Japanese Yen as an alternative vehicle currency in Asian

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Introduction

The grouping of 10 Southeast Asian nations may be able to emulate the European Union (EU) but this is unlikely to come true in the near future, former Prime Minister Tun Dr Mahathir Mohamad has predicted. He said the 10 nations could become closer like the EU but this would happen only over time as there were too many differences among the ASEAN countries. “In time, maybe we can introduce a common currency. But this must not be done by doing away with local currencies. The local currency can be used domestically while the common currency for trade between the 10 countries. That would be a start.”

China has emerged as a major economic power and attracted many western investors to the East, and for many, the legendary wealth and prosperity of the ancient culture of India and rich resources in South Asia, has attracted European commerce, exploration and colonialism. Japan is particularly managed to develop its economy due to a reformation in the 19th century. The Japanese economy continues to grow well into the 20th century and its economic growth resulted numerous shortages of resources. As a result, Japan began to expand into other Asian countries which were rich in natural resources and cheap labours. Hence, a great part of Asian countries were annexed with Japanese economic expansions.

The Indian economy coupled with the Chinese economy started to power Asia into one of the hotspots for world trade. The Chinese economy was already booming with the economical measures undertaken by Jiang Zemin. Currently, China's GDP topped at 10% growth annually and India's at around 9%. Asia is showing its potential. One of the factors is the sheer size of the population in this region. Given the large number of cheap and amply available labour in the region, particularly in China and India, where large workforces provide numerous advantages for economy growth.

During the early 1990s, most of the Asian countries enjoyed a growth rate of nearly 9% annually (Table 1). However, this impressive growth had dramatically changed in 1997. Massive devaluation on Thai Baht took place on 14 and 15 May 1997, forced the Central Bank of Thailand to float the baht on 2 July 1997. At first, the economic crisis was limited to Thailand's financial sector, but it quickly spread to engulf other Asian economies as well. The economy of Thailand, Korea, Malaysia and Indonesia were subsequently contracted more than 6% in 1998. The damages on Singapore and the Philippines were comparatively small, while Japan, China and India were largely escaped from the crisis. Nevertheless, by 1999, most countries had recovered from the crisis. This table also highlights Asia and World rank of selected Asian countries in 2006. It’s clearly indicated that the GDP nominal of Japan, China, Korea and India are the top rank in Asia whereas Japan and China remained at top five in the world.

The Asian economic crisis had alerted the members of Asian countries to review the sole dependence on the U.S. Dollar for regional trade. It seems like Japanese Yen, the major currency in this world besides U.S. Dollar, Euro Dollar and British Pound, maybe can be used as an alternative vehicle currency in Asian region. Several incidents in the past when the Yen appreciates against the Dollar, the economic growth rate of Asia picks up. It has happened between 1986 and 1988 and again between 1991 and 1995. At the end of 1997, Thailand was hit by currency speculators, and the value of the Baht along with its annual growth rate fell dramatically. Soon after, the crisis spread to Indonesia, Malaysia, South Korea, Hong Kong, Singapore and many other Asian economies, resulting in great economic damages to the affected countries except Japan.

This study attempts to empirically assess the financial integration of Asian countries by examining their exchange rates movements. Both the multilateral and bilateral relationship between the individual exchange rates denominated in Yen is examined through the cointegration and Granger-causality

techniques. It has been suspected that the 1997 Asian financial crisis may have affected any financial integration among these countries. Hence, the analysis of data is separated into three sample periods, pre-crisis, during-crisis and post-crisis periods in order to identify any possible differences in the pattern of financial integration of Asian currencies in these three sub-periods

Literature Reviews on Asian Exchange Rates Integration

Several authors have used the convergence of exchange rates to investigate financial integration in Asian countries. Aggarwal and Mougoue (1993) examined the existence of 'yen bloc' by employing the time-series stochastic behavior and cointegration of five Asian currencies (Japanese Yen, Hong Kong Dollar, Malaysian Ringgit, Philippines Peso, and Singapore Dollar). Based on daily exchange rates from 27 September 1982 to 22 December 1989, they found strong evidences of a Yen block.

