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2009

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ABSTRACT

As the economies of Asian have moved towards closer economic ties and trade integration in recent years, the establishment of regional exchange rate arrangement is becoming an important regional policy concern, particularly in the wake of the Asian currency crisis of 1997. Financial integration in ASEAN+3 is assessed in this paper by examining the time-series stochastic behaviour and cointegration in a set of eight ASEAN+3 currencies in pre-crisis, 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. Evidence of cointegration was found among a few Asian currencies in the crisis and post-crisis periods. These findings have important implications for understanding the potential of developing a common currency area.

Keywords: Exchange Rate, Cointegration, Granger-causality, Asian

JEL Code: F31, F33

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INTRODUCTION

The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967 in Bangkok by Indonesia, Malaysia, the Philippines, Singapore, and Thailand[1]. In the early 1970s, most of the South East Asia did not have a close relationship with the world economy. Economic linkages among the ASEAN have tightened, following the establishment of the Preferential Trade Agreement in 1977 and ASEAN Free Trade Area (AFTA) in 1993. The realization of the ASEAN Free Trade Area in no way lessens the importance of ASEAN's economic partners. The ASEAN Plus Three cooperation began in 1997 and was institutionalised in 1999 when the Leaders issued a Joint Statement on East Asia Cooperation at their 3rd ASEAN Plus Three Summit in Manila. Since then, cooperation in economic, and monetary and financial fields between ASEAN and their counterparts from East Asia, namely China, Japan and the Republic of Korea (ROK) had made substantive progress.

This study attempts to empirically assess the financial integration of ASEAN+3 by examining their exchange rates movements. Both the multilateral and bilateral relationship between the individual ASEAN+3 exchange rates is examined through the cointegration and Granger-causality techniques. It has been suspected that the 1997 Asia financial crisis may have affected any financial integration among these countries. Hence, the analysis of data is separated into three sample periods, pre-crisis period, crisis-period

[1] Brunei Darussalam joined on 8 January 1984, Vietnam on 28 July 1995, Laos and Myanmar on 23 July 1997, and Cambodia on 30 April 1999.

and post-crisis period in order to identify any possible differences in the pattern of financial integration of ASEAN+3 in these three sub-periods.

This paper is organized as follows. Related literatures are reviewed in Section II. The data set is described and the empirical results are discussed in Section III, and the final section concludes.

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 evidence 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 ASEAN, Malaysia, the Philippines, Thailand and Singapore. Daily exchange rates spanning from October 1983 to February 1992 are 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 US dollar. Their result showed that influence of Japanese yen in both sets of the currencies has increased relative to the US 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 suggest that the Japanese Yen, Australian Dollar and Singapore Dollar influence the behaviour of the other currencies. In addition, they also investigate 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 is 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+3 cooperation. Take into account the 1997 financial crisis, this study also investigate any possible differences in the pattern of financial integration of ASEAN+3 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 4 January 1988 to 16 May 2007. The exchange rates are Indonesian rupiah (ID), Malaysian Ringgit (MY), Philippines Peso (PH), Singapore Dollar (SG), Thailand Baht (TH), China Yuan (CN), Japanese Yen (JP) and Korean Won (KR) against the US Dollar. The analysis of data is divided into three sample periods: first, pre-crisis period spanning from 4 January 1988 to 13 May 1997; second, crisis-period from 14 May 1997 to 31 August 1998; and third, post-crisis period from 1 September 1998 to 16 May 2007[2].

The order of integration of the series was determined using the Dickey-Fuller (ADF) / Augmented Dickey-Fuller (ADF) unit root test. Table 1 reports 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 indicated that all eight Asian currencies are integrated of order one, $I(1)$.

Table 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 reported in Table 2. The results indicated that the null hypothesis of no cointegrating vector couldn't be rejected in the pre-crisis period. It is rejected in the crisis and post-crisis periods. This implies that ASEAN+3 currencies are not cointegrated in the

[2] 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.

pre-crisis period but they are cointegrated with one cointegrating vector in the crisis and post-crisis periods.

Table 2

We are aware that although the cointegration may exist among eight Asian currencies in the crisis and post-crisis periods, not all of these currencies will enter the cointegration vector. To this purpose, we perform the exclusion test by imposing zero restriction on the β coefficient of cointegrating vector. Table 3 reports the results. The log-likelihood ratio (LR) showed that Indonesia rupiah, Malaysia ringgit, Philippines peso, Thai baht and Korea won rejected the hypothesis null of cointegrating parameter equal to zero during the crisis period. This suggested that Singapore dollar, China yuan and Japanese yen could be excluded from the system of exchange rate. For post-crisis period, the log-likelihood ratio indicated that all except Indonesia rupiah and Japan yen rejected the exclusion hypothesis. This implies that Indonesia and Japan currencies could be excluded from the system of exchange rate.

