

An Empirical Study on Financial Crisis Contagion of Emerging Markets

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Abstract. The contagion effect has been the typical feature of financial crises in emerging markets. This article studies on the contagion effect of four representative financial crises in emerging markets empirically to find out their respective and common reasons and put forward some effective contagion-proof measures.

Keywords: financial crises; contagion effect; common causes

1. Introduction

The contagion effect has been a typical feature of financial crisis in emerging markets. The devaluation of the baht in 1997 spread rapidly in Southeast Asia; the Argentine crisis in 2001 also had a global effect in that both developed and developing countries had been affected more or less [1]. Further, the subprime mortgage crisis of the United States in 2007 opened a prelude to a global recession. Therefore, to find the potential causes of financial crisis contagion and put forward some effective contagion-proof measures, this paper empirically studies on the contagion effect of the Asian Crisis in 1997, Russia Crisis in 1998, Argentine Crisis in 2001 and Vietnam Crisis in 2008. According to the estimation results, we propose some policy recommendations for emerging markets.

2. Testing for existence of the contagion effect

2.1 Sample selection and data sources

We choose four typical financial crises of emerging markets to test for existence of the contagion effect. The four crises are Asian Crisis, Russia Crisis, Argentine Crisis and Vietnam Crisis. The daily foreign exchange data of relevant countries is used for estimation. The division of the sample interval is based on the hallmark event in the crisis. All data is collected from <http://pacific.commerce.ubc.ca/xr>, and statistical analysis is carried out by Eviews 5.0.

Table 1. The selected sample countries and period

Crisis Name	Periods		Foreign Exchange Rate
	Tranquil	Crisis	
Asian Crisis	1995.11.16-1997.6.30	1997.7.1-1998.6.30	Taiwan(TWD), Korea(KRW), Malaysia(MYR), Japan(JPY), Indonesia(IDR), Philippines (PHP), Hong Kong (HKD), Singapore(SGD), Thailand (THB)
Russia Crisis	1997.4.3-1998.8.16	1998.8.17-2000.12.31	Russia (RUB), Ukraine (UAH), Lithuania (LTL), Latvia (LVL), Estonia (EEK)
Argentine Crisis	2000.1.1-2001.12.18	2001.12.9-2003.12.31	Argentina (ARS), Uruguay (UYP), Brazil (BRL), Colombia (COP), Peru (PEN), Mexico (MXN)
Vietnam Crisis	2006.1.1-2008.5.16	2008.5.17-2010.12.31	Vietnam (VID), Thailand (THB), Indonesia (IDR), Philippines (PHP), Malaysia (MYR)

2.2 Methodology

Here we use Vector Autoregression (VAR) estimate to test the contagion effect. Then Granger causality test is used to confirm the existence of contagion effect by comparing results in crisis period with those in

tranquil period. If there is a causal relationship of both sub-periods, it is necessary to use impulse responses method to find whether the contagion effect exists or not.

To avoid pseudo-regression in Granger causality test, Dickey-Fuller's ADF-test is used for unit root test and then all data are treated by first-order differential processing.

2.3 The estimation results

2.3.1 Asian Crisis

Table 2 ADF UNIT ROOT TEST IN TRANQUIL PERIOD

	HKD	IDR	JPY	KRW	MYR	PHP	SGD	THB	TWD
L	-2.090	-0.570	-1.382	-0.333	-2.002	-0.543	-1.382	-1.526	-1.247
D (1)	-30.96*	-19.65*	-19.36*	-20.61*	-15.46*	-13.25*	-21.78*	-8.417*	-16.41*

Note: * denote that the null hypothesis is rejected at 1% significance level.

Table 3. ADF UNIT ROOT TEST IN CRISIS PERIOD

	HKD	IDR	JPY	KRW	MYR	PHP	SGD	THB	TWD
L	-5.64*	-1.737	-2.110	-1.852	2.455	-2.820	-2.345	-2.324	-2.313
D (1)	-22.54*	-17.43*	-16.65*	-5.987*	-16.53*	-14.49*	-20.48*	-17.78*	-15.57*

Note: * denote that the null hypothesis is rejected at 1% significance level..

