The Exchange Rate Regime and International Trade

Romulus-Catalin Damaceanu

The study of the relation between the exchange rates regime and international trade is done using an inter-disciplinary vision that contains knowledge from four different disciplines: economics, history, mathematics and computer sciences. In the case of pure theory of international trade, there is made an abstraction of the fact that international trade is done using money. The theoretical analysis of international trade including the monetary factor deals with static equilibrium and linear models. We conceived a macroeconomic model of the world economy and used this model to make three simulation experiments. The conclusion of these experiments is that a broader exchange rate band has a negative impact over the volume of world trade. This conclusion is confirmed by the historical analysis.

Key Words: historical analysis, macroeconomic modelling, simulation of international trade, design of exchange rate regime experiments
JEL *Classification:* F47, C99

Introduction

An important factor of the international trade volume is the level of exports and imports prices. These prices also depend on the value of exchange rates. As consequence, the exchange rates regime has a major influence over the international trade volume. The relation between the exchange rate regime and international trade is bivalent. International trade, in its turn, has a major influence over the exchange rates regime. Under certain conditions, the international trade evolution can determine the changing of exchange rates regime by the central banks. This happens, in the most cases, when the central bank has not enough reserves to maintain a certain exchange rates regime. The study of the interconditional relation between the exchange rates regime and international trade is done using an inter-disciplinary vision that contains knowledge from four disciplines: economics, history, mathematics and computer sciences.

The analysis of the complex relation between the exchange rate regime

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and international trade is done based on the following *methodological principles:*

1. Analysis of the pure theory of international trade.
2. Analysis of the main theoretical approaches of international trade taking into consideration the monetary factor.
3. A historical analysis of the relation between the exchange rates regime and international trade.
4. Mathematical modelling of relation between the exchange rate and the international trade.
5. Simulation of the correlation between the exchange rate and international trade using experiments.

The classical economists were the first to elaborate a theory of international trade (Smith 1962; Ricardo 1959). This theory was a reaction to the mercantilist conception in contradiction with the liberal doctrine that stressed the importance of individuals and considered the nation just as the sum of its inhabitants. The theory of international trade was improved by the Hecksher-Ohlin model (Heckscher 1919; Ohlin 1933). Paul Samuelson and Ronald W. Johnson transformed the classical model of international trade into one with three factors of production, two goods and two countries that use neoclassical production functions (Samuelson 1971; Jones 1971). The most recent theoretical conceptions are those that use the notion of intra-industrial trade. In the case of all these theories, there is made an abstraction that international trade is done by using money.

The connections between the variations of exchange rates and the international trade flows are described using the following theories: the elasticity theory, the absorption theory, the J curve theory, the Mundell-Fleming theory, the monetarist theory and the neoclassical theory (Mundell 1962; 1963; Fleming 1962; Walras 1954; Marshall 1923; Burr 1960).

The hystorical analysis shows us that, over time, the nations have used the following types of exchange rates regimes:

1. the fixed exchange rates regime (FIX), when the central bank maintains the exchange rate between the national currency and the reference currency in a relatively narrow pegging band of ± 1% in comparison with the target level of exchange rate;
2. the floating exchange rates regime (FLT), when the central bank make no interventions on the foreign currency markets;

TABLE 1 The average rate of growth obtained under the three regimes

Regime	Monetary system	Rate of growth of world trade	Rank
FIX	Gold standard	4.1	III
	Bretton Woods	8.1	I
FLT	Inter-war period	2.1	IV
CTR	Present monetary system	5.0	II

NOTE Data calculated and updated from Damaceanu 2005.

3. the controlled exchange rates regime (CTR), when the exchange rate is determined by the interaction between the intervention of the state and the relation between demand and supply.

The average rate of growth of world trade obtained under these types of regimes is presented in table 1.

Based on the data of table 1, we can conclude that the highest rate of growth of world trade was obtained during the fixed exchange rate regime of the Bretton Woods system; in second place is the rate obtained for the controlled exchange rates regime; in third place is the rate obtained during the gold standard, and the lowest rate is obtained during the inter-war period.

The rest of the paper is organized as follows: the second section describes the macroeconomic model of the world economy used to simulate the relations between the exchange rate regime and international trade, the third analyses the simulation results and the fourth section presents the conclusions.

