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An Output Perspective on a Northeast Asia Currency Union

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11.1 Introduction

The 1997 financial crisis highlights the vulnerability of Asian countries as a group to one country's financial instability. Since then various initiatives and plans on fostering monetary and financial cooperation in the region have been proposed to forestall financial crises. The proposals include improved dialogues, the establishment of central bank swap arrangements (the Chiang Mai Initiative), the idea of an Asian monetary fund, the possibility that currencies collectively peg to the US dollar or a basket of currencies, the creation of an Asian currency unit, and the formation of a currency union.[1] These discussions generate some interests in assessing whether the Asian countries meet the preconditions of an optimum currency area and are suitable for forming a currency union.[2]

This chapter examines the prospect of creating a currency union that consists of China, Japan, and Korea. The formation of a currency union requires deep commitments from its member countries. For instance, member countries have to relinquish their monetary autonomy to use a common single currency. Because China, Japan, and Korea are the three largest economies in East Asia, it is hard to perceive that an effective coordination scheme in the region does not involve these three countries. In Europe the two largest countries, France and Germany, are usually credited for the formation of European monetary union and the launch of the single currency, euro. The Franco–German partnership is deemed to be pivotal for the migration toward the European currency union.[3] Given the European experience, we focus the suitability of an Asian currency union that comprises China, Japan, and Korea.

The standard literature lists a few criteria for countries to constitute an optimum currency area.[4] Business cycle synchronization is one of the major criteria used to evaluate the desirability of a common currency.[5] When business cycles across countries are synchronous, the cost of using a single currency is reduced because there is less need for asymmetric monetary policy responses to common shocks, ceteris paribus. On the other hand, currency union may not be an optimal monetary arrangement when the countries display asynchronous business cycles.[6]

In the literature the contemporaneous correlation of output shocks is commonly used to gauge the degree of business cycle synchronization. Several approaches have been used to derive output shocks for correlation calculation. The results, however, are sensitive to the choice of detrending methods.[7] Bayoumi and Eichengreen (1994) popularize the use of the Blanchard and Quah (1989) decomposition method to measure the size and correlation of output shocks and assert that the supply shock correlation is the relevant measure to evaluate the output shock asymmetry among countries.

Contemporaneous correlation, however, does not necessarily provide a complete picture. The effects of shocks on economies crucially depend on the transmission mechanism within and across them. Divergent monetary or exchange rate policies may deem necessary even in the presence of a high correlation of shocks if the transmission mechanisms are sufficiently different across the countries. On the other hand, a low contemporaneous shock correlation does not exclude the possibility that the economies are in similar phases of a business cycle and do not require different monetary or exchange rate policies. Thus we adopt a *complementary* approach and directly examine comovement patterns of national outputs.

The current exercise assesses output synchronization at both long-run and short-run horizons. First, we investigate whether the national output data tend to move together in the long run. If national output data are drifting apart in the long run, it is impracticable, if not impossible, to pursue a common policy to manage these economies. Thus long-run output co-movement is a basic condition for currency union discussion. Second, we determine whether the countries share short-run cyclical business cycles. After all, most monetary policies are devised to manage transitory shocks. If the countries under consideration share long-run growth trends and short-run economic fluctuations, then a single common currency is a feasible proposition.

The Johansen cointegration approach is used to examine the output comovement pattern. A currency union has implications for interactions among all its member countries that go beyond bilateral relationships. In contrast with the usual bilateral setting embedded in most, if not all, recent studies on currency unions, the cointegration model is a multivariate framework that incorporates interactions between all data series in assessing the output co-movement pattern. Further the error correction specification derived from a cointegration model provides a coherent structure to study output comovements in the long run, effects of deviations from the long-run relationship on short-run variations, and output interactions in the short run. The structure is flexible enough to accommodate various types of data dynamics in the analysis.

The presence of contemporaneous output co-movement is the relevant information when countries have similar and simultaneous responses to a common shock. However, because of structural or institutional differences, countries can display different initial responses to a common shock even though they react similarly to the shock after an initial phase. Thus, in studying short-run cyclical cycles, we consider both "common feature" and "codependence" business cycles—the former type of common business cycles requires countries to be in similar positions throughout a cycle, and the latter type allows countries to behave differently in the initial phase but to be in similar cyclical phases after some initial period. The inclusion of co-dependent business cycles, in addition to common feature ones, alleviates the possibility of understating the degree of output symmetry between countries and the desirability of a currency union.

