A Common Currency for China, Japan and Korea?

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Abstract:

China, Japan and Korea have recently shown their collective interest for adopting a common monetary unity. It could serve in the long run as the base of a common currency in Asia. In an OCA analysis framework, this study analyzes their economic conditions for assessing the viability of a possible common currency for these three countries. Results indicate that their economic conditions, represented by macro-structural shock symmetries, plead in favor of a common currency among them.

Keywords: Economic shock, structural VAR, correlation, China, Japan, Korea.

JEL Codes: C32, F15, F42, N25

1. Introduction

In May 2006, the Finance Ministers of China, Japan and Korea have jointly declared that they agreed on further studies of related issues, including the usefulness of a common regional currency unit, in order to strengthen their roles in achieving global as well as regional sustainable growth and financial market stability. Before considering a common regional currency project in Asia, it is interesting to assess the viability of a fixed exchange rate regime among these three Asian countries in an Optimum Currency Areas (OCA) analysis framework.

In an OCA approach, exchange rate flexibility is considered as a principal adjustment mechanism to asymmetric shocks. Thus, characteristic of economic shocks and exchange rate variability are at the core of an OCA analysis. In this paper, some essential macro-structural shocks to these three countries will be estimated and characterized for an assessment of their economic conditions. The nature of these shocks could clarify the necessity of exchange rate flexibility, or on the contrary, could plead in favor of a fixed exchange rate regime or a monetary union among them.

These economic shocks not being initially observable, it should be obtained empirically. Among others, the structural VAR[1] system proposed by Blanchard and Quah (1989) allows to define, identify and generate these series. This estimation method is used by many macroeconomic shock analyses. For example, Bayoumi and Eichengreen (1994) apply this method to a macroeconomic model in order to obtain aggregate supply and demand shock series. They propose then to characterize these shocks through international static correlation coefficients in an OCA framework. But, being based on the traditional lessons of the OCA theories, they consider that only supply shock symmetry is important for an assessment of economic convergence.

In our analysis, economic shocks will be distinguished in three types: aggregate supply shock (AS), real demand shock (IS) and monetary demand shock (LM). One can consider that the aggregate demand shock in Bayoumi and Eichengreen is decomposed here into IS and LM shocks. The purpose of this extended distinction is to verify the importance of supply side shock symmetry (importance underlined by the OCA theories), and to take into account the implications of demand side shocks (implications neglected by traditional approaches). This distinction also allows to examine the implications of monetary aspects for exchange rate policy decisions, in particular for the choice of exchange rate regime.

After characterizing these shocks, we will examine the relation between exchange rate variability and characteristics of shocks. Such an analysis allows to test the main assumption of the OCA theories - exchange rate variations absorb asymmetric shocks. If the assumption holds, an important shock asymmetry implies strong exchange rate variability, whereas an important symmetry implies a low variability. In terms of exchange rate determination, this implies that shock asymmetry should significantly explain a considerable share of exchange rate variations. With the distinction of shocks in the three types, the estimates of their impacts on exchange rate variations allow to compare their relative importance of each type of shock in exchange rate determination.

[1] Vector Auto-Regressive.

This relative importance has significant implications for the choice of exchange rate regime. For example, if monetary shock (LM shock) asymmetry is more important than that of real shocks (AS and IS shocks) for exchange rate variability, a simple co-operation of exchange rate policies between two countries can stabilize the bilateral exchange rate. In this case, the adoption of a fixed exchange rate or the formation of a monetary union between them would not involve a high cost. On the contrary, if real shock asymmetry is exclusively decisive for exchange rate variability, a flexible exchange rate would be appropriate as long as real shocks are significantly asymmetric and there is any other corrective mechanism.

Another point of deepening this analysis relates to the dynamics of structural shock characteristics. After a standard examination on the static correlations used by Bayoumi and Eichengreen (1994), we will consider these dynamics by using sliding correlation coefficients. This examination allows to observe possible changes in dynamic characteristics of structural shocks.

This study will be developed in the following way. Section 2 will present our methodology, data and shock estimation model. Section 3 will describe the estimated shocks for the three Asian countries. Section 4 will examine the relation between exchange rate variability and shock asymmetries, in order to discern the types of shocks, which are more important for an OCA analysis. Sections 5 and 6 will consist in characterizing the estimated shocks to assess the economic conditions necessary for the creation of a monetary union between the three Asian countries. Section 7 will conclude this study.

2. Methodology

2.1. Structural VAR system

The VAR model is a simultaneous equations system, and is often used to examine dynamic impacts of exogenous shocks on endogenous variables. The structural VAR model allows to identify initially unobservable exogenous shocks and to examine their dynamic effects on endogenous variables, using some restrictions theoretically imposed. These restrictions, known as identification restrictions, can be imposed in some different ways. One can distinguish two principal methods, which depend on the time horizon on which these restrictions are imposed: (1) the method of Sims (1986) and Bernanke (1986); and (2) the method of Blanchard and Quah (1989).

The first method consists in imposing restrictions on simultaneous interactions between endogenous variables. In this case, restrictions are imposed in the very short run. For example, the assumption of short-run price rigidity can be imposed as a restriction: the immediate impact of a money supply variation on the price level is null. The imposition of this short-run constraint in the VAR system allows to identify structural shocks, at least in statistical terms. However, interactions between economic variables remain often unexplained because of short-run dynamic uncertainties. Thus, the restrictions imposed in the short run are likely to imply an economic structure that is not compatible with economic theories. Consequently, this method is often criticized because of its lack of theoretical base.

