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EXTENDED ABSTRACT

There is controversy about whether a monetary union is feasible in the East Asian region. Amongst the criteria for establishing a monetary union, most of the existing studies focus on the symmetric issue of fundamental shocks and the extent of correlations by applying the Blanchard and Quah (1989) structural vector autoregression (VAR) technique, which includes the first-differenced variables in the model and examines only bilateral relationships. When forming a monetary union, the member countries need to renounce their monetary policy autonomy. If shocks to respective economies are symmetric, the cost of relinquishing the discretionary monetary policy is likely to be outweighed by the benefits of establishing a common currency. In contrast, if shocks are asymmetric, it will be more costly to give up the autonomous monetary policy and, hence, to establish a monetary union. However, the shock symmetry does not necessarily mean the co-movements of the real output variables (common business cycles) between the countries concerned are present.

The present paper employs the Johansen (1988) cointegration test to check the long-run co-movements of real outputs and also conducts the Vahid and Engle (1993) common feature test to detect the short-term common business cycles. The novelty of this paper is twofold. First, whereas the structural VAR approach considers shocks to correlation bilaterally, we use a multivariate VAR framework to allow for the relationships within a specific group of countries. Second, we employ the cointegration technique to examine both the long-run and the short-run dynamics of linkage of the real variables to determine the suitability and costs of forming a monetary union in the region.

We include in this study Japan and the United States in addition to the nine East Asian economies including three Asian NIEs (Korea, Taiwan and Hong Kong), ASEAN5 (Singapore, Malaysia, Indonesia, Thailand and the Philippines), and Mainland China to investigate the co-movements of the real output variables spanning a period from 1978Q1 to 2006Q4. We first perform the Johansen (1988) cointegration test to check whether a group of countries concerned shares common stochastic trend(s), and then, conduct the Vahid and Engle (1993) common feature test to explore the existence of short-term common business cycles among the countries if the real output series are cointegrated. This will allow the assessment of how the output variables among these countries interact in both the short-term and long-term within a multivariate framework. The cointegration results and the common feature tests will ensure business cycle synchronization across the economies and determine the effectiveness of a common monetary policy to a union-wide shock. Based on a multivariate framework, this study will provide important implications for cost effectiveness in establishing a regional monetary union.

The results of the Vahid and Engle (1993) common feature test indicate that there exists a linearly independent common feature vector, i.e., a linear independent combination of real output growth which has no correlation with the relevant past. This leads to the conclusion that besides the cointegrating relationship of real outputs, the concerned countries share common short-term business cycles. In particular, the results for the presence of one or two common feature vector(s) indicate the existence of synchronized common business cycles in two groups: the first one includes the Asian NIEs that consists of Korea, Hong Kong and Singapore, and the second one the ASEAN5 plus Japan. These economies would be the good candidates for a monetary union as they share both long-run output co-movements as well as synchronized common business cycles. However, the results show that the United States and China are not suitable for a membership of the grouped economies, as do the ASEAN5 and Japan.

1. INTRODUCTION

The feasibility of forming a monetary union and establishing a regional (common) monetary unit in East Asia has been lively debated in industrial, governmental and academic arena. There are a number of studies on this issue which examine some of the preconditions for forming a monetary union. These include (i) the openness and goods market integration; (ii) factor market integration; (iii) similarity in economic structure and symmetry in (real) shocks; (iv) financial market integration; and (v) policy coordination. Studies of the symmetric nature of fundamental (real) shocks emphasize that shocks to the candidate economies must be symmetric so that the costs of relinquishing the discretionary monetary policy when forming a monetary union are likely to be outweighed by the benefits of establishing a common currency. In contrast, if shocks are asymmetric, it will be more costly to give up the autonomous monetary policy and, hence, to establish a monetary union.

