Chapter

Momentum Periods of Feedback Trading toward Exchange Rate Volatility in ASEAN Countries

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Abstract

In this paper, the authors apply empirical evidence to demonstrate how important positive feedback trading factors are in understanding exchange rate behavior. Utilizing the GARCH augmented feedback model, or the exchange rate model set out by Laopodis, the author analyzes autocorrelation in exchange rate parameters and volatility in key ASEAN markets to yield deeper understanding of inducted exchange rates induced by the actions of positive feedback traders. The authors contend that positive feedback traders affect exchange rate volatility in ASEAN countries and induce the autocorrelation of negative returns within high exchange rate volatility. This study found that Singapore demonstrated a significant positive feedback trading during the period 1995–2014, while the authors further contend that Thailand, Indonesia, Malaysia, the Philippines, Brunei Darussalam, and Singapore also demonstrated positive feedback trading during the 1997–1998 Asian financial crisis. In addition to analyzing the positive feedback trading on exchange rate volatility, we also identify the exchange rate volatility spillover across the ASEAN countries. Related to this context, we found that Indonesia and Thailand play a dominant role as a dominant exchange rate volatility transmitter in the ASEAN region.

Keywords: feedback trading, volatility, momentum periods, high volatility, positive feedback trading

1. Introduction

In this paper, we provide empirical evidence that confirms how important positive feedback trading is as a factor in exchange rate behavior in key ASEAN markets. Utilizing Laopodis' [1] exchange rate model, we analyze autocorrelation of exchange rates and volatility for deeper understanding of inducted exchange rates caused by the positive feedback trading behavior of foreign exchange traders. Our thesis is that

positive feedback traders affect exchange rate volatility in ASEAN countries and induce autocorrelation of negative returns within high exchange rate volatility.

Related to this concern, Keynes [2] asserted that while investor sentiment and market psychology play important roles in financial markets, it is also almost impossible for individual economic agents to impound all market information so as to make consistently rational investment decisions, as the following renowned quote elaborates: "Investment based on genuine long-term expectation is so difficult as to be scarcely practicable. He who attempts it must surely lead much more laborious days and run greater risks than he who tries to guess better than the crowd how the crowd will behave; and, given equal intelligence, he may make more disastrous mistakes" ([2] quoted by [3]). According to Keynes, it's hard to measure objective value from market fundamentals, and even were it possible, it will cost more to gather all relevant information in order to make such an assessment.

Indeed, exchange rate markets do not reflect fundamental value for most of the time [4]. Messe and Rogoff [5] provide the most distinguished empirical support of this perspective, one of a number of different exchange rate modeling approaches that emerged following the breakdown of the Bretton Woods exchange rate environment that prevailed up until the 1970s. Sub-sequent studies introduced non-linear features in exchange rate dynamics, such as initiated by Frankel and Froot [6] and further developed in the context of stock prices [4, 7–9] and Laopodis [1]. This paper is based on this approach.

Some country's exchange rates can be affected by monetary policy and market forces, the latter reflecting the actions of traders. In this study, we will focus on analyzing the traders' influence toward exchange rate through volatility that is formed by their trading pattern. One indication of traders' force in determining exchange rates is through estimation of feedback trading.

1.1 Research contributions

It is the authors' contention that feedback trading in key ASEAN countries' exchange rate markets causes increasing exchange rate volatility and causes such currencies to deviate from fundamental value, such as happened in the 1997–1998 Asian financial crisis. Hence, we make research of sub periods analysis due to change in exchange rate policy and the effect toward exchange rate volatility.

The exchange rate feedback trading research scope of this paper covers key ASEAN countries including Thailand, Indonesia, Malaysia, the Philippines, Brunei Darussalam, and Singapore. Precedent research examined pre and post crisis without analyzing sub-periods for exchange rate policy and its effect on exchange rate volatility.

The researcher motivation used the Laopodis model [1] is to identified the positive feedback trading effect on exchange rate volatilities in ASEAN countries more detailed with sub period analysis whereas the positive feedback trading was rarely discussed in precedent research about ASEAN countries' exchange rate volatility.

The paper's research focus is on sub-periods crisis during the 1997–1998 period because several subject countries of this study changed their exchange rate system during this time in attempts to mitigate the monetary and real economy impacts of the 1997–1998 Asian Financial Crisis. Such sub-period study of the exchange rate volatility experienced by the indicated ASEAN countries is also examined in 2007–2008 Global Financial Crisis period and thereafter.

2. Literature review

2.1 The trader

As with other prices, buyer and seller interactions, such as between economic agents like a household, a firm, and any other international trading currency company determine the exchange rate of two floating currencies, ceteris paribus. A market where international currency is traded is called foreign exchange market [10].

Traders are all economic agents who make sales or purchase transactions. Meanwhile, the main actors in exchange rate market are a commercial bank, an international trading firm, non-bank financial institutions such as management asset and insurance institutions, and central bank [10].

This paper refers to the studies on trader behavior conducted by Laopodis [1], De Long et al. [11], Sentana and Wadhwani [12]. From feedback trading behavior patterns, they divide the traders into two distinct groups:

- Positive feedback traders; that is, those traders who buy when prices are high and sell when prices are low ([1]; Sentana and Wadhwani [12]).

- Negative feedback trader; those traders who sell when prices are high and buy when prices are low ([1]; Sentana and Wadhwani [12]).

In Section 2.2 there is explanation regarding trader's influence on exchange rate volatility or, in other words, feedback trading as set out in Laopodis' exchange rate model [1].

