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OF REGIONAL EXCHANGE
RATE REGIMES

Harris Dellas
George S. Tavlas



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Harris Dellas

University of Bern, Department of Economics, CEPR and IMOP

George Tavlas

Bank of Greece, Economic Research Department

ABSTRACT

We examine the implications of a regional, fixed exchange rate regime for global exchange rate volatility. The concept of the optimum currency area turns out to play an important role. The formation of a regional regime tends to decrease global volatility when countries are symmetric. The effects tend to be ambiguous in the case of asymmetries. The reduction in global volatility is larger when the rest of the world has more rigid labor markets than the peggers. When the exchange rate management is done mostly by countries with relatively more flexible labor markets. And in the presence of a negative correlation in productivity shocks across countries.

Key words: Regional exchange rate systems, global exchange rate volatility, optimum currency area

JEL classification: E4, E5, F4

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Address for correspondence:

George Tavlas,
Economic Research Department,
Bank of Greece, 21 El. Venizelou St.,
10250 Athens, Greece,
Tel. +30210-320.2370, Fax +30210 320.2432
Email: gtavlas@bankofgreece.gr

1 Introduction

The post Bretton Woods international monetary arrangements have been asymmetric. Typically, some countries maintain a system of -more or less- fixed parities among themselves while, at the same time, allowing the external value of their currencies to move freely against currencies that do not belong to their monetary arrangement. We call such a regime a *mixed* system. The EMS and the EMU are the most important examples in recent history of such regional, mixed regimes (other examples include unilateral pegs, currency boards and so on).

Although a great deal of attention has been devoted to the study of fixed and flexible exchange rate regimes as well as of monetary union¹ *in isolation*, to the best of our knowledge, no attempt has been made to study mixed systems. The objective of this paper is to fill this gap. We are mostly interested in the *global* implications of a regional fixed exchange rate regime and, in particular, whether such a regime leads to a global reduction of exchange rate volatility or simply transfers volatility from one part of the global system to another. Also, we examine the factors that determine the type and magnitude of volatility transfer that takes place. Note that our analysis is also applicable to currency unions, not only fixed regimes. While in principle, a currency union may seem different from a bilateral peg, in practice they have very similar properties.

The answers to the questions raised above are of practical importance. For instance, they can help evaluate the contribution of the EMS (or EMU) to global exchange rate volatility (for instance, its effects on the DM/USD or the DM/GBP rate). They can also form the basis for assessing the implications of EMU for the EUR and USD exchange rates. If the formation of EMU brings about greater global stability in exchange rates by itself then there may be less of a need for explicit international policy coordination (e.g. the adoption of target zones by major currency blocks) in order to achieve such an objective. Finally, one can use our findings to think about what would happen to the rest of the world (say, China's exchange rate) if the EU, the USA and Japan decided to limit fluctuations in their exchange rates.

The existing literature has not yet provided a concrete framework for thinking

¹See De Grauwe (2000).

about these issues. And a priori, there does not seem to exist any strong presumption concerning the sign of the global effects. Volatility eliminated in one place (say, in the DM/FF rate or in economic activity in Germany) may completely disappear from the system. Alternatively, it may simply resurface elsewhere (say, in the DM/GBP rate and in British macroeconomic activity). Moreover, general arguments of the type that “..if the fixed exchange rate system lowers macroeconomic volatility in the pegging countries then it will also reduce exchange rate volatility..” may not be informative because the direction of volatility changes is not uniform across the main economic variables.

We believe that these questions can be best addressed within the context of a multi-country, general equilibrium model of the type commonly used nowadays in the exchange rate literature (for examples of a *two* country version, see Chari, Kehoe and McGrattan, 2000, Collard and Dellas, 2002). We use a three country model whose main features include perfect competition, nominal wage rigidities², active monetary policy (forward looking Taylor rules) and a variety of shocks (supply, fiscal and monetary). We use a generic calibration of the model that relies heavily on parameters commonly used in the literature and serves as a useful benchmark. Its purpose is to illuminate the role played by various factors that have been emphasized in the optimum currency area literature (the degree of labor market flexibility and the existence of various types of international asymmetries).