On the other hand, the method of Blanchard and Quah (1989) uses constraints, theoretically founded, resulting from long-run equilibrium models, in which temporary and permanent shocks are distinguished. For example, if it is supposed that a shock affects a variable only temporarily, this assumption can be interpreted as restriction that the long-run impact is null. In fact, many macroeconomic models can support this type of restrictions relating to the long run. This method is then more compatible with lessons of economic theories than the method of Sims and Bernanke. It is the principal reason why many analyses are based on the method of Blanchard and Quah to analyze the impacts of shocks on the economy, by imposing restrictions resulting from various theoretical models.[2]

This method can be described as follows. The first step consists in constructing and estimating a VAR system with {n} stationary (first-differentiated here) variables. The included variables are endogenous and represented by vector X_t which can be written as follows:

$$A(L)X_t = e_t \quad \text{and} \quad var(e_t) = \Omega \qquad [1]$$

where A (L) is a {n*n} matrix of polynomial lags. This system can be represented by a moving average (MA) process as follows:

$$X_t = B(L)e_t \quad \text{where} \quad B(L) = A(L)^{-1} \qquad [2]$$

This being always in a reduced form, the shocks (e_t) cannot be interpreted yet. The objective is to obtain another alternative MA representation, which could formulate the variations of the endogenous variables as a function of structural shocks (ε_t). The term of 'structural' implies that the shocks have certain effects on the levels of the endogenous variables and that they are economic phenomena independent of each other (i.e. not-correlated with each other). This representation can be rewritten as follows:

$$X_t = C(L)\varepsilon_t \ \text{and} \ var(\varepsilon_t) = I \qquad [3]$$

The objective of this method is to transform Equation [1] in Equation [3]. Initially it is supposed that a non-singular matrix (S) exists, and this makes the connection between the structural shocks (ε_t) and the residues of the VAR system equations (e_t). That is, $e_t = S\varepsilon_t$. The comparison between Equation [1] and Equation [3] reveals that $C_0 = S$ (because, A(L)C(L) = S et $A_0 = I$). As $ee' = (S\varepsilon)(S\varepsilon)' = (S\varepsilon)(\varepsilon' S') = SIS' = SS' = C_0C_0$, one have:

$$C_0C_0' = \Omega \qquad [4]$$

To identify C_0, it is necessary to put {n²} restrictions (because the matrix C_0 contains {n²} unknown elements), {n} being the number of variables in the VAR system. In fact, the usual assumption of orthogonality and unit variance of the structural shocks (ε_t) provides only {n*(n+1)/2} restrictions, because (equation 4) offers {n*(n+1)/2} equalities for a {n²}-unknown system. Consequently, {n*(n-1)/2} additional restrictions are necessary for an exact identification of the matrix C_0. Here, one can use some theoretical lessons.

[2] See for example, Mody and Taylor (2003), Lucas (2003), Corsetti and al. (2003), Gali (1992,1999), Rogers (1998), Lee and Chinn (1998), Bayoumi and Eichengreen (1994,1996), Pisany-Ferry (1994), Clarida and Gali (1994), Lastrapes (1992).

In the approach of Blanchard and Quah (1989), these theoretical restrictions are not imposed directly on the matrix C0. In fact, as the VAR system is estimated in first-differentiated variables, the effect of a shock on the level of a variable in the long run is represented by the sum of all the coefficients of structural terms. That is, if one notes as C_S the matrix of these sums (structural multiplicator matrix) of the long run, one obtains $C_S = C_0 + C_1 + C_2 +...+ C_k$, where k is the length of the examined time horizon. For example, the theoretical restriction that a shock *j* does not have a long-run effect on the level of a variable *i* means that $C_{Sij} = 0$. In order to facilitate matrix algebras and to use directly the Choleski decomposition at the following step, one puts the shocks in a particular order: C_S is a lower triangular matrix.
If one thus has theoretical restrictions necessary in terms of C_S elements, one can develop the estimation process for C_0. First, one calculates:

$$B_S \Omega B_S' \qquad [5]$$

where B_S and Ω are both obtained in the reduced form of the VAR system. It is shown that C_S follows the following equality:

$$B_S \Omega B_S' = C_S C_S' \qquad [6]$$

In addition, one can calculate the Choleski decomposition for Equation [5], which is a lower triangular matrix and noted as H. As C_S is also a lower triangular matrix, resulting from the theoretical restrictions, one has $C_S = H$. Combined with the fact that $C_S = B_S C_0$, because $B_S \Omega B_S' = B_S C_0 C_0' B_S' = C_S C_S'$, one can obtain C_0 as follows:

$$C_0 = B_S^{-1} H \qquad [7]$$

Once C_0 is obtained, one can write with Equation [1] and Equation [4], that:

$$C_j = B_j C_0 \qquad [8]$$

Equation [8] indicates that the identification of the matrix C_0 allows to calculate the dynamic responses of the endogenous variables to the structural shocks. In other words, given the elements of B_j (*j*=1,2,...), a restriction on a specific element of the long run structural multiplicator matrix (C_S), imposes a linear restriction on the elements of C_0.

Now, the time series of structural shocks can be easily obtained with $\{\varepsilon_t = C_0^{-1} e_t\}$. These series, obtained for each examined country, allow to characterize their symmetrical or asymmetrical nature, using the international correlations.

2.2. New open economy macroeconomics with rational expectations

Using the structural VAR system proposed by Blanchard and Quah (1989) but in a different approach from Bayoumi and Eichengreen (1994), we here try to define and estimate aggregate supply (AS) shock, real demand (IS) shock and monetary demand (LM) shock. As described previously, this empirical system needs some theoretical restrictions for solving the model and identifying the series in question. The theoretical model with which the VAR system is here combined is a new open economy macroeconomic model with rational expectations, proposed by Clarida and Gali (1994). By including nominal and real exchange rates which are affected by the interest rate parity condition and by the anticipated price level changes, this model provides some theoretical restrictions necessary for identifying and generating the three types of shocks. The specification of econometric model will be then presented. Finally, the series of estimated shocks will be briefly described.

Clarida and Gali (1994) use in fact the new open economy macroeconomic model developed by Obstfeld (1986), for a structural shocks analysis. Obstfeld (1986) confirms the standard lesson that the short-run price adjustment to various shocks is rigid. In addition, this model takes into account the long-run properties that characterize the macroeconomic equilibrium of an open economy when the price adjustment to shocks is complete. Based on this model and using relative variables, Clarida and Gali (1994) introduce stochastic natures of shocks into their theoretical model solution for justifying precisely their long-run restrictions necessary to identify structural shocks.