2.2 Exchange rate model

Feedback Trading in Exchange Rate Market—Laopodis Theoritical Model [1]. Despite the existence of economic agents assumed to behave in a rational manner that maximizes the fundamental of smart money, other investors (noise-trader) use random price or trend trading. Both investors' interactions create instability in asset prices that push those asset prices away from their fundamental value.

2.2.1 Rational traders

The first group of traders (smart money) are trying to maximize their portfolio's (N) function exclusively in return and risk factor [12]. As result, this kind of investors will hold an optimal share fraction ($F_{1,\,t}$) from the market portfolio as below:

$$F_{1,t} = \left[(E_{t-1}(R_t) - \alpha)/k\sigma_t{}^2\right] \tag{1}$$

Where R_t is ex post return in t time, E_{t-1} is expectation operator in $t-1$ time, α is return level at risk free asset, $\sigma_t{}^2$ is the conditional variance at t time and k is the coefficient representing risk aversion level from the investor. With assumption k is positive, $k\sigma_t{}^2$ is premium risk that needed in t time. Equation (1) is a mean–variance model from every asset requests which implies the risk asset demand increases with excess return as expected $(R_t - \alpha)$ and reversing with $\sigma_t{}^2$ risk level.

2.2.2 Noise traders

The second type of investor, the noise traders are assumed to follow a feedback strategy where they tend to buy while prices are increasing and tend to sell when prices are falling. Thus, their functional demand where $F_{2,t}$ is share proportion owned by this group and p assumed positive. This strategy indicates noisy information trading, which is irrelevant in regards to the fundamental economy. Also, this will pull the asset price out like exchange rate from their essential value. Therefore, negative serial return correlation is seen as price increases followed by high demand that affects higher prices in the future. If $p < 0$, negative feedback trading is seen as a trader who buys in low price and sells in high price. Market equilibrium requests all demand should be hold by these two types of investor:

$$F_{1,t} + F_{2,t} = 1 \tag{2}$$

With the equality of (1) and (2), we can substitute the following

$$R_t = a + k\sigma_t^2 - k\sigma_t^2 \rho R_{t-1} \tag{3}$$

And we can assume the rational expectation until the Eq. (3) becomes stochastic as follows

$$R_t = a + k\sigma_t^2 - k\sigma_t^2 \rho R_{t-1} + \varepsilon_t \tag{4}$$

It indicates dependency in noise trader type, positive feedback trader will deliver negative serial correlation in return. It's common when the volatility level is higher, the negativity autocorrelation will increase. This point simply illustrates with Eq. (5)

$$R_t = a + k\sigma_t^2 + (\phi_0 + \phi_1 \sigma_t^2) R_{t-1} + \varepsilon_t \tag{5}$$

Where the direct influence of noise trader (in constant level risk) comes from positive sign in $\varnothing_0$.

Therefore, to calculate the effect of intense trading during exchange rate appreciation, it needs the augmentation of Eq. (5) as follows:

$$R_t = a + k\sigma_t^2 + (\phi_0 + \phi_1 \sigma_t^2) R_{t-1} + \phi_2 |R_{t-1}| + \varepsilon_t \tag{6}$$

We conclude a simple Eq. (6) into:

$$R_t = a + k\sigma_t^2 + \phi_0 R_{t-1} + \phi_1 \sigma_t^2 R_{t-1} + \phi_2 |R_{t-1}| + \varepsilon_t \tag{7}$$

A positive feedback reflects in $\varnothing_1$ negative sign. The last part indicates the possibility of asymmetric trading behavior, where negative return is followed by higher feedback trading volume, if $\varnothing_2 > 0$. Positive and significant sign in asymmetric coefficient $\varnothing_2$ refers to the higher intention of positive feedback trading during appreciation rather than during depreciation. As cited in the Laopodis' previous research [1], this paper will utilize the Generalized Error Distribution [13] as an assumption of error distribution, with the GED's parameter $r > 0$. GED is a normal distribution if $r = 2$ and a leptokurtic if $r < 2$. If $r = 1$, the distribution is double exponential [13].

Related to the concern of this study, Laopodis' research [1] indicated that there are $\varnothing_0$ negative autoregressive and significant parameter in Franc, Singaporean Dollar, Peseta, Greek Drachma, Rupee, and Ringgit for all periods. It means that there is contrarian effect on those currencies. A $\varnothing_0$ positive autoregressive and significant parameter in Pound, Canadian Dollar, Mark, and Won indicated a bandwagon effect on those currencies.

An autoregressive $\varnothing_1$ parameter—that shows positive feedback trading and has similarity with herding (an agent who buy after prices increase)—will produce negative autocorrelation ($\varnothing_1$ negative parameter value). On the contrary, negative feedback trading that has similarity with profit taking or a trader who sell after the price has increased, will result in positive autocorrelation ($\varnothing_1$ positive parameter value). A $\varnothing_1$ positive and significant parameter value shows in British Pound, denotes negative feedback trading exists in the British Pound. A $\varnothing_1$ negative and significant parameter value can be found in Canadian Dollar, Lira, Mark, Peseta, Rupee, Ringgit, Mexican Peso, Singapore Dollar (SGD), Won and Baht. It indicates positive feedback trading on those currencies.

Asymmetric feedback trading signed by $\varnothing_2$ positive and significant parameter value. This leads into positive feedback trading that has intensively increased during appreciation rather than depreciation. It shows in Franc, Mark, Lira, Peseta, Mexican Peso, Rupee, and Won. A disparity value for an autocorrelation within pre- and post-crisis scenarios indicates a fluctuation in currency autocorrelation return. An autocorrelation will have positive value during quiet periods and will have negative value during volatile periods ([1]; Sentana and Wadhwani [12]).