To offer further insight into the prospect of a currency union in Asia, we quantify the individual countries' potential output losses of establishing one. Since the ideal preconditions of a currency union are rarely fulfilled, there is always a cost for a country to relinquish policy autonomy and join a currency union. The willingness to join is undoubtedly affected by potential costs. Thus, in addition to business cycle synchronization, it is instructive to estimate the individual countries' potential costs of joining a currency union. It is expected that the output cost estimate depends on the characterization of an economy and of shocks affecting it. In this exercise we evaluate output losses using (1) the model in Ghosh and Wolf (1994) to characterize the economy, (2) shocks estimated by three different techniques, and (3) two policy objectives.

The chapter is organized as follows: A brief discussion of the economic interactions, including trade and investment, among the three

Northeast Asia countries is given in the next section. Section 11.3 offers some preliminary analyses on the real per capita GDP data from China, Japan, and Korea. Patterns of output co-movement are studied in section 11.4. The Johansen cointegration test is used to determine the empirical long-run relationship between the output data and the associated error correction model is used to study the links between the long-run and short-run interactions. In the same section, we also investigate the presence of common business cycles using the common feature and codependence tests. Section 11.5 evaluates the output costs of forming a currency union. Using a macro model, the output losses of individual countries and of the three countries as a group are calculated under different shock-identifying schemes and policy objectives. Some concluding remarks are given in section 11.6.

11.2 Recent Developments

What is the prospect of a Northeast Asia economic bloc? As recent as the turn of the millennium, China, Japan, and Korea were not members of any regional economic or trade establishments. Indeed, the discussion on the integration among China, Japan, and Korea is quite recent and scant. Japan and Korea operated mostly within the framework of the General Agreement on Tariffs and Trade and the succeeding World Trade Organization to formulate their trade policies. China only joined the World Trade Organization in December 2001. However, the desire for improved coordination after the 1997 financial crisis offers an incentive for the three Northeast Asian countries—China, Japan, and Korea to cooperate and deepen integration.

Although a currency union is unlikely to happen immediately, the prospect of enhancing integration among the three countries has drawn certain interest among policy makers and think tanks. For instance, in 2001 the Japanese Cabinet Office published a study that, among other things, examined the prospect of forming a free-trade area encompassing China, Japan, and Korea.[8] The study suggested that while a China–Japan–Korea free-trade area offers a potentially larger economic benefit, a two-country Japan–Korea free-trade area might entail a less painful adjustment process and thus "might be considered as a first step toward a larger free-trade area."[9]

Possibly the Japanese Cabinet Office's inquiry on a free-trade area consisting of China, Japan, and Korea was a consequence of an initiative that was proposed in November 1999 by officials from these three countries to investigate the prospects of economic cooperation. In November 2000 three research organizations—the Development Research Center of the State Council of China, the National Institute of Research Advancement of Japan, and the Korea Institute for International Economic Policy—formally launched a joint research program on strengthening economic cooperation among China, Japan, and Korea. In the first three years the joint research program focused on trade facilitation (2001), mutual investment among the three countries (2002), and finally, on the economic effects of such a free-trade area among China, Japan, and Korea (2003).[10]

The pace of integration among these three countries was quite fast in recent years. Specifically, the volume of trade among them has experienced astonishing growth along with, albeit slowly, changes in institutional arrangements. With China's WTO accession, further integration is widely anticipated.

As shown in table 11.1, trade among China, Japan, and Korea increased at a faster rate than world trade.[11] Over the last decade the average annual growth rate of the bilateral trade was 14 percent between China and Japan and is 58 percent between China and Korea. In

Table 11.1
China's trade with selected economies (US$mil)

	Year	Japan	Korea
A. Exports	1991	10,252	2,179
	2002	48,483	15,508
Proportion of China's exports	1991	0.142	0.030
	2002	0.149	0.048
Average annual growth rate	1991–2002	13.85	57.06
B. Imports	1991	10,032	1,066
	2002	53,489	28,581
Proportion of China's imports	1991	0.157	0.017
	2002	0.181	0.097
Average annual growth rate	1991–2002	14.41	62.55
C. Total trade with China	1991	20,284	3,245
	2002	101,972	44,089
Proportion of China's trade	1991	0.149	0.024
	2002	0.164	0.071
Average annual growth rate	1991–2002	13.69	57.92