Table 3

The cointegration tests are re-estimated on the remaining series. Results of the cointegration tests are shown in Table 4. In both period, 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 result rejected the null hypothesis of cointegrating parameter equal to zero for all currencies (Table 5). These suggest that these few Asian currencies are bonded together by long-run relationships during the crisis and post-crisis periods but not in the pre-crisis period.

Table 4

Table 5

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 6 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 Indonesia and Korea equations, implying that the currency of these countries endogenously react to past deviations from the cointegrating relationship and adjusts to restore the long-run equilibrium. Short-run unidirectional causal relationship is detected running from Thai baht to Indonesia rupiah and Philippines peso. There is a bidirectional feedback relationship between Indonesia rupiah, Malaysia ringgit and Korea won. There is also unidirectional causal relationship running from Malaysia ringgit to Thai baht, and to Philippines peso. Philippines peso is the most endogenous variable where it is found to be Granger-caused by Malaysia ringgit and Thai baht. These relationships are summarized as Figure 1. Figure 1 showed that the countries most affected by 1997 currency crisis are interdependence. The results seem to suggest that the crisis that began

in Thailand spreads through 2 channels: the Philippines and Indonesia. Then through Indonesia it spreads to Malaysia and Korea.

Table 6

Figure 1

The results of the Granger-causality test based on vector error-correction model (VECM) for post-crisis period is presented in Table 7 and depicted as Figure 2. The hypothesis that coefficient of error-correction term (ECT) is equal to zero is easily rejected for the Thailand, Malaysia and Singapore equations, implying that the currency of these three 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. There is a bidirectional feedback relationship between Malaysia ringgit, Singapore dollar and Korea won. There is unidirectional causal relationship running from Singapore dollar to Philippines peso, Thai baht and China yuan. At the same time, there is a unidirectional causal relationship running from China yuan to Malaysia ringgit. It is found that Philippines peso is the most endogenous country. It Granger-caused by Thai baht, Singapore dollar and Korea won. The results seem to suggest that currency of the developed country (Singapore) tends to lead the currencies of those less developed countries.

Table 7

Figure 2

CONCLUSIONS

As the economies of the Asian countries expand and become more integrated following the establishment of ASEAN+3 cooperation, this study attempts to examine the financial linkages between the currencies of the ASEAN+3. In order to identify any differences in the pattern of financial integration following the 1997 Asia financial crisis, the analysis is separated into: pre-crisis, 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. Cointegration relationship was detected among five Asian currencies (Indonesia, Korea, Malaysia, Philippines and Thailand) during the crisis period while evidence of cointegration was found among six Asian currencies (China, Korea, Malaysia, Philippines, Singapore and Thailand) 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 addition, not all of the ASEAN+3 countries, but only Korea, Malaysia, Philippines, and Thailand are financial integrated during these two periods. This finding provided weak support upon formation of regional monetary and exchange rate arrangement.

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Table 1: DF/ADF Unit Root Tests