The Model of the World Economy

The macroeconomic model that we are going to use is associated with a world economy with $m = 2$ national economies NE_1 and NE_2. The objective of this model is to simulate world trade under the following exchange rates regimes: the floating exchange rates (*FLT*), the fixed exchange rates regime (*FIX*) and the controlled exchange rates regime (CTR_p), where p is the pegging band of $\pm p$ ($p \neq 0.1$) in comparison with the target level of exchange rates.

Our model takes into consideration the next simplifying assumptions:

- The equations of the model are stable: the parameters do not change during the period of simulation.
- There are no anticipations connected with the evolution of the exchange rates and no speculations on foreign currency markets.

- There are no commercial barriers.

The model is structured in the next objects:

$$WE \longrightarrow NE_1 \longrightarrow FCM_{1,2}$$
$$\longrightarrow NE_2 \longrightarrow FCM_{2,1},$$

where WE is the world economy, NE_i is the national economy with the number $i \in \{1, 2\}$, and $FCM_{i,j}$ is the foreign currency market of economy NE_i where is traded the currency of economy NE_j; $i \neq j$; $i, j \in \{1, 2\}$.

The non-linearity of model is given by the variable $ICB_{i,j,t}$ that quantifies the intervention of central bank on the foreign currency market.

THE EQUATIONS OF OBJECT WE

The object WE contains two variables: the world exports X_t and the world imports M_t. Thus, the world exports X_t evaluated in the currency of the economy NE_1 are determined by the next equation:

$$X_t = X_{1,t} + X_{2,t} \cdot er_{1,2,t}, \tag{1}$$

where $X_{i,t}$ represents the aggregated exports of economy NE_i, and $er_{i,j,t}$ is the exchange rate between the currencies of economies NE_i and NE_j, $i \neq j$, $i \in \{1, 2\}$.

The world imports M_t evaluated in the currency of economy NE_1 are determined by the next equation:

$$X_t = M_{1,t} + M_{2,t} \cdot er_{1,2,t}, \tag{2}$$

where $M_{i,t}$ represents the aggregated imports of economy NE_i, $i \in \{1, 2\}$.

THE EQUATIONS OF OBJECTS NE_i

We can express the variation in time of the average level of prices of economy NE_i using the next relation:

$$p_{i,t} = p_{i,t} - 1 + a_i \cdot (D_{i,t-1} - S_{i,t-1}), \tag{3}$$

where $a_i \geq 0$ is a parameter that quantifies the elasticity of prices, $D_{i,t}$ is the aggregated demand of economy NE_i, and $S_{i,t}$ is the aggregated supply of economy NE_i.

$D_{i,t}$ has four components:

- the aggregated consumption $C_{i,t}$;
- the aggregated investments $I_{i,t}$;
- the governmental spending $G_{i,t}$;

- the aggregated exports $X_{i,t}$.

$S_{i,t}$ has the next elements:

- the aggregated output $Y_{i,t}$;
- the aggregated imports $M_{i,t}$.

Equation (4) determines, from the mathematical point of view, the aggregated demand $D_{i,t}$ as being the sum between the aggregated consumption $C_{i,t}$, the aggregated investments $I_{i,t}$, the governmental spending $G_{i,t}$ and the aggregated exports $X_{i,t}$:

$$D_{i,t} = C_{i,t} + I_{i,t} + G_{i,t} + X_{i,t}. \tag{4}$$

Equation (5) expresses the aggregated supply $S_{i,t}$ as being the sum between the aggregated output $Y_{i,t}$ and the aggregated imports $M_{i,t}$:

$$S_{i,t} = Y_{i,t} + M_{i,t}. \tag{5}$$

We can describe the variation of the aggregated consumption $C_{i,t}$ in function of average level of prices $p_{i,t}$, of available income $YD_{i,t}$ and of interest rate $ir_{i,t}$ using the equation:

$$\begin{aligned} C_{i,t} = {} & C_{i,t-1} - c_{p,i} \cdot (p_{i,t-1} - p_{i,t-2}) \\ & + c_{yd,i} \cdot (YD_{i,t-1} - YD_{i,t-2}) \\ & - c_{ir,i} \cdot (ir_{i,t-1} - ir_{i,t-2}), \end{aligned} \tag{6}$$

where $c_{p,i} \geq 0$ is the elasticity of consumption in function of price, $c_{yd,i} \in [0, 1]$ is the elasticity of consumption in function of available income, and $c_{ir,i} \geq 0$ is the elasticity of consumption in function of interest rate.