We try to apply their approach to the relations between the USA and three Asian countries (China, Japan and Korea) in order to define and generate series of AS, IS and LM shocks. The variables are in log value and relative to the USA. For example, the Chinese output and money supply are obtained respectively by $\{ y_t = y_t^{china} - y_t^{usa} \}$ and $\{ m_t = m_t^{china} - m_t^{usa} \}$. The variable of interest rate represents the interest rate differential, that is, $\{ i_t = i_t^{china} - i_t^{usa} \}$.

This model is based on four equations, which describe IS and LM curves, price setting system and interest rate parity condition.

$$y_t^d = d_t + \eta(s_t - p_t) - \sigma(i_t - E_t(p_{t+1} - p_t)) \qquad [9]$$

$$m_t^s - p_t = y_t - \lambda i_t \qquad [10]$$

where: y^d = Asian country's demand for output relative to that of the USA; d = relative demand shocks; s = nominal exchange rate; p = relative price level; (s-p) = real exchange rate; i = nominal interest rate differential; $E_t(p_{t+1}-p_t)$ = rational expectation of inflation; m^s = relative money supply; y = relative output.

Equation [9] represent an Asian open economy IS curve in which the demand for the Asian country's output relative to the USA is a positive function of relative demand shock and of its real exchange rate vis-à-vis the US dollar (value of the Asian currency in the US dollar). For example, a positive demand shock represents an Asian budgetary policy more expansionist than that of the USA. At the same time, the relative demand is a negative function of real interest differential, that is, an Asian real interest rate higher than that of the USA lowers the relative demand for the Asian country's output. Equation [10] represents the standard LM curve.

$$p_t = (1 - \theta)E_{t-1}p_t^e + \theta p_t^e \qquad [11]$$

$$i_t = E_t s_{t+1} - s_t \qquad [12]$$

where: p_t = price level in period t; $E_{t-1}p^e_t$ = price level expected in period t-1; i_t = nominal interest rate differential; $E_t s_{t+1}$ = nominal exchange rate ex ante expected in period t; s_t = current nominal exchange rate.

Based on rational expectations, Equation [11] describes the price setting system, whereas Equation [12] represents the interest rate parity condition. Equation [11] describes the price adjustment in an open economy, proposed by Flood (1979) and Mussa (1982). The price level in period t is a weighted average of prices expected in period t-1 and of prices on output market prevalent in period t. When $\theta = 1$, the prices are entirely flexible and the output is determined by the supply. When $\theta = 0$, the prices are fixed (perfectly rigid) and are predetermined at the previous period. Equation [12] implies that nominal interest rate differential is determined by the difference between nominal exchange rate ex ante expected rationally on the basis of information available in period t, and current nominal exchange rate.

The model considers then the effects of three types of structural shocks: (1) shock that controls relative output supply (y_s). This is an aggregate supply or AS shock (***z***), which includes all the factors moving the aggregate supply (for example, productivity differential); (2) shock that controls relative output demand (d). This is a shock on the goods and services market, defined as relative real demand or IS shock ($\boldsymbol{\delta}$), which covers exogenous changes in the demand for goods of Asian country relative to that of the USA, resulting from changes in preferences, consumer behaviours, investments or government expenditure; (3) shock that controls relative monetary demand (m). This is a shock on the money market, defined as relative monetary demand or LM shock ($\boldsymbol{\nu}$), which reflects changes in monetary supply and demand of Asian country relative to the USA.

In order to identify and generate these shocks, one could suppose that three relative variables (y_s, d, m) result from transitory and/or permanent shocks. In particular, Clarida and Gali (1994) propose to specify stochastic processes that affect mainly these relative variables in order to obtain explicit solutions for these types of model. On the one hand, they suppose that $\boldsymbol{y_s}$ and ***m*** are generated by permanent random walk. In other words, the AS and LM shocks are supposed as permanent. On the other hand, they suppose that ***d*** is generated by the IS shock, which includes two components, permanent and transitory. That is, a fraction ($\boldsymbol{\gamma}$) in the IS shock in period *t* is supposed to be recompensed in period t+1. These specifications can be written as follows:

$$y_t^s = y_{t-1}^s + z_t \quad [13]$$

$$d_t = d_{t-1} + \delta_t - \gamma\delta_{t-1} \quad [14]$$

$$m_t = m_{t-1} + \nu_t \quad [15]$$

Under the assumption of perfect long-run price flexibility with rational expectations ($\theta = 1$), these stochastic shocks specifications allow to obtain the long-run equilibrium expression for each variable: output (y_e), nominal and real exchange rate (q_e and s_e), and price level (p_e). This long-run equilibrium can be written in the following way:

Long-run equilibrium

$$y_t^e = y_t^s$$

$$q_t^e = (y_t^s - d_t)/\eta + (\eta(\eta+\sigma))^{-1}\sigma\gamma\delta_t$$

$$p_t^e = m_t - y_t^s + \lambda(1+\lambda)^{-1}(\eta+\sigma)^{-1}\gamma\delta_t$$

$$s_t^e = m_t + y_t^s(1-\eta)\eta^{-1} - d_t\eta + [\eta(\eta+\sigma))^{-1}\sigma + \lambda(1+\lambda)^{-1}(\eta+\sigma)^{-1}]\gamma\delta_t$$

On the other hand, the short-run price rigidity assumption with stochastic shocks specifications, leads to obtain the short-run equilibrium, which can be described as follows:

Short-run equilibrium

$$y_t = y_t^s + (\eta + \sigma)\nu(1-\theta)(\nu_t - z_t + \alpha\gamma\delta_t)$$
$$q_t = q_t^e + \nu(1-\theta)(\nu - z_t + \alpha\gamma\delta_t)$$
$$p_t = p_t^e - (1-\theta)(\nu_t - z_t + \alpha\gamma\delta_t)$$
$$s_t = s_t^e + (1-\sigma-\eta)(\lambda+\sigma+\eta)^{-1}(1-\theta)(\nu_t - z_t + \alpha\gamma\delta_t)$$

with $\alpha = \lambda(1+\lambda)^{-1}(\eta+\sigma)^{-1}$. This short-run equilibrium shows that the three types of shocks affect all the examined variables. However, the long-run equilibrium highlights that certain variables, in particular such as output and real exchange rate, are not affected by these shocks. More precisely, one can observe, in the long-run equilibrium equations, that: (1) output is affected only by AS shocks; (2) real exchange rate is affected by AS and IS shocks; (3) price level and nominal exchange rate are affected by all the three types of shocks. We underline that, even if output and real exchange rate are affected by the shocks in the short run, it is not the case in the long run. Theses theoretical lessons will be used as identification restrictions in the following econometric estimations.