By nature, traders' asymmetric behavior indicates that they depend on central banks to gain short term profit. This action can trigger instability in foreign exchange market either by smart money or noise trader. Besides, this asymmetric action can lead into less credible account and shows that traders depend on central bank's reserve to gain short term profit. At the end, ϕ_0 positive and significant autoregressive parameter can be termed as the bandwagon effect, which occurs when past currency movement followed by expected currency movement are on the same route.

3. Method, data and analysis

3.1 Data description

This research used daily basis data of ASEAN currency exchange rate start from 1995 to 2014. We used daily basis data in accordance to Laopodis [1]. To be informed, all exchange rates data toward US Dollar of the countries analyzed in this study were obtained from Thomson Reuters Datastream.

3.2 Model specification

3.2.1 Conditional variance

The conditional variance of the returns (σ_t^2) of various asset prices such as the exchange rate is found to be plagued by conditional heteroscedasticity as thus it can be modeled as a GARCH (1,1) process as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1\left(e_{t-1}^2\right) + \beta_1\left(\sigma_{t-1}^2\right)$$

And the half-life (HL) of a shock must be computed, which is defined as HL = ln (0.5)/ln(α1 + β1).

3.2.2 Estimation by Laopodis model

We adapt the econometric model proposed by Laopodis [1] which is called GARCH augmented feedback model. We apply maximum likelihood estimation [14] (BHHH algorithm) to estimate this model, with equation as follows:

$$R_t = a + k\sigma_t^2 + \phi_0 R_{t-1} + \phi_1 \sigma_t^2 R_{t-1} + \phi_2 |R_{t-1}| + \varepsilon_t \quad (8)$$

Where,
R_t: return in t time
a: constantan
k: coefficient investor's degree of risk aversion
σ_t^2: conditional variants return
ϕ_0: parameter that represents autoregressive process in return, if negative indicates contrarian effect (previous deviation from mean value that affects currency value moves in reverse). Whereas positive indicates bandwagon effect (previous currency observation is expected to move forward)
ϕ_1: autocorrelation feedback trading parameter: if negative, it presents a positive feedback trader; if positive, it presents negative feedback trader.
R_{t-1}: return in $t - 1$
ϕ_2: asymmmetric trading behavior parameter: if positive, it dentoes a negative return (exchange rate value appreciation). It's followed by a higher volume of feedback trading. In other words, positive feedback trading is more intese during apreciation rather than during depreciation.
$|R_{t-1}|$: absolute value from $t - 1$ return
ε_t: error term

4. Results

After examining the periods 1995–2014, the ASEAN countries do not exhibit significant positive feedback trading. Only Singapore that shows significant positive feedback trading (at α = 5%). The $\varnothing_1$ parameter value, in reaching thousands of units, indicates that the GARCH value in SGDs is very small, meaning that even if Singapore's Dollar has positive feedback trading, the Singapore currency is stable, fluctuating only in a small range. **Table 1** shows estimate result during 1995–2014 using maximum likelihood estimation GARCH augmented feedback model.

As can be shown from the **Table 1**, the autoregressive parameter is significant in the Philippines and Vietnam. The Philippines has negative autoregressive parameter yet significant (at α = 5%). This indicates a presence of contrarian effect in the Philippine currency during 1995–2014. This means previous currency movements resulted in the present currency moving in reverse. Vietnam has negative autoregressive parameter and significant (at α = 1%). This also shows a presence of contrarian effect in Vietnam's currency during 1995–2014. Vietnam has a significant

No	Countries	Periods	k	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	r	HL
1	Indonesia	1/1/1995–31/12/2014	0.108179	−0.000352	−1.798838	−0.0031	0.00000023**	0.401017** r	0.731644**	0.761625**	5.564
	prob		0.6925	0.9734	0.3125	0.8254	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
2	Malaysia	1/1/1995–31/12/2014	0.613392	0.007723	−19.95998	−0.007387	0.00000000025*	0.493388**	0.738432**	0.711784**	3.3246
	prob		0.4435	0.4157	0.3814	0.4939	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
3	Thailand	1/1/1995–31/12/2014	−0.022884	0.000157	−47.73276	−0.000444	0.0000000548**	0.148054**	0.871393**	1.026591**	35.988
	Prob		0.9882	0.99	0.2131	0.9794	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
4	Philippines	1/1/1995–31/12/2014	0.560224	−0.023936*	−77.48001	−0.01876	0.00000000342*	0.124357**	0.893084**	1.0414**	40.088
	Prob		0.7767	**0.0485**	0.3074	0.2451	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
5	Singapore	1/1/1995–31/12/2014	2.635466	−0.015648	−1316.924*	−0.010148	0.0000000579**	0.066105**	0.931445**	1.281344**	282.57
	Prob		0.607	0.3334	**0.0229**	0.6313	**0.0002**	**0.0000**	**0.0000**	**0.0000**	
6	Brunei D.	1/1/1995–31/12/2014	−0.037597	0.000082	−0.772018	−0.000284	0.000000156**	0.092572**	0.909251**	0.772919**	380.57
	Prob		0.9701	0.9932	0.9207	0.9853	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
7	Cambodia	1/1/1995–31/12/2014	0.04838	0.000562	−0.606319	−0.001498	0.0000000158**	0.707803**	0.530158**	0.546711**	3.2471
	Prob		0.8506	0.6866	0.5891	0.8977	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
8	Vietnam	1/1/1995–31/12/2014	−1.152384	−0.088325**	−12.24466	0.087888**	0.0000000183**	0.167304**	0.705865**	1.009344**	5.111
	Prob		0.8414	**0 0.0000**	0.9527	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	
9	Myanmar	1/1/1995–31/12/2014	No arch effect								
	Prob										
10	Laos	01/01/1995–31/12/2014	No arch effect								
	Prob										

**sig at 0.1; **sig at 0.01.*

Table 1.
The estimation results.

asymmetric trading behavior too ($\varnothing_2$ positive and significant parameter). This indicates positive feedback trading in Vietnam's currency is more intense during appreciation rather than depreciation. Other ASEAN countries, during the period 1995–2014, are not indicated having any bandwagon effect or contrarian effect. Additionally, in the periods of 1995–2014, the other ASEAN countries are not indicated to have any asymmetric trading behavior. The "HL" value shows how many days of volatility persist in each currency.