We find that a regional fixed exchange rate regime tends to decrease global exchange rate volatility if there is sufficient symmetry in the world economy. The results tend to be more ambiguous in the presence of asymmetries, a factor that has been emphasized by the optimum currency area –OCA– theory. In particular, the reduction in volatility is greater when the “ins” have more flexible labor markets than the “outs”. When the pegging is done by a country with a relatively more flexible labor market and with more volatile productivity. And in the presence of negative correlation in productivity across countries. Based on the obtained relationship between country characteristics and volatility, we speculate that global exchange rate volatility would be more likely to decline under a bilateral EUR/USD targeting or if it were the US –rather than the EMU members– that unilaterally

²Other sources of nominal rigidities are possible. Our choice of wage rather than price rigidities is motivated by recent empirical work by Christiano et al (2001) that finds that the former dominate.

targeted the EUR/USD rate.

The remainder of the paper is organized as follows. Section 1 presents the three country model. Section 2 describes the calibration and section 3 presents the main findings.

2 The model

There three countries, A, B and C which are modelled in a similar fashion³ so we describe only one country, B (a technical appendix to this paper, available at our website, offers a detailed description of the other two countries).

The economy consists of a large number of identical households and firms, a fiscal authority and a monetary authority.

2.1 The household

The household maximizes expected lifetime utility:

$$E_0\left[\sum_{t=\infty} \beta^t U(C_t^B, h_t^B)\right] \quad (1)$$

where $0 < \beta < 1$ is a constant discount factor, C_t^B denotes consumption in period t and h_t^B number of hours worked by the representative household in country B. $U(C_t^B, h_t^B)$ is a utility function, increasing and concave in its first argument, and decreasing and convex in its last argument. The following utility function will be used:

$$U(C_t^B, h_t^B) = \log(C_t^B) + \theta \log(1 - h_t^B) \quad (2)$$

where θ is a weight for the marginal utility of leisure.

In each and every period the B household faces two budget constraints. The first takes the form:

$$\begin{aligned} & P_t^B C_t^B + P_t^B I_t^B + \int_{\ell} \left(\frac{\tilde{P}_t^A}{e_t} b_{A,t+1}^B + \frac{\tilde{P}_t^C}{e_t} b_{C,t+1}^B + \tilde{P}_t^B b_{B,t+1}^B \right) d\ell + M_{t+1}^B + P_t^B T_t^B \\ = & W_t^B h_t^B + z_t^B K_t^B + \Pi_t^B + \frac{b_{A,t}^B}{e_t} + \frac{b_{C,t}^B}{e_t} + b_{B,t}^B + M_t^B + N_t^B \end{aligned} \quad (3)$$

³Nevertheless, they may still differ in terms of size, economic structure, shocks and so on.

where P_t^B denotes the price of B's consumption and investment goods, I_t^B is investment, $e_t^{B,A}$ is the B-A exchange rate, $e_t^{B,C}$ is the B-C exchange rate, \tilde{P}_t^j is the price paid for an asset that will deliver 1 unit of country j's currency (j = A, B, C) next period if state ℓ realizes (that is, we assume complete asset markets). A typical B household owns $b_{j,t}^B$, j = A, B, C, such assets entering period t . M_t^B is the stock of money held by the UK household in period t , T_t^B is lump-sum taxes, W_t^B is the nominal wage, z_t^B is the rental rate for capital, K_t^B is the physical capital stock at the beginning of period t , Π_t^B are the profits of the UK firms and N_t^B is a per-capita amount of money issued by the central bank of B and given to the households in the form of a helicopter drop.

According to the budget constraint, the B household enters period t holding an amount of money equal to M_t ; it receives income from its financial investments, $b_{j,t}^B$, from its labor services, and from renting capital to the firms. It also receives its share of the profits distributed by the firms and its share of the money injection by the central bank of country B. It uses these funds to buy new financial assets, to build its cash reserves, to pay taxes and to purchase goods for consumption and investment purposes.