Note: Panel A gives China's exports to Japan and Korea. It also gives these exports as proportions of China's total exports and the average annual growth rates of these exports. Similar information for imports and for total trade is provided in panel B and panel C.

contrast, the world trade grew at an average annual rate of 5.68 percent from 1991 to 2002. Clearly, the trade volume between China and these two countries was nontrivial—the total trade between China and these two countries accounted for 1.16 percent of world trade in 2002. If the trade between Japan and Korea is included, then the trade among these three countries accounted for 1.45 percent of world trade.

After normalizing their diplomatic relationship in 1992, Korea and China have enjoyed rapid growth in bilateral trade—the average annual growth rate exceeded 57 percent. China even overtook the United States as Korea's largest export market in 2003. Japan, on the other hand, was China's large trading partner and accounted for 16.4 percent of China's trade in 2002. The figures underscore the trading intensity between the three Northeast Asian countries. Indeed, China traded more with the other two Northeast Asian countries than with the other two Greater China economies, namely Hong Kong and Taiwan.

The Japanese and Korean foreign direct investments in China were presented in table 11.2. Again, the Japanese and Korean investments in China increased substantially between 1991 and 2002. The average growth rate of investment in China was 23 percent for Japan and 48 percent for Korea. If one excludes Hong Kong and Taiwan, which are known to provide the lion share of foreign direct investment in China, Japan and Korea are two main foreign investors in China.

Both tables 11.1 and 11.2 suggest that China, Japan, and Korea have extensive trade and investment interactions. The trend is likely to persist in the near future. The extensive interactions among these countries provides a good foundation for advancing integration to a higher level.

Table 11.2
Foreign direct investment inflow to China (US$mil)

	Year	Korea	Japan
Inflow to China	1991	119[a]	533
	2002	2721	4190
Proportion of China's FDI	1991	0.01[a]	0.12
	2002	0.05	0.08
Average annual growth rate	1991–2002	48.11[b]	23.14

Note: The foreign direct investment is from Japan and Korea to China.
a. This is the 1992 figure.
b. This is the 1993–2002 figure.

11.3 Data and Preliminary Analyses

The data considered in this study are quarterly real per capita GDPs of China, Japan, and Korea. The data are seasonally adjusted and expressed in logarithms. The sample period is from 1993:IV to 2001:IV. The sample is selected according to the liberalization processes in China and Korea. Specifically, China had a substantially controlled economy before the early 1990s. Extending the data series backward would not yield more information relevant to assessing output integration. The data are retrieved from the CEIC and International Financial Statistics databases. For brevity, the quarterly real per capita GDP data are referred to as GDP or output data henceforth.

As a preliminary analysis, the augmented Dickey-Fuller (ADF) test for a unit root is performed on individual output series. The ADF test is based on the regression equation,

$$\Delta X_{it} = c_i + \tau_i t + \delta_i X_{it-1} + \sum_{j=1}^{p} \alpha_{ij} \Delta X_{it-j} + u_{it}, \quad (1)$$

where X_{it} is the country i's GDP at time t for $i =$ China, Japan, and Korea. Under the unit root hypothesis, $\delta_i = 0$. A trend, a constant, or both, are included if they are significant in the ADF test. The lag parameter (p) is chosen to eliminate serial correlation in the estimated residuals.

The unit root test results of the GDP series and their first differences are reported in table 11.3. The null hypothesis of a unit root is rejected

Table 11.3
Augmented Dickey-Fuller test results

	Levels		First differences	
	Test statistic (lags)	Q(4), Q(8)	Test statistic (lags)	Q(4), Q(8)
China	−2.08 (4)	2.67, 8.87	−8.54* (3)	4.39, 9.04
Japan	−1.56 (3)	0.09, 7.52	−5.14* (2)	0.08, 5.67
Korea	−2.09 (1)	2.70, 9.61	−2.49* (1)	2.44, 4.02

Note: The results of applying the augmented Dickey-Fuller test to the national real per capita GDP data are reported. Lags are selected to remove serial correlation in the estimated residuals and are given in parentheses next to the test statistics. The Box-Ljung statistics based on the first four and first eight serial correlations of the estimated residuals are given under the heading "Q(4) and Q(8)." All the reported Q-statistics are not significant. * indicates significance at the 5 percent level (Cheung and Lai 1995).

not by GDP data but by their first differences. That is, the three output series are difference stationary. The diagnostic Q-statistics indicate that the lag specifications are appropriate, and there is no evidence of serial correlation in the estimated residuals. The inference is consistent with the conventional findings that real per capita GDP data series are unit root processes. Hereafter we treat the GDP series as I(1) processes.

