Pacific Economic Review, 10: 1 (2005) pp. 83–103

THE SUITABILITY OF A GREATER CHINA CURRENCY UNION

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Abstract. The study assesses the level of integration among the three Greater China economies (China, Hong Kong and Taiwan) and examines the suitability of a Greater China currency union. The three economies already have extensive trade and investment linkages. Our analyses show that they share common long-run and short-run cyclical variations. We also estimate the output costs of relinquishing policy autonomy to form a currency union. The estimated output losses, which depend on, e.g., the method used to generate shock estimates, seem to be moderate and are likely to be less than the efficient gains derived from a currency union.

1. INTRODUCTION

The economic entity comprising China, Hong Kong and Taiwan is referred to by different names. Those commonly used include 'Greater China', the 'China Circle' and the 'Chinese economic area'.[1] As would be expected, the exact geographic coverage of these terms depends on the time and context in which they are referred to and differs across users. In this study we adopt the term 'Greater China' (*DaZhongHua* in Chinese), despite the potential resentment caused by the similarity between this term and the 'Greater East Asia Co-Prosperity Sphere', which was proposed by Japan during the Second World War.

Greater China is one of the most dynamic regions in the world. Its importance to the global economy has been widely anticipated since China began its reforms in 1978.[2] While the ascent of Greater China is attributable to the transition in China, it also reflects the success of the export-oriented development policy pursued by these economies. The three economies have strong complementary assets – China has huge low-cost resources, Taiwan has advanced technological know-how and capital, and Hong Kong offers capital,

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[1] Harding (1993) provided a succinct account of the origins and various interpretations of the usage of Greater China. Naughton (1997) adopted the term 'China circle'. The term 'Chinese economic area' was used in, for example, Jones *et al.* (1992).

[2] See e.g. Das Gupta (1997), Jones *et al.* (1992), Naughton (1997), and Maddison (1998).

sophisticated financial services, modern management skills and a well developed legal system. Consequently, the integration of these economies offers tremendous synergy which propels Greater China to a high-growth trajectory.

Since the 1997 financial crisis, the Asian economies have devoted considerable effort to promote policy coordination and economic integration. Besides trade arrangements, there are proposals to foster policy coordination and economic integration. These proposals include the establishment of an Asian Monetary Fund, the use of a basket of currencies as an anchor of exchange rates, the adoption of a 'dollarization' policy and the formation of an Asian currency union.

The notion of a currency union represents a profound commitment by its member economies, and has attracted considerable interest in the academic circle. While some studies have found that the Asian economies are not unsuitable for a currency union,[3] we observe that the differences in the stage of economic development among these economies, the lack of effective institutional arrangements and the diverse political structures are unfavourable factors for the establishment of an Asian currency union.

It is hard to deny that there are substantial economic and political hurdles to forming a currency union among a large group of Asian economies in the near future. The prospect of a few economies setting up a currency union, however, is not so remote. For instance, the three Greater China economies have very intensive economic interaction. This is likely to be further strengthened and could set the stage for a future currency union. Thus, the theme of the present study is to assess the suitability of a Greater China currency union.

The standard literature considers a few criteria for an optimum currency area.[4] Business cycle synchronization is one of the criteria used to evaluate the desirability of a currency union. Others include the similarities of trade patterns and levels of economic development, the degrees of trade and financial integration and the mobility of labour markets. In this study we focus on the business cycle synchronization criterion. When business cycles across economies are synchronous, the cost of using a single currency is reduced because, *ceteris paribus*, there is less need for asymmetric monetary policy responses to shocks. On the other hand, a currency union may not be an optimal monetary arrangement when the economies display asynchronous business cycles.

In the literature various approaches have been adopted to assess the contemporaneous correlation of output shocks, which is commonly used to gauge the degree of business cycle synchronization.[5] Contemporaneous correlation, however, does not necessarily provide a complete picture.[6] The effects of shocks on economies depend crucially on the transmission mechanism within and

[3] See e.g. Bayoumi and Mauro (1999); Eichengreen and Bayoumi (1999); Lee *et al.* (2002); McKinnon and Schnabl (2003); Ng (2002); Tsang (2002).

[4] Some recent reviews are Lafrance and St-Amant (1999) and Bayoumi and Eichengreen (1999).

[5] See e.g. Bayoumi and Eichengreen (1994); Alesina *et al.* (2002).

[6] Another difficulty is that output shock correlation results are not robust to different shock estimation methods.

across them. Divergent monetary or exchange rate policies may be deemed necessary even in the presence of high shock correlation if the transmission mechanisms are sufficiently different among the economies. On the other hand, a relatively low contemporaneous shock correlation does not exclude the possibility that the economies are in similar phases of the business cycle, and hence does not require different monetary or exchange rate policies. In view of this consideration, we consider a *complementary* approach and directly examine co-movement patterns of output series.

The current exercise assesses both long-run and short-run output synchronization. First, we investigate whether the outputs from the three Greater China economies move together in the long run, which is considered as a minimum requirement for a currency union discussion. Second, we determine whether the three economies share common short-run cyclical business cycles. After all, most monetary policies are devised to smooth out transitory shocks. If these economies share long-run growth trends and short-run economic fluctuations, then a single common currency is a plausible proposition.

To offer further insight to the prospect of establishing a Greater China currency union, we quantify the individual economies' potential output losses of creating one. Since the ideal preconditions of a currency union are rarely fulfilled, there is always a cost to an economy of relinquishing policy autonomy and joining a currency union. Thus, in addition to business cycle synchronization, it is instructive to estimate the individual economies' possible costs of joining a currency union. In this exercise we use the Ghose–Wolf model (Ghosh and Wolf, 1994) to characterize the economy and evaluate output losses.

The remainder of the paper is organized as follows. In the next section we provide some background information on the trade and investment flows within Greater China. Section 3 presents some preliminary analyses on the real *per capita* GDP data from China, Hong Kong and Taiwan. The Johansen cointegration test results and links between the long-run and short–run output interactions are reported in Section 4. In the same section we also test for the presence of common business cycles. Section 5 evaluates the output costs of forming a currency union. The output losses of Greater China and its individual member economies under different shock-identifying schemes and policy objectives are reported. Some concluding remarks are given in Section 6.