The household also faces a cash-in-advance (CIA) constraint on consumption purchases:

$$P_t^B C_t^B \leq M_t^B \quad (4)$$

Physical capital accumulates according to

$$K_{t+1}^B = \Phi\left(\frac{I_t^B}{K_t^B}\right)K_t^B + (1 - \delta)K_t^B \quad (5)$$

where $0 \leq \delta \leq 1$ denotes the rate of depreciation. The concave function $\Phi(\cdot)$ captures the presence of adjustment costs to investment. It is assumed to be twice differentiable and homogenous of degree 0. Furthermore, we assume the absence of adjustment costs in the steady state: $\Phi(\gamma + \delta - 1) = \gamma + \delta - 1$, $\Phi'(\gamma + \delta - 1) = 1$ and $\frac{\Phi''(\gamma + \delta - 1)(\gamma + \delta - 1)}{\Phi'(\gamma + \delta - 1)} = \varphi$.

Finally, we will assume that –at least a fraction of– the nominal wages is fixed one period in advance at a level that is equal to the expected labor market clearing

wage. In particular, the fixed nominal wages are set using labor contracts of the form $W_t^j = (1 - \vartheta)\widetilde{W}_t^j + \vartheta E_{t-1}\widetilde{W}_t^j$ where \widetilde{W}_t^j is the nominal wage that would clear the labor market in a Walrasian framework, and $0 \leq \vartheta \leq 1$ is the share of labor contracts in the economy. Admittedly, this assumption is ad hoc, in spite its popularity. Nevertheless, setting the nominal wage based on some maximization criterion does not change the properties of the model.

The households that have signed labor contracts must then supply whatever quantity of labor is demanded by the firms.

2.2 The firms

There are two types of firms, those that produce an intermediate good, Y , and those that produce a final good, Q .

The production of the intermediate good is done according to:

$$Y_t^B = a_t^B (K_t^B)^\alpha (\Gamma_t h_t^B)^{1-\alpha} \quad (6)$$

where K_t denotes the physical capital stock at the beginning of period t . Γ_t represents Harrod neutral, deterministic, technical progress evolving according to $\Gamma_t = \gamma \Gamma_{t-1}$. $\gamma \geq 1$ denotes the deterministic rate of growth. a_t^B is a stationary, exogenous, stochastic technology shock.⁴

The representative intermediate good firm chooses the quantity of capital and labor to lease in period t in order to maximize its current profits

$$\pi_t = P_{Yt}^B Y_t^B - W_t^B h_t^B - z_t^B K_t^B \quad (7)$$

where P_{Yt}^B is the price of the B intermediate good.

The country specific intermediate goods are then combined to produce the final goods in the three countries.

$$Y_t^B = Y_{At}^B + Y_{Ct}^B + Y_{Bt}^B \quad (8)$$

where $Y_{j,t}^B$ denotes the amount of B intermediate good that is used as an input to produce country j 's final good in period t .

Note that physical capital, once installed, cannot be shifted internationally. This seems plausible. Note also that financial capital is perfectly mobile.

⁴The stochastic properties of the technology shock will be specified later.

2.3 Production of the final domestic good

The production of the final good in B, Q_t^B , takes place according to:

$$Q_t^B = [\varpi_4^{1-\rho}(Y_{B,t}^A)^\rho + \varpi_5^{1-\rho}(Y_{B,t}^C)^\rho + \varpi_6^{1-\rho}(Y_{B,t}^B)^\rho]^{\frac{1}{\rho}} \quad (9)$$

The level of production is selected in order to maximize profits:

$$\pi^B = P_t^B Q_t^B - \frac{P_{Yt}^A}{e_t^{B,A}} Y_{B,t}^A - \frac{P_{Yt}^C}{e_t^{B,C}} Y_{B,t}^C - P_{Yt}^B Y_{B,t}^B \quad (10)$$

where ϖ_4 , is the weight of A goods in the B final good basket, ϖ_5 , is the weight of C goods in this basket and ϖ_6 denotes the weight of B goods in the domestic (B) basket. Recall that $Y_{B,t}^j$ is the amount of the intermediate good of country j ($j = A, B, C$) used in the production of the B final good. $\frac{1}{\rho-1}$ is the elasticity of substitution between the domestic and foreign intermediate goods. This way of modelling import and export activities is called the *Armington aggregation* and implies that the imported goods have to be transformed into a domestic good, Q_t^B , before they can be consumed or used for investment. It follows that the three countries will have different price levels for their final goods, P_t^i , as these goods are not perfect substitutes.