Equation (7) describes the variation of investments $I_{i,t}$ in function of average level of prices $p_{i,t}$, of the variation of the aggregated demand $D_{i,t}$ and of the interest rate $ir_{i,t}$:

$$\begin{aligned} I_{i,t} = {} & I_{i,t-1} - i_{p,i} \cdot (p_{i,t-1} - p_{i,t-2}) \\ & + i_{d,i} \cdot (D_{i,t-1} - D_{i,t-2}) \\ & - i_{ir,i} \cdot (ir_{i,t-1} - ir_{i,t-2}), \end{aligned} \tag{7}$$

where $i_{p,i} \geq 0$ is the elasticity of investments in function of price, $i_{d,i} \in [0, 1]$ is the elasticity of investments in function of aggregated investments, and $i_{ir,i} \geq 0$ is the elasticity of investments in function of interest rate.

Equation (8) describes the variation of the governmental spending $G_{i,t}$ in function of the budgetary surplus or deficit $BG_{i,t}$:

$$G_{i,t} = G_{i,t-1} + BG_{i,t-1}. \tag{8}$$

Equation (9) shows us that the variation of the output $Y_{i,t}$ is determined by the variation of the aggregated demand $D_{i,t}$, by the variation of the aggregated inputs of capital coming from abroad $IK_{i,t}$ - especially the direct foreign investments made in the frame of economy NE_i, and by the variation of prices $p_{i,t}$:

$$\begin{aligned} Y_{i,t} = {} & Y_{i,t-1} + y_{d,i} \cdot (D_{i,t-1} - D_{i,t-2}) \\ & + y_{ik,i} \cdot (IK_{i,t-1} - IK_{i,t-2}) \\ & - y_{p,i} \cdot (p_{i,t-1} - p_{i,t-2}). \end{aligned} \tag{9}$$

where $y_{d,i} \in [0, 1]$ is the elasticity of output in function of demand, $y_{ik,i} \in [0, 1]$ is the elasticity of output in function of inputs of capital from abroad, and $y_{p,i} \geq 0$ is the elasticity of output in function of price.

Equation (10) describes the available income $YD_{i,t}$ as being equal with the difference between the aggregated output/income $Y_{i,t}$ and the aggregated taxes $T_{i,t}$:

$$YD_{i,t} = Y_{i,t} - T_{i,t}. \tag{10}$$

Equation (11)describes the variation of taxes $T_{i,t}$ in function of the variation of output $Y_{i,t}$:

$$T_{i,t} = T_{i,t-1} - t_{y,i} \cdot (Y_{i,t-1} - Y_{i,t-2}), \tag{11}$$

where $t_{y,i} \in [0, 1]$ is the elasticity of taxes in function of income.

The value of budgetary surplus of deficit $BG_{i,t}$ is determined by:

$$BG_{i,t} = BG_{i,t-1} + T_{i,t} - G_{i,t}. \tag{12}$$

Equation (13)describes the variation of the interest rate $ir_{i,t}$ in function of the difference between the monetary demand $MD_{i,t}$ and supply $MS_{i,t}$:

$$ir_{i,t} = ir_{i,t-1} + b_i \cdot (MD_{i,t-1} - MS_{i,t-1}), \tag{13}$$

where b_i is the elasticity of interest rate.

Equation (14) describes the monetary demand using the simple Keynesian specification that specifies the money requested for transactions and for speculative purposes (Keynes 1936). Under these conditions, the monetary demand $MD_{i,t}$ is determined by the variation of aggregated supply $S_{i,t}$ and of interest rate $ir_{i,t}$:

$$MD_{i,t} = MD_{i,t-1} + md_{s,i} \cdot (S_{i,t-1} - S_{i,t-2}) - md_{ir,i} \cdot (ir_{i,t-1} - ir_{i,t-2}), \quad (14)$$

where $md_{s,i} \in [0, 1]$ and $md_{ir,i} \geq 0$ are the elasticity of monetary demand in function of supply of goods and services and, respectively, of interest rate.

Equation (15) shows us the way in which the monetary supply $MS_{i,t}$ variates in function of aggregated supply $S_{i,t}$ and of interest rate $ir_{i,t}$:

$$MS_{i,t} = MS_{i,t-1} + ms_{s,i} \cdot (S_{i,t-1} - S_{i,t-2}) + ms_{ir,i} \cdot (ir_{i,t-1} - ir_{i,t-2}), \quad (15)$$

where $ms_{s,i} \in [0, 1])$ and $ms_{ir,i} \geq 0$ are the elasticity of monetary supply in function of supply of goods and services and, respectively, of interest rate.