Tse and Ng (1997) pointed out that the inclusion of Hong Kong Dollar in the set of exchange rate by Aggarwal and Mougoue (1993) may be inappropriate as the currency has been pegged to U.S. Dollar and countries like South Korea and Taiwan that have close trade relationship with Japan should be included in the analysis. They disaggregate the sample period into two sample-periods. First sample-period is from September 1982 to December 1989 that corresponded with Aggarwal and Mougoue (1993), and second sample-period ended in 30 June 1994. In contrast to the finding of Aggarwal and Mougoue (1993), they found that if South Korea Won and Taiwan Dollar are excluded from the set of currencies, the currencies are not cointegrated. They also indicated that the number of cointegrating vectors increased when sample period extended to 1994.

Aggarwal and Mougoue (1996) examined the cointegrating relationship of exchange rates between Japanese Yen with two sets of Asian currencies. First set of currencies consisted of currencies of the Asian Tigers Hong Kong, South Korea, Singapore, and Taiwan; and second set, the currencies of Malaysia, the Philippines, Thailand and Singapore. Daily exchange rates spanning from October 1983 to February 1992 were used. By using the procedure advocated by Park and Sung (1994), a structural break that coincided with October 1987 stock market crash was detected and further analysis were conducted on two sub-periods. Both sets of Asian currencies are found to be cointegrated. Besides, they also examined the influence of the Japanese Yen among the other Asian currencies relative to the U.S. Dollar. Their results showed that influence of Japanese Yen in both sets of the currencies has increased relatively to the U.S. Dollar.

Chaudhry (1996) examined the co-movement in the Japanese Yen, Australian Dollar, Singapore Dollar, Malaysian Ringgit and New Zealand Dollar. The results from the VAR suggested that the Japanese Yen, Australian Dollar and Singapore Dollar influence the behaviour of the other currencies. In addition, they have also investigated the nature of change in these relationships over the two important currency-coordinating agreements, the 'managed-float' Plaza Accord (January, 1985 to February, 1987) and the 'target-zone' Louvre Accord (February 1987 to December 1989). Evidence of integration of these currencies during the 'target-zone' Louvre Accord was found. However, evidence does not support integration for the 'managed-float' Plaza Accord interval.

Baharumshah and Goh (2005) examined the exchange rates relationship between Japan and seven East Asian countries (Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan and Thailand) using quarterly data from 1978:1 to 1998:3. In order to investigate whether several events that took place in 1990s (the Mexico tequila crisis, rise of U.S. dollar, devaluation of yuan) had affected these financial markets, three sub-periods have been used in the analysis. Period 1 spans from 1978:1 to 1994:1; Period 2 covers from 1978:1 to 1996:2; Period 3 starts from 1978:1 and ends in 1998:3. They found that the

Philippines Peso and Korean Won do not belong to the cointegrating relationship and the macroeconomic shocks experienced in 1994-1996 have not distorted the Yen's influence in the region.

This study attempts to extent the existing literatures by including more Asian countries and more recent data, following the establishment of ASEAN-5+3 cooperation. Taking into account the 1997 financial crisis, this study also investigate any possible differences in the pattern of financial integration of Asian countries in pre-crisis, during-crisis and post-crisis periods.