Clearing of the final good market requires:

$$Q_t^B = C_t^B + I_t^B + G_t^B \quad (11)$$

where G^B is B's government expenditure.

2.4 The government

In each period the government acquires an amount G_t of the final good. The cyclical component of government expenditures ($g_t = G_t/\Gamma_t$) is exogenously determined by a stationary AR(1) process such that:

$$\log(g_t) = \rho_g \log(g_{t-1}) + (1 - \rho_g) \log(g) + \varepsilon_{gt} \quad (12)$$

with $|\rho_g| < 1$ and $\varepsilon_{gt} \rightsquigarrow \mathcal{N}(0, \sigma_g)$.

These expenditures are financed by means of lump-sum taxation

$$P_t^B G_t^B = P_t^B T_t^B \quad (13)$$

2.5 The monetary authorities

The behavior of the monetary authorities depends on the international monetary arrangement in place. Under a flexible exchange rate regime, we assume that monetary authorities pursue active monetary policy. In particular, central banks are assumed to follow an interest rate rule. For instance, in B this rule takes the form⁵

$$\widehat{R}_t^B = \rho^B \widehat{R}_{t-1}^B + (1 - \rho^B)(K_y^B E_t(\widehat{Y}_{t+1}^B) + K_\Pi^B E_t(\widehat{\Pi}_{t+1}^B)) + \zeta_{r,t}^B \quad (14)$$

where R_t^B is the gross nominal interest rate, ρ^B denotes the degree of interest rate smoothing, $E_t(\widehat{Y}_{t+1}^B)$ is expected output (relative to target), $E_t(\widehat{\Pi}_{t+1}^B)$ is expected CPI inflation (relative to target) and $\zeta_{r,t}^B$ is an exogenous policy shock (for instance, a change in the inflation target or variation in the nominal interest rate that is not due to a response of the central bank in B to deviations of inflation or output growth from their target levels). K_y^B and K_Π^B are fixed weights.

The supply of money then evolves according to

$$M_{t+1}^B = \mu_t^B M_t^B \quad (15)$$

where μ_t is the gross rate of growth. This is selected endogenously in order to deliver the nominal interest rate dictated by the Taylor rule above. Note that per capita $(\mu_t^B - 1)M_t^B$ is equal to N_t^B (see the household's budget constraint).

In addition to the flexible exchange rate system we consider a unilateral peg by country A. Under this regime, A selects the growth rate of its supply of money, μ_t , in order to maintain a fixed A-C exchange rate (while the central bank in C pursues its own interest rate rule). This policy is implemented by solving for the exchange rate as a function of the state variables of the system (a set that includes μ_t) and then selecting a value for μ_t that satisfies the exchange rate target, e . Our framework can be easily adapted to deal with bilaterally pegged systems. We abstract from them because they seem to be of limited practical relevance.

⁵We have also experimented with Taylor rules that include an exchange rate target. As it is commonly reported in the literature, such specifications do not find much of an independent role for exchange rate policy.

2.6 The equilibrium

We now turn to the description of the equilibrium of the economy. Recall that capital is perfectly mobile across countries while labor is not.