2. INTEGRATION WITHIN GREATER CHINA

For most of contemporary history, Hong Kong has been China's gateway to the global economy. In the last two decades the two economies have experienced a rapid increase in economic interaction. Hong Kong is a main entrepot and intermediates the lion's share of China's external trade via re-exports and offshore trade. Also, China raises a substantial amount of international capital (in the form of foreign direct investment, equity and bond financing and syndicated loans) through Hong Kong. At the same time, intermediating trade and financial flows to China have become a major form of economic activity in Hong Kong and have greatly transformed its economic structure.

Despite ideological differences and occasional political tensions, the economic linkages between China and Taiwan have proliferated since the 1990s. According to official statistics, in 2002 China was the largest recipient of Taiwan's overseas investment, and Taiwan was China's third-largest source of foreign direct investment. Furthermore, it is widely believed that official statistics under-represent the overall Taiwanese economic interest in China. Some analysts estimated that Taiwan's total investment in China is just behind Hong Kong's but ahead of the USA's.

The integration process between the three Greater China economies is proceeding more along *de facto* than *de jure* lines. Unlike other economic cooperative entities such as the European Union, the integration process within Greater China was not preceded and governed by explicit bilateral or multilateral (trade) agreements, but was fostered by China's liberalization policy and Taiwan's relaxation of its restrictions on economic interaction with China. These policy changes offer opportunities for private-sector actors to capitalize on the benefits from combining strengths in these economies, and the economic gains further encourage the liberalization process. To some observers, the growing economic integration among the Greater China economies reflects the triumph of economic forces over political constraints.

One way to assess the extent of integration is to look at trade and investment flows. These are the subjects of the next two subsections.

2.1 Trade relationships

China's external trade with Hong Kong reflects the evolution of Hong Kong's role as China's gateway to the world economy. In 1991 China's exports to Hong Kong reached US$32 billion, which accounted for 44.7% of China exports (Table 1). Of course, Hong Kong re-exported most of its imports from China to the rest of the world. Between 1991 and 2002 the volume of China's exports to Hong Kong increased by US$26 billion. Despite the huge volume increase, the Hong Kong market accounted for only 18% of total China's exports in 2002.

There are two reasons for Hong Kong's decreasing market share in China's exports. First, in the process of intensifying its open door policy, China has expanded its capacity to export directly by establishing various direct trade links with the rest of the world and developing its own port and harbour facilities. These changes occurred at a fast pace in the 1990s. Thus, China's reliance on Hong Kong to re-export its merchandise to the rest of the world has been mitigated.

Another reason is the change in the manner in which Chinese trade data are recorded.[7] Before 1992 Chinese official statistics greatly distorted its trading relationships with its trading partners, because China had no official record of the final destination of goods and merchandise that were exported through

[7] See General Agreement on Tariffs and Trade (1994), International Monetary Fund (1995) and an un-circulated International Monetary Fund internal document.

Table 1. Trade between Greater China economies (US$ millions)

	Hong Kong–China	*Taiwan–China*	*Taiwan–Hong Kong*
Panel A: Exports			
Value			
1991	32,138	595	3,967
2002	58,483	6,590	4,438
Proportion			
1991	0.447	0.008	0.040
2002	0.180	0.020	0.022
Panel B: Imports			
Value			
1991	17,543	3,639	9,600
2002	10,788	38,082	14,922
Proportion			
1991	0.275	0.057	0.096
2002	0.037	0.129	0.071
Panel C: Total external trade			
Value			
1991	49,681	4,234	13,567
2002	69,271	44,672	19,361
Proportion			
1991	0.366	0.031	0.068
2002	0.112	0.072	0.047

Note: The table presents the trade activities between the three Greater China economies in 1991 and 2002. Columns labelled 'X-Y' give the data assuming that Y is the focal economy, i.e. Y's exports to X, . . . , etc. The rows labelled 'Value' give the value of trade activities, and those labelled 'Proportion' give the ratio of the trade value between X and Y to the total trade value of Y. 'Total external trade' refers to the sum of exports and imports.

Hong Kong. In 1992, however, China began to report its exports according to their final destinations. This change in reporting method caused a big drop in trade between China and Hong Kong – its major entrepot in 1993. Indeed, exclusion of the 1993 figure increases the average annual growth rate of China's exports to Hong Kong from 9.23% to 13.82%.

The evolution of China's imports from and total trade with Hong Kong is similar to that of its exports. While China has created an extensive international trade network in the wake of its open door policy, Hong Kong still plays an important role in China trade. Given the Closer Economic Partnership Arrangement signed by China and Hong Kong in 2003 and the proposal on developing the Pearl River Delta region, one can only anticipate further integration between China and Hong Kong.

Strictly speaking, China and Taiwan do not have direct trade. Taiwan's official stance was to prohibit any trade with China until the early 1990s. Since then, Taiwan has allowed indirect trade with China via a third territory (mainly via Hong Kong). In 1999 the rule was further loosened so that Taiwan merchandise can now transit via the third territory without unloading before being shipped to China. Even without direct trade, the trade volume between these two economies has grown two times or ten times, depending on the

data sources, in the 1990s. According to the Chinese statistics, the trade between China and Taiwan has enjoyed a remarkable growth – an average annual growth rate of 22% since 1991.[8,9] Despite this phenomenal growth, however, Taiwan's total trade (exports plus imports) with China was still less than Hong Kong's even though Taiwan exported more to China than Hong Kong did in 2002.

In the early 1990s Taiwan imported only a minute amount of goods from China. Import restrictions, justified by security reasons, rather than anaemic demand were the main reason for this. With such relatively small exports to Taiwan, China maintained a considerable trade deficit with Taiwan throughout the decade, even though the growth rate of its exports to Taiwan was higher than that of its imports. According to the 2002 Chinese figures, its trade deficit with Taiwan stood at US$31.5 billion, which is comparable to the overall trade surplus recorded for Taiwan in the same year.