4.1 Sub-periods exchange rate policy analysis

We made the sub-periods analysis arbitrary based on the date of authority change exchange rate policy, the period of US Financial crisis 2007–2008, and the period post US Financial crisis (2010–2014) which was begin with QE phase 2 period until 2014.

a. Indonesia

In the **Table 2**, we see Indonesia's currency displays no ARCH in 1995–1996 (before the Asian financial crisis). This shows Indonesia's currency was stable at that time. During early 1997 until before 14 August 1997, the Rupiah had begun to show an ARCH effect but no $\varnothing$ significant parameter. This is consistent with the fact that the Rupiah was, at this time, still managed under a floating rate within a crawling band policy.

On 14 August 1997, the Rupiah 's band intervention was released into a market mechanism called free floating policy that has been applied until now. During this period, the research resulted $\varnothing_0$ positive and significant parameter. This shows the presence of a bandwagon effect that is previous currency movement affected currency's expectation to move in the same way. Positive feedback trading appeared during this period by a presence of $\varnothing_1$ negative and significant parameter. Many factors impacted the Rupiah exchange rate's attenuation during this period. Trust and panic crisis led the society to buy US$ to stabilize their wealth, even to gain profit from that. A snowball effect undeniable, US$ became treasure. Many Indonesian wealthy had been prepared since previous years saving their assets abroad to anticipate domestic political instability. In other hand, private foreign debt either short-term or medium-term placed huge pressure on the Rupiah until the domestic foreign exchange reserves were left insufficient to repay the debt and the interest in the day of maturity [15]. Private foreign debt was accumulated since early 1990s and had reached an enormous amount even surpassing official government debt that had been decreasing in recent years. Mostly these private foreign loans were not hedged [15].

Indonesia's GDP growth in 1997 was 4.69% and in 1998 it plunged to −13.12%. The crisis impacted Indonesia's GDP growth drastically. While Indonesia's annual inflation rate (calculated from consumer prices) leapt higher from 6.22% in 1997 to 58.38% in 1998. From 14 August 1997 until 2014, volatility appeared in the Rupiah exchange rate, but showed no significant $\varnothing$ parameter that indicates the volatility affected by positive feedback trading, asymmetric trading, bandwagon nor contrarian effect.

Looking further at **Table 2**, in the period 2007–2008, the Rupiah did not exhibit ARCH effect. This was indicated that the Rupiah did not volatize during this period. The 2007–2008 global financial crisis affected Indonesia's economy, this was evidenced by decreasing annual GDP growth rates from 6.34% in 2007 to 6.01% in 2008. In 2007, annual inflation based on consumer prices in Indonesia was 6.4% and increased in 2008 to 9.77%. Indonesia's current account balance, as a percentage of GDP, also decreased from 2.42% in 2007 to 0.0024% in 2008.

No	Countries	Periods	Model	a	k	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	r
1	Indonesia	02/01/1995–31/12/1996	No arch effect									
	Prob											
		02/01/1997–13/08/1997	GARCH (1,1)	0.00000154	−0.681506	0.004938	−173.7801	−0.004701	0.000000282*	0.544318*	0.605745**	0.791666**
	Prob			0.9871	0.9477	0.9353	0.8273	0.9677	**0.0826**	**0.0311**	**0.0000**	**0.0000**
		14/08/1997–31/12/1998	GARCH (1,1)	0.002043	−0.133022	0.172647**	−6.713448**	−0.05331	0.0000635*	0.162186*	0.818367**	0.869269**
	Prob			0.1324	0.8039	**0.0001**	**0.0043**	0.4853	**0.0589**	**0.0157**	**0.0000**	**0.0000**
		14/08/1997–31/12/2014	GARCH (1,1)	0.00000238	−0.00447	−0.000503	−1.377,055	−0.000469	0.000000878**	0.404217**	0.69695**	0.781052**
	Prob			0.9496	0.9878	0.9507	0.4184	0.9727	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		2007–2008	No arch effect									
	Prob											
		After global crisis	GARCH (1,1)	$6.83E^{-06}$	−0.194753	0.052516*	−482.0333*	0.044698	0.000000129*	0.244688**	0.80867**	0.781586**
	Prob	December 2010–2014		0.8773	0.9481	**0.0259**	**0.017**	0.2154	**0.0225**	**0.0000**	**0.0000**	**0.0000**

**sig at 0.1; **sig at 0.01.*

Table 2.
Estimation result for Indonesia.

We also examined the post-global financial crisis period from the end of 2010 until 2014. The Federal Reserve, The US Central Bank adopted an unprecedented quantitative easing policy. On November 2010, The Fed declared to begin QE phase 2 [16]. In 2013, The Fed began tapering to reduce bond purchasing since 18 December 2013 [17]. These Federal Reserve policy settings over the 2010–2014 period affected Indonesia's exchange rate. A $\varnothing_0$ positive autoregressive and significant parameter emerged in the Rupiah. Meanwhile $\varnothing_1$ negative and significant parameter indicated a bandwagon effect and positive feedback trading during that period.