Definition 1 *An equilibrium of this economy is a sequence of prices*

$$\{\mathcal{P}_t\}_{t=0}^\infty = \left\{ W_t^j, z_t^j, P_t^j, P_{Y_t}^j, P_{b_t}^j(s'), R_t^j, e_t^{B,A}, e_t^{B,C} \right\}_{t=0}^\infty \quad j \in (A, B, C)$$

and a sequence of quantities

$$\{\mathcal{Q}_t\}_{t=0}^\infty = \left\{ \left\{ \mathcal{Q}_t^1 \right\}_{t=0}^\infty, \left\{ \mathcal{Q}_t^2 \right\}_{t=0}^\infty \right\}$$

with

$$\left\{ \mathcal{Q}_t^1 \right\}_{t=0}^\infty = \left\{ \left\{ C_t^j, I_t^j, \{b_{it+1}^j\}_{i \in (A,B,C)}, K_{t+1}^j, M_{t+1}^j \right\}_{j \in (A,B,C)} \right\}_{t=0}^\infty$$

and

$$\left\{ \mathcal{Q}_t^2 \right\}_{t=0}^\infty = \left\{ \left\{ K_t^j, h_t^j, Y_t^j, \{Y_{it}^j\}_{i \in (A,B,C)}, Q_t^j \right\}_{j \in (A,B,C)} \right\}_{t=0}^\infty$$

such that:

- (i) given a sequence of prices $\{\mathcal{P}_t\}_{t=0}^\infty$ and a sequence of shocks, $\{\mathcal{Q}_t^1\}_{t=0}^\infty$ is a solution to the representative household's problem;
- (ii) given a sequence of prices $\{\mathcal{P}_t\}_{t=0}^\infty$ and a sequence of shocks, $\{\mathcal{Q}_t^2\}_{t=0}^\infty$ is a solution to the representative firms' problem;
- (iii) given a sequence of quantities $\{\mathcal{Q}_t\}_{t=0}^\infty$ and a sequence of shocks, $\{\mathcal{P}_t\}_{t=0}^\infty$ clears the goods markets

$$Q_t^A = C_t^A + I_t^A + G_t^A \quad (16)$$

$$Q_t^B = C_t^B + I_t^B + G_t^B \quad (17)$$

$$Q_t^C = C_t^C + I_t^C + G_t^C \quad (18)$$

$$Y_t^A = Y_{At}^A + Y_{Bt}^A + Y_{Ct}^A \quad (19)$$

$$Y_t^B = Y_{At}^B + Y_{Bt}^B + Y_{Ct}^B \quad (20)$$

$$Y_t^C = Y_{At}^C + Y_{Bt}^C + Y_{Ct}^C \quad (21)$$

as well as the financial, money and capital markets.

(iv) Nominal wages are set using labor contracts of the form $W_t^j = (1 - \vartheta)\widetilde{W}_t^j + \vartheta E_{t-1}\widetilde{W}_t^j$ where \widetilde{W}_t^j is the nominal wage that would clear the labor market in a Walrasian framework, and $0 \leq \vartheta \leq 1$ is the share of labor contracts in the economy.

3 Model parameterization: Calibration

The model is solved under a generic set of parameters. which imposes perfect symmetry across countries in all but a single dimension. The asymmetric dimension regards either the labor markets where we allow different degrees of wage rigidities across countries, or the conduct of monetary policy where we allow different countries to follow different Taylor rules, or, finally, the properties of the exogenous shocks. The symmetric parameter values used⁶ are similar to those typically used in the open economy literature (see Backus, Kehoe and Kydland, 1995) shown in table 1.

Insert Table 1

The technology shock is assumed to follow a stationary AR(1) process of the form

$$\log(a_t) = \rho_a \log(a_{t-1}) + (1 - \rho_a) \log(\bar{a}) + \varepsilon_{a,t} \quad (22)$$

with $|\rho_a| < 1$ and $\varepsilon_{a,t} \rightsquigarrow \mathcal{N}(0, \sigma_a^2)$. We set $\bar{a} = 1$.

3.1 Solution

After adjusting the variables for both technological progress and nominal growth (that is, making the model stationary) we calculate the deterministic steady state and log-linearize around it. The resulting dynamic system is solved using standard methods.

⁶We assume a common average rate of money supply growth for simplicity. For the flexible exchange rate regime we can easily allow for long term differences in money supply and inflation. This does not matter for the results, as we work with deviations from the steady state.