Data and Empirical Results

The data set consists of the daily exchange rates for eight Asian currencies covering the period from 1st November 1993 to 31th December 2007. The exchange rates are Indonesian Rupiah (ID), Malaysian Ringgit (MY), Philippines Peso (PH), Singapore Dollar (SG), Thailand Baht (TH), China Yuan (CN), Korean Won (KR) and Indian Rupee (IR) against the Japanese Yen. The analysis of data are divided into three sample periods: first, pre-crisis period spanning from 1st November 1988 to 13th May 1997; second, crisis-period from 14th May 1997 to 31st August 1998; and third, post-crisis period from 1st September 1998 to 31th December 2007.[1]

The order of integration of the series was determined using the Dickey-Fuller (DF) / Augmented Dickey-Fuller (ADF) unit root test. Table 3 shows the results. The results of both unit root tests clearly show that the null hypothesis of a unit root cannot be rejected at the 5% level for all currencies in their levels. However, the null hypothesis is rejected at 5% level when all currencies have been tested in their first-differences. Thus, these result indicates that all eight Asian currencies are integrated of order one, $I(1)$.

Since the series are of same order, we proceed to test the existence of cointegrating relations among the exchange rate series using Johansen multivariate cointegration test. The results are shown in Table 4. The results indicated that the null hypothesis of no cointegrating vector couldn't be rejected in the pre-crisis period because only trace test statistically significant but not significant for max-eigen test. We only consider the existence of cointegrating vector if both statistics are significant at the same time. Therefore, we concluded that there is no cointegration among the currencies before the crisis. It is rejected in the crisis with 5 percent level of significance and post-crisis periods with 1 percent level of significance. This implies that Asian currencies are not cointegrated in the pre-crisis period but they are cointegrated with one cointegrating vector in the crisis and post-crisis periods.

We are aware that although the cointegration may exist among eight Asian currencies in the crisis and post-crisis periods, but not all of these currencies will enter the cointegration vector. To this purpose, we performed the exclusion test by imposing zero restriction on the β coefficient of cointegrating vector. Table 5 shows the results. The log-likelihood ratio (LR) showed that Indonesia Rupiah, the Philippines Peso, Korea Won, China Yuan and India Rupee rejected the hypothesis null of cointegrating parameter equal to zero during the crisis period. The results suggested that Singapore Dollar, Malaysia Ringgit and Thailand Baht could be excluded from the system of exchange rate. For post-crisis period, the log-likelihood ratio indicated that all except Indonesia Rupiah, Thailand Baht, China Yuan and India Rupee rejected the exclusion hypothesis. This implies that Indonesia, Thailand, China and India currencies could be excluded from the system of exchange rate.

[1] Crisis period was considered starting from massive attack on the Thai baht on 14 May 1997 and ended in 31 August 1998 where the ringgit Malaysia was pegged to USD in the next day.

The cointegration tests are re-estimated on the remaining series. Results of the cointegration tests are shown in Table 5. In these two periods, both the maximum eigenvalue test and trace test rejected the null hypothesis of no cointegrating vector at 1 percent level of significance. The results indicated that these currencies are cointegrated with a unique cointegrating vector. In addition, the exclusion test results rejected the null hypothesis of cointegrating parameter equal to zero for all currencies (Table 6).

As the presence of cointegrating vector had been ascertain, the next step would be identifying the direction of causality among these few Asian currencies. Table 7 reports the results of the Granger-causality test based on vector error-correction model (VECM) for crisis period. The negative and significant error-correction term (ECT) for the Philippines, India and China equations, implying that the currencies of these countries endogenously react to past deviations from the cointegrating relationship and adjusts to restore the long-run equilibrium. The small magnitude of the coefficient of error-correction term indicates that the adjustment towards equilibrium is rather slow. Short-run unidirectional causal relationship has detected running from Korea Won to Indonesia Rupiah and also Indonesia Rupiah to the Philippines Peso. The changes in Korea Won indirectly granger caused changes in the Philippines Peso. These relationships are summarized as Figure 1.

The results of the Granger-causality test based on vector error-correction model (VECM) for post-crisis period is presented in Table 8 and depicted as Figure 2. The hypothesis that coefficient of error-correction term (ECT) is equal to zero is easily rejected for Malaysia and Singapore equations, implying that the currencies of these two countries endogenously react to past deviations from the cointegrating relationship and adjusts to restore the long-run equilibrium. However, the speed of adjustment is quite slow. There is a bidirectional feedback relationship between Malaysia Ringgit and Korea Won. There is unidirectional causal relationship running from Singapore Dollar to Malaysia Ringgit, Korea Won and the Philippines Peso. Concurrently, there is a unidirectional causal relationship running from the Philippines Peso to Malaysia Ringgit and Korea Won.