Table 4. GRANGER CAUSAULTY TEST IN TRANQUIL PERIOD

	HKD	IDR	JPY	KRW	MYR	PHP	SGD	THB	TWD
HKD	—	0.20	1.46	0.88	3.12 *	2.51	2.33	0.84	0.33
IDR	0.88	—	1.24	1.09	0.74	0.72	0.36	0.33	0.87
JPY	4.07**	0.09	—	1.31	1.25	0.77	1.98	5.28**	0.47
KRW	6.11**	0.59	1.93	—	1.78	0.61	1.09	1.56	2.03
MYR	1.20	0.17	0.57	3.10*	—	1.36	1.19	0.33	1.27
PHP	0.29	0.59	0.99	0.31	1.28	—	2.70*	1.15	0.05
SGD	0.76	0.25	1.22	0.49	3.39*	1.23	—	0.40	0.36
THB	6.16**	0.24	1.03	0.05	1.31	0.35	1.35	—	0.08
TWD	1.18	0.90	2.41	0.26	0.45	1.05	0.76	0.03	—

Note:**(*)indicate that there is a causal relationship at 1% (5%) significance level.

Table 5. GRANGER CAUSAULTY TEST IN CRISIS PERIOD

	HKD	IDR	JPY	KRW	MYR	DPHP	DSGD	THB	TWD
HKD	—	2.13*	0.80	1.42	0.30	0.004	0.001	0.82	0.0001
IDR	7.15**	—	0.19	1.83*	1.38	1.33	4.45*	0.71	0.95
JPY	0.29	0.02	—	8.63**	0.00	0.03	3.01*	0.53	1.02
KRW	3.83*	3.57*	1.79*	—	0.31	11.9**	0.82	3.28*	6.12*
MYR	0.46	5.81*	0.29	1.06	—	5.12*	0.71	1.02	2.56*
PHP	1.70	7.81**	0.70	0.93	1.35	—	5.13*	3.48*	6.18*
SGD	0.02	0.19	4.29*	3.13*	3.53*	0.83	—	0.84	0.11
THB	0.56	0.54	1.45	0.47	0.23	3.85*	0.001	—	1.29
TWD	2.37*	0.45	0.02	4.13*	2.86*	0.07	6.93**	0.08	—

Note:**(*)indicate that there is a causal relationship at 1% (5%) significance level.

In tranquil period, there are eight pairs unidirectional causality while seven pairs unidirectional causality and thirteen pairs two-way causality exist in crisis period. So we can conclude contagion effect exists in those eighteen pairs.

For other three pairs in which there is causality both in tranquil and crisis period, it is necessary to use impulse responses method to find whether the contagion effect exists or not. The results are shown in figure 1-3.