2.3. Data and model

The data relate to real GDP, Consumer Price Index (CPI) and nominal and real exchange rates for the three countries. The data are in quarterly frequency and the examined period goes from 1980Q1 to 2005Q4 for Japan and Korea, but from 1987Q1 to 2005Q4 for China (*Source: Datastream*). A structural VAR system with three variables (real GDP, real exchange rate and CPI) is finally used to obtain AS, IS and LM shocks. By maintaining the aggregate supply and demand analysis framework, this method allows to decompose aggregate demand shocks into real and monetary demand shocks. Thus, we could distinguish the impacts of various economic policies from an OCA point of view.

Our preliminary tests indicate that the three initial variables are characterized as I(1), and that they are not co-integrated with each other. The elements of VAR system can be described as follows, with difference operator (Δ), lag operator (L) and L indicating the number of lags:

$$X_t = \begin{bmatrix} \Delta GDP \\ \Delta REX \\ \Delta CPI \end{bmatrix}_t ; e_t = \begin{bmatrix} e_{\Delta GDP} \\ e_{\Delta REX} \\ e_{\Delta CPI} \end{bmatrix}_t ; \varepsilon_t = \begin{bmatrix} \varepsilon_{AS} \\ \varepsilon_{IS} \\ \varepsilon_{LM} \end{bmatrix}_t ; B(L) = B_L = \begin{bmatrix} B_{L11} B_{L12} B_{L13} \\ B_{L21} B_{L22} B_{L23} \\ B_{L31} B_{L32} B_{L33} \end{bmatrix} ; C(L) = C_L = \begin{bmatrix} C_{L11} C_{L12} C_{L13} \\ C_{L21} C_{L22} C_{L23} \\ C_{L31} C_{L32} C_{L33} \end{bmatrix}$$

with: X = variable vector; ΔREX = real exchange rate variation; e = disturbance vector; {ε} = structural shock vector. The terms of $\boldsymbol{\varepsilon_{AS}}$, $\boldsymbol{\varepsilon_{IS}}$ and $\boldsymbol{\varepsilon_{LM}}$ correspond respectively to the shocks previously noted by $\boldsymbol{Z}$, $\boldsymbol{\delta}$ and $\boldsymbol{\nu}$. As $X_t = B(L)e_t$ and $X_t = C(L)\varepsilon_t$ with {L = 0, 1, 2,…, k}, the estimation equations are written then as follows:

$$X_t = \begin{bmatrix} \Delta GDP \\ \Delta REX \\ \Delta CPI \end{bmatrix}_t = \sum_{L=0}^{k} \begin{bmatrix} B_{L11} B_{L12} B_{L13} \\ B_{L21} B_{L22} B_{L23} \\ B_{L31} B_{L32} B_{L33} \end{bmatrix} \begin{bmatrix} e_{\Delta GDP} \\ e_{\Delta REX} \\ e_{\Delta CPI} \end{bmatrix}_{t-L} = \sum_{L=0}^{k} \begin{bmatrix} C_{L11} C_{L12} C_{L13} \\ C_{L21} C_{L22} C_{L23} \\ C_{L31} C_{L32} C_{L33} \end{bmatrix} \begin{bmatrix} \varepsilon_{AS} \\ \varepsilon_{IS} \\ \varepsilon_{LM} \end{bmatrix}_{t-L}$$

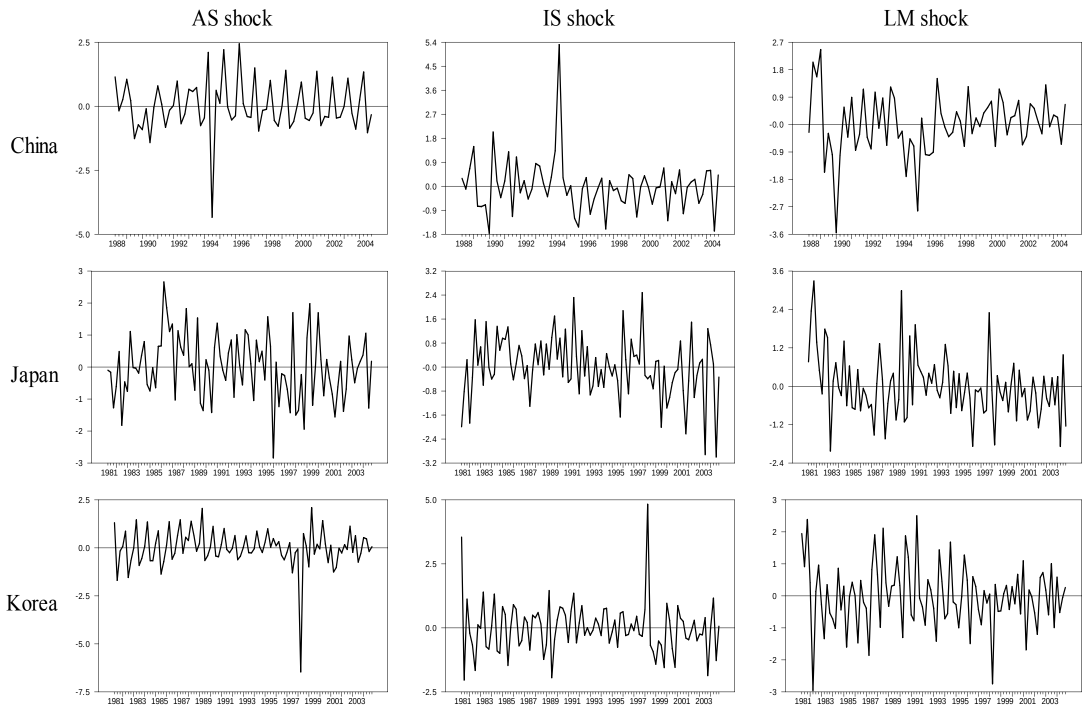
The principal theoretical lessons retained as identification restrictions are long-run ones: (1) the impact of IS shocks on the real GDP variation is null; (2) the impact of LM shocks on the real GDP variation is null; and (3) the impact of LM shocks on the real exchange rate variation is null. In terms of the elements of the matrix C_S of which each element represents the sum of all the time horizon coefficients. That is, $C_S = C_0 + C_1 + C_2 + C_3 + \ldots + C_k$, with k = the length of the examined time horizon. These theoretical lessons imply respectively $\{C_{S12} = 0\}$, $\{C_{S13} = 0\}$ and $\{C_{S23} = 0\}$.