Most of the existing studies use the Blanchard and Quah (1989) structural vector autoregression (VAR) technique to identify fundamental shocks and conduct the correlation analysis to determine the symmetry of the shocks (see Bayoumi and Eichengreen 1994, Bayoumi, Eichengree and Mauro 2000, Zhang, Sato and McAleer 2004, and Zhang and Sato 2007). However, this approach has several weaknesses. First, a correlation analysis of shocks identified by the structural VAR is inherently a bivariate method, whereas it is obvious that an analysis of OCA must be based on a multi-country framework. More specifically, the bivariate approach reveals just country-to-country correlations without taking into account the relationship with other possible partner countries. In this paper we will adopt a multi-country framework to assess the common business cycles. Second, it is important to distinguish between the short- and the long-run dynamics in consideration of a monetary union (Beine, Candelon and Hecq 2000). If real output variables are not cointegrated among the countries concerned, each output variable wonders randomly over time, which leads to a different growth path for each country. Since nominal exchange rate changes as well as other macroeconomic policies have only transitory effects to stabilize the economy, the long-run economic divergence among the economies can be an obstacle for forming a monetary union. A commonality of business cycle phase is also an imminent concern to the countries participating in the monetary union, even though business cycle shocks tend to originate from the demand side and to be relatively short-lived. As long as they face a well-synchronized business cycle, it will be less costly for the countries to renounce the monetary policy autonomy. The structural VAR approach generally employs a bivariate VAR model including the first-differenced variables and imposes a restriction to allow only supply shock to affect the real output series in the long run, a result of which would be a lack of distinction between stochastic trends and common cycles. In this paper we adopt an estimation procedure based on the Johansen (1988) cointegration test and the Vahid and Engle (1993) common feature test, which would be more appropriate to distinguish between the short- and the long-run dynamics.

Recently, Cheung and Yuen (2005) use the cointegration technique and the common business cycles approach to assess the level of integration among the three Greater China economies (the Mainland, Hong Kong and Taiwan). Sato and Zhang (2006) apply a similar approach to the 9 East Asian economies plus Japan and the United States to assess 54 pairs of countries for the cointegration and common cycle tests and to explore whether these economies share common business cycles. However, Sato and Zhang (2006) still employ a bivariate VAR of real output series for possible pairs of countries, namely, a country-to-country analysis.

In contrast to the previous studies, the novelty of this paper is two-hold. First, the present paper investigates whether a group of East Asian countries share common business cycles as well as a common stochastic trend of real outputs by using a multivariate VAR framework. Second, we attempt to investigate sixty groups of countries to detect possible regional currency areas, which is far more comprehensive than the previous literature. We include in this study Japan and the United States in addition to the nine East Asian economies including three Asian NIEs (Korea, Taiwan and Hong Kong), ASEAN5 (Singapore, Malaysia, Indonesia, Thailand and the Philippines), and Mainland China to investigate the co-movements of the real output variables spanning a period from 1978Q1 to 2006Q4. We first perform the Johansen (1988) cointegration test to check whether a group of countries concerned share common stochastic trend(s), and then, conduct the Vahid and Engle (1993) common feature test to explore the existence of short-term common business cycles among the countries if the real output series are cointegrated. This will allow for the assessment of how the output variables among these countries interact in both the short-term and long-term within a multivariate framework. The cointegration results and the common feature tests will ensure business cycle synchronization across the economies and determine the effectiveness of a common monetary policy to a union-wide shock. Based on a multivariate framework, this study will provide important implications for cost effectiveness in establishing a regional monetary union.

The rest of the paper is structured as follows. Section 2 discusses the analytical framework. Section 3 describes the data and presents the results of empirical examination. Finally, section 4 concludes the paper.