Relative to China trade, the trade growth between Hong Kong and Taiwan is quite slow. Hong Kong's exports to, imports from and total external trade with Taiwan registered only single-digit growth rates in the 1990s.

The trade figures indicate that China has significantly intensified its trade relationship with Hong Kong and Taiwan. A smaller improvement was reflected in the trade volume between Hong Kong and Taiwan. The trade volume between these three economies was quite non-trivial in 2002 – the total external trade between the three Greater China economies accounted for 1% of world trade.

2.2 Foreign direct investment

Should Hong Kong's investment in China be considered foreign investment? Even before reclaiming its sovereignty in July 1997, China's official position was that Hong Kong is an integral part of China. Similarly, China considers Taiwan its sovereign territory and not an independent political entity. If this is the case, then investments from Hong Kong and Taiwan are not 'foreign' investments in China! In practice, however, the investment from these two economies is treated as foreign investment in China and enjoys substantial preferential treatments. Thus, we follow common practice and label Hong Kong's and Taiwan's investment in China foreign investment.

Hong Kong and Taiwan provide a large proportion of foreign direct investment to China (Table 2). The substantial presence of Hong Kong in these investment data is a testament to its role as a main platform for investment

[8] Because of trade restrictions and other political reasons, the official data on trade between China and Taiwan are usually perceived to be incomplete. For instance, the value (in US$ billions) of total trade between China and Taiwan was 5.8 in 1991 and 10.5 in 2001, according to Hong Kong customs (re-export) data; 0.6 in 1991 and 10.6 in 2001 according to Taiwanese customs data; and 4.2 in 1991 and 32.4 in 2001 according to Chinese customs data.

[9] Apparently, steps have been taken to provide accurate China trade data. For instance, Taiwan authorities, despite its official ban on direct trade with China, have been asking exporters to report the final destination of their shipments, even if it is China.

Table 2. China's foreign direct investment from Hong Kong and Taiwan (US$millions)

	Hong Kong	*Taiwan*
Panel A: Value		
1991	2,405	466
2002	17,861	3971
Panel B: Proportion		
1991	0.55	0.11
2002	0.34	0.08

Note: Hong Kong's and Taiwan's investments in China during the years 1991 and 2002 are presented. 'Value' gives the US dollar amount of investment and 'Proportion' gives the ratio of the investment amount to China's total foreign direct investment.

in China. The role was enhanced by China's policies in its early reform programmes, which were aimed at attracting investment from Hong Kong, Macao and Taiwan. Clearly, Hong Kong's domestic resources were not enough to account for the reported capital flow. In addition to its domestic sources, it is believed that Hong Kong investment in China was funded by (a) capital originating in China, which was invested back into China via Hong Kong entities to enjoy the preferential treatments that are not available to China's own local capital; (b) Taiwan's investment, which was channelled through Hong Kong to circumvent restrictions imposed by the Taiwanese authorities; and (c) multinational corporations, which used Hong Kong as the bridgehead to enter the Chinese market.

Hong Kong, one of the renowned international finance centres, has a number of advantageous features that facilitate capital flow to China. These include a well established legal system, a business environment similar to that of other developed countries, an efficient financial sector, the kinship network, and expertise in the Chinese economy. The role of middleman to channel foreign capital into China has reinforced Hong Kong's status as an international finance centre.

Both Chinese and Taiwanese data are perceived to under-report Taiwan's investment interest in China. The official figures rank Taiwan's investment in China behind that of Hong Kong, the USA and Japan. Nonetheless, the guesstimate usually puts Taiwan as the second largest source of investment funds, after Hong Kong. In addition to Hong Kong, it is believed that a substantial amount of Taiwan's interest in China is invested through, the Virgin Islands. The investment flow from the Virgin Islands to China has been quite astonishing. In 1992 China received US$4 million foreign direct investment from the Virgin Islands, while in 2002 the investment flow reached US$6.1 billion.[10]

Undeniably, capital from Hong Kong and Taiwan plays an important role in China's recent economic success. The two economies provided the lion's share of foreign capital to China – a total of 66% in 1991 and 42% in 2002.

[10] See the *Almanac of China's Foreign Economic Relations and Trade*, various issues.

It is worth noting that neither Hong Kong nor Taiwan is a major supplier in the world capital market. Their investment commitments in China are underpinned by China's policy and by the kinship network that spreads across the Greater China region. These investment opportunities allow the three Greater China economies to combine their complementary resources, foster their economic growth and elevate Greater China to the world economic stage.

In sum, the three Greater China economies display a high level of economic integration. The extensive interaction between the economies provides a good foundation for advancing integration to a higher level.

3. PRELIMINARY ANALYSES

In this section, we present some basic properties of the output data. Quarterly China, Hong Kong and Taiwan real per capita GDP data are considered. The sample period is 1994(I)–2002(IV). The sample period is dictated mainly by data availability and the liberalization process in China. Although China started its economic reforms in 1978, it continued to have a substantially controlled economy until the early 1990s. Extending the data series backward would not yield useful information relevant to our exercise. The data are retrieved from the CEIC and International Financial Statistics databases and are seasonally adjusted using the Census Bureau's X12 method. 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 is used to test for a unit root in individual output series. The ADF test is based on the regression equation

$$\Delta X_{it} = c_i + \tau_i t + \delta_i X_{it-1} + \sum_{j=1}^{p} \alpha_{ij} \Delta X_{it-j} + \varepsilon_{it}, \tag{1}$$

where X_{it} is the economy i's GDP at time t, expressed in logs, for i = China, Hong Kong and Taiwan, Δ is the first-difference operator, c_i and t are, respectively, an intercept and time trend, and ε_{it} is the associated error term. Under the unit-root hypothesis, $\delta_I = 0$. The lag parameter (p) is chosen to eliminate serial correlation in the estimated residuals.