Conclusion

As the economy of the Asian countries expand and become more integrated following the establishment of ASEAN-5+3 cooperation, this study attempts to examine the financial linkages between the currencies of the Asian countries. At the end of 1997, Thailand was hit by currency speculators. Soon after the crisis spread to Indonesia, Malaysia, South Korea and many other Asian countries, resulting in great damages to the affected countries (Japan largely escaped the crisis). This is showed that Japanese Yen is much sturdy as compared to other Asian currencies. Hence, we choose Japanese Yen as a vehicle currency in Asian countries for this study. We used local exchange rates denominated in Yen to study the relationship among the Asian countries currencies. In order to identify any differences in the pattern of financial integration following the 1997 Asian financial crisis, the analysis is separated into: pre-crisis, during-crisis and post-crisis periods. Significant non-stationarity, and the presence of unit roots were documented for each currency in each sample period. The results of cointegration analysis showed that the currencies are not cointegrated during the pre-crisis period. The cointegration relationship was detected among five Asian countries currencies (the Philippines, Indonesia, Korea, India and China) during the crisis period while evidence of cointegration was found among four Asian currencies (Malaysia, the Philippines, Singapore and Korea) in the post-crisis period. These findings imply that there is low financial integration before the crisis, but Asian countries are financially more integrated during and after the crisis. In particular, during the post crisis period, Japan, Korea, the Philippines, Malaysia and Singapore are financially integrated in long-run. Since we found that most of major countries in Asian have financial integration after the crisis, therefore Japanese Yen is highly recommended as a potential alternative vehicle currency for Asian region in the future.

Table 1: Nominal GDP and Nominal GDP Growth Rate in Asian Countries from 1990 to 2006.

Asia 06' Rank	World 06' Rank	Country	1990 - 1996	1997	1998	1999	2000 - 2006	2006 GDP (nominal) millions of US dollars
1	2	Japan	2.3	1.8	-1.0	-0.1	1.7	4,367,459
2	4	China	10.7	9.3	7.8	7.6	9.6	2,630,113
3	12	Korea	7.9	4.7	-6.9	9.5	5.2	888,267
4	13	India	5.8	4.8	6.5	6.1	6.8	886,867
7	21	Indonesia	8.0	4.7	-13.1	0.8	4.9	364,239
11	34	Thailand	8.6	-1.4	-10.5	4.4	5.0	206,258
14	39	Malaysia	9.5	7.3	-7.4	6.1	5.5	150,923
16	44	Singapore	8.8	8.3	-1.4	7.2	5.5	132,155
18	47	Philippines	2.8	5.2	-0.6	3.4	4.6	123,931