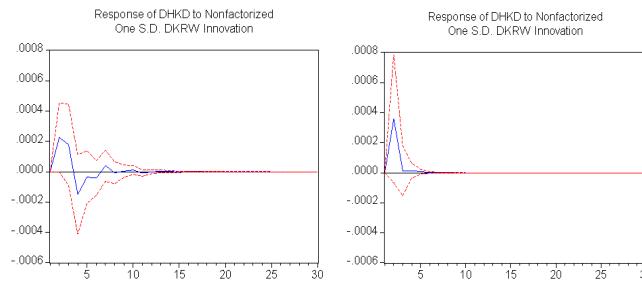


Figure 1. Response of HKD to Nonfactorized One S.D. KRW Innovation

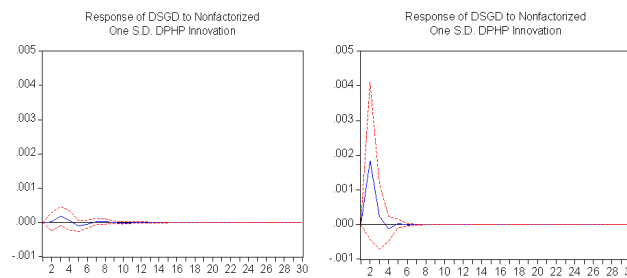


Figure 2. Response of SGD to Nonfactorized One S.D. PHP Innovation

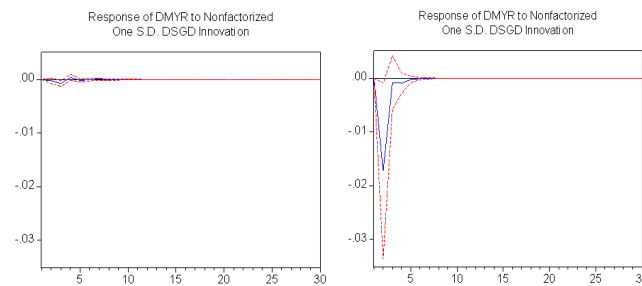


Figure 3. Response of MYR to Nonfactorized One S.D. SGD Innovation

By impulse response analysis, we can find the impulse response of HKD to KRW doesn't strengthen significantly from tranquil period to crisis period, which means there is no contagion effect between HKD and KRW. But the impulse response of the other two pairs increases obviously, contagion effect did exist. All in all, results support the existence of contagion in Asia Crisis

2.3.2 Russia Crisis

Table 6. ADF UNIT ROOT TEST IN TRANQUIL PERIOD

	EK	LTL	LVL	RUB	UAH
L	-2.117437	-5.675625*	-1.685413	1.336748	0.405329
D(1)	-17.20929*	-17.63721*	-17.75260*	-21.52816*	-17.70416*

Note: * denote that the null hypothesis is rejected at 1% significance level.

Table 7. ADF UNIT ROOT TEST IN CRISIS PERIOD

	EK	LTL	LVL	RUB	UAH
L	0.587311	-7.329575*	-2.296044	-5.095765*	-2.538140
D(1)	-23.35517*	-19.53599*	-23.68710*	-13.10532*	-25.51856*

Note: * denote that the null hypothesis is rejected at 1% significance level.

Table 8. GRANGER CAUSAULTY TEST IN TRANQUIL PERIOD

	EEK	LTL	LVL	RUB	UAH
EEK	—	0.11342	9.0033 ^{**}	1.51643	0.23241
LTL	0.64274	—	3.71914 [*]	1.45854	0.71575
LVL	0.23072	0.66313	—	0.26183	0.64668
RUB	0.40697	0.17063	0.45509	—	0.84950
UAH	0.33585	0.07887	0.94719	0.08315	—

Note: ^{**}(^{*}) indicate that there is a causal relationship at 1% (5%) significance level.

Table 9. GRANGER CAUSAULTY TEST IN CRISIS PERIOD

	EEK	LTL	LVL	RUB	UAH
EEK	—	0.00323	4.50066 [*]	0.13268	5.37683 [*]
LTL	0.90275	—	3.36284	1.52313	0.15697
LVL	0.02845	1.15961	—	1.56829	2.03390
RUB	4.79555 [*]	0.10971	0.12348	—	1.06892
UAH	1.44486	0.82118	0.01033	0.14501	—

Note: ^{**}(^{*}) indicate that there is a causal relationship at 1% (5%) significance level.

Also, we need to use impulse responses method for the pair (LVL, EEK) to verify their contagion effect. The results are shown in figure 4.