Equation (16) shows us that the balance of payments $BP_{i,t}$ is determined by the sum between the current account balance BCi, t and the capital account balance $BK_{i,t}$:

$$BP_{i,t} = BC_{i,t} + BK_{i,t}. \quad (16)$$

Equation (17) determines the current account balance $BC_{i,t}$ as being the difference between the aggregated exports $X_{i,t}$ and the aggregated imports $M_{i,t}$:

$$BC_{i,t} = X_{1,t} - M_{i,t}. \quad (17)$$

Equation (18) determines the capital account balance $BK_{i,t}$ as being the difference between the inputs of capital $IK_{i,t}$ and exits of capital $EK_{i,t}$:

$$BK_{i,t} = IK_{i,t} - EK_{i,t}. \quad (18)$$

Equation (19) determines the value of aggregated exports $X_{i,t}$ as the sum of exports $X_{i,j,t}$ made by the economy NE_i to the others economies, where $j \neq i$:

$$X_{i,t} = \sum X_{i,j,t}. \quad (19)$$

Equation (20) determines the value of the aggregated imports $M_{i,t}$ as being the sum of imports $M_{i,j,t}$ made by the economy NE_i from the others economies, where $j \neq i$:

$$M_{i,t} = \sum M_{i,j,t}. \quad (20)$$

Equation (21) calculates the value of aggregated inputs of capital $IK_{i,t}$ as being the sum of inputs of capital $IK_{i,j,t}$ coming from abroad, where $j \neq i$:

$$IK_{i,t} = \sum IK_{i,j,t}. \tag{21}$$

Equation (22) calculates the value of aggregated outputs of capital $EK_{i,t}$ as being the sum of outputs of capital $EK_{i,j,t}$ destined abroad, where $j \neq i$:

$$EK_{i,t} = \sum EK_{i,j,t}. \tag{22}$$

THE EQUATIONS OF OBJECTS $FCM_{i,j}$

The exchange rate $er_{i,j,t}$ represents the price of one monetary unit of economy NE_j evaluated in the currency of economy NE_i. The value of exchange rate $er_{i,j,t}$ is determined by the next factors: the foreign currency demand $CD_{i,j,t}$; the foreign currency supply $CS_{i,j,t}$; the value of the central bank intervention $ICB_{i,j,t}$ – this last factor appears only when the central bank selects the regimes *FIX* or CTR_p, and the exchange rate $er_{i,j,t}$ exits from the permitted floating band.

We can express from the mathematical point of view the dynamics of exchange rates $er_{i,j,t}$ by the equation:

$$er_{i,j,t} = er_{i,j,t-1} + c_{i,j} \cdot (CD_{i,j,t-1} - CS_{i,j,t-1} + ICB_{i,j,t}), \tag{23}$$

where $c_{i,j} \geq 0$ is a parameter that quantifies the elasticity of exchange rate.

The foreign currency demand $CD_{i,j,t}$ represents the total value of currencies bought on the foreign currency market $FCM_{i,j}$. $CD_{i,j,t}$ is generated by the next factors: the value of imports $M_{i,j,t}$; the value of exits of capital $EK_{i,j,t}$. $CD_{i,j,t}$ is expressed by equation:

$$CD_{i,j,t} = M_{i,j,t} + EK_{i,j,t}. \tag{24}$$

The foreign currency supply $CS_{i,j,t}$ is the total value of currencies destined to be sold on the market $FCM_{i,j}$. $CS_{i,j,t}$ is generated by the value of exports $X_{i,j,t}$ and by the value of inputs of capital $IK_{i,j,t}$. $CD_{i,j,t}$ is determined by:

$$CS_{i,j,t} = X_{i,j,t} + IK_{i,j,t}. \tag{25}$$

When the central bank selects the regime *FLT* of floating exchange

rates and $r_{i,j} = 0$ then we do not have interventions on the market $FCM_{i,j}$ and

$$ICB_{i,j,t} = 0.$$

When the central bank selects the regime *FIX* of fixed exchange rates ($r_{i,j} = 1$) or the regime CTR_p of controlled exchange rates ($r_{i,j} = 2$) and the exchange rate $er_{i,j,t}$ has the tendency to exit the floating band then we have an intervention on the market $FCM_{i,j}$ in order to sell or buy currencies and to modify the exchange at the target level $er^{\star}_{i,j}$. When the central bank buys currencies then $ICB_{i,j,t} > 0$ and when it sells then $ICB_{i,j,t} < 0$.