The Rupiah's exchange rate had sloppy trend during this time. Autoregressive parameters showed bandwagon effect, a previous currency movement affected currency's expectation to move in the same way during this period. Hence, volatility in Rupiah during this time also was affected by positive feedback trading. In this period, annual GDP growth was decreasing from 6.2% in 2010 to 5.0% in 2014, while the current account surplus as a percentage of GDP also decreased from 0.7% in 2010 and moved to a deficit of −3.2% 2013.

b. Malaysia

Similar to the Indonesian Rupiah, Malaysia's Ringgit also did not demonstrate the ARCH effect before the Asian financial crisis period (based on data in the period 1995–30/06/1997). From July 1997 to August 1998, however, the Ringgit detached its value into floating. This was proved in the data by the presence of ARCH effect in Ringgit. Meanwhile, there was no $\varnothing$ significant parameter during this time. However, Malaysia obviously experienced the crisis' effect with GDP decreasing on an annual percentage basis from 7.3% in 1997 to −7.3% in 1998. At the same time, inflation on an annual percentage basis based on consumer price crawled higher from 2.66% in 1997 to 5.27% in 1998. The lowest Ringgit rate occurred on 8 January 1998, when it hits 4.6805 to the United States dollar (**Table 3**).

From September 1998 until 20 July 2005, Malaysia employed a fixed exchange rate system which was pegged toward US$ and floating toward other currencies. This is seen in $\varnothing_0$ and $\varnothing_2$ significant parameter derived in the author's modeling of the Ringgit's performance during this period. A $\varnothing_0$ negative and significant parameter indicated that the Ringgit had experienced a contrarian effect, and that a previous currency movement affected crosscurrent expectations during that period. Additionally, $\varnothing_2$ denoted negative and significant number. We can conclude that during the sub-period policy, an asymmetric trading behavior emerged in Ringgit and showed no significant positive feedback trading during this time. Therefrom, Ringgit was pegged to US$ movement at this period and just in fact, Ringgit moved around 3.8 US$.

After economic conditions had stable following the Asian financial crisis, Malaysia removed the Ringgit from its peg to the United States dollar on 21 July 2005 after China removed the Renminbi from its peg to the United States dollar. From 21 July 2005, Malaysia applied a managed floating exchange rate system once again.

We found a presence of $\varnothing_0$, $\varnothing_1$, and $\varnothing_2$ significant parameter from 21 July 2005 until the end of 2014. A $\varnothing_0$ positive and significant parameter denoted a bandwagon effect during this time. Positive feedback trading was indicated by a presence of $\varnothing_1$ parameter during this period. Meanwhile, a $\varnothing_2$ negative and significant parameter showed asymmetric trading behavior during that period. In other words, positive feedback trading was more intense during depreciation rather than appreciation.

No	Countries	Periods	Model	a	k	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	r
2	Malaysia	02/01/1995–30/06/1997	No arch effect									
	Prob											
		01/07/1997–31/08/1998	GARCH (1,1)	0.00126*	−0.884495	0.027907	−38.52741	0.05094	$5.33E^{-06}$	0.109995*	0.87854**	1.054552**
	Prob			**0.0821**	0.6404	0.6985	0.3941	0.5703	0.1486	0.0111	**0.0000**	**0.0000**
		09/1998–31/12/1998	GARCH (1,1)	0.0001	−62251E-01	0.878278**	−913.4873**	−0.937503**	0.000000233**	0.809532**	0.139062**	1.737544**
	Prob			0.5762	0.2638	**0.0000**	**0.0000**	**0.0000**	**0.0000**	0.0004	0.0095	**0.0000**
		09/1998–20/07/2005	GARCH (1,1)	3.81 E-09	−3.671559*	−0.129247**	−48.04654	−0.153701**	0.000000000117**	0.028744**	0.79958**	0.609419**
	Prob			0.9948	**0.0575**	**0.0000**	0.5547	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		2007–2008	GARCH (1,1)	−0.0000824	0.023844	0.161737**	−2498.654**	0.016359	$7.83E^{-08}$	0.265345**	0.79888**	0.982996**
	Prob			0.3767	0.9975	**0.0021**	**0.0097**	0.8067	0.2439	**0.0000**	**0.0000**	**0.0000**
		21/07/2005–31/12/2014	GARCH (1,1)	−0.00000291	7.400178*	0.047004*	−639.8292*	−0.069351*	4.06^{E-09}	0.155886**	0.874154**	1.050412**
	Prob			0.9283	**0.0269**	**0.0492**	**0.0925**	**0.0248**	0.1893	**0.0000**	**0.0000**	**0.0000**
		After global crisis	GARCH (1,1)	$-9.03E^{-05}$	13.13979*	0.017666	−190.2781	−0.070041	0.000000538**	0.080107**	0.889356**	1.154591**
	Prob	December 2010–2014		0.5272	**0.0146**	0.6952	0.7949	0.1672	**0.0429**	**0.0003**	**0.0000**	**0.0000**

**sig at 0.1; **sig at 0.01.*

Table 3.
Malaysia estimation results.

Ringgit had $\varnothing_0$ and $\varnothing_1$ significant parameter during 2007–2008. A bandwagon effect emerged during this period by a presence of $\varnothing_0$ parameter. A big number and $\varnothing_1$ negative parameter value showed a positive feedback trading during this period, albeit with a small range fluctuation. In the Malaysian economic system, 2007's annual GDP percentage growth was 6.29% and decreased to 4.83% in 2008, while the annual percentage change in inflation based on consumer prices grew from 2.02% to 5.44% in 2008. During this time period, Malaysia's current account balance itself increased from 15.3 in 2007 to 16.8 (% of GDP) in 2008.