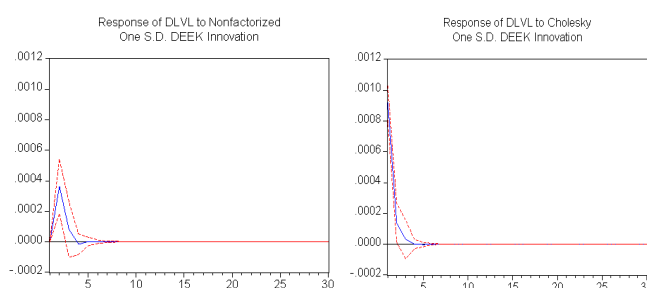


Figure 4. Response of LVL to Nonfactorized One S.D. EEK Innovation

Therefore the contagion effect also can be found in Russia Crisis, but comparing with that of Asian Crisis, it is less significant [3].

2.3.3 Argentine Crisis

Table 10. ADF UNIT ROOT TEST IN TRANQUIL PERIOD

	ARS	BRL	COP	MXN	PEN	PYG	UYR
L	-5.9624 [*]	-0.67723	-2.08675	-2.25845	-2.14768	-0.50359	0.09061
D(1)	-12.584 [*]	-21.563 [*]	-22.189 [*]	-20.667 [*]	-23.959 [*]	-23.212 [*]	-22.621 [*]

Note: ^{*} denote that the null hypothesis is rejected at 1% significance level.

Table 11. ADF UNIT ROOT TEST IN CRISIS PERIOD

	ARS	BRL	COP	MXN	PEN	PYG	UYR
L	-3.9795 [*]	-1.68027	-1.44957	-1.06525	-1.71732	1.48305	-1.71773
D(1)	-17.650 [*]	-20.251 [*]	-22.327 [*]	-22.460 [*]	-17.941 [*]	-26.431 [*]	-15.266 [*]

Note: ^{*} denote that the null hypothesis is rejected at 1% significance level.

Table 12. GRANGER CAUSAULTY TEST IN TRANQUIL PERIOD

	ARS	BRL	COP	MXN	PEN	PYG	UYR
ARS	—	0.6027	0.1563	3.129 [*]	0.98884	2.50201	0.00012
BRL	0.2701	—	1.0530	1.3229	0.66256	1.54828	3.686 [*]
COP	1.0633	0.0204	—	1.5821	1.19938	0.75516	0.05416

MXN	0.5774	0.5034	2.4879	—	0.15681	0.05701	0.24702
PEN	0.2527	0.6490	0.8835	3.052 [*]	—	1.50235	0.01792
PYG	1.3583	0.5073	0.5185	0.8756	1.36692	—	0.46889
UYP	1.2382	0.6215	0.3013	0.2470	0.07853	0.2314	—

Note: **(*) indicate that there is a causal relationship at 1% (5%) significance level.

Table 13. GRANGER CAUSAULTY TEST IN CRISIS PERIOD

	ARS	BRL	COP	MXN	PEN	PYG	UYP
ARS	—	0.19378	1.00814	0.65189	0.20553	0.08411	0.1156
BRL	1.085	—	5.91 ^{**}	1.877	5.13 ^{**}	1.614	3.361 [*]
COP	0.18193	0.94794	—	0.46597	0.17828	0.07441	2.918 [*]
MXN	0.50912	0.35815	0.76044	—	0.70985	1.69772	0.4873
PEN	1.50671	0.39417	2.844 [*]	2.3529	—	2.11781	1.5331
PYG	0.05544	4.75 ^{**}	0.88656	0.82238	0.9476	—	0.1687
UYP	0.07345	2.07535	0.54943	0.26861	3.89 ^{**}	0.09883	—

Note: **(*) indicate that there is a causal relationship at 1% (5%) significance level.

And then, we need to use impulse responses method for the pair (UYP, BRL) to verify their contagion effect. The results are shown in figure5.