3. Description of the estimated shocks

Graph 1 presents the series of AS, IS and LM shocks to China, Japan and Korea. Their basic statistics confirm that all these series have a null expectation and a unit variance, as supposed. In other words, these shocks are generated by a process of white noise, and this characteristic also respects the imposed assumption of orthogonality: the shocks are not correlated with each other.

In addition, these shock series seem to reflect closely the economic conditions in these countries. For example, we can observe some sudden changements in the shock amplitude, which we can suppose corresponding to the Chinese economy's recession in 1994-95 as well as to the impact of the crisis of 1997 on the Korean economy.

Graph 1. AS, IS and LM shocks to China, Japan and Korea



Note: The series of shocks are estimated for the period going from 1988 to 2005 for China, and from 1981 to 2005 for Japan and Korea.

4. Shock asymmetries as exchange rate determinants

One of the principal lessons of the OCA theories is that real exchange rate flexibility is necessary for absorbing asymmetric shocks. By definition, real exchange rate flexibility depends, simultaneously, on nominal exchange rate flexibility and on price flexibility. If prices are rigid, it is the flexibility of nominal exchange rate that determines entirely the flexibility of real exchange rate. In this case, the real flexibility is identical to the nominal one, and the choice between nominal and real exchange rates is neutral in an OCA analysis. But, if prices are flexible, the flexibility of nominal exchange rate and that of prices determine together the flexibility of real exchange rate. In this case, the flexibility of real exchange rate differs from that of nominal one. It is then the real exchange rate, and not the nominal one, which one examines in an OCA analysis framework.

These arguments suggest that it is the flexibility of real exchange rate that absorbs asymmetric shocks, independently of the price rigidity or flexibility. The extent of shock asymmetries should then explain the majority of real exchange rate variations. In addition, according to Bayoumi and Eichengreen (1994), it is the supply shocks asymmetry that is the most important for explaining the exchange rate variation. In order to verify the influence of shock asymmetries on the variations of real exchange rates, these variations are regressed to some measurements of AS, IS and LM shocks asymmetries. We propose to use the differential of these shocks between two countries as asymmetry measurement. Each differential observation represents each asymmetry extent, and the series of differentials are finally used as explanatory variable in the regression equation of the exchange rate variations.

Given that the series of shocks estimated previously are a white noise and that the variation of exchange rate and the series of differentials are stationary and non-correlated among them, the estimation of a simple regression between these time series is legitimate. The regression equation for the relation between two countries *i* and *j* can be written then as follows:

$$\Delta TdC_t^{i,j} = \alpha + \beta_{AS} ECAS_t^{i,j} + \beta_{IS} ECIS_t^{i,j} + \beta_{LM} ECLM_t^{i,j} + e_t \, .$$

with: $\Delta TdC^{i,j}$ = log value index of real exchange rate variation which is the real value of currency *i* expressed in currency *j*; $ECAS^{i,j}$ = differential of AS shocks which is the value of AS shock to country *i* minus that to country *j*; $ECIS^{i,j}$ = differential of IS shocks which is the value of IS shock to country *i* minus that to country *j*; $ECLM^{i,j}$ = differential of LM shock which is the value of LM shock to country *i* minus that to country *j*; $\boldsymbol{\alpha}$ is a constant and $\boldsymbol{e}$ is error terms. It should be noted that differential observation could have a negative, null or positive value. A negative value represents a negative asymmetry, whereas a positive value represents a positive asymmetry. A positive asymmetry means that the shock to country *i* is stronger than the shock to country *j*. For example, a positive asymmetry of AS shocks indicates that production technology of country *i* has a lead over that of country *j*. Or, a negative asymmetry of LM shock reflects that monetary policy of country *j* is more expansionist than that of country *i*.

The determination coefficient represents the explanation power of all the shock asymmetries for the exchange rate variations. Subject to a significant relation between variables, the coefficients of various types of asymmetry are compared with each other. This comparison allows to verify the relative importance of supply shocks (AS) underlined by Bayoumi and

Eichengreen (1994), in comparison with demand shocks (IS and LM). Moreover, the relative importance of real shocks (AS and IS) can be compared with that of monetary shocks (LM).

These comparisons can clarify the reasons of exchange rates volatility, on the one hand. In addition, they can highlight useful criteria for the choice of exchange rate regime or for the participation in a monetary union. For example, if the asymmetry of monetary shocks is more significant for exchange rate variations than that of real shocks, one could undoubtedly conclude that exchange rates can be stabilized by using financial and monetary policies cooperation. In this case, a monetary union will be an objective easier to carry out.

If, on the contrary, real shocks are more important than monetary ones, real integrations, such as production convergence or commercial integration will be necessary to reduce shock asymmetries before being able to fix exchange rates. In this case, certain international cooperations in terms of trade or fiscal policies could encourage real integrations, and it is a confirmation of essential lessons from the traditional OCA theories: trade integration or real convergence are prerequisite to a monetary integration.

The regression equation is estimated for each expression of real exchange rate between China, Japan and Korea. Table 1 shows the estimate results, which indicate in general high explanation power of asymmetries for real exchange rates variations. For example, according to the results, 88% of the variation of exchange rate of CHY/KRW are explained by the AS, IS and LM shocks asymmetries. The main assumption of the OCA theories is thus verified by these results.