Source: International Monetary Fund

Table 2: DF/ADF Unit Root Tests

Country	Nominal exchange rate (against YEN) Level		First Difference	
	constant	constant with trend	constant	constant with trend
I. Pre-crisis (1993 Nov 1 – 1997 May 13)				
Indonesia (ID)	-1.45 (1)	-1.55 (1)	-31.87 (0) [a]	-31.92 (0) [a]
Malaysia (MY)	-0.49 (1)	-2.01 (1)	-31.34 (0) [a]	-31.40 (0) [a]
Philippines (PH)	-0.87 (1)	-1.54 (1)	-32.82 (0) [a]	-32.82 (0) [a]
Singapore (SG)	-0.28 (1)	-1.84 (1)	-33.09 (0) [a]	-33.11 (0) [a]
Thailand (TH)	-2.37 (1)	-2.39 (1)	-67.36 (0) [a]	-67.35 (0) [a]
China (CN)	-0.58 (0)	-1.51 (0)	-33.33 (0) [a]	-33.38 (0) [a]
Korea (KR)	-1.49 (1)	-1.95 (1)	-32.65 (0) [a]	-32.65 (0) [a]
India (IR)	-1.73 (1)	-1.57 (1)	-32.86 (0) [a]	-32.89 (0) [a]
II. Crisis (1997 May 14 – 1998 Aug 31)				
Indonesia (ID)	-1.09 (1)	-1.92 (1)	-18.46 (0) [a]	-18.45 (0) [a]
Malaysia (MY)	-1.84 (1)	-1.97 (1)	-18.44 (0) [a]	-18.45 (0) [a]
Philippines (PH)	-1.99 (0)	-2.01 (0)	-16.87 (1) [a]	-16.88 (1) [a]
Singapore (SG)	-2.28 (0)	-2.64 (0)	-22.10 (0) [a]	-22.07 (0) [a]
Thailand (TH)	-1.99 (0)	-1.50 (0)	-16.91 (1) [a]	-17.00 (1) [a]
China (CN)	-0.80 (6)	-2.95 (6)	-19.42 (0) [a]	-19.40 (0) [a]
Korea (KR)	-1.56 (0)	-1.43 (0)	-22.13 (0) [a]	-22.12 (0) [a]
India (IR)	-2.81 (9)	-3.24 (9)	-19.71 (0) [a]	-19.69 (0) [a]
III. Post-crisis (1998 Sept 1 – 2007 Dec 31)				
Indonesia (ID)	-2.81 (70)	-3.38 (60)	-58.40 (0) [a]	-58.39 (0) [a]
Malaysia (MY)	-2.45 (7)	-2.84 (7)	-22.73 (6) [a]	-22.76 (6) [a]
Philippines (PH)	-2.05 (0)	-1.16 (0)	-59.65 (0) [a]	-59.72 (0) [a]
Singapore (SG)	-2.28 (2)	-3.36 (2)	-37.41 (1) [a]	-37.45 (1) [a]
Thailand (TH)	-1.02 (0)	-1.88 (0)	-30.54 (3) [a]	-30.61 (3) [a]
China (CN)	-2.84 (2)	-3.23 (2)	-37.56 (1) [a]	-37.58 (1) [a]
Korea (KR)	-1.11 (3)	-2.73 (3)	-40.19 (2) [a]	-40.19 (2) [a]
India (IR)	-2.70 (36)	-2.92 (36)	-37.95 (1) [a]	-38.00 (1) [a]

Notes: The numbers in parenthesis are lag length. The tests employ a null hypothesis of a unit root. All series are log transformed. a and b denotes significance at 1% and 5% levels.