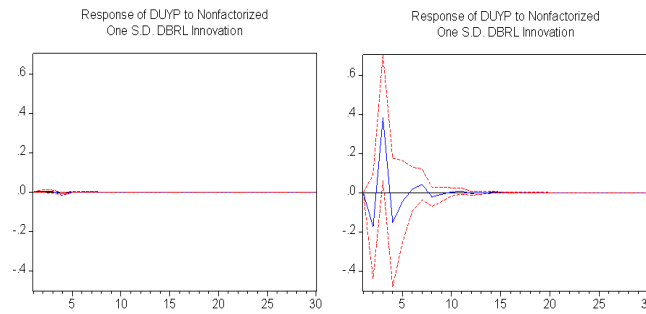


Figure 5. Response of UYP to Nonfactorized One S.D. BRL Innovation

From the estimation results, we can reach a conclusion that the contagion effect exists in Argentine Crisis, too. Meanwhile, the degree of transmission in Argentine Crisis, as the same with Russia crisis, is lower than that in Asian Crisis.

2.3.4 Vietnam Crisis

Table 14. ADF UNIT ROOT TEST IN TRANQUIL PERIOD

	INR	MYR	PHP	THB	VND
L	0.992825	-0.632637	-1.671117	0.838903	0.646768
D(1)	-26.49499 [*]	-26.39026 [*]	-26.86845 [*]	-24.63080 [*]	-19.12793 [*]

Note: * denote that the null hypothesis is rejected at 1% significance level.

Table 15. ADF UNIT ROOT TEST IN CRISIS PERIOD

	INR	MYR	PHP	THB	VND
L	-4.050015 [*]	-1.133783	-1.104191	-1.977658	-3.037520 [*]
D(1)	-31.08136 [*]	-24.02087 [*]	-25.27153 [*]	-26.35638 [*]	-15.28415 [*]

Note: * denote that the null hypothesis is rejected at 1% significance level.

Table 16. GRANGER CAUSAULTY TEST IN TRANQUIL PERIOD

	INR	MYR	PHP	THB	VND
INR	—	2.18430	1.34115	1.92786	3.17011
MYR	0.50823	—	5.17951	6.33123	6.56381
PHP	1.07653	7.30531	—	7.13769	7.34228

THB	0.33749	0.73340	1.40821	—	7.41459
VND	0.35819	1.10889	2.13421	1.83171	—

Table 17. GRANGER CAUSAULTY TEST IN CRISIS PERIOD

	INR	MYR	PHP	THB	VND
INR	—	6.19547	46.3489	6.18325	4.76993
MYR	0.95346	—	57.1843	7.47854	0.68218
PHP	2.37867	2.48419	—	5.44314	1.31167
THB	0.49110	0.32277	1.67846	—	0.52997
VND	0.21380	2.78235	1.77179	4.43333	—

It is worth noting that there is no significant causal relationship in the Vietnam crisis, that is, no contagion effect can be found in this crisis, at least no apparent one in it. It is because comparing with Thailand, Russia or Argentina, Vietnam has some different features [2]: firstly, Vietnamese Dong is not freely convertible under capital account; secondly, its foreign exchange reserves have already exceeded the 3-month warning line; thirdly, the ratio of external debt to GDP of Vietnam is about 30%, far below the warning line of 100%; last but not least, its trade partners all have trade surplus except for Philippines. Those features made the Vietnam crisis less infectious, and that is why its regression results behave a little poor.

3. Testing for causes of the contagion effect

3.1 Sample selection and data sources

Taking into account the representativeness of the sample and the interaction between the crises, we select the annual macroeconomic data of relevant countries. Compared with using cross-sectional data or time series data, panel data can increase the degree of freedom and reduce collinearity between the explanatory variables, which improves the efficiency of estimation. The whole data is stemmed from the International Financial Statistics (IFS) and the CEIC Database. The data analysis is carried out by Eviews 5.0. Considering Vietnam Crisis shows little contagion effect, we test only the other three crises to find their potential causes.