The ADF test results are reported in panel A of Table 3. For all three GDP series, the test statistics do not reject the unit root hypothesis. Panel B contains the results from first-differences of GDP data. In this case only a constant term was included in the ADF regression equation. The first-differenced GDP data reject the unit root null hypothesis; that is, the first-differenced data are I(0). As indicated by the Q-statistics, the lag specifications used to conduct these tests adequately capture the intertemporal GDP dynamics. These results suggest that the GDP series are I(1) processes.

4. LONG-RUN AND SHORT-RUN OUTPUT VARIATIONS

Since the GDP data are I(1), each series has a stochastic trend. Thus, we employ the Johansen cointegration procedure to examine whether the three GDP series

Table 3. Unit root test results

	China	*Hong Kong*	*Taiwan*
Panel A: Levels			
Test statistic	–2.71	–2.21	–1.45
No. of lags	1	4	1
Q-statistics			
Q(4)	7.131 (0.129)	0.526 (0.971)	1.744 (0.783)
Q(8)	10.357 (0.241)	11.411 (0.179)	3.392 (0.859)
Panel B: First differences			
Test statistic	–8.31*	–3.95*	–4.08*
No. of lags	1	3	0
Q-statistics			
Q(4)	6.074 (0.194)	0.387 (0.984)	1.439 (0.837)
Q(8)	6.339 (0.609)	9.786 (0.280)	2.827 (0.945)

Note: The results of applying augmented Dickey–Fuller tests to the China, Hong Kong and Taiwan real per capita GDP data are reported. Lags are selected to make the serial correlation in residuals insignificant. 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)' and their *p*-values are given in parentheses underneath. '*' indicates significance at the 5% level (Cheung and Lai, 1995).

share any common stochastic trend, i.e. whether they are cointegrated. In addition to identifying common long-run co-movement, the cointegration results help specify the appropriate model to study short-run output interactions and cycles.

4.1 Common stochastic trend

A currency union has implications for interactions between its member economies that go beyond bilateral relationships. The cointegration model, in contrast to the bilateral setting adopted in most recent studies on currency unions, provides a multivariate framework that allows for interactions between all data series in modelling output co-movement. Further, the model provides a coherent structure to study both long-run and short–run output interactions. Specifically, we can infer whether the output series move together in the long run, how deviations from the long-run relationship affect short-run output movements and how outputs interact in the short run. The structure is flexible enough to accommodate various types of data dynamics in the analysis.

The Johansen cointegration test procedure is conducted as follows. Suppose $\mathbf{X}_t$ is a $n \times 1$ vector containing individual GDP series X_{it}s and has a $(p+1)$th-order autoregressive representation

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

where μ is the intercept term and ε_t is the innovation vector. To test whether the elements in $\mathbf{X}_t$ are cointegrated, the Johansen procedure tests for significant canonical correlations between $\Delta\mathbf{X}_t$ and $\mathbf{X}_{t-p-1}$, after adjusting for all intervening lags. Johansen (1991) and Johansen and Juselius (1990), for example, give a detailed description of the test.

Table 4. Cointegration test results

H(0)	*Max. Eigen. statistic*	*Trace statistic*
$r \leq 2$	0.07	0.07
$r \leq 1$	10.80	10.87
$r \leq 0$	22.60*	33.40*

Note: The Johansen maximum eigenvalue test and trace test statistics are reported, respectively, under the headings 'Max. Eigen. statistic' and 'Trace statistic.' The 5% level of significance is indicated by * (Cheung and Lai, 1993). The lag parameter is 2. The estimated cointegrating vector is (1, –1.66, –1.31) with the China coefficient normalized to 1. The test statistics for the cointegrating coefficients are 14.88 (China), 20.71 (Hong Kong) and 12.17 (Taiwan); that is, each element of the cointegrating vector is significant.

The cointegration test results are reported in Table 4. Again, the lag parameter (p) is selected to obtain insignificant serial correlation in the residuals. According to both the maximum eigenvalue and trace statistics, the null hypothesis of no cointegration is rejected in favour of the presence of one cointegrating vector. Further, there is no evidence that there exists more than one cointegrating vector. These results suggest that the output series are cointegrated; that is, the stochastic trends that drive the individual output series to wander randomly over time are common to the three Greater China economies such that the output series have synchronous long-term movements. The empirical long-run relationship is given by the cointegrating vector.

The cointegration of output data may be viewed as a necessary condition for establishing a currency union. If the output series are not cointegrated, they drift apart in the long run. In this case it is difficult to effectively manage the three economies using a common monetary policy and a common currency. Thus, the cointegration result, which implies that the national output data are synchronous in the long run, is supportive of the concept of a currency union between China, Hong Kong and Taiwan.

4.2 Short–run interaction

Since the three GDP series are cointegrated, a vector error correction model (VECM), instead of a vector autoregressive model, is the appropriate framework to study their interactions. The VECM is given by

$$\Delta \mathbf{X}_t = \mu + \sum_{i=1}^{p} \Gamma_i \Delta \mathbf{X}_{t-i} + \alpha Z_{t-p-1} + \varepsilon_t, \tag{3}$$

where Z_{t-p-1} is the error correction term (ECT) given by $\hat{\beta}' \mathbf{X}_{t-p-1}$ and $\hat{\beta}$ is the estimated cointegrating vector. The VECM results are presented in Table 5. The Q-statistics affirm that the selected VECM models adequately capture the data dynamics and the resulting disturbance terms display no statistically significant serial correlation.