2. ANALYTICAL FRAMEWORK

To investigate the existence of a stable linear steady-state relationship between the variables, we need to conduct unit-root and cointegration tests to determine whether a time-series variable is stationary, and whether there is a long-run (cointegrating) relationship between the variables if all the variables are found non-stationary (i.e., have unit roots). If all variables studied are I(1) non-stationary, we proceed to the Johansen maximum likelihood (ML) method (Johansen, 1988; Johansen and Juselius, 1990) to test whether these variables are cointegrated. The Johansen approach allows testing of the long run relationship between variables in a multivariate framework, and considers the error structure of the data processes and the interactions in the determination of the relevant economic variables. If the variables are cointegrated, the real output series have a common stochastic trend, implying synchronous long-run movements of the real outputs among the economies.

The Johansen cointegration technique is based on the maximum likelihood estimation of the vector error-correction model. Let X_t be an $(n \times 1)$ vector of I(1) variables. Then, it is possible to specify the following unrestricted VAR involving up to k-lags of X_t:

$$X_t = A_1 X_{t-1} + \ldots + A_k X_{t-k} + \varepsilon_t, \qquad (1)$$

where A_i is an $(n \times n)$ matrix of parameters and ε_t are a Gaussian error term. The above equation can be expressed as a vector error-correction form:

$$\Delta X_t = \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \varepsilon_t \qquad (2)$$

where $\Pi = \sum_{i=1}^{k} A_i - I_n$ and $\Gamma_i = -\sum_{i=i+1}^{k} A_i$. Our major interest is in the matrix $\Pi = \alpha\beta'$, where α represents the speed of adjustment to disequilibrium, while β is a matrix of long-run coefficients such that the term $\beta' X_{t-1}$ represents up to $(n-1)$ cointegration relationship in the multivariate model. Thus, the test for cointegration is to determine how many $r \leq (n-1)$ cointegration vectors exist in β, which amounts to testing whether $\Pi = \alpha\beta'$ has reduced rank.

We use in this paper the trace statistic by which the null hypothesis that there are at most r cointegrating vectors ($0 \leq r \leq n$) can be tested:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i), \qquad (3)$$

where $\hat{\lambda}_i$'s are the $(n-r)$ smallest squared canonical correlations of X_{t-1} with respect to ΔX_t corrected for lagged differences and T is the sample size used for estimation. Rejection of this hypothesis suggests the existence of the maximum r cointegrating vectors. To avoid the finite-sample bias toward over-rejection of the no cointegration hypothesis, we employ the small sample correction of the trace test provided by CATS in RATS, Version 2, which is based on Johansen (2000, 2002).

Once a cointegrating relationship is found in real outputs among the economies, our next interest is to test whether they share common short-term output fluctuations. If the economies face an asynchronous business cycle, a common monetary policy would be ineffective in responding to the asymmetric shocks across the economies. It would therefore be very costly for these economies to form a monetary union. In contrast, if the economies share common business cycles, a common monetary policy would be desirable. Thus, it will be less costly for them to renounce an autonomous monetary policy and to form a monetary union among the economies.

The test for a common business cycle will feature a test for a serial correlation common feature in the difference of the variables. Engle and Kozicki (1993) devise the test for a serial correlation common feature for stationary variables based on the two-stage least square regression using the lagged value of all variables as the instruments. If there exists a linear combination of variables that eliminates all correlation with the past and is not correlated with the past information set, we then conclude that the set of variables shares a common cycle. Vahid and Engle (1993) extend the Engle and Kozicki test to propose the test procedure for common serial correlation cycles given the presence of cointegration. It is to find a sample canonical correlation between ΔX_t and $W(p) \equiv (\Delta X'_{t-1}, ..., \Delta X'_{t-p}, Z'_{t-1})'$ where Z_{t-1} is the error-correction term. Under the null hypothesis that there exist at least s linearly independent common feature vectors, the test statistic is given by:

$$C(p,s) = -(T-p-1)\sum_{j=1}^{s} \ln(1-\lambda_j^2), \qquad (4)$$

where λ_j^2 ($j = 1, ..., s$) is the sth smallest squared canonical correlations between ΔX_t and $W(p)$. Under the null hypothesis, the statistic $C(p,s)$ has a χ^2 distribution with $(s^2 + snp + sr - sn)$ degrees of freedom, where n is the number of endogenous variables, p is the lag order of the differenced variables in the error-correction model, and r is the number of cointegrating vectors..