Table 1. Asymmetries as exchange rate variation determinant

exchange rate	R^2	α*	β_{AS}	β_{IS}	β_{LM}
	0.74	-0.014	0.039	-0.039	-0.003
CHY/JPY	t	-2.480	8.730	-8.568	-0.580
	p	0.010	0.000	0.000	0.560
	0.88	0.006	0.052	-0.042	-0.006
CHY/KRW	t	1.310	9.989	-8.767	-1.054
	p	0.190	0.000	0.000	0.290
	0.86	0.024	0.055	-0.031	0.004
JPY/KRW	t	7.157	19.14	-13.65	1.354
	p	0.000	0.000	0.000	0.170

Note: CHY = Chinese yuan; JPY = Japanese yen; KRW = Korean won.
(*) The sign of α depend on the expression of exchange rate in question.

It should be however noted that the estimate results for the variation of the exchange rates of JPY/CHY, KRW/CHY and KRW/JPY are not presented here, because they are respectively identical to those for the exchange rates of CHY/JPY, CHY/KRW and JPY/KRW, except for the sign of α. In fact, the sign of α and its t-statistic depend on the expression of exchange rate in question. For example, α is negative for the rate of CHY/JPY, although it is positive for the rate of JPY/CHY. It is interesting to remark that the sign of α seems to indicate the economic power of the one money superior to the other. That is, α is positive when the more powerful money is expressed in the less powerful money, whereas it is negative when the less powerful money is expressed in the more powerful money. For example, α is positive when the Japanese yen is expressed in the Chinese yuan or in the Korean won. α is also positive when the Chinese yuan is expressed in the Korean won. In other words, this aspect confirm that, if there is no shock asymmetry, the value of the Japanese yen goes up and that of the Korean won goes down with respect to the others.

The estimated coefficients allow to compare the relative importance of each asymmetry in the exchange rate variation explanation. This result shows that the coefficients of real shock asymmetries are all significant but those of monetary shocks are insignificant. Coefficients are positive for AS shocks but negative for IS shocks. In absolute value, the impacts of AS shocks are stronger than those of IS shocks. This confirms the essential lessons of the traditional OCA theories: these are the real shocks and not the monetary shocks which are principal determinants or the real exchange rate variations. Moreover, they are compatible with the argument of Bayoumi and Eichengreen (1994): the supply shocks are more important than the demand shocks for taking into account the asymmetry of shocks in an OCA analysis. On the other hand, it should be noted that the IS shocks, which are on the demand side, play also an important part of the determination of real exchange rates.

These results lead to retain three interesting aspects. First, the asymmetries of AS and IS shocks are significant at 99% in all the case without any exception, confirming the idea that real shocks are principal determinants of the variation of real exchange rates. This result confirms the essential lessons of the OCA theories. The nature of AS and IS shocks then will be mainly used, in the following section, as an OCA criterion for an evaluation of Asian OCA.

Secondly, the impacts of these two real shocks are opposite. A positive asymmetry of AS shocks increases the currency value of the country in question, whereas a positive asymmetry of IS shocks decreases it. This result is compatible with the theoretical lessons which provide that a relatively high productivity (which results for example from a technological advance and which is interpreted here as a positive asymmetry of AS shock) of a country makes its currency appreciate, and then a relatively expansionist budgetary policy (which is interpreted here as a positive asymmetry of IS shocks) of a country makes its currency depreciate.

Thirdly, the asymmetry of LM shocks is not significant at all in any case, supporting the idea that any monetary changes do not affect real exchange rates. One can consider then that, in general, monetary policies or manipulations do not affect the purchasing power, and that the choice of exchange rate regime could be neutral.

5. Nature of shocks as an OCA criterion

The nature of shocks is defined and used as an OCA criterion in order to bring answers to the questions on the viability of a common currency for China, Japan and Korea. In particular, the essential lessons of the OCA theories being previously confirmed, the symmetry of AS and IS shocks is necessary to support a fixed exchange rate regime among them.

Given that the variables used in the VAR system relate to the USA, the series of shocks that are not null represent by themselves certain asymmetric shocks with respect to the USA. The symmetry of shocks between these Asian countries is however measured by correlation coefficients. That is, the intra-Asian symmetry of shocks is represented by international correlation coefficient between the series of shocks estimated for each Asian country. In addition, this method allows to obtain proper symmetries between Asian countries by eliminating the share of symmetries due to their simultaneous correlations with the USA.

Bayoumi and Eichengreen (1994) propose to use static correlation coefficients as a symmetry indicator. It is a general measurement of shock symmetry for a given period. Concerning the evaluation of shock symmetry between Asian countries, they propose a value of 0.39 as critical value for a positive correlation. Following them, a correlation coefficient higher than 0.39 will be considered as an indicator that attests certain structural shock symmetry.

However, this method is limited insofar as a static correlation, covering all the examined period, does not allow to consider possible dynamic changes of shock nature. In order to take into account the dynamic characteristic of shocks, sliding correlations are used in this study. So that an international correlation coefficient can significantly indicate the symmetric nature of shocks, sliding correlations will be calculated for a period of seven years, which can represent a medium-long run. The 28-quarters period used for the calculation will slide by a step of a quarter. These sliding correlation coefficients will finally allow to characterize the structural shocks from a dynamic point of view.

It should be noted that the sample size on which the correlation calculation is based, could pose a statistical problem. For example, the observation number is here limited to 28, and the normal distribution is not ensured for such an observation number. In this case, the use of parametric correlations, such as Pearson's correlation, is likely to be illegitimate, because these correlations suppose the normal distribution of the examined series. In order to obtain robust results while avoiding posing the assumption of normal distribution of structural shocks, we use a non-parametric correlation, Spearman's correlation, which is independent of this assumption.

6. Estimated shock symmetries

The feasibility of a common currency for China, Japan and Korea is assessed by using not only the general symmetry based on the static correlations for the total period, but also the dynamic symmetry based on the sliding correlations. Table 2 presents the static correlations for the total period. According to this result, the pair of Japan and Korea seems to be the most appropriate group for adopting a fixed exchange rate among these bilateral relations.