4 The results

The solution to the model is used to compute the various moments. We focus exclusively on the issue of volatility, but other properties of the solutions can be easily computed. Tables 2–4 report the results. We report results under different configurations of

- the degree of nominal wage rigidity (tables 2–3)
- the properties of the supply shock and the monetary policy rule (table 4)

in the three countries.

Insert Table 2

Insert Table 3

Insert Table 4

Several interesting patterns emerge. First, if all the countries are symmetric, then the regional peg leads to lower global exchange rate volatility, and this occurs independent of the overall level of nominal wage rigidity (see first three blocks in table 2). Second, the positive effects on volatility are more pronounced when the "outs" have less flexible labor markets than the "ins" (compare the fourth and fifth blocks in table 2 under either a bilateral or a unilateral peg). Third, labor market asymmetries for the "ins" matter significantly, specially when the rest of the world (ROW) has rigid labor markets (compare the results in the first block –high ROW wage rigidity– to those in the second block –low ROW wage rigidity– in table 3). Fourth, the positive effects on global exchange rate volatility are greater under a unilateral peg when the relatively more flexible wage country does the exchange rate targeting (in the first block in table 3, the country doing the exchange rate targeting, A , has flexible labor markets; in the third one, it has a relatively inflexible labor market). And fifth, the sign of the correlation between productivity shocks in the "ins" matters for the effects of the mixed regime on exchange rate volatility. As expected, volatility decreases when this correlation is positive and increases when it is negative (second block in table 4).

Based on the obtained relationship between country characteristics and volatility, we can draw some conclusions concerning what would happen to the global volatility of the exchange rates if the *EUR/USD* rate were targeted by either the *US* or *EMU* members or both. First, assuming that the *US* has flexible and the *EMU* zone rigid labor markets, the effects of targeting the *EUR/USD* on the remaining flexible rates depends on whether the rest of the world had flexible or rigid labor markets. Volatility would be more likely to decrease –and by more– in the latter case (again compare the first to the second block in table 3). And second, we speculate that global exchange rate volatility would be more likely to decline under a bilateral peg or if it were the *US* –rather than the Euro zone countries– that targeted the *EUR/USD* rate. We base this on the fact that volatility decreases by more when the exchange rate targeting is done by the country with: a) the more flexible labor market (compare the first to the third blocks in table 3); b) the more volatile supply shocks (table 4). Both of these factors favor exchange targeting by the *US* (which has a higher volatility of the estimated Solow residuals and more flexible labor markets than the Euro zone).

Before concluding, we must offer a caveat. Our results depend critically on the assumption that the only source of volatility in the economy is fundamental shocks. There is a widespread belief, though, that much of the volatility in exchange rates, at least in the short run, is due to noise. Unfortunately, there does not yet exist a satisfactory way for modelling such factors in current general equilibrium macroeconomic models.

5 Conclusions

A great deal of attention has been devoted to the study of fixed and flexible exchange rate regimes but no attempt has been made to study mixed systems. In this paper we have investigated the implications of a regional fixed exchange rate system for global exchange rate volatility.

The main finding is that asymmetry (a concept emphasized in the optimum currency area literature, see Tavlas, 1993), plays an important role in determining how much of the volatility that is eliminated somewhere in the global system resurfaces somewhere else. Global exchange rate volatility tends to decrease under symmetry. This effect is more pronounced when the rest of the world has more

rigid labor markets than the countries that peg their exchange rate. There are greater gains under asymmetry, when the exchange rate stabilization is done by more flexible wage countries. And finally, positive comovements in productivity across countries tend to increase global exchange rate volatility under a regional fixed regime.

Based on the obtained relationship between country characteristics and volatility we speculate that global exchange rate volatility nowadays would decline were the US and the EMU group to bilaterally target the EUR/USD peg (and the effect would be larger if the rest of the world had relatively rigid labor markets). Under the same circumstances, a unilateral arrangement would also have good exchange rate volatility properties as long as it were the US rather than the Euro zone countries that did the exchange rate targeting.