The adjustment of output growth $\Delta \mathbf{X}_t$ to deviations from the empirical long-run relationship is captured by the α coefficient vector. The ECT is significant for Hong Kong and Taiwan, but not for China; that is, Hong Kong and Taiwan respond to deviations from the empirical long-run relationship, which are given by

Table 5. China/Hong Kong/Taiwan vector error correction model

	China	*Hong Kong*	*Taiwan*
ECT	−0.003	0.162*	0.141*
	(−0.118)	(3.510)	(3.645)
CH GDPG(−1)	−0.317*	−0.171	−0.094
	(−2.025)	(−0.662)	(−0.434)
CH GDPG(−2)	−0.410*	0.400**	0.252
	(−2.987)	(1.766)	(1.333)
HK GDPG(−1)	−0.031	0.438*	−0.202
	(−0.269)	(2.334)	(−1.288)
HK GDPG(−2)	0.026	0.031	0.127
	(0.236)	(0.169)	(0.837)
TW GDPG(-1)	0.099	−0.449*	0.041
	(0.755)	(−2.063)	(0.223)
TW GDPG(-2)	0.101	−0.125	−0.143
	(0.737)	(−0.548)	(−0.751)
Constant	−0.055	4.128*	3.593*
	(−0.078)	(3.509)	(3.648)
Adjusted R^2	0.162	0.489	0.299
Q(4)	6.631	7.053	2.023
	(0.157)	(0.133)	(0.732)
Q(8)	7.499	9.625	8.890
	(0.484)	(0.292)	(0.352)

Note: The estimates of the vector error correction model for China (CH), Hong Kong (HK) and Taiwan (TW) are presented. GDPG refers to GDP growth. Robust *t*-statistics are given in parentheses below the parameter estimates. * and ** indicate significant at the 5% and 10% level, 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 parentheses underneath.

the cointegrating vector. On the other hand, China does not react to the deviation, as its ECT has a small and insignificant coefficient estimate. One interpretation of these α coefficient estimates is that the Chinese output affects both Hong Kong and Taiwan GDP data in the long run, but not vice versa (Granger and Lin, 1995). The result seems reasonable. Since the 1980s Hong Kong and Taiwan have invested a large amount of capital and relocated a large number of manufacturing facilities to China, and at the same time China has become a significant export market for both economies. In addition, the Chinese economy is much larger than the other two. These factors have created some complex economic linkages that lead to the reliance of the two small economies on the large one.

The short-run dynamics are described by the Γ_i matrices, which relate output growth to variation in lagged output movements. The three equations display different responses to lagged GDP growth. The Chinese economy, which is the largest of the three, depends only on its own lagged growth rates. The Hong Kong economy, on the other hand, responds to growth rates in all three economies. The Hong Kong result corroborates with its size and openness – Hong Kong is the smallest and the most open economy in the group.[11] Taiwanese

[11] The 2002 PPP-based GDPs (in US$ billions), are 6136 for China, 487 for Taiwan and 194 for Hong Kong. The levels of openness measured by the trade to GDP ratio are 2.54 for Hong Kong, 0.83 for Taiwan and 0.48 for China in 2002.

growth, on the other hand, is not affected by any lagged variable. Even though the economic links between China and Taiwan have increased substantially, our analysis reveals a significant China effect on the Taiwanese growth rate only through the ECT but not through the lagged China GDP growth.

4.3 Synchronized and non-synchronized short-run cycles

In addition to long-run trends, the commonality of cyclical movements and business cycle synchronization are crucial and practical aspects to consider in formulating policy coordination. A common currency and a common monetary policy can be relatively ineffective in managing economic activities in a currency union if shocks are asymmetric and business cycles are asynchronous. On the other hand, if business cycles are synchronous across economies, asymmetric monetary policy responses to shocks may not be indispensable, and thus a common monetary policy can be acceptable.

Since cyclical behaviour is often represented by the serial correlation of output growth, the presence of common serial correlation patterns is taken as evidence of common business cycles. In this exercise the common feature test (Engle and Kozicki, 1993; Vahid and Engle, 1993) is used to detect common serial correlations. The test is based on sample canonical correlations between $\Delta \mathbf{X}_t$ and $\mathbf{W}(p) \equiv (\Delta \mathbf{X}'_{t-1}, \ldots, \Delta \mathbf{X}'_{t-p}, Z_{t-1})$. Under common serial correlation, there exists (at least) one linear combination of the components of $\Delta \mathbf{X}_t$, defined by a co-feature vector, that displays no serial correlation. The test statistic for the null hypothesis that there are at least s co-feature vectors is given by

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

where λ_j is the jth smallest squared canonical correlations between $\Delta \mathbf{X}_t$ and $\mathbf{W}(p)$. The dimension (rank) of the co-feature space is the number of statistically zero squared canonical correlations. Under the null hypothesis, the statistic $C(p, s)$ has a χ^2 distribution with $s^2 + snp + sr - sn$ degrees of freedom.

The presence of a common feature requires the component series to display similar and simultaneous responses to shocks. If the component series have different initial responses to stochastic shocks, there will be no common feature. However, because of economy-specific factors, including institutional structures and capital/labour input, shocks can propagate at uneven speeds across the Greater China economies, and therefore these economies can have different initial responses to shocks. Despite asymmetric initial responses, these economies can react fully and symmetrically to a shock in later periods. This type of 'non-synchronized' cycle might be difficult to detect using the common feature test statistic (4), which is designed to detect synchronized cycles. Vahid and Engle (1997) devise the co-dependence test to test for the presence of common but non-synchronized business cycles. Specifically, the test statistic for the null hypothesis that there are at least s co-dependence vectors after the kth period is

$$C(k, p, s) = -(T - p - 1)\sum_{j=1}^{s} \ln\{1 - [\lambda_j(k)/d_j(k)]\}, \tag{5}$$

Table 6. Synchronized and non-synchronized cycles

	Common feature test		*Co-dependence test*		
Null	*Squared canonical correlation*	*Statistic C (p, s)*	*Squared canonical correlation*	*Statistic C (p, k, s)*	*d.f.*
$S = 1$	0.166	5.472	0.104	2.363	5
$S = 2$	0.417	21.659*	0.188	8.140	12
$S = 3$	0.909	93.807*	0.917	96.912*	21

Note: The common feature and co-dependence test results are reported. s gives the number of common feature or co-dependence vectors. Under the null hypothesis, the common feature test statistic $C(p, s)$ and co-dependence test statistic $C(p, k, s)$ have an asymptotic χ^2 distribution with $s^2 + snp + sr - sn$ degrees of freedom, where, in this exercise, $n = 3$, $p = 2$, $k = 1$ and $r = .$ * indicates significance at the 5% level.

