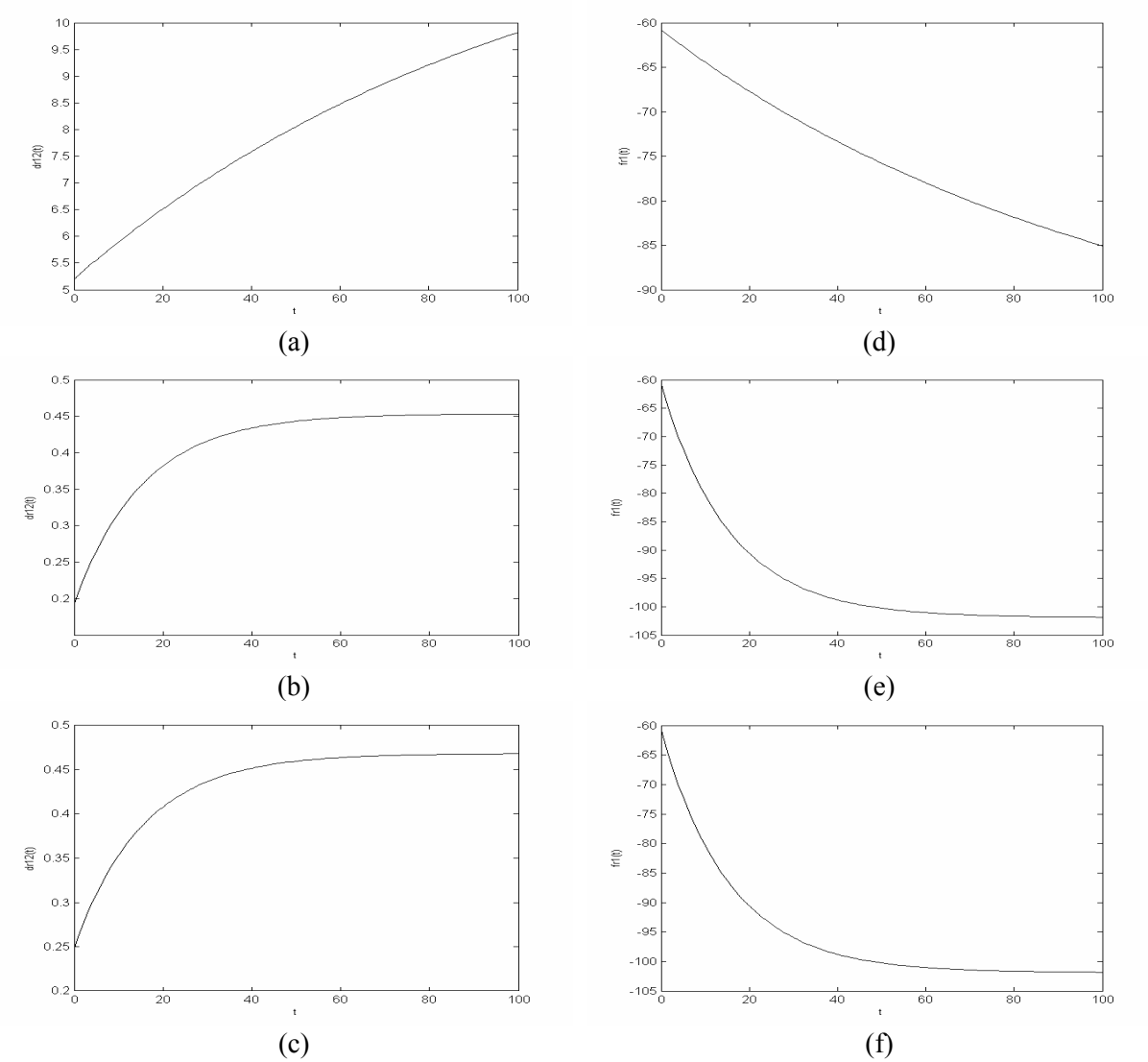

Figure 3 Interest rate differentials and the trade accounts — The cases of non-cooperation and Czech Republic-ECB coalition