11.4 Common Long-Run and Short-Run Cycles

The I(1) nonstationary property suggests that individual output series tend to drift around without an anchor or steady state. If these output series drift in different directions, then it will be difficult to adopt a common currency and pursue a common monetary policy to manage these economies. In the following subsection, the Johansen (1991) cointegration test is used to test whether these I(1) output series move together in the long run or, technically speaking, whether they have common stochastic trends.

11.4.1 Common Stochastic Trends

The Johansen cointegration test is conducted as follows. Let $\mathbf{X}_t$ be the $n \times 1$ vector containing the three output series ($n = 3$) that can be modeled by a $(p+1)$th order vector autoregression process:

$$\mathbf{X}_t = \mu + \sum_{i=1}^{p+1} \gamma_i \mathbf{X}_{t-i} + \varepsilon_t, \qquad (2)$$

where μ is the intercept term and ε_t is the vector of innovations. The lag parameter p is chosen to set the serial correlation of resulting residuals to zero. The Johansen test statistics are devised from the sample canonical correlations between $\Delta\mathbf{X}_t$ and $\mathbf{X}_{t-p}$, adjusting for all intervening lags. To implement the procedure, we first obtain the least squares residuals from

$$\Delta\mathbf{X}_t = \mu_1 + \sum_{i=1}^{p} \Gamma_i \Delta\mathbf{X}_{t-i} + \varepsilon_{1t}$$

and

$$\mathbf{X}_{t-p} = \mu_2 + \sum_{i=1}^{p} \Gamma_i \Delta\mathbf{X}_{t-i} + \varepsilon_{2t}, \qquad (3)$$

where μ_1 and μ_2 are constant vectors. Next we define the matrices $\Omega_{ij} = T^{-1}\sum_t \hat{\varepsilon}_{it}\hat{\varepsilon}_{jt}'$ for $i, j = 1, 2$ and T is the sample size. The Johansen test is based on the eigenvalues, $\lambda_1 \geq \cdots \geq \lambda_n$, of $\Omega_{21}\Omega_{11}^{-1}\Omega_{12}$ with respect to Ω_{22}. λ_i's are the squared canonical correlations between $\Delta\mathbf{X}_t$ and $\mathbf{X}_{t-p}$, adjusting for all intervening lags. The trace statistic,

$$t_r = -T \sum_{j=r+1}^{n} \ln(1-\lambda_j), \qquad 0 \leq r \leq n, \qquad (4)$$

tests the null hypothesis that there are no more than r cointegrating vectors. For the null hypothesis of r against the alternative of $r+1$ cointegrating vectors, we use the maximum eigenvalue statistic

$$\lambda_{r|r+1} = -T \ln(1-\lambda_{r+1}). \qquad (5)$$

The eigenvectors $v_1, \ldots, v_n$ associated with the eigenvalues $\lambda_1 \geq \cdots \geq \lambda_n$ are the sample estimates of the cointegrating vectors.

The cointegration test results are reported in table 11.4. The lag parameter p is set to 3, which gives insignificant Q-statistics and thus, adequately accounts for the intertemporal dynamics in the data (see table 11.5). Both the trace and maximum eigenvalue statistics reject the hypothesis of no cointegration but not the hypothesis of one cointegrating vector. That is, the output data are cointegrated with one cointegrating vector. The cointegration result implies that even when the individual output series wander randomly over time on their own, they are driven by common stochastic trends and hence have synchronous long-term movements. Despite the differences in output mixes, corporate cultures, and infrastructures, the Johansen test statistics

Table 11.4
Cointegration test results

	Max statistic	Trace statistic
$r = 2$	1.14	1.14
$r = 1$	13.59	14.73
$r = 0$	37.55*	52.28*

Note: The Johansen maximum eigenvalue test and trace test statistics are reported, respectively, under the headings "max statistic" and "trace statistic." The 5 percent level significance is indicated by * (Cheung and Lai 1993). The lag parameter is 3. The estimated cointegrating vector is (1, 5.39, −2.90) with the China coefficient normalized to 1. The chi-square test statistics for the significance of individual cointegrating coefficient estimates are, respectively, 23.32, 20.77, and 33.03. Thus each of the cointegrating coefficient estimates is significant.