where $\lambda_n(k) \geq \ldots \geq \lambda_1(k)$ are the squared canonical correlations between $\Delta \mathbf{X}_t$ and

$$\mathbf{W}(k, p) \equiv (\Delta \mathbf{X}'_{t-k-1}, \ldots, \Delta \mathbf{X}'_{t-k-p}, Z_{t-1}),$$

and where $d_j(k)$ is given by $d_j(k) = 1$, for $k = 0$, and

$$d_j(k) = 1 + 2\sum_{\upsilon=1}^{k} \rho_\upsilon(\alpha' \Delta X_t)\rho_\upsilon(\gamma' W(k, p)) \quad \text{for} \quad k \geq 1,$$

where $\rho_\upsilon(y_t)$ is the sample autocorrelation of y_t at υth lag, and α and γ are the canonical variates corresponding to $\lambda_j(k)$. Note that when $k = 0$ the co-dependence test statistic $C(k, p, s)$ is reduced to the common feature test statistic; that is, $C(0, p, s) = C(p, s)$. Under the null hypothesis, the statistic $C(k, p, s)$ has a χ^2 distribution with $s^2 + snp + sr - sn$ degrees of freedom.

The common feature and co-dependence test results are reported in Table 6. In panel A the hypothesis of one co-feature vector is not rejected but the hypotheses of two and three co-feature vectors are both rejected. In other words, the Greater China GDP series share synchronized cyclical movements, and there exists a linear combination of these output growth series that displays no significant serial correlation. In addition to common long-run trends, the three Greater China economies share common business cycles.

The co-dependence test results in panel B are based on $k = 1$ and are indicative of the presence of two co-dependence vectors. In addition to synchronized business cycles, these Greater China economies also share non-synchronized business cycles. Since the co-dependence test is a generalized version of the common feature test, the synchronized cyclical component detected by the common feature test will also be detected by the co-dependence test. It is appropriate to interpret that one of the two co-dependence vectors is the co-feature vector reported in panel A. Overall, the results indicate that the Greater China economies share common business cycles – some are synchronized, and some are non-synchronized – and display dissimilar patterns in the first quarter of the cycle.

5. POSSIBLE OUTPUT LOSSES

There are both benefits and costs from forming a currency union. It is perceived that benefits come at the microeconomic level and are derive from, for example, gains in economic efficiency, a reduction in transaction costs (for both businesses and consumers), the elimination of foreign exchange uncertainty and improved cross-border price transparency. The typical costs are related to macroeconomic management. Joining a currency union means that the monetary authorities have to relinquish policy autonomy and lose the capacity to fine-tune the economy. When shocks to individual economies are not identical, a common monetary policy has limited scope to stabilize and offset the effects of shocks on all its member economies; thus, the inability of fine-tuning is a potential macro cost. Even though the three Greater China economies are quite well integrated, they do not meet all the ideal pre-conditions of a currency union. Thus, it is instructive to investigate the potential cost of joining a currency union.[12]

5.1 The model

Intuitively, the cost of giving up monetary policy autonomy is low if the union's common monetary policy is effective in managing shocks to its member economies. The common monetary policy can be ineffective, and the costs can be high if shocks to the economies are different and there are significant (nominal) rigidities. While it is not easy to evaluate these costs, we use the Ghosh–Wolf model (Ghosh and Wolf, 1994) to illustrate the possible consequences of relinquishing monetary policy autonomy. Specifically, the model assumes nominal wage rigidity to establish the benefits of autonomous monetary policy. Before joining a currency union, individual economies use their own monetary policies to fine-tune their economies in the presence of adverse shocks to achieve full employment. Under a currency union arrangement, however, a common monetary policy is used to combat a union-wise shock, which is a function of shocks to its member economies. Since the union-wise shock is not necessarily the same as an individual shock, the adoption of a common policy does not allow every member economy to achieve full employment simultaneously, and hence induces the output cost of joining a currency union.

Suppose an economy's output is given by

$$\theta_t = \varepsilon^{\theta_t} l_t^{\alpha} \tag{6}$$

where θ_t is a productivity shock, l_t is labour employed in period t, and $0 < \alpha < 1$ is the labour share.

The real wage is equal to the marginal product of labour. The nominal wage rate, w_t, is downward sticky and is based on information available at $t-1$, i.e.

$$\log(w_t) = \log(E_{t-1} p_t) + \log(\alpha) + E_{t-1}\theta_t + (\alpha - 1)\log(\bar{l}), \tag{7}$$

[12] Evaluating the benefits of forming a currency union is an important and involving task that is beyond the scope of the current exercise.

where p_t is the price level and E_{t-1} is the expectations operator based on information available at time $t-1$. It is assumed that the wage is set (given the expected price and expected productivity shock) to clear the labour market; thus, $\bar{l}$ is the equilibrium employment level. Since the nominal wage is only rigid downward, the wage rate adjusts to clear the market if the unexpected productivity shock $\varepsilon_t (\cong \theta_t - E_{t-1}\theta_t)$ is positive. However, if the unexpected productivity shock ε_t is negative, the wage rate does not move down, and the actual *ex post* labour demand (l_t) is given by

$$\log(p_t) + \theta_t + (\alpha - 1)\log(l_t) = \log(w_t). \tag{8}$$

Note that l_t does not represent the equilibrium employment level. If the economy is not in a currency union, monetary policies can be used to offset the adverse shock and restore labour market equilibrium by setting the price at the level

$$\log(p_t) - \log(E_{t-1}p_t) = -\varepsilon_t. \tag{9}$$

In this case,

$$\log(p_t)+\theta_t+(\alpha-1)\log(\bar{l})=\log(w_t)=\log(E_{t-1}p_t)+E_{t-1}\theta_t+(\alpha-1)\log(\bar{l}). \tag{10}$$

Now suppose the economy forms a currency union with another economy. Let the productivity shock to the currency union be ε_t^c, which is a combination of shocks to the two member countries. Further, assume that the currency union's monetary authorities pursue a stabilization policy similar to (9) and set the union's price level (p_t^c) according to

$$\log(p_t^c) - \log(E_{t-1}p_t^c) = -\varepsilon_t^c. \tag{11}$$

When $\varepsilon_t < \varepsilon_t^c$, the policy (11) does not yield full employment for the economy under consideration. From (6), (8) and (11), the economy's output loss, in percentage terms, is given by

$$L_t = 1 - \exp[(\varepsilon_t - \varepsilon_t^c)\alpha/(1-\alpha)]. \tag{12}$$

Equation (12) summarizes the three factors that determine the output loss of joining a currency union: the shock to the economy ε_t, the shock to the currency union ε_t^c, and the labour share α. See Ghosh and Wolf (1994) for a detailed discussion of the model, interpretations and caveats.