Table 2. Shock symmetries for the total period

	China - Japan	China - Korea	Japan - Korea
AS shocks	0.12	0.15	0.34
IS shocks	0.22	0.12	0.04
LM shocks	0.23	0.22	0.41

Note: The total period goes from 1981 to 2005 for 'Japan-Korea', but from 1988 to 2005 for 'China-Japan' and 'China-Korea'. All the correlation coefficients are significant at 10%, tested by t-stat = $\rho(N-2)0,5/(1-\rho)^2$, N=72, DF=70 for 'China-Japa' and 'China-Korea', and N=100, DF=98 for 'Japan-Korea'.

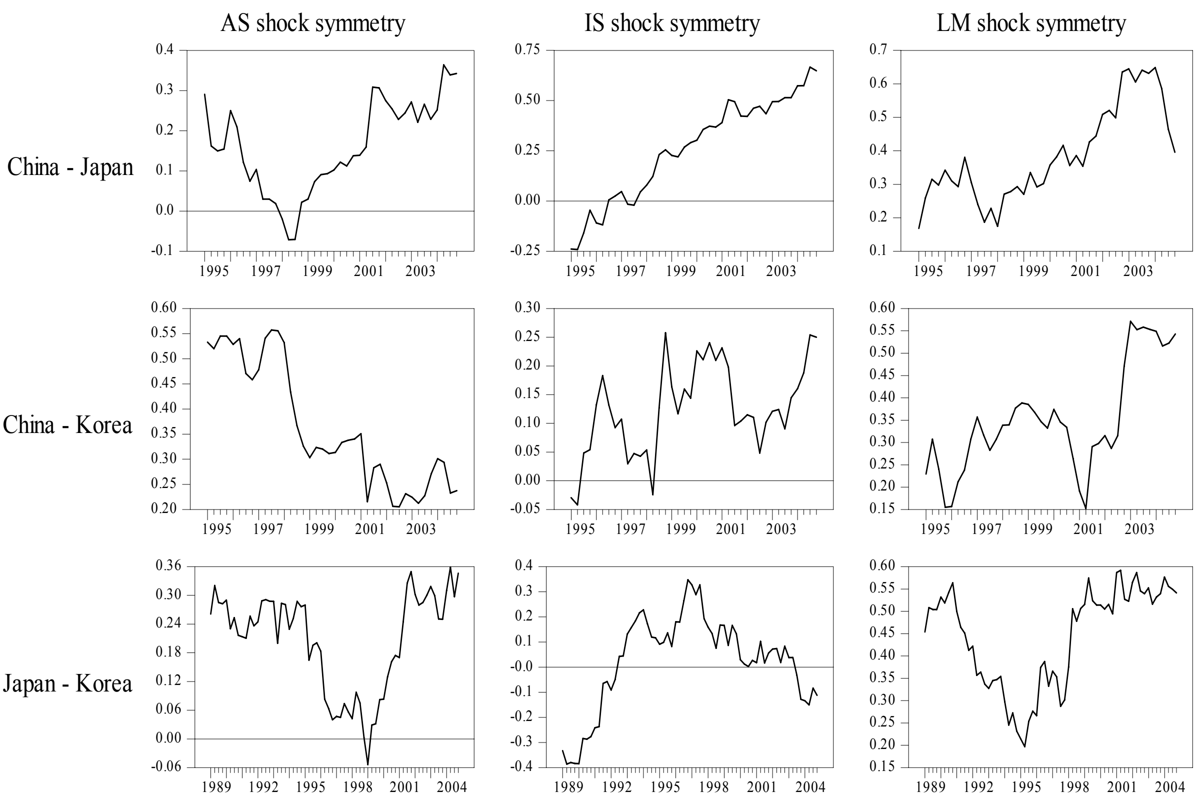
Concerning the sliding correlation coefficients, they are calculated for a period of seven years, which moves by one-quarter step. As the series of estimated structural shocks cover the period from the second quarter of 1982 to the fourth quarter of 2005, the first correlation coefficient characterizes the shocks for the period from 1982 (Q2) to 1989 (Q1), whereas the last for the period from 1999 (Q1) to 2005 (Q4). Graph 2 describes the sliding correlations of shocks for each pair of countries, whereas Table 3 presents the correlations for the three reference periods. All the estimated correlation coefficients are significant at 10%. For a detailed study, the results are separately discussed from the point of view of each country, and the correlations for the three reference periods of seven years are compared.

6.1. China - Japan

According to the static correlation results for the total period, the pair of China and Japan does not show a sufficiently symmetric shock to justify the adoption of a fixed exchange rate regime. However, these static results do not allow to examine neither the dynamic nature of shocks, nor the characteristic posterior to the crisis. In fact, given that the characteristic of the Chinese economy (its relatively recent passage to market economy), it is particularly interesting to analyze the dynamic nature of shocks. Graph 2 shows in general an increasing tendency in the symmetry of all the shocks, and Table 3 confirms this tendency: before the crisis, the level of shock symmetry was very low, but it became relatively high after the crisis.

In particular, the IS and LM shocks are characterized as symmetric even according to the criterion of Bayoumi and Eichengreen (1994), with a critical value of 0.39. The financial cooperations set up after the crisis and the increased trade flow of goods and services could explain the increase in the symmetry of shocks. This result underlines the interest and feasibility to adopt a fixed regime between them. In addition, this aspect is particularly interesting insofar as the relation between Japan and China represents a paramount importance for the advance of any intra-Asian cooperation projects.

Graph 2. Dynamics of shock symmetries



Note: Each point of symmetry corresponds to the correlation coefficient obtained for a period of 7 years. For example, the first point in the AS shock symmetry for the pair of China-Japan, is marked 1995 but represents the period going from 1989 to 1995. We also note that the examined period goes from 1982 to 2005 for the pair of Japan-Korea, but from 1989 to 2005 for the two pairs including China.

6.2. China - Korea

Concerning the pair of China and Korea, the static correlations of shocks have not high values to support a fixed exchange rate of CHY/KRW.

But the dynamic results differ from these static results. The symmetry of IS and LM shocks has an increasing tendency, whereas that of AS shocks has a decreasing one. The AS shocks remain although relatively symmetric. The financial cooperations established after the crisis can explain their strong monetary symmetry. One can also suppose a certain similarity in terms of monetary policies conduct (simultaneous setting up of an expansionist monetary policy, for example). The strong monetary symmetry and relatively symmetric AS and IS shocks could confirm the idea that China and Korea are potential partners for a fixed regime with respect to each other.