Table 18. THE SELECTED SAMPLE COUNTRIES AND PERIOD

Crisis name	Periods	Country
Asian Crisis	1990-1998	Indonesia (IND), Korea (KOR), Malaysia (MAL), Philippines (PHP), Thailand (THA)
Russia Crisis	1994-2000	Russia(RUB), Ukraine(UAH), Lithuania(LTL), Latvia(LVL), Estonia(EEK)
Argentine Crisis	1996-2003	Argentina (ARG), Uruguay (UYU), Brazil (BRA), Colombia (COL), Peru (PER), Mexico (MEX)

3.2 Methodology

The single-equation econometric model is used here to analyze what kinds of reasons can affect the contagion effect of financial crisis. Its basic panel model is as follows:

$$\Psi_{i\tau} = \alpha_{i\tau} + \beta_{i\tau} \xi_{i\tau} + \varepsilon_{i\tau}, \quad i=1,2,\dots,N; \quad \tau=1,2,\dots,T \quad (1)$$

Where $\Psi_{i\tau}$ represents the contagion effect of financial crisis, $\xi_{i\tau}$ represents the potential reasons, $\alpha_{i\tau}$ represents the constant, $\beta_{i\tau}$ represents coefficient vector, and $\varepsilon_{i\tau}$ represents residuals.

For estimation, GLS method is used to correct heteroscedasticity and short-term autocorrelation.

3.3 The selection of explanatory variables

Under normal circumstance, the country infected by crisis often shows sharp depreciation of the currency and decrease of foreign exchange reserves and increase of interest rates and so on. So we use EMP (Exchange market pressure index) which was proposed in 1997 by Eichengreen and Rose and Wyplosz to represent contagion effect [4]. EMP is a weighted average of the change in exchange rates, interest rates and in foreign exchange reserves.

3.4 The selection of explained variables

Here we choose explained variables as follows: the growth rate of GDP (GDP), the inflation rate (CPI), the capital account balance (CAP), the ratio of external debt to GDP (FB), the ratio of current account balance to GDP (CA), domestic deficit or surplus (DEF), the ratio of M2 to foreign exchange reserves (LIB), the domestic credit (DC), the trade account balance (TRA) and American interest (USA).

3.5 The estimation results

Table 19. THE ESTIMATION OF ASIAN CRISIS

Variable	CAP	CA	DC	FB	LIB	TRA
Value	2.52E-05	-0.239	5.01E-06	0.007	-0.105	0.0001
t	2.4094	-3.518	5.235	5.922	-5.057	7.128

Table 20. THE ESTIMATION OF RUSSIA CRISIS

Variable	C	CAP	DEF	FB	LIB	TRA
Value	1.485	-0.004	6.6E-06	1.2E-06	0.02	-8.4E-05
t	11.28	-5.139	2.2485	2.4000	2.31	-3.924

Table 21. THE ESTIMATION OF ARGENTINE CRISIS

Variable	C	CAP	DEF	FB	LIB	TRA
Value	3.32	4.7E-05	3.3E-05	-0.057	0.008	8.5E-05
t	4.59	3.706	4.955	-4.376	3.105	7.777

From above results, significant estimations can be found in all crises. As for Asian crisis, the capital account balance, the ratio of external debt to GDP, the ratio of current account balance to GDP, the ratio of M2 to foreign exchange reserves, the domestic credit and the trade account balance can explain its contagion effect.

On the other hand, the capital account balance, the ratio of external debt to GDP, domestic deficit or surplus, the ratio of M2 to foreign exchange reserves and the trade account balance contribute the contagion effect in Russia crisis.

As for Argentine Crisis, the capital account balance, the ratio of external debt to GDP, domestic deficit or surplus, the ratio of M2 to foreign exchange reserves and the trade account balance account for the contagion effect.