3. EMPIRICAL RESULTS

3.1 The Data

We use the quarterly series of real GDP for cointegration analysis of real outputs among the concerned economies. All data are expressed in natural logarithms and seasonally adjusted using the Census X-12 method. The eleven economies taken up in this paper include the three Asian NIEs (Korea, Taiwan and Hong Kong), ASEAN5 (Singapore, Malaysia, Indonesia, Thailand and the Philippines), China, Japan and the United States. The sample period covers 1978Q1 through 2006Q4 for all economies. The data on real GDP is obtained from Abeysinghe and Gulasekaran (2004), the CEIC Asia Database, and the web sites of the Japanese METI (Ministry of Economy, Trade and Industry) and the FRB (Federal Reserve Board).

We first check the stationarity of the real GDP series using the ADF (Augmented Dickey-Fuller) test and DFGLS test (Dickey-Fuller test with GLS detrending) proposed by Elliott, Rothenberg and Stock (1996). The test statistics show that for the levels of all the series, the null hypothesis that a unit root exists cannot be rejected. The unit root tests of the first difference of the variables reject the null hypothesis. These findings suggest that each series contains one unit root and is thus I(1) process (the results are not reported in the paper but available upon request). Then we proceed to the cointegration analysis in the next section.

3.2. Results of Cointegration Tests

We employ the Johansen cointegration test to test whether the I(1) output series for the economies concerned move together in the long-run. We first estimate vector autoregressions (VAR) with four lags and then conduct the lag reduction tests based on the χ^2-distributed Likelihood Ratio (LR) tests. Once the common lag length is determined, we perform the test for reduced rank. Doornik et al. (1999) propose to include the impulse dummies to allow for the outliers so that the VAR residuals may be normally distributed. We include impulse dummies in a VAR model since the Johansen cointegration test is very sensitive to the assumption that errors are independently normal. The inclusion of impulse dummy variables is necessary in this study given that our sample includes the currency crisis period in 1997-98. Following Doornik et al. (1999), we initially make a preliminary VAR estimation without dummies to investigate the histogram of the standardized residuals. Then, in the presence of extreme outliers, we include the impulse dummies and re-conduct the VAR estimation. In particular, we attempted much closer inspection of the estimated residuals than the visual investigation of the residual graph. If we detect large residuals with absolute values larger than the threshold (2.576), we included impulse dummies and re-estimate a VAR. The dummies are included when the following economies are in the VAR (the dates of dummies are listed in parenthesis): Korea (1980Q4, 1988Q1), Taiwan (1999Q2, 2003Q2), Hong Kong (1984Q4-1985Q2, 2003Q2), Singapore (1985Q2, 2003Q2), Malaysia (1984Q4, 1998Q1), Indonesia (1993Q1, 1998Q1, 1998Q2), Thailand (1980Q2, 1997Q4), the Philippines (1979Q4, 1984Q3, 1987Q4), China (1986Q1, 1989Q1, 1989Q3), Japan (1993Q2) and the United States (1981Q2, 1981Q4, 1982Q1). In conducting the VAR estimation, we tried to scrutinize the existence of large residuals carefully and to include as small a number of dummies as possible. Hence, all the dummies above were not used at the same time for estimation.