There was a volatility in the Ringgit at the end of period 2010–2014, but it showed no $\varnothing$ significant parameter. This means that the volatility in the Ringgit wasn't affected by positive feedback trading, asymmetric trading, bandwagon nor contrarian effect. A variable macroeconomic performance was seen in Malaysia during the 2010–2014 period, but in 2013–2014, it climbed from 4.73 in 2013 to 6.03 (% of GDP). Malaysia's current account balance was lowering but still in positive condition. Malaysia's current account balance was recorded 10.906 (% of GDP) in 2010 and 3.74 in 2013 (% of GDP).

c. Thailand

The Baht demonstrated the ARCH effect just before crisis period (1995–1996), but had no $\varnothing$ significant parameter. In the crisis period (early 1997 until mid-1997) there was $\varnothing_0$ negative and significant parameter. This indicated a presence of contrarian effects in the trading of the Baht during that period. During 14–15 May 1997, the Baht was hit by enormous speculative attacks [18]. On 2 July 1997 after spending billions of dollars to defend Baht, the Thai Central Bank was forced to let its currency float [19]. The Thai Baht fell to its lowest point at 56 to the United States dollar on 12 January 1998, [19]. During the deepest of the crisis period from 2 July 1997 until 31 December 1998, the Baht exchange rate showed a bandwagon effect and positive feedback trading. Due this crisis Thailand's GDP growth was declining. In 1997 Thailand's annual GDP percentage growth was −1.4% and in 1998 plunged to −10.5%. Meanwhile, based on annual percentage changes in consumer prices, inflation in Thailand went higher from 5.6% in 1997 to 8.0% in 1998. Thailand's current account balance in 1997 was valued −2% of GDP (**Table 4**).

At the end of the period 2010–2014, the authors modeling highlights the volatility in the Thai Baht, but the research also pointed to an absence of $\varnothing$ significant parameter in the Baht, therefore indicating that the volatility wasn't affected by positive feedback trading, asymmetric trading, bandwagon nor contrarian effect.

During this period, Thailand experienced variable economic growth in terms of annual percentage changes in GDP growth, moving from 7.8% in 2010 to 0.7% in 2014. The current account balance in Thailand decreased during this period: In 2009, the current account balance was 8.3 (% of GDP) and then the negative current account balance happened in 2012–2013, hitting −0.3984 in 2012, easing further down to −0.97644 (% of GDP) in 2013, but recovering in 2014 to 3.51% of GDP.

d. Vietnam

Vietnam maintained the Vietnamese Dong (VND) in point around 10.000–11.000 for 3 years, 1993–1996 [20]. The research showed that Vietnam had the ARCH effect in the early 1995 until January 1997. Additionally, $\varnothing_0$ parameter denoted positive and significant value. This indicated that the bandwagon effect existed in the VND at that time. The $\varnothing_1$ parameter in the VND yielded negative yet significant value, on contrary the parameter had a big number. It exhibited a positive feedback trading on the

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No	Negara	Periods	Model	a	k	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	r
3	Thailand	02/01/1995–31/12/1996	GARCH (1,1)	0.000101	−29.77067	−0.049986	19.78596	−0.013797	0.0000000334*	0.047783*	0.916995**	1.137272**
	Prob			0.1414	0.5775	0.5007	0.5196	0.8272	**0.0805**	**0.0481**	**0.0000**	**0.0000**
		01/01/1997–01/07/1997	GARCH (1,1)	0.00023	4.729407	−0.233357**	−285623	−0.1953	0.000000233	0.782481*	0.592685**	0.841169**
	Prob			0.0639	0.3937	**0.0098**	0.3151	0.1322	0.4241	**0.053**	**0.0004**	**0.0000**
		02/07/1997–31/12/1998	GARCH (1,1)	−0.001128*	20.166	0.116529*	−177.326**	0.0691	0.000025**	0.467093**	0.542638**	0.907214**
				0.0324	0.2222	**0.0265**	**0.0026**	0.2847	**0.0051**	**0.0014**	**0.0000**	**0.0000**
		2007–2008	GARCH (1,1)	0.000301	−1.474605	0.013949	−25.54712	−0.019957	0.00000706**	0.668198**	0.484566**	0.741343**
	Prob			0.0139	0.0897	0.6667	0.8312	0.567	**0.0061**	**0.0009**	**0.0000**	**0.0000**
		After global crisis	GARCH (1,1)	$-2.14E^{-05}$	−0.131412	−0.002294	−7919062	0.028256	0.000000259**	0.089813**	0.886711**	1.232899**
	Prob	December 2010–2014		0.8679	0.9928	0.9663	0.7932	0.5716	**0.0142**	**0.0001**	**0.0000**	**0.0000**

**sig at 0.1; **sig at 0.01.*

Table 4.
Thailand estimation result.

currency, even occurred the fluctuation in a very small range. As a result, the VND exchange rate pushed to its lowest point (it was during 1995 until January 1997). On 17 January 1997, the exchange rate was hitting 11,180. While $\varnothing_2$ negative and significant parameter value termed as a presence of the asymmetric trading behavior in the period. The positive feedback trading was more intense during depreciation rather than appreciation. During the Asian financial crisis (1997–1998), Vietnam expanded its band-intervention to ±5% in February 1997 and ±10% in October 1997 (**Table 5**).