5.2 The estimated losses

Equation (12), which quantifies the possible output cost of joining a currency union, is used to assess the potential output losses. We calculate the output losses for each of the three Greater China economies and for Greater China as a group. To accommodate various possible scenarios, the output losses are calculated from the following configurations: (a) the labour share ranges from 0.3 to 0.7; (b) two ways to characterize the currency-union-wide shock: the GDP-weighted average of individual economies' output shocks, and the simple average of the individual economies' output shocks; and (c) three approaches to derive output shocks: one based on the VECM, one based on the Hodrick–Prescott

Table 7. Estimated average output losses in percentages

		GDP-weighted average of shocks			*Simple average of shocks*		
		VECM	*HP filter*	*BQ*	*VECM*	*HP filter*	*BQ*
$\alpha = 0.7$	China	0.140	0.280	0.074	0.209	0.408	0.150
	Hong Kong	0.617	1.712	0.471	0.542	1.224	0.382
	Taiwan	0.505	0.868	0.043	0.445	0.517	0.066
	Greater China	0.272	0.563	0.122	0.301	0.521	0.169
$\alpha = 0.6$	China	0.090	0.181	0.048	0.134	0.263	0.096
	Hong Kong	0.399	1.111	0.305	0.350	0.792	0.247
	Taiwan	0.326	0.563	0.028	0.287	0.334	0.043
	Greater China	0.175	0.365	0.079	0.194	0.337	0.109
$\alpha = 0.5$	China	0.060	0.121	0.032	0.090	0.176	0.064
	Hong Kong	0.267	0.745	0.204	0.234	0.530	0.165
	Taiwan	0.218	0.377	0.019	0.192	0.224	0.029
	Greater China	0.117	0.244	0.053	0.130	0.225	0.073
$\alpha = 0.4$	China	0.040	0.080	0.021	0.060	0.117	0.043
	Hong Kong	0.178	0.498	0.137	0.156	0.354	0.110
	Taiwan	0.146	0.252	0.012	0.128	0.149	0.019
	Greater China	0.078	0.163	0.035	0.087	0.150	0.049
$\alpha = 0.3$	China	0.026	0.052	0.014	0.039	0.076	0.027
	Hong Kong	0.115	0.321	0.088	0.100	0.228	0.071
	Taiwan	0.094	0.163	0.008	0.082	0.096	0.012
	Greater China	0.050	0.105	0.023	0.056	0.097	0.031

Note: 'GDP-weighted average of shocks' and 'Simple average of shocks' give the estimated average percentage output losses based on the assumptions that the currency union shock is given by the GDP-weighted average and by the simple average of shocks to individual economies. The row 'Greater China' gives the losses for the three economies as a group. Results based on shocks estimated from the vector error correction model, the HP filter and the Blanchard–Quah method are given under the column headings 'VECM', 'HP filter' and 'BQ', respectively. 'α' is the labour share parameter.

(HP) filter, and one based on the Blanchard–Quah (BQ) method (Blanchard and Quah, 1989).

Table 7 presents the estimated average percentage output losses. The estimates, based on the assumption that the currency union shock is the GDP-weighted average of shocks to individual economies, are given in columns (3)–(5), and those based on the simple average are given in columns (6)–(8). A few observations are in order.

First, the estimates illustrate the role of labour share quite clearly. As indicated by equation (12), a larger labour share implies a larger percentage of output loss, which is a consequence of the nominal wage rigidity assumption. Indeed, when the labour share increases, the estimated output loss increases quite significantly. For instance, China's percentage output loss estimate increases more than fivefold when the labour share parameter increases from 0.3 to 0.7. Similar changes in output losses are found in the other two economies.

Second, the percentage output loss estimate appears quite sensitive to the method used to extract the shock. Under both currency union shock specifications, the HP filter yields the highest output loss estimates and the BQ method delivers the lowest estimates. The results highlight the importance of the shock estimation method in evaluating the output loss of joining a currency

union. The sensitivity of loss estimates to the shock extraction method is comparable to the sensitivity of the estimated benefits from free trade derived from different specifications reported in, e.g., Brown *et al.* (2002) and Scollay and Gilbert (2001).

Third, the rankings of output losses across the two alternative specifications of currency union shocks are quite similar. For instance, Hong Kong has the highest percentage output loss estimates in all the cases under consideration, ranging from 0.071% (simple average, $\alpha = 0.3$, BQ) to 1.712% (GDP weighted average, $\alpha = 0.7$, HP). China, on the other hand, has the smallest estimates when the shocks are extracted using either the VECM or HP filter approach. The diverse output losses imply that the three Greater China economies can have different views on the prospect of forming a common currency union. China, for instance, has the lowest output cost and is likely to be more receptive to the notion of a Greater China currency union than the other two economies.