Table 3: Johansen-Juselius Likelihood Cointegration Tests for Asian

Null Hypotheses	Eigen value	Trace	Critical Value (5%)	Critical Value (1%)	Max-Eigen	Critical Value (5%)	Critical Value (1%)
I. Pre-crisis (1993 Nov 1 – 1997 May 13)							
(r = 0)	0.035900	162.6148[b]	156.00	168.36	48.83405	51.42	57.69
(r ≤ 1)	0.025968	115.7808	124.24	133.57	33.70440	45.28	51.57
(r ≤ 2)	0.023770	82.07637	94.15	103.18	30.81664	39.37	45.10
(r ≤ 3)	0.016201	51.25974	68.52	76.07	20.92311	33.46	38.77
(r ≤ 4)	0.009484	30.33663	47.21	54.46	12.20754	27.07	32.24
(r ≤ 5)	0.007110	18.12908	29.68	35.65	9.140781	20.97	25.52
(r ≤ 6)	0.006218	8.988304	15.41	20.04	7.989948	14.07	18.63
(r ≤ 7)	0.000779	0.998356	3.76	6.65	0.998356	3.76	6.65
II. Crisis (1997 May 14 – 1998 Aug 31)							
(r = 0) [b]	0.113574	167.7175[b]	156.00	168.36	56.66206[b]	51.42	57.69
(r ≤ 1)	0.075095	111.0554	124.24	133.57	36.69027	45.28	51.57
(r ≤ 2)	0.066220	74.36516	94.15	103.18	32.20163	39.37	45.10
(r ≤ 3)	0.030821	42.16353	68.52	76.07	14.71385	33.46	38.77
(r ≤ 4)	0.026452	27.44968	47.21	54.46	12.60004	27.07	32.24
(r ≤ 5)	0.019837	14.84964	29.68	35.65	9.416916	20.97	25.52
(r ≤ 6)	0.009708	5.432721	15.41	20.04	4.585001	14.07	18.63
(r ≤ 7)	0.001802	0.847720	3.76	6.65	0.847720	3.76	6.65
III. Post-crisis (1998 Sept 1 – 2007 Dec 31)							
(r = 0) [a]	0.018495	186.1556[a]	156.00	168.36	63.45291[a]	51.42	57.69
(r ≤ 1)	0.010720	122.7027	124.24	133.57	36.63416	45.28	51.57
(r ≤ 2)	0.009383	86.06854	94.15	103.18	32.04352	39.37	45.10
(r ≤ 3)	0.006371	54.02502	68.52	76.07	21.72329	33.46	38.77
(r ≤ 4)	0.004248	32.30173	47.21	54.46	14.46817	27.07	32.24
(r ≤ 5)	0.003130	17.83356	29.68	35.65	10.65703	20.97	25.52
(r ≤ 6)	0.001455	7.176534	15.41	20.04	4.948503	14.07	18.63
(r ≤ 7)	0.000655	2.228031	3.76	6.65	2.228031	3.76	6.65

Notes: r indicates the number of cointegrating vectors. Trace and Max-Eigen denote the trace statistic and maximum eigenvalue statistic. The critical values are obtained from Osterwald-Lenum (1992). a and b denote rejection of the hypothesis at 1% and 5% critical values. Lag selection (k) is based on Schwert (1987) formula, where k=9 for pre-crisis period, k=5 for crisis period, and k=11 for post crisis period.

Table 4: Exclusion Restriction Tests for Asian

Country	Likelihood Ratio (LR)	
	II. Crisis (1997 May 14 – 1998 Aug 31)	**III. Post-crisis (1998 Sept 1 – 2007 May 16)**
ID	5.299[b]	1.161
MY	1.139	2.815[c]
PH	6.700[a]	4.101[b]
SG	1.486	15.628[a]
TH	2.072	0.714
CN	5.727[b]	0.851
KR	10.993[a]	11.886[a]
IR	19.605[a]	1.717

Note: Figures are the likelihood ratio statistics (asymptotically distributed χ^2) for testing the null hypothesis that each coefficient is statistically equivalent to zero in single cointegrating vector. a, b, and c denotes significance at 1% , 5% and 10% levels, respectively.

Table 5: Johansen-Juselius Likelihood Cointegration Tests for Remaining Asian Countries

Null Hypotheses	Eigen value	Trace	Critical Value (5%)	Critical Value (1%)	Max-Eigen	Critical Value (5%)	Critical Value (1%)
II. Crisis (1997 May 14 – 1998 Aug 31)							
Countries: ID, PH, CN, KR, IR							
(r = 0) [a]	0.102180	91.35758[a]	68.52	76.07	50.65910[a]	33.46	38.77
(r ≤ 1)	0.060246	40.69848	47.21	54.46	29.20461[b]	27.07	32.24
(r ≤ 2)	0.013765	11.49388	29.68	35.65	6.514349	20.97	25.52
(r ≤ 3)	0.010480	4.979526	15.41	20.04	4.951391	14.07	18.63
(r ≤ 4)	0.000059	0.028136	3.76	6.65	0.028136	3.76	6.65
III. Post-crisis (1998 Sept 1 – 2007 Dec 31)							
Countries: MY, PH, SG, KR							
(r = 0) [a]	0.013593	66.89630[a]	47.21	54.46	46.51799[a]	14.07	18.63
(r ≤ 1)	0.003490	20.37831	29.68	35.65	11.88254	3.76	6.65
(r ≤ 2)	0.001829	8.495776	15.41	20.04	6.222113	14.07	18.63
(r ≤ 3)	0.000669	2.273663	3.76	6.65	2.273663	3.76	6.65