Table 3. Shock symmetries for the reference periods

AS shocks	China - Japan	China - Korea	Japan - Korea
1990Q1-1996Q4	0.07	0.46	0.04
1994Q1-2000Q4	0.14	0.34	0.17
1999Q1-2005Q4	0.34	0.24	0.35
IS shocks	China - Japan	China - Korea	Japan - Korea
1990Q1-1996Q4	0.03	0.09	0.35
1994Q1-2000Q4	0.37	0.21	0.03
1999Q1-2005Q4	0.65	0.25	-0.11
LM shocks	China - Japan	China - Korea	Japan - Korea
1990Q1-1996Q4	0.38	0.31	0.33
1994Q1-2000Q4	0.36	0.26	0.49
1999Q1-2005Q4	0.40	0.54	0.54

Note: All the correlation coefficients are significant at 10%, tested by t-stat = $\rho(N-2)0,5/(1-\rho)^2$, N=28, DF=26.

6.3. Japan - Korea

The static correlations for the total period for the pair of Japan and Korea show that the LM shock is the most symmetric one, that the symmetry of AS shock is relatively important, and that the IS shocks are the least symmetric one. The LM shock symmetry indicates that the financial and monetary markets know a certain integration level between Japan and Korea, particularly resulting from some bilateral cooperations. Otherwise, the symmetry can be explained by the impacts of Japanese monetary policies on Korea or by certain similarities in terms of monetary policy conduct. The relatively high level of AS shock symmetry reflects a certain similarity of the two economies in terms of production or economic structure. In this sense, Japan and Korea seem to be appropriate partners for a fixed exchange rate regime towards each other.

Concerning the dynamic symmetries, the AS and LM shocks show a tendency opposed to that of IS shocks: the first two shocks show a decreasing tendency and after that an increasing one, whereas the last show an increasing tendency and then a decreasing one. Finally, for the period posterior to the crisis, the AS and LM shocks are characterized as symmetric, whereas the IS shocks as asymmetric. These dynamic results are quasi-identical to the static results. This aspect reflects that the nature of shocks remains finally constant: Japan and Korea could be appropriate partners for a fixed regime with respect to each other.

6.4. China - Japan - Korea

The static results concerning all the three bilateral relations among China, Japan and Korea show certain general conditions, which do not support the adoption of a fixed exchange rate among them: the economic shocks are characterized, for the total examined period, as non-symmetric among these three countries.

The dynamic results show however some important changes in shocks symmetry tendency. Concretely, these results show that these countries are appropriate, or at least potentially appropriate partners for the adoption of a fixed exchange rate regime among them, in particular for the period posterior to the crisis. These changes are particularly important in the sense that they supplement in a certain manner the conditions so that the three principal Asian countries could consider a multilateral fixed regime together or form an yuan or yen zone by adopting a common fixity with respect to the yuan or the yen. In a larger perspective, these countries could even establish a powerful core to form later on a greater Asian monetary union which could include jointly all other appropriate Asian partners.

7. Conclusion

The purpose of this analysis was to assess, from a purely economic point of view, the feasibility and the interest of adoption of a fixed exchange rate regime among China, Japan and Korea. Their economic structural shocks were obtained by the structural VAR system with some theoretical restrictions. Three types of shocks were characterized under the assumption that if these shocks were symmetric in a bilateral relation, a fixed exchange rate regime is viable.

To check the importance of shock symmetry for the question of exchange rate regime choice, the role of shock asymmetry in real exchange rate determinations was verified. In fact, it was a test of the main assumption of the OCA approach: if there is no other corrective mechanism, exchange rate flexibility is necessary to absorb asymmetric shocks. The regression equations of the real exchange rate variations on the extent of shock asymmetry were estimated. The explanation power of all asymmetries of these shocks for real exchange rate variations was verified, and their relative importance was compared.

First, the results showed that a very important part (from 74% to 88%) of exchange rate variations was explained by the asymmetries of AS, IS and LM shocks. Secondly, the results showed that asymmetry of real shocks (AS and IS) was more important determinant of variations than that of monetary shocks (LM). The main assumption of the OCA approach was thus confirmed by these results. In addition, this aspect joined partially the argument of Bayoumi and Eichengreen (1994): asymmetry of aggregate supply shocks is more important than asymmetry of aggregate demand shocks for an OCA assessment. However, these results also underlined the fact that asymmetry of demand shocks, in particular IS shocks, should not be completely neglected in an OCA analysis: insofar as economic policies can affect the demand side and that the choice of exchange rate regime is a subject of economic policy, the nature of IS and LM shocks has important implications for an OCA analysis.

In order to assess the possibility of adopting a fixed exchange rate regime among China, Japan and Korea, static correlation of economic shock were first used as indicator of shock symmetry, following the approach of Bayoumi and Eichengreen (1994). Then, symmetry dynamic was analyzed using sliding correlations. This extended approach allowed in particular to verify some changes, likely to be caused by the crisis of 1997, in characteristics of structural shocks.

Being based on the OCA lessons, which underline the importance of the symmetry of real shocks, the static results for the total period did not supported adoption of a fixed exchange rate among China, Japan and Korea: according to these results, the economic shocks are asymmetric, consequently, the exchange rate flexibility is necessary for absorbing these shocks.

But the dynamic results confirmed that the crisis of 1997 significantly changed the characteristics of these shocks. The results for the period posterior to the crisis showed that the shock symmetries were intensified after the crisis, in particular those of AS and IS shocks. On the contrary to the proposal of Bayoumi and Eichengreen who consider only the symmetry of supply shocks for an OCA analysis, the symmetry of IS shocks was also took into account, because the IS shock is as important as the AS shock in real exchange rate determination.

According to the dynamic AS and IS shock symmetries, the economies and economic policies of China, Japan and Korea converge in a general way after the crisis. This result supports the adoption of a fixed exchange rate or a common currency for China, Japan and Korea in the near future. By reducing the asymmetry of real shocks, further cooperations in terms of economic policies could improve even more the actual economic conditions in Asia to fulfill a regional monetary integration project.

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