Country	Nominal exchange rate (against USD)			
	Level		First Difference	
	constant	constant with trend	constant	constant with trend
I. Pre-crisis (1988 Jan 4 – 1997 May 13)				
Indonesia (ID)	-0.56 (4)	-2.18 (4)	-31.51 (3) [a]	-31.50 (3) [a]
Malaysia (MY)	-1.38 (1)	-2.57 (1)	-46.48 (0) [a]	-46.49 (0) [a]
Philippines (PH)	-1.87 (1)	-1.49 (1)	-42.34 (0) [a]	-42.36 (0) [a]
Singapore (SG)	-0.68 (0)	-1.92 (0)	-50.57 (0) [a]	-50.56 (0) [a]
Thailand (TH)	-2.37 (1)	-2.39 (1)	-67.36 (0) [a]	-67.35 (0) [a]
China (CN)	-0.88 (0)	-2.30 (0)	-45.39 (0) [a]	-45.38 (0) [a]
Japan (JP)	-0.72 (0)	-1.56 (0)	-44.66 (0) [a]	-44.66 (0) [a]
Korea (KR)	2.05 (1)	-2.71 (1)	-48.98 (0) [a]	-49.46 (0) [a]
II. Crisis (1997 May 14 – 1998 Aug 31)				
Indonesia (ID)	-0.44 (3)	-1.06 (0)	-11.83 (2) [a]	-11.81 (2) [a]
Malaysia (MY)	-1.64 (0)	-1.46 (0)	-16.69 (0) [a]	-16.72 (0) [a]
Philippines (PH)	-1.74 (3)	-2.60 (1)	-11.80 (2) [a]	-11.83 (2) [a]
Singapore (SG)	-1.53 (0)	-2.40 (0)	-18.13 (0) [a]	-18.11 (0) [a]
Thailand (TH)	-2.23 (0)	-1.82 (1)	-18.39 (0) [a]	-18.46 (0) [a]
China (CN)	-2.25 (10)	-2.78 (10)	-13.87 (3) [a]	-13.85 (3) [a]
Japan (JP)	-0.09 (18)	-3.11 (18)	-16.77 (0) [a]	-16.74 (0) [a]
Korea (KR)	-1.19 (1)	-1.00 (1)	-14.69 (0) [a]	-14.69 (0) [a]
III. Post-crisis (1998 Sept 1 – 2007 May 16)				
Indonesia (ID)	-1.93 (22)	-2.86 (22)	-6.52 (21) [a]	-6.99 (21) [a]
Malaysia (MY)	0.11 (23)	-0.49 (23)	-3.32 (22) [b]	-3.49 (22) [b]
Philippines (PH)	-0.91 (0)	-0.14 (0)	-45.44 (0) [a]	-45.47 (0) [a]
Singapore (SG)	-1.24 (0)	-2.02 (0)	-33.47 (1) [a]	-33.47 (1) [a]
Thailand (TH)	-0.66 (0)	-0.94 (0)	-45.05 (0) [a]	-45.05 (0) [a]
China (CN)	3.59 (2)	1.71 (2)	-32.79 (0) [a]	-33.07 (1) [a]
Japan (JP)	-2.30 (41)	-2.37 (41)	-44.22 (0) [a]	-44.28 (0) [a]
Korea (KR)	-0.95 (0)	-1.66 (0)	-46.24 (0) [a]	-46.22 (0) [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 2: Johansen-Juselius Likelihood Cointegration Tests for ASEAN+3

Null Hypotheses	Eigen value	Trace	Critical Value (1%)	Critical Value (5%)	Max-Eigen	Critical Value (1%)	Critical Value (5%)
I. Pre-crisis (1988 Jan 4 – 1997 May 13)							
(r = 0)	0.067822	112.6048	156.00	168.36	55.06132[b]	51.42	57.69
(r ≤ 1)	0.032689	57.54348	124.24	133.57	26.05627	45.28	51.57
(r ≤ 2)	0.019339	31.48721	94.15	103.18	15.31007	39.37	45.10
(r ≤ 3)	0.010966	16.17715	68.52	76.07	8.644617	33.46	38.77
(r ≤ 4)	0.005035	7.532529	47.21	54.46	3.957322	27.07	32.24
(r ≤ 5)	0.002748	3.575207	29.68	35.65	2.157106	20.97	25.52
(r ≤ 6)	0.001660	1.418101	15.41	20.04	1.302525	14.07	18.63
(r ≤ 7)	0.000147	0.115576	3.76	6.65	0.115576	3.76	6.65
II. Crisis (1997 May 14 – 1998 Aug 31)							
(r = 0)	0.336076	174.7494[a]	156.00	168.36	63.07646[a]	51.42	57.69
(r ≤ 1)	0.184062	111.6729	124.24	133.57	31.32617	45.28	51.57
(r ≤ 2)	0.178300	80.34673	94.15	103.18	30.24252	39.37	45.10
(r ≤ 3)	0.138360	50.10421	68.52	76.07	22.93329	33.46	38.77
(r ≤ 4)	0.114934	27.17092	47.21	54.46	18.80240	27.07	32.24
(r ≤ 5)	0.040021	8.368521	29.68	35.65	6.289884	20.97	25.52
(r ≤ 6)	0.012744	2.078637	15.41	20.04	1.975264	14.07	18.63
(r ≤ 7)	0.000671	0.103373	3.76	6.65	0.103373	3.76	6.65
III. Post-crisis (1998 Sept 1 – 2007 May 16)							
(r = 0) [a]	0.216900	230.2222[a]	156.00	168.36	168.4566[a]	51.42	57.69
(r ≤ 1)	0.038270	61.76557	124.24	133.57	26.88591	45.28	51.57
(r ≤ 2)	0.019462	34.87966	94.15	103.18	13.54130	39.37	45.10
(r ≤ 3)	0.012779	21.33835	68.52	76.07	8.861799	33.46	38.77
(r ≤ 4)	0.011467	12.47656	47.21	54.46	7.946189	27.07	32.24
(r ≤ 5)	0.003211	4.530366	29.68	35.65	2.215813	20.97	25.52
(r ≤ 6)	0.002740	2.314553	15.41	20.04	1.890484	14.07	18.63
(r ≤ 7)	0.000615	0.424069	3.76	6.65	0.424069	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=8 for post crisis period.