To determine the value of $ICB_{i,j,t}$, we start from equation (25) and we fix the exchange rate $er_{i,j,t}$ at the target level $er^{\star}_{i,j}$. As a consequence, we have:

$$er^{\star}_{i,j} = er_{i,j,t-1} + c_{i,j} \cdot (CD_{i,j,t-1} - CS_{i,j,t-1} + ICB_{i,j,t}). \qquad (25')$$

This is equivalent with:

$$ICB_{i,j,t} = \frac{1}{c_{i,j}} \cdot (er^{\star}_{i,j} - er_{i,j,t-1}) - CD_{i,j,t-1} + CS_{i,j,t-1}. \qquad (25')$$

If the exchange rate $er_{i,j,t}$ is being maintained in the floating band then the central bank does not make interventions on the market $FCM_{i,j}$ and:

$$ICB_{i,j,t} = 0.$$

In the case of buying currencies, the reserve $R_{i,j,t}$ of the central bank is growing, and, in the case of selling currencies, the reserve $R_{i,j,t}$ is becoming smaller. In the second case, the reserve $R_{i,j,t}$ might prove insufficient to accomplish the intervention on the market $FCM_{i,j}$. This happens when we have the next relation:

$$R_{i,j,t-1} + ICB_{i,j,t} < 0.$$

By using equation (25), we have:

$$R_{i,j,t-1} + \frac{1}{c_{i,j}} \cdot (er^{\star}_{i,j} - er_{i,j,t-1}) - CD_{i,j,t} + CS_{i,j,t} < 0.$$

In this case, the value of $ICB_{i,j,t}$ is equal with:

$$ICB_{i,j,t} = -R_{i,j,t-1}.$$

Taking into consideration all these possible cases, we can determine the value of $ICB_{i,j,t}$ by the nonlinear equation:

$$ICB_{i,j,t} = \begin{cases} 0, \text{ if } r_{i,j} = 0. \\ 0, \text{ if } r_{i,j} = 1 \text{ and } er_{i,j,t-1} \in (0.99 \cdot er^{\star}_{i,j}, 1.01 \cdot er^{\star}_{i,j}). \\ 0, \text{ if } r(i,j) = 2 \text{ and } er_{i,j,t-1} \in ((1 - p_{i,j}) \\ \quad \cdot er^{\star}_{i,j}, (1 + p_{i,j}) \cdot er^{\star}_{i,j}). \\ \frac{1}{c_{i,j}} \cdot (er^{\star}_{i,j} - er_{i,j,t-1}) - CD_{i,j,t-1} + CS_{i,j,t-1}, \text{if } r_{i,j} = 1, \\ \quad er_{i,j,t-1} \in (-\infty, 0.99 \cdot er^{\star}_{i,j}] \cup [1.01 \cdot er^{\star}_{i,j}, +\infty) \\ \quad \text{and } R_{i,j,t-1} + ICB_{i,j,t} \geq 0. \\ -R_{i,j,t-1}, \text{if } r_{i,j} = 1, er_{i,j,t-1} \in (-\infty, 0.99 \cdot er^{\star}_{i,j}] \\ \quad \cup [1.01 \cdot er^{\star}_{i,j}, +\infty) \text{ and } R_{i,j,t-1} + ICB_{i,j,t} < 0. \\ \frac{1}{c_{i,j}} \cdot (er^{\star}_{i,j} - er_{i,j,t-1}) - CD_{i,j,t-1} + CS_{i,j,t-1}, \text{if } r_{i,j} = 2, \\ \quad er_{i,j,t-1} \in (-\infty, (1 - p_{i,j} \cdot er^{\star}_{i,j}] \cup [(1 + p_{i,j}) \\ \quad \cdot er^{\star}_{i,j}, +\infty) \text{ and } R_{i,j,t-1} + ICB_{i,j,t} \geq 0. \\ -R_{i,j,t-1}, \text{ if } r_{i,j} = 2, er_{i,j,t-1} \in (-\infty, (1 - p_{i,j} \cdot er^{\star}_{i,j}] \\ \quad \cup [(1 + p_{i,j}) \cdot er^{\star}_{i,j}, +\infty) \\ \quad \text{and } R_{i,j,t-1} + ICB_{i,j,t} < 0. \end{cases} \tag{26}$$