Table 11.5
Vector error correction models for output data

	China	Japan	Korea
Constant	0.040*	−0.001	0.004
	(8.729)	(−0.095)	(0.176)
ECT	−0.051*	−0.045	0.123
	(−3.590)	(−1.209)	(1.717)
CH GDP(-1)	−0.696**	−0.192	0.457
	(−4.793)	(−0.500)	(0.623)
CH GDP(-2)	−0.591*	0.069	0.730
	(−4.963)	(0.219)	(1.212)
CH GDP(-3)	−0.597*	−0.195	−0.106
	(−4.475)	(−0.554)	(−0.157)
JP GDP(-1)	0.199**	−0.692*	1.178**
	(1.787)	(−2.359)	(2.094)
JP GDP(-2)	0.079	−0.724*	1.748*
	(0.629)	(−2.178)	(2.745)
JP GDP(-3)	−0.065	−0.314	2.098*
	(−0.491)	(−0.899)	(3.135)
KO GDP(-1)	0.139*	0.225	0.164
	(2.252)	(1.380)	(0.526)
KO GDP(-2)	0.045	0.056	0.018
	(0.773)	(0.366)	(0.062)
KO GDP(-3)	0.000	0.167	−0.558*
	(0.024)	(1.187)	(−2.068)
Adjusted R^2	0.726	0.354	0.513
Q(4)	3.197	1.082	2.267
	(0.525)	(0.897)	(0.687)
Q(8)	5.425	8.672	4.904
	(0.711)	(0.371)	(0.768)

Note: Robust t-statistics are given in parentheses below the parameter estimates. * and ** indicate significant at the 5 and 10 percent levels, respectively. *ECT* is the error correction term. $Q(p)$ is the Q-statistic calculated from the first p sample autocorrelations with the associated p-value given in the parentheses underneath.

indicate that the output series of China, Japan, and Korea share some common stochastic trends, move in tandem, and do not drift apart in the long run.

The cointegration of output data may be viewed as a necessary condition for forming a currency union. If the output series are not cointegrated, they drift apart in the long run, and it is difficult to effectively manage the three economies using a common monetary policy and a common currency. Thus the cointegration result, which implies the national output data are synchronous in the long run, is supportive of the concept of a China–Japan–Korea currency union.

11.4.2 Vector Error Correction Model

Since the GDP data are cointegrated, a vector error correction model (VECM) is used to examine the interactions between the output growth rates. The VECM is given by

$$\Delta \mathbf{X}_t = \mu + \sum_{i=1}^{p} \Gamma_i \Delta \mathbf{X}_{t-i} + \alpha Z_{t-p-1} + \varepsilon_t, \qquad (6)$$

where μ is a vector of constants, Z_{t-p-1} is the error correction term given by $\hat{\beta}'\mathbf{X}_{t-p-1}$, and $\hat{\beta}$ is the estimated cointegrating vector. The responses of output growth to short-term output movements are captured by the Γ_i coefficient matrices. The α coefficient vector reveals the speed of adjustment to the error correction term, which measures deviations from the empirical long-run relationship.

The estimates of (6) are reported in table 11.5. As indicated by the diagnostic Q-statistics, the fitted models are adequate in the sense that the residual estimates display no significant serial correlation. The China equation has the highest adjusted R^2, which is followed by the Korea equation and the Japan equation. A few observations are in order. First, the Chinese growth rate but not the other two is significantly affected by the error correction term. In the trivariate system China is the only country that adjusts to deviations from the empirical long-run output relationship. (Using the Granger causality terminology for the VECM framework [Granger and Lin 1995], Chinese output is Granger caused by the other two economies in the long run.) This result is consistent with the view that China is still at an early development stage and its growth is likely to be sensitive to the external environment.[12] Japan and Korea are relatively matured economies and do not response to the error correction term.