The results for cointegration rank tests are reported in Table 1. Due to the space limitation, we report if the cointegrating relationship exists or not only (the detailed test results are available upon request). The results show that, with the exclusion of Japan and the United States, the hypothesis of no cointegrating relationships is rejected in 8 out of 20 cases (groups). Among others, at least one is observed in most East Asian groups and Northeast Asia/NIEs groups. In contrast, no cointegrating relationships are found in ASEAN groups. When Japan is included, the results indicate that there are 7 out of 20 cases (groups) that show at least one cointegrating relationship and mostly within the

Japan and ASEAN groups. In contrast, the inclusion of Japan reduces the number of cointegrating relationship in Northeast Asia/NIEs groups. If the United States is included, the number of cointegrating relationship improves substantially: It is found that 15 out of 20 groups share the long-run output co-movements. Thus, the inclusion of Japan or the United States in a group considerably changes the pattern and the number of possible combinations of countries that exhibit cointegrating relationship of real outputs.

We have also conducted the significance test of the cointegrating vectors, with the null hypothesis set as zero for the coefficient. If we cannot reject the zero restriction on one of β coefficients, it means that the variable corresponding to zero-restricted coefficients will be excluded from the cointegrating relationship. The results are not reported but are available upon request. It is found that only 6 out of 25 groups reject the zero-restrictions in all coefficients of their cointegrating vectors; otherwise, at least one coefficient in long-run cointegrating vectors cannot reject the zero-restriction. As a result, the test for common business cycles is conducted for just 6 groups of countries.

3.3. Results of Common Business Cycle Tests

Once the long-term real output co-movement is found, the next step is to examine whether the group of countries concerned share the synchronous business cycles. We conduct the Vahid and Engle (1993) procedure to test for the common serial correlation of the business cycles in the presence of cointegrating relationship. The test results are reported in Table 2. If the null hypothesis of, say, $s = 1$ is not rejected, it means that there exists a linearly independent common feature vector, i.e., we have found a linear independent combination of real output growth which has no correlation with the relevant past. Then, we can say that besides the cointegrating relationship of real outputs, the concerned countries share common short-term business cycles.

As it can be seen from Table 2, the null hypothesis of one common feature vector ($s = 1$) is not rejected even at the 10 percent significance level but the null of two or more common feature vectors is rejected for the group A09 (Korea, Hong Kong and Singapore) and B19 (Japan, Singapore, Malaysia and Thailand). The null hypotheses of one and two common feature vectors ($s = 1$ and $s = 2$) are not rejected at the 10 percent level for the group B15 (Japan, Singapore, Malaysia, Thailand and the Philippines) and B17 (Japan, Singapore, Malaysia, Indonesia and Thailand). However, the group of A10 (Taiwan, Hong Kong and Singapore) rejected the null hypothesis that there exists common feature vector(s) at least at the 10 percent significance level. This holds true even if the United States is included in the group A10, as the group C10 rejects the hypothesis that there exists one common feature vector.

4. CONCLUSION

This study adopts a multivariate cointegration approach to test for synchronized common business cycles in order to assess the feasibility of a monetary union in the East Asian region. The results suggest that some Asian NIEs (Korea, Hong Kong and Singapore) and ASEAN5 plus Japan should be a potential candidate group to form a monetary union as they share both long-run output co-movements as well as synchronous business cycles. Interestingly, the United States and Mainland China are excluded from the candidates groups. Furthermore, ASEAN countries cannot form a candidate group unless Japan is included as a member country, which has important implications for the role of Japan to establish a regional monetary union.

However, there are some limitations to our analysis which will be addressed in the future work. First, we need to conduct a robust test to check the sensitivity of the results for the formation of other possible groups as we have only sixty groups of countries. Second, our analysis might have not fully reflected the impacts of the regional integration process and the emerging Chinese economy. Third, our analysis focuses on the synchronization of business cycles among the regional countries. However, countries may have different initial response to shocks and have started to react symmetrically to shocks with one or two period lag(s). Such asymmetric response at the initial stage and the synchronous reaction in later periods are not counted in the current study, but reward a consideration in further analysis of a regional monetary union.