The next equation calculates the value of reserve $R_{i,j,t}$:

$$R_{i,j,t} = R_{i,j,t-1} + ICB_{i,j,t}. \tag{27}$$

Using the principle of generalized gravitation equation (Bergstrand 1989), we can consider that the value of exports $X_{i,j,t}$ is determined by the next factors: the output $Y_{i,t}$, the output $Y_{j,t}$, the exchange rate $er_{i,j,t}$ and the difference $p_{i,t} - p_{j,t} \cdot er_{i,j,t}$ between internal prices and foreign prices. From the mathematical point of view, the influence of these factors over $X_{i,j,t}$ can be described by:

$$\begin{aligned} X_{i,j,t} = X_{i,j,t-1} &+ x_{y,i,j} \cdot (Y_{i,t-1} - Y_{i,t-2}) + x_{yf,i,j} \cdot (Y_{j,t-1} - Y_{j,t-2}) \\ &+ x_{er,i,j} \cdot (er_{i,j,t-1} - er_{i,j,t-2}) - x_{p,i,j} \cdot (p_{i,t-1} - p_{j,t} \cdot er_{i,j,t}), \end{aligned} \tag{28}$$

where $x_{y,i,j} \in [0,1]$ is the elasticity of exports in function of national output, $x_{yf,i,j} \in [0,1]$ is the elasticity of exports in function of foreign output, $x_{er,i,j} \in [0,1]$ is the elasticity of exports in function of the ex-

change rate, and $x_{p,i,j} \in [0, 1]$ is the elasticity of exports in function of the difference between the national and the foreign prices evaluated in the national currency.

The imports $M_{i,j,t}$ are equal with the exports $X_{j,i,t}$ multiplied by the exchange rate $er_{i,j,t}$:

$$M_{i,j,t} = X_{j,i,t} \cdot er_{i,j,t}. \tag{29}$$

In the case of exits of capital $EK_{i,j,t}$, we will apply the same principle of generalized gravitation equation, completed with the theory of capital flows. The origins of this last theory can be found in the time of gold specie standard, when an increase of internal interest rate was seen as a way of stimulating the inputs of gold from abroad (Artis and Lewis 1991). The modern theory of capital flows states that in a world with two countries A and B, the others factors remaining unchanged, we can write the variation of external liabilities of country A like this:

$$dF_A = I_A + f_A(ir_A, ir_B),$$

where F_A is the value of liabilities, dF_A is the variation of liabilities (a capital flow), ir_A and ir_B are the interest rates of countries A and B, and I_A is the component of F_A that does not depend on interest rates. It is supposed that $dF_A/dir_A > 0$ and $df_A/dir_B < 0$.

Under these circumstances, the exits of capital $EK_{i,j,t}$ are determined by: the output $Y_{i,t}$, the output $Y_{j,t}$, the exchange rate $er_{i,j,t}$ and the difference $ir_{i,t} - ir_{j,t}$ between internal interest rate and foreign interest rate. The influence of these four factors over $EK_{i,j,t}$ can be described, from the mathematical point of view, by:

$$\begin{aligned} EK_{i,j,t} = {} & EK_{i,j,t-1} + ek_{y,i,j} \cdot (Y_{i,t-1} - Y_{i,t-2}) \\ & + ek_{yf,i,j} \cdot (Y(j, t-1) - Y(j, t-2)) \\ & - ek_{er,i,j} \cdot (er_{i,j,t-1} - er_{i,j,t-2}) \\ & - ek_{ir,i,j} \cdot (ir_{i,t-1} - ir_{j,t-1}), \end{aligned} \tag{30}$$

where $ek_{y,i,j} \in [0, 1]$ is the elasticity of exits of capital in function of national output, $ek_{yf,i,j} \in [0, 1]$ is the elasticity of exits of capital in function of foreign output, $ek_{er,i,j} \in [0, 1]$ is the elasticity of exits of capital in function of exchange rate, and $ek_{ir,i,j} \in [0, 1]$ is the elasticity of exports in function of difference between the national and the foreign interest rates.

The inputs of capital $IK_{i,j,t}$ are equal with the exits of capital $EK_{i,j,t}$ multiplied by the exchange rate $er_{i,j,t}$:

$$IK_{i,j,t} = EK_{j,i,t} \cdot er_{i,j,t}. \tag{31}$$

Analysis of simulation results

We make three simulation experiments:

- *EXP*1 will simulate the world trade under the regime *FLT*;
- *EXP*2 will simulate the world trade under the regime *FIX*;
- *EXP*3 will simulate the world trade under the regime $CTR_{0.02}$.