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Table 1: Calibration

Discount factor	β	0.99
Rate of real growth	γ	1.0069
Depreciation rate	δ	0.020
Labor share	$1 - \alpha$	0.64
Substitution between domestic and foreign goods	ρ	0.25
Adjustment cost	φ	-0.174
Weight of home goods in home GDP	ϖ_{ii}	0.80
Trade interdependence between i and j	ϖ_{ij}	0.10
Persistence of technology shock	ρ_a	0.93
Volatility (sd) of technology shock	σ_a	0.007
Persistence of government spending shock	ρ_g	0.90
Volatility (sd) of government spending shock	σ_g	0.02
Money supply gross rate of growth	μ	1.0228
Persistence of money shock	ρ_m	0.0
Persistence in policy rule	ρ	0.8
Inflation reaction coefficient	K_{Π}	1.5
Output reaction coefficient	K_y	0.1
Volatility (sd) of money shock	σ_m	0.0014

Table 2: The effects of labor market flexibility on exchange rate volatility under symmetry^a

	y^A	y^C	y^B	p^A	p^C	p^B	e^{AC}	e^{AB}	e^{CB}
$\vartheta^A = 1, \vartheta^C = 1, \vartheta^B = 1$									
FL	1.80	1.80	1.80	1.82	1.82	1.82	2.02	2.02	2.02
FU	1.81	1.76	1.80	1.55	1.72	1.83	0.00	2.02	2.02
FB	1.76	1.76	1.80	1.60	1.60	1.82	0.00	1.75	1.75
$\vartheta^A = 0.5, \vartheta^C = 0.5, \vartheta^B = 0.5$									
FL	2.06	2.06	2.06	2.75	2.75	2.75	4.19	4.19	4.19
FU	1.79	1.90	2.09	2.14	2.38	2.82	0.00	4.19	4.19
FB	1.84	1.84	2.06	2.01	2.01	2.75	0.00	3.63	3.63
$\vartheta^A = 0.1, \vartheta^C = 0.1, \vartheta^B = 0.1$									
FL	2.47	2.47	2.47	3.69	3.69	3.69	5.94	5.94	5.94
FU	1.97	2.17	2.54	2.82	3.07	3.80	0.00	5.94	5.94
FB	1.99	1.99	2.47	2.47	2.47	3.69	0.00	5.15	5.15
$\vartheta^A = 1, \vartheta^C = 1, \vartheta^B = 0.5$									
FL	1.80	1.80	2.05	1.82	1.82	2.73	2.02	3.20	3.20
FU	1.81	1.76	2.08	1.56	1.72	2.79	0.00	3.32	3.32
FB	1.76	1.76	2.05	1.61	1.61	2.73	0.00	3.03	3.03
$\vartheta^A = 0.5, \vartheta^C = 0.5, \vartheta^B = 1$									
FL	2.05	2.05	1.80	2.74	2.74	1.83	4.19	3.20	3.20
FU	1.79	1.90	1.81	2.13	2.36	1.85	0.00	2.98	2.98
FB	1.83	1.83	1.80	2.00	2.00	1.83	0.00	2.42	2.42

^aThe reported numbers are standard deviations. y^i is GDP in country i , $i = A, B, C$. p^i is inflation in i . e^{ij} is the nominal exchange rate between i and j . FL has all three countries in a flexible exchange rate system while FU has A pegging unilaterally its currency to C 's currency and FB refers to a symmetric bilateral peg between C and A . ϑ^i is the degree of nominal wage rigidity in country i ($\vartheta^i = 1$ denotes perfect wage rigidity).