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Table 1. Tests for Cointegration Rank

Groups (Country Name)	(A) East Asia Only	(B) Including Japan	(C) Including USA
a) East Asia (EA)			
(01) EA9	Yes	Yes	Yes
(02) EA8	Yes	Yes	Yes
b) Northeast Asia/NIEs			
(03) NIEs4 (Kr,Tw,Hk,Sg) + Ch	No	No	Yes
(04) NIEs3 (Kr,Tw,Hk) + Ch	Yes	No	Yes
(05) Greater China (Tw,HK,Ch)	Yes	No	Yes
(06) NIEs4 (Kr,Tw,Hk,Sg)	Yes	No	Yes
(07) NIEs3 (Kr,Tw,Hk)	Yes	No	Yes
(08) Kr, Tw, Sg	No	No	Yes
(09) Kr, Hk, Sg	Yes	Yes	Yes
(10) Tw, Hk, Sg	Yes	No	Yes

Table 1. Tests for Cointegration Rank (cont'd)

Groups (Country Name)	(A) East Asia Only	(B) Including Japan	(C) Including USA
c) ASEAN			
(11) ASEAN5 + Ch	No	No	Yes
(12) ASEAN5 (Sg,My,Id,Th,Ph)	No	Yes	Yes
(13) ASEAN4 (My,Id,Th,Ph)	No	Yes	Yes
(14) Sg, Id, Th, Ph	No	No	No
(15) Sg, My, Th, Ph	No	Yes	Yes
(16) Sg, My, Id, Ph	No	No	No
(17) Sg, My, Id, Th	No	Yes	No
(18) Sg, My, Id	No	No	No
(19) Sg, My, Th	No	Yes	No
(20) My, Id, Th	No	Yes	Yes

Table 2: Results of Common Feature Tests

Group (Country Name)	Null Hypothesis	Degrees of Freedom	Squared Canonical Correlation	Common Feature Stat. C(p,s)	Critical Value (10% level)	Critical Value (5% level)
(A09) Kr, Hk, Sg	$s=1$	5	0.075	8.44	9.24	11.07
	$s=2$	12	0.229	36.54 *	18.55	21.03
	$s=3$	21	0.624	142.24 *	29.62	32.67
(A10) Tw, Hk, Sg	$s=1$	5	0.095	10.78 #	9.24	11.07
	$s=2$	12	0.187	33.10 *	18.55	21.03
	$s=3$	21	0.723	171.80 *	29.62	32.67
(B15) Jp, Sg, My, Th, Ph	$s=1$	12	0.097	10.76	18.55	21.03
	$s=2$	26	0.109	22.90	35.56	38.89
	$s=3$	42	0.279	57.17 #	54.09	58.12
	$s=4$	60	0.331	99.32 *	74.40	79.08
	$s=5$	80	0.774	255.57 *	96.58	101.88
(B17) Jp, Sg, My, Id, Th	$s=1$	12	0.063	6.81	18.55	21.03
	$s=2$	26	0.169	26.29	35.56	38.89
	$s=3$	42	0.237	54.70 #	54.09	58.12
	$s=4$	60	0.361	101.68 *	74.40	79.08
	$s=5$	80	0.776	258.72 *	96.58	101.88
(B19) Jp, Sg, My, Th	$s=1$	10	0.069	7.47	15.99	18.31
	$s=2$	22	0.201	30.98 #	30.81	33.92
	$s=3$	36	0.260	62.65 *	47.21	51.00
	$s=4$	52	0.748	207.56 *	65.42	69.83
(C10) US, Tw, Hk, Sg	$s=1$	7	0.115	13.22 #	12.02	14.07
	$s=2$	16	0.168	33.07 *	23.54	26.30
	$s=3$	27	0.200	57.20 *	36.74	40.11
	$s=4$	40	0.792	226.74 *	51.81	55.76

Note: "s" denotes the number of common feature vectors. An asterisk (*) and a sharp (#) denote that the null hypothesis is rejected at the 5 percent and 10 percent significance level, respectively.