To make such experiments, I used the application LSD - (Laboratory for Simulation Development, see Damaceanu 2006) for the implementation of the mathematical model in the simulation macrolanguage LSD. This application was developed by Marco Valente in the frame of the project IIASA, Vienna, conducted by Prof. G. Dosi and upgraded at DRUID, Aalborg, in the frame of a research program conducted by Prof. E. S. Andersen (Valente and Andersen 2002).

In order to make a comparative analysis, all three experiments will have the same values for the input variables and parameters with the exception of the parameters $r_{i,j}$ (tables 2, 3 and 4). In addition, the period of simulation will be the same: from $t = 1$ to $t = 90$.

In table 5, we have the evolution in time of variables $X(t)$ and $M(t)$ under the three regimes:

$$FLT: \{r_{1,2} = 0, r_{2,1} = 0\};$$

$$FIX: \{r_{1,2} = 1, r_{2,1} = 1\};$$

$$CTR_{0.02}: \{r_{1,2} = 2, r_{2,1} = 2, p_{1,2} = 0.02, p_{2,1} = 0.02\}.$$

If we compare the total value of world trade obtained under these three regimes of exchange rates, we observe that the biggest value ($\sum X_t = 12672.63$ and $\sum M_t = 12672.55$) was obtained under the regime *FIX*, in second place is the world trade ($\sum X_t = 12649.37$ and $\sum M_t = 12648.13$) obtained under the regime $CTR_{0.02}$ and in the last place is the world trade ($\sum X_t = 12562.95$ and $\sum M_t = 12561.95$) obtained under the regime *FLT*.

The conclusion of these three experiments is that a broader exchange rate band has a negative impact over the volume of the world trade.

Conclusions

Based on historical and experimental analysis, we can tell that a fixed or a relative narrow pegging exchange rate regime can assure a faster growth of international trade with the condition that the national economies

TABLE 2 The input variables and parameters for the objects NE_1 and NE_2

NE_1	NE_2	NE_1	NE_2
$p_{1,0} = 9.83$	$p_{2,0} = 9.91$	$yd_1 = 0.01$	$yd_2 = 0.01$
$p_{1,-1} = 9.84$	$p_{2,-1} = 9.92$	$yp_1 = 0.01$	$yp_2 = 0.01$
$a_1 = 0.01$	$a_2 = 0.01$	$yik_1 = 0.01$	$yik_2 = 0.01$
$D_{1,0} = 487.52$	$D_{2,0} = 945.79$	$YD_{1,0} = 355.55$	$YD_{2,0} = 812.83$
$D_{1,-1} = 488.69$	$D_{2,-1} = 946.57$	$YD_{1,-1} = 356.75$	$YD_{2,-1} = 813.62$
$S_{1,0} = 480.08$	$S_{2,0} = 946.38$	$T_{1,0} = 41$	$T_{2,0} = 94$
$S_{1,-1} = 481.25$	$S_{2,-1} = 947.14$	$ty_1 = 0.01$	$ty_2 = 0.01$
$C_{1,0} = 174.43$	$C_{2,0} = 357.03$	$BG_{1,0} = 9.0$	$BG_{2,0} = 6.0$
$C_{1,-1} = 174.42$	$C_{2,-1} = 357.02$	$ir_{1,0} = 1.01$	$ir_{2,0} = 1.14$
$cp_1 = 0.01$	$cp_2 = 0.01$	$ir_{1,-1} = 1.00$	$ir_{2,-1} = 1.15$
$cyd_1 = 0.01$	$cyd_2 = 0.01$	$b_1 = 0.01$	$b_2 = 0.01$
$cir_1 = 0.01$	$cir_2 = 0.01$	$MD_{1,0} = 518.22$	$MD_{2,0} = 980.51$
$I_{1,0} = 223.53$	$I_{2,0} = 407.23$	$mds_1 = 0.01$	$mds_2 = 0.01$
$I_{1,-1} = 224.75$	$I_{2,-1} = 408.05$	$mdir_1 = 0.01$	$mdir_2 = 0.01$
$id_1 = 0.01$	$id_2 = 0.01$	$MS_{1,0} = 518.12$	$MS_{2,0} = 980.61$
$iir_1 = 0.01$	$iir_2 = 0.01$	$mss_1 = 0.01$	$mss_2 = 0.01$
$ip_1 = 0.01$	$ip_2 = 0.01$	$msir_1 = 0.01$	$msir_2 = 0.01$
$G_{1,0} = 32$	$G_{2,0} = 88$	$IK_{1,0} = 93.52$	$IK_{2,0} = 47.55$
$Y_{1,0} = 396.55$	$Y_{2,0} = 906.83$	$IK_{i,-1} = 93.49$	$IK_{i,-1} = 47.51$
$Y_{1,-1} = 397.75$	$Y_{2,-1} = 907.624$		

within the world economy are functional in the sense of not having an economic crisis.