Table 3: The effects of labor market flexibility on exchange rate volatility under asymmetry^a

	y^A	y^C	y^B	p^A	p^C	p^B	e^{AC}	e^{AB}	e^{CB}
$\vartheta^A = 0.1, \vartheta^C = 0.8, \vartheta^B = 1$									
FL	2.45	1.86	1.80	3.66	2.15	1.83	4.55	4.22	2.47
FU	2.15	1.81	1.80	2.31	2.02	1.81	0.00	2.39	2.39
FB	2.04	1.76	1.80	2.25	1.87	1.83	0.00	2.49	2.49
$\vartheta^A = 0.1, \vartheta^C = 0.8, \vartheta^B = .4$									
FL	2.46	1.86	2.15	3.67	2.16	2.97	4.55	5.30	3.80
FU	2.17	1.82	2.15	2.33	2.04	2.98	0.00	3.92	3.92
FB	2.05	1.76	2.15	2.26	1.88	2.97	0.00	3.94	3.94
$\vartheta^A = 0.8, \vartheta^C = 0.1, \vartheta^B = 1$									
FL	1.86	2.45	1.80	2.15	3.66	1.83	4.55	2.47	4.22
FU	1.82	2.10	1.82	2.11	2.93	1.90	0.00	3.80	3.80
FB	1.76	2.04	1.80	1.87	2.25	1.83	0.00	2.49	2.49

^aThe reported numbers are standard deviations. y^i is GDP in country i , $i = A, B, C$. p^i is inflation in i . e^{ij} is the nominal exchange rate between i and j . FL has all three countries in a flexible exchange rate system while FU has A pegging unilaterally its currency to C 's currency and FB refers to a symmetric bilateral peg between C and A . ϑ^i is the degree of nominal wage rigidity in country i ($\vartheta^i = 1$ denotes perfect wage rigidity).

Table 4: The role of asymmetries in the supply shocks and policy in exchange rate volatility^a

	y^A	y^C	y^B	p^A	p^C	p^B	e^{AC}	e^{AB}	e^{CB}
$\sigma(\varepsilon_{\xi}^A) = 0.004, \sigma(\varepsilon_{\xi}^C) = 0.007, \sigma(\varepsilon_{\xi}^B) = 0.007$									
FL	1.15	1.79	1.79	1.17	1.81	1.81	1.84	1.84	2.02
FU	1.19	1.74	1.79	1.08	1.70	1.82	0.00	2.02	2.02
FB	1.14	1.74	1.79	1.04	1.57	1.81	0.00	1.70	1.70
$\sigma(\varepsilon_{\xi}^A) = 0.007, \sigma(\varepsilon_{\xi}^C) = 0.004, \sigma(\varepsilon_{\xi}^B) = 0.007$									
FL	1.79	1.15	1.79	1.81	1.17	1.81	1.84	2.02	1.84
FU	1.78	1.14	1.80	1.49	1.10	1.82	0.00	1.84	1.84
FB	1.74	1.14	1.79	1.57	1.04	1.81	0.00	1.70	1.70
$\sigma(\varepsilon_{\xi^A, \xi^B}) = 0.009$									
FL	2.03	2.03	1.83	2.03	2.03	1.86	0.85	2.02	2.02
FU	2.04	2.07	1.83	2.13	2.05	1.86	0.00	2.02	2.02
FB	2.05	2.05	1.83	2.09	2.09	1.86	0.00	1.97	1.97
$\sigma(\varepsilon_{\xi^A, \xi^B}) = -0.014$									
FL	0.99	0.99	1.71	1.13	1.13	1.71	3.52	2.02	2.02
FU	0.99	0.35	1.73	0.00	0.00	1.76	0.00	2.02	2.02
FB	0.54	0.54	1.71	0.00	0.00	1.71	0.00	0.98	0.98
$\sigma(\varepsilon_z^B) = 0.0045$									
FL	1.93	1.81	1.81	2.23	1.85	1.85	3.63	3.63	2.02
FU	1.81	1.76	1.80	1.55	1.72	1.83	0.00	2.02	2.02
FB	1.82	1.82	1.81	1.68	1.68	1.85	0.00	2.31	2.31

^aThe reported numbers are standard deviations. y^i is GDP in country i , $i = A, B, C$. p^i is inflation in i . e^{ij} is the nominal exchange rate between i and j . FL has all three countries in a flexible exchange rate system while FU has A pegging unilaterally its currency to C 's currency and FB refers to a symmetric bilateral peg between C and A . ϑ^i is the degree of nominal wage rigidity in country i ($\vartheta^i = 1$ denotes perfect wage rigidity).

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