We highlight the Vietnam's GDP growth (in 1997–1998) was decreasing but the value was still positive at 8.15 in 1997 and became 5.76 in 1998. The inflation based on consumer price in 1997, Vietnam had 3.2 inflation rate and increased to 7.26 in 1998. The VND exchange rate pushed to its lowest (13907) on 24 August 1998. It signified, even applied managed floating system, the VND still pushed to the lowest rate.

This research showed that there was no ARCH effect in the VND during 1 February 1997 until 31 January 1999. It indicated that SBV played significant role during this period in the VND movement. After financial crisis period in February 1999 until 2014, Vietnam changed its currency system into managed float regime. We can see $\varnothing_0$ negative and significant parameter. It indicated a presence of contrarian effect during this period. Also, this indicated that the VND had a significant asymmetric trading behavior ($\varnothing_2$ positive and significant parameter). This showed that a positive feedback trading in VND had more intense in appreciation rather than in depreciation.

The VND experienced an ARCH effect without $\varnothing$ significant parameter during 2007–2008. Vietnam's GDP growth decreased from 7.12 in 2007 to 5.66 in 2008. Based on consumer price, Vietnam's inflation went higher from 8.3 in 2007 to 23.11 in 2008. Vietnam's current account balance fell from −8.98 in 2007 to −10.91 (% of GDP) in 2008. In the end of period 2010 until 2014, the VND signed no ARCH effect. It concluded that there was no volatility in the VND during this period. Hence, SBV maintained the VND exchange rate during this period. Vietnam's GDP growth in this period was quite good, it was valued >5. In 2013, GDP growth was in 5.42 and moved to 5.98 in 2014. Vietnam's current account balance was moving from −3.68 in 2010 to 5.81 in 2012 and decreased slightly in 2013 to 5.53 (% of GDP). Though, SBV maintained the exchange rate with managed float system, the VND exchange rate still lowered since 2010 until 2014. The VND exchange rate was 18,469 in early January 2010 and hit its lowest point on 27 November 2014 to 21,390.

e. Philippine

The Philippine Peso (PHP) had been used floating system before crisis. Though, they still paid the effect of 1997–1998 the Asian financial crisis. This denoted $\varnothing_0$ positive and $\varnothing_1$ negative significant parameter. The author concludes that the Philippine Peso (PHP) experienced a bandwagon effect and positive feedback trading behavior during this period. The exchange rate pushed to its lowest point on 6 January 1998 to 45.2. This affected the Philippines GDP growth fell down. It fell from 5.18 in 1997 to −0.57 in 1998. It followed by the inflation increment based on consumer price, from 5.59 in 1997 to 9.23 in 1998. There signed no ARCH effect in 2007–2008. Meanwhile the financial crisis impacted the PHP that denoted in the decrement of GDP growth from 6.61 in 2007 to 4.15 in 2008. The inflation also increased in 2007. Based on consumer price, the inflation went almost tripled from 2.9 to 8.26 in 2008. The Philippine's current account balance during 2007–2008 fall from 5.40 in 2007 to 0.08 (% of GDP) in 2008 (**Table 6**).

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No	Negara	Periods	Model	*a*	*k*	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	*r*
4	Vietnam	02/01/1995–31/01/1997	GARCH (1,1)	−0.0000419**	738.8006**	0.032935*	−806555.4**	−0.079674**	0.00000000227*	0.124039**	0.821613**	0.507143**
	Prob			**0.0000**	**0.0000**	**0.0772**	**0.0000**	**0.0000**	**0.0166**	**0.0086**	**0.0000**	**0.0000**
		01/02/1997–31/01/1999	No arch effect									
	Prob											
		01/02/1999–31/12/2014	GARCH (1,1)	0.000000368	−5.531236	−0.173693**	365.4061	0.163149**	0.00000000127**	0.124497**	0.871726**	1.084233**
	Prob			0.9425	0.5544	**0.0000**	0.3091	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		2007–2008	GARCH (1,1)	0.00000066	0.682373	−0.000872	−286.1015	−0.001408	0.0000000514**	0.279101**	0.716467**	0.696813**
	Prob			0.9746	0.9505	0.9789	0.9212	0.9709	**0.0001**	**0.0000**	**0.0000**	**0.0000**
	Prob	After global crisis December 2010–2014	No arch effect									

**sig at 0.1; **sig at 0.01.*

Table 5.
Vietnam result estimation.

No	Negara	Periods	Model	a	k	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	r
5	Philippines	02/01/1995–31/12/1996	GARCH (1,1)	0.000000334	−0.4696	−0.067297*	−1209.4020	−0.0615	**0.0000**	0.1443	0.8763	0.7587
	prob			0.9905	0.9571	**0.0189**	0.3297	0.1671	**0.0402**	**0.0154**	**0.0000**	**0.0000**
		1/1/1997–31/12/1998	GARCH (1,1)	0.000000537	−2,.22548	0.249147**	−430.1327**	0.025304	0.0000000138*	0.3505**	0.710945**	0.713202**
	prob			0.9831	0.1933	**0.0000**	**0.0001**	0.5082	**0.0774**	**0.0000**	**0.0000**	**0.0000**
		2007–2008	No arch effect									
		After global crisis	No arch effect									
	prob	December 2010–2014										

**sig at 0.1; **sig at 0.01.*

Table 6.
Philippine estimation result.