3.6 Analysis

According to the results, we can find some common potential reasons for all the three crises. We will analyze each one as follows:

- The capital account balance (CAP): The common signs of three crises are the sudden reversal of international capital, so CAP is one of the incentives of financial contagion. Large number of international capital flows makes emerging markets vulnerable to the external attack and weaken their macroeconomic fundamentals. An important reason for China and India who survived the crisis in Southeast Asia is that they still practice capital controls, thus reducing the possibility of suffering a speculative attack. It also can explain little contagion in Vietnam Crisis.
- The ratio of external debt to GDP (FB): Huge external debt burden is the most obvious cause of the three crises. All the crisis countries have a rapid or sustained formation of large amounts of external debt before the crisis t. And these capital inflows are always contains a high proportion of short-term debt[5]. Those capital inflows in the form of portfolio investment do not form debt, but because they are mostly operated by the agency portfolio, and these organizations often actively change the investment portfolio, rather than the long position to hold securities. Main reasons for the rapid expansion of external debt in emerging markets are: the failure of macro-policy, external forces beyond the control of domestic authorities, structural weakness of domestic financial intermediation, the key property sector overcapacity, the negative effect of exchange rate peg or purely political unrest, all of which can play important roles and mutually reinforcing.

- The ratio of M2 to foreign exchange reserves (LIB): Financial liberalization is also a trigger[6]. Financial liberalization has deepened economic ties between countries, smoothing the transmission channels among countries with close geographical and similar economic conditions, thus increasing the transmission range, accelerating the rate of spread and deepening the degree of hazard. A country's financial turmoil quickly spread to neighboring countries, which is the so-called "butterfly effect". And, as a core of financial liberalization, capital account liberalization attracts a large number of international hot money for emerging markets, exacerbating their vulnerability. Therefore, inappropriate financial liberalization has further aggravated the possibility of contagion effect.
- The trade account balance (TRA): Most emerging market countries have an export-oriented strategy. With the development of economic integration, the trade ties between countries are more complex[7]. In this case, once a country breaks financial crisis, it is bound to affect their trade partners through wealth effect and income effect. The currency devaluation of crisis country can weaken the competitiveness of export products of other countries and reducing its import from other countries, causing contagion.

4. Conclusions

In this paper, we focus four representative financial crises in emerging markets to test the existence of contagion effect in crises empirically and then try to find out their common reasons by a single-equation econometric model.

Through our analyses, we find that in all crises there is significant contagion effect except for Vietnam Crisis. The reasons are as follows: Vietnamese Dong is not freely convertible under capital account; its foreign exchange reserves exceed the 3-month warning line; the ratio of external debt to GDP of Vietnam is about 30%, far below the warning line of 100%; and its trade partners almost have trade surplus.

As for the common potential causes of contagion effect of the three crises, there are four factors. First is the capital account balance, second is the ratio of external debt to GDP, and then is the ratio of M2 to foreign exchange reserves, last is trade account balance. All of them are consistent with the results of existing researches, which supports the selected explanatory variables and the model in this paper.

All in all, for emerging markets, it is imperative to enhance their own economic qualities, carefully open capital account, gradually liberalize financial market and strengthen international cooperation in order to avoid financial crisis and its contagion effect.

5. References

- [1] T. Disier, P. Mauro, S. Schmukler. "Vanishing Contagion?" IMF Policy Discussion Paper, Jan. 2006, pp. 4-6,
- [2] Ma Jianping, Empirical Analysis on the Causes of the Inflation in Vietnam, Journal of Yunnan Finance & Economics University, Feb. 2009, pp.154-158.
- [3] Kaminsky, Reinhart, Vegh, "The Unholy Trinity of Financial Contagion", Journal of Economic Perspectives, 17th. 2003, pp. 51-74.
- [4] Eichengreen, A.Rose, C. Wyplosz, "Contagious Currency Crises". NBER Working Paper No.5681, Jul. 1996, pp 21-22
- [5] P. Krugman, "A Model of Balance-of-Payment Crises", Journal of Money, Credit and Banking, Nov. 1979, pp. 311-325.
- [6] Demirgüç-Kunt, Detragiache, "Financial Liberalization and Financial Fragility". IMF Working Paper 98/83, May. 1998, pp. 7-10.
- [7] S. Chakravorti, S. Lall, "Managerial Incentives and Financial Contagion", IMF Working Paper 03/21, May. 2004, pp.1-5.