On the other hand, a national economy in crisis should choose a floating exchange rate or a relatively broader pegging regime because, under these conditions, these regimes proved to assure better economic performances. The experience of Eastern and Central Europe demonstrates that these regimes helped to pass the critical periods while the experience of Argentina was eloquent because this country suffered a dramatic economic crisis under the regime of monetary council anchored to the US dollar.

It seems that the future international monetary system will be one in which euro and US dollar will be the pillars of the system. In the present days, the dramatic variations of exchange rates between these two

TABLE 3 Variables and parameters for the objects $FCM_{1,2}$ and $FCM_{2,1}$

$FCM_{1,2}$	$FCM_{2,1}$	$FCM_{1,2}$	$FCM_{2,1}$
$er^{\star}_{1,2} = 1$	$er^{\star}_{2,1} = 1$	$xy_{1,2} = 0.01$	$xy_{2,1} = 0.01$
$r_{1,2} \in \{0, 1, 2\}$	$r_{2,1} \in \{0, 1, 2\}$	$xyf_{1,2} = 0.01$	$xyf_{2,1} = 0.01$
$p_{1,2} = 0.02$	$p_{2,1} = 0.02$	$xer_{1,2} = 0.01$	$xer_{2,1} = 0.01$
$er_{1,2,0} = 1$	$er_{2,1,0} = 1$	$xp_{1,2} = 0.01$	$xp_{2,1} = 0.01$
$er_{1,2,-1} = 1$	$er_{2,1,-1} = 1$	$EK_{1,2,0} = 47.55$	$EK_{2,1,0} = 93.52$
$c_{1,2} = 0.01$	$c_{2,1} = 0.01$	$eky_{1,2} = 0.01$	$eky_{2,1} = 0.01$
$CD_{1,2,0} = 141.07$	$CD_{2,1,0} = 141.07$	$ekyf_{1,2} = 0.01$	$ekyf_{2,1} = 0.01$
$CS_{1,2,0} = 141.07$	$CS_{2,1,0} = 141.07$	$eker_{1,2} = 0.01$	$eker_{2,1} = 0.01$
$R_{1,2,0} = 500.00$	$R_{2,1,0} = 1000.00$	$ekir_{1,2} = 0.01$	$ekir_{2,1} = 0.01$
$X_{1,2,0} = 47.55$	$X_{2,1,0} = 93.52$		

TABLE 4 The parameters $reg_{i,j}$ in the case of experiments *EXP*1, *EXP*2 and *EXP*3

*EXP*1	*EXP*2	*EXP*3
$r_{1,2} = 0$	$r_{1,2} = 1$	$r_{1,2} = 2$
$r_{2,1} = 0$	$r_{2,1} = 1$	$r_{2,1} = 2$

TABLE 5 The evolution of world trade under the regimes *FLT*, *FIX* and $CTR_{0.02}$

t	*FLT*		*FIX*		$CTR_{0.02}$	
	$\sum X_t$	$\sum M_t$	$\sum X_t$	$\sum M_t$	$\sum X_t$	$\sum M_t$
$t \in [1, 10]$	1410.63	1410.63	1410.63	1410.63	1410.63	1410.63
$t \in [11, 20]$	1412.26	1412.26	1412.26	1412.26	1412.26	1412.26
$t \in [21, 30]$	1413.32	1413.32	1413.32	1413.32	1413.32	1413.32
$t \in [31, 40]$	1410.89	1410.89	1410.89	1410.89	1410.89	1410.89
$t \in [41, 50]$	1402.94	1402.92	1405.20	1405.19	1402.94	1402.92
$t \in [51, 60]$	1389.88	1389.76	1405.35	1405.34	1400.37	1400.33
$t \in [61, 70]$	1375.84	1375.49	1405.11	1405.09	1398.82	1397.93
$t \in [71, 80]$	1368.75	1368.25	1405.06	1405.05	1400.15	1399.99
$t \in [81, 90]$	1378.43	1378.11	1404.80	1404.79	1399.98	1399.86
Total	12562.95	12561.64	12672.63	12672.55	12649.37	12648.13

currencies have generated negative effects regarding international trade transactions. My opinion is that these problems can be solved by selecting a controlled exchange rates regime with a relatively narrow pegging band.

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