Notes: r indicates the number of cointegrating vectors. Trace and Max-Eigen denote the trace statistic and maximum eigenvalue statistic. The critical values are obtained from Osterwald-Lenum (1992). a and b denote rejection of the hypothesis at 1% and 5% critical values. Lag selection (k) is based on Schwert (1987) formula, where k=5 for crisis period and k=11 for post crisis period.

Table 6: Exclusion Restriction Tests for Remaining Asian Countries

Country	Likelihood Ratio (LR)	
	II. Crisis (1997 May 14 – 1998 Aug 31)	**III. Post-crisis (1998 Sept 1 – 2007 May 16)**
ID	4.329[b]	
MY		15.813[a]
PH	20.660[a]	4.927[b]
SG		31.199[a]
TH		
CN	6.789[a]	
KR	13.416[a]	26.337[a]
IR	20.152[a]	

Note: Figures are the likelihood ratio statistics (asymptotically distributed χ^2) for testing the null hypothesis that each coefficient is statistically equivalent to zero in single cointegrating vector. a, b, and c denotes significance at 1% , 5% and 10% levels, respectively.

Table 7: Granger Causality Results based on VECM (Crisis)

Dependent Variable	Independent Variable: χ^2-statistic					ECT
	ΔPH	ΔID	ΔKR	ΔIR	ΔCH	[t-stat]
ΔPH	-	10.367[b]	4.319	1.841	3.677	-0.019[b]
		[0.0347]	[0.3645]	[0.7649]	[0.4515]	[-2.1043]
ΔID	7.094	-	21.050[a]	9.382	3.496	-0.010
	[0.1310]		[0.0003]	[0.0522]	[0.4784]	[-0.3465]
ΔKR	3.158	0.924	-	1.275	1.541	-0.013
	[0.5317]	[0.9212]		[0.8656]	[0.8193]	[-0.6932]
ΔIR	3.433	5.52	5.771	-	3.626	-0.035[a]
	[0.4881]	[0.2380]	[0.2169]		[0.4590]	[-6.5627]
ΔCH	1.913	1.703	6.58	4.051	-	-0.024[a]
	[0.7517]	[0.7902]	[0.1598]	[0.3991]		[-4.8719]

Note: χ^2-statistic tests the joint significance of the lagged values of the independent variables, and t-statistic tests the significance of the error-correction term (ECT). a and b denotes significance at 1% and 5% levels.

Figure 1: Short-run Causal Relationship (Crisis)

Table 8: Granger Causality Results based on VECM (Post-crisis)

Dependent Variable	Independent Variable χ^2-statistic				ECT
	ΔMY	ΔPH	ΔSG	ΔKR	[t-stat]
ΔMY	-	66.325[a]	234.638[a]	27.493[a]	-0.020[a]
		[0.0000]	[0.0000]	[0.0012]	[-2.9738]
ΔPH	5.991	-	36.314[a]	7.760	0.007
	[0.7408]		[0.0000]	[0.5585]	[1.3211]
ΔSG	1.293	8.200	-	7.222	-0.014[a]
	[0.9984]	[0.5141]		[0.6141]	[-3.4019]
ΔKR	46.522[a]	21.431[b]	112.007[a]	-	-0.006
	[0.0000]	[0.0109]	[0.0000]		[-0.8723]

Note: χ^2-statistic tests the joint significance of the lagged values of the independent variables, and t-statistic tests the significance of the error-correction term (ECT). a and b denotes significance at 1% and 5% levels.

Figure 2: Short-run Causal Relationship (Post-crisis)