Fourth, there will be a debate over how to define the currency union shock. The Chinese output loss estimates are always smaller when the GDP-weighted average shock is used. Thus, it is conceivable that China would prefer a policy that abates the average of GDP-weighted shocks. The result is quite intuitive. Under the GDP-weighted average definition, the stabilization policy is more responsive to shocks originated in China, which is the largest economy in the group. On the other hand, the smallest economy in the group, Hong Kong, would favour a policy that focuses on the simple average shock because it incurs smaller output losses under such a policy. The Taiwan case is slightly different; its choice between the two currency union shocks depends on which shock extraction method is considered. For Taiwan, the notion of the GDP-weighted average shock is better under both the VECM and HP filter but not under the BQ setting.[13]

Fifth, the output loss estimates of Greater China as a group, which are reported under the row heading 'Greater China', are quite small. There are only four cases in which the percentage output loss is larger than 0.3%. These high-end loss estimates are comparable to some estimates of the benefits of a currency union. For example, in an earlier study (Commission of the European Communities, 1990) cost savings for European countries to adopt a single currency were estimated to range between 0.3% and 0.4% of the aggregate GDP. The benefit of price convergence, which is a plausible consequence of creating a currency union, was estimated by Hufbauer *et al*. (2002) to be 0.55% of the world GDP. Further, we should recall that the output loss is derived under the assumption that individual monetary authorities can perfectly fine-tune their economies, and thus that the output loss should be properly interpreted as an upper bound of potential losses. Therefore, if a common currency for the three Greater China economies generates a similar magnitude of savings,

[13] Cheung and Yuen (2004), which reported the output loss estimates in monetary terms, suggests that China may be able to persuade the other two economies to adopt a policy that manages the GDP-weighted average shock by redistributing its gain from adopting such a policy to the other two economies.

Table 8. Estimated average output losses in percentages based on a specific set of labour share values

	GDP-weighted average of shocks			*Simple average of shocks*		
	VECM	*HP filter*	*BQ*	*VECM*	*HP filter*	*BQ*
China	0.034	0.068	0.018	0.051	0.099	0.036
Hong Kong	0.256	0.716	0.197	0.225	0.509	0.159
Taiwan	0.210	0.363	0.018	0.184	0.215	0.027
Greater China	0.096	0.204	0.042	0.100	0.171	0.052

Note: The percentage output loss estimates are based on the labour share values: 0.36 for China and 0.49 for both Hong Kong and Taiwan (Harrison, 2002). See the footnote to Table 7 for details.

the benefits of forming a currency union can outweigh the estimated output losses.

If shocks are accurately estimated by the VECM or the BQ method, Greater China will prefer the policy of managing the GDP-weighted average of shocks to individual economies, because such a policy leads to a smaller percentage output loss. However, if the HP filter yields better estimates of shocks, then it will be beneficial to pursue a policy of managing the simple average of shocks to individual economies. Thus, the results reinforce the relevance of the choice of shock estimation method in evaluating issues related to a currency union.

The loss estimates in Table 7 are derived from a range of labour share values. It is instructive to consider losses corresponding to some 'reasonable' estimates of labour shares in these economies. In her recent study, Harrison (2002) provides labour share estimates for a large number of economies. In this exercise we adopt her 1993–96 labour share figures and calculate the corresponding output losses. Specifically, the labour share parameter is set to 0.36 for China and to 0.49 for Hong Kong and Taiwan.[14]

The percentage output loss estimates based on the specific set of labour shares are presented in Table 8. If the selected labour share figures are consistent with the economic structures of these three economies, then the output cost of forming a currency union is lower than the potential benefit estimated by the Commission of the European Communities (1990). While the potential gain can offset the potential loss in forming a currency union, there is a re-distribution issue. As evidenced in the table, the output loss of Hong Kong can be quite high – more than 0.7%, according to the HP filter approach under the GDP-weighted average policy. At the same time, a small economy is likely to achieve a low level of cost savings from a gain in economic efficiency and reduction in transaction costs. Thus, without an appropriate re-distribution scheme or other economic incentives, Hong Kong may not elect to join the union because the cost could be higher than the benefit.[15]

[14] We assume China is a member of Harrison's 'bottom–middle' income group, and Hong Kong and Taiwan are members of the 'upper–middle' income group.

[15] For instance, an early access of the huge Chinese market can provide a strong incentive for Hong Kong to join a Greater China currency union.

6. CONCLUDING REMARKS

The three Greater China economies have experienced a fast pace of integration since China launched economic reforms two decades ago. Currently, the three economies have extensive trade and investment linkages. Our analyses show that these economies share common long-run and short-run cyclical variations. The potential output costs of relinquishing policy autonomy seem to be moderate and likely less than the efficient gains to be derived from a currency union arrangement.[16]

Despite the positive evidence, it is fair to consider the hurdles that may be faced along a path towards a Greater China currency union. There are both economic and non-economic obstacles. For instance, segments of populations in these economies are quite agonistic about the legacies of war, differences in political structures and communism. The political squabbles between China and Taiwan and the democracy movement in Hong Kong, for instance, are likely to create undulations along the path to a currency union. Another challenge is the costs of adjustment. China, Hong Kong and Taiwan are at different stages of economic development. The difference can lead to huge gains from trade and integration, and at the same time can create serious adjustment problems. For instance, it is believed that China has hollowed out the manufacturing sector in Hong Kong, and a similar process is happening to the manufacturing sector in Taiwan.

However, the prospect is reasonably encouraging. China, Hong Kong and Taiwan have a common history, culture and language, and share an extensive kinship network. These are good catalysts for integration. For both historical reasons and political reality, China has a stronger link with Hong Kong than with Taiwan. The pace of integration between China and Hong Kong is likely to be enhanced by their 2003 Closer Economic Partnership Arrangement and the development of the Pearl River Delta economic region.

There are differences between China and Taiwan. Given the existing economic ties, any severe political and military conflicts could inflict a huge cost on both economies. Even though China is agonistic about Taiwan's attempts to engage in any bilateral and multilateral trade agreement as a sovereign country, China is willing to negotiate a trade agreement with Taiwan.[17] As mentioned earlier, the current integration process between the three Greater China economies is proceeding more along *de facto* than *de jure* lines. Usually, institutional changes are made to accommodate economic developments in these economies. There is a possibility that the road to a Greater China currency union is being led by economic considerations rather than politics.

[16] One caveat is in order. The empirical results are derived from existing data. Given the rapid developments in these countries, especially in China, the future could look very different from that inferred from the reported empirical results. However, some extant studies (Frankel and Rose, 1998; Corestti and Pesenti, 2002; Engel and Rose, 2002) show that the implementation of a currency union can induce structural changes that facilitate integration and increase the strength of common business cycles.

[17] People's Daily Online (2003).

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