Table 3: Exclusion Restriction Tests for ASEAN+3

Country	Likelihood Ratio (LR)	
	II. Crisis (1997 May 14 – 1998 Aug 31)	**III. Post-crisis (1998 Sept 1 – 2007 May 16)**
ID	21.253[a]	0.005
MY	12.239[a]	135.610[a]
PH	5.289[b]	4.460[b]
SG	2.080	3.837[c]
TH	3.110[c]	8.951[a]
CN	2.503	77.938[a]
JP	0.309	2.547
KR	6.990[a]	20.163 [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 4: Johansen-Juselius Likelihood Cointegration Tests for Remaining Asian Countries

Null Hypotheses	Eigen value	Trace	Critical Value (1%)	Critical Value (5%)	Max-Eigen	Critical Value (1%)	Critical Value (5%)
II. Crisis (1997 May 14 – 1998 Aug 31)							
Countries: PH, ID, KR, MY, TH							
(r = 0)	0.290681	83.75780[a]	68.52	76.07	54.60855[a]	33.46	38.77
(r ≤ 1)	0.096857	29.14926	47.21	54.46	16.19806	27.07	32.24
(r ≤ 2)	0.053662	12.95120	29.68	35.65	8.769755	20.97	25.52
(r ≤ 3)	0.017400	4.181444	15.41	20.04	2.790907	14.07	18.63
(r ≤ 4)	0.008707	1.390537	3.76	6.65	1.390537	3.76	6.65
III. Post-crisis (1998 Sept 1 – 2007 May 16)							
Countries: PH, CN, TH, MY, KR, SG							
(r = 0)	0.192514	250.6924[a]	94.15	103.18	220.2448[a]	39.37	45.10
(r ≤ 1)	0.013099	30.44767	68.52	76.07	13.58138	33.46	38.77
(r ≤ 2)	0.010738	16.86630	47.21	54.46	11.11994	27.07	32.24
(r ≤ 3)	0.004613	5.746355	29.68	35.65	4.762064	20.97	25.52
(r ≤ 4)	0.000893	0.984291	15.41	20.04	0.919934	14.07	18.63
(r ≤ 5)	6.25E-05	0.064358	3.76	6.65	0.064358	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=8 for post crisis period.

Table 5: 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	21.747[a]	
MY	24.740[a]	200.806[a]
PH	7.695[a]	5.493[b]
SG		2.770[c]
TH	3.097[c]	15.496[a]
CN		190.146[a]
JP		
KR	6.673[a]	46.609[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 6: Granger Causality Results based on VECM (Crisis)

Dependent Variable	Independent Variable χ^2-statistic					
	PH	ID	KR	MY	TH	ECT
PH	-	2.173	4.275	12.948[b]	14.334[a]	0.039
ID	0.923	-	21.112[a]	25.981[a]	12.220[b]	-0.137[a]
KR	1.286	16.580[a]	-	9.840[b]	4.801	-0.048[b]
MY	5.005	11.929[b]	26.515[a]	-	3.646	0.149
TH	0.135	3.757	8.875	12.364[b]	-	0.007

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.

Table 7: Granger Causality Results based on VECM (Post-crisis)

Dependent Variable	Independent Variable χ^2-statistic						
	PH	CN	TH	MY	KR	SG	ECT
PH	-	1.049	32.847[a]	8.848	22.306[a]	24.878[a]	-0.0002
CN	3.543	-	4.521	10.145	11.848	60.408[a]	0.00001
TH	4.640	9.226	-	15.636	3.692	20.096[a]	-0.001[a]
MY	12.721	16.454[b]	18.797[a]	-	21.100[a]	16.150[b]	-0.002[a]
KR	11.827	1.613	7.505	15.120[b]	-	47.120[a]	-0.0003
SG	8.143	9.457	9.611	50.558[a]	14.855[b]	-	-0.001[a]

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)

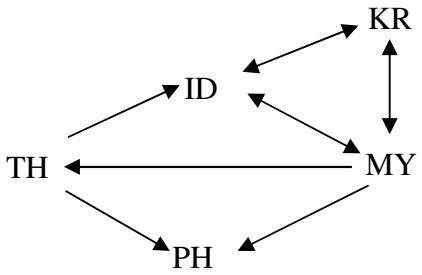

Figure 2: Short-run Causal Relationship (Post-crisis)