After crisis in the end of 2010 until 2014, the PHP experienced no ARCH effect. This showed that the PHP had not volatility during this period. The GDP growth was in positive range from 7.63 in 2010 to 6.09 in 2014. Philippines current account balance was still positive. In 2010, Philippine's current account balance was 3.59, and increased in 2014 to 4.44 (% of GDP).

f. Singapore

The financial crisis also impacted the SGD. This was seen during 1997–1998. The $\varnothing_1$ parameter was valued negative and significant. This indicated a positive feedback trading during this period. The $\varnothing_1$ huge parameter denoted that fluctuation occurred in a small range. Therefore, Singaporean Dollar (SGD) sloped downward to its lowest on 12 January 1998 at point 1791.Meanwhile the SGD $\varnothing_2$ parameter termed as positive and significant. This exhibited that positive feedback trading was more intense during this appreciation rather than depreciation. Although the SGD was quite stable, GDP growth decreased from 8.29 in 1997 to −2.22 in 1998. The inflation based on consumer price also adjusted. It sank from 2.0 in 1997 to −0.26 in 1998. The SGD had a significant $\varnothing_0$ (positive) and $\varnothing_1$ (negative) parameter during 2007–2008. This indicated that there were a bandwagon effect and positive feedback trading behavior. This economic situation impacted the Singapore's GDP growth. It went down from 9.11 in 2007 to 1.7 in 2008 along with the increasing number of inflation from 2.09 in 2007 to 6.51 in 2008.Singapore's current account balance in this period was 25.97 in 2007 and sloped down to 14.4 (% of GDP) (**Table 7**).

There was a sign of volatility in the SGD during 2010–2014. But there were no $\varnothing$ significant parameter that denoted volatility affected by positive feedback trading, asymmetric trading, bandwagon or contrarian effect. Singapore's GDP growth decreased from 15.24 in 2010 to 2.91 in 2014. During this period, the current account balance was fluctuated but still at range between 17% and 23 (% of GDP). The current account balance in Singapore was 23.66 in 2010 and in 2015 it was valued 19.08 (% of GDP).

g. Brunei Darussalam

During 1997–1998, Brunei's currency had $\varnothing_1$ negative and significant parameter. It indicated a positive feedback trading behavior during this period. Therefore, the currency pushed to its lowest on 6 August 1998, at point 2.0112. On contrary, the GDP growth increased from −1.47 in 1997 to −0.55 in 1998. Meanwhile, the inflation based on consumer price decreased from 1.7 to −0.44 in 1998. The Brunei Dollar (BND) had a significant $\varnothing_0$ (positive) and $\varnothing_1$ (negative) parameter during 2007–2008. It indicated a presence of bandwagon effect and positive feedback trading behavior. Such as Singapore, the $\varnothing_1$ parameter was valued negative and had a large number. This showed a positive feedback trading in this period even affected it a small range of fluctuation. Brunei's GDP growth declined from 0.15 in 2007 to −1.9 in 2008. The inflation based on consumer price was increasing from 0.96 to 2.08 in 2008. Brunei's current account balance climbed up from 39.42 in 2007 to 48.2 (% of GDP) in 2008 (**Table 8**).

During 2010–2014, after financial crisis period, there was a volatility in the BND, but It had no significant $\varnothing$ parameter. It indicated that the volatility wasn't affected by positive feedback trading, asymmetric trading, bandwagon nor contrarian effect. The GDP growth was fluctuated during this period but inclined from −1.7 in 2013 to 5.3 in 2014. In 2012, the current account balance was 33.52 (% of GDP).

No	Countries	Periods	Model	a	k	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	r
6	Singapore	02/01/1995–31/12/1996	GARCH (1,1)	0.0000177	$-22472E^{+01}$	−0.121885*	−2318.9100	$2.11E^{-02}$	$4.98E^{-07}$	0.368049	0.579737	0.972402
				0.8266	0.2193	**0.0555**	0.7321	0.7441	**0.0068**	**0.0007**	**0.0000**	**0.0000**
		1/1/1997–31/12/1998	GARCH (1,1)	0.0000901	0.233784	0.051853	−1317.534*	0.133241*	$1.21\ E^{-07}$	0.125286**	0.890436**	0.968537**
	Prob			0.5011	0.9738	0.3028	**0.0414**	**0.0169**	0.2293	**0.0002**	**0.0000**	**0.0000**
		2007–2008	GARCH (1,1)	-0.0000558	4.489112	0.104117*	−4484.978**	0.004011	0.0000000269	0.000646**	0.997412**	1.765285**
	Prob			0.7256	0.548	**0.0366**	**0.0006**	0.9328		**0.0227**	**0.0000**	**0.0000**
		After global crisis	GARCH (1,1)	0.000101	−0.515869	−0.018236	−1114308	−0.062631	0.000000108**	0.075689**	0.916008**	1.393457**
	Prob	December 2010–2014		0.4174	0.9681	0.6638	0.521	0.225	**0.0509**	**0.0000**	**0.0000**	**0.0000**

**sig at 0.1; **sig at 0.01.*

Table 7.
Singapore estimation result.

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No	Countries	Periods	Model	*a*	*k*	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	*r*
7	Brunei D.	02/01/1995–31/12/1996	No arch effect									
		1/1/1997–31/12/1998	GARCH (1,1)	0.00000535	−0.111147	0.004022	−40.99186*	−0.000969	0.000000583**	0.020133**	0.873668**	0.918024**
	Prob			0.9788	0.9523	0.8471	**0.0277**	0.9681	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		2007–2008	GARCH (1,1)	−0.000252	12.86418	0.099232*	−5255.174**	−0.035262	0.000000000416**	0.000284**	1.004222**	1.356014**
	Prob			0.1222	0.446	**0.0631**	**0.0063**	0.5844	0.955	**0.9228**	**0.0000**	**0.0000**
		After global crisis	GARCH (1,1)	$3.77E^{-05}$	5.011454	−0.03235	−207.2297	−0.049652	0.000000105*	0.066026**	0.925894**	1.267054**
	Prob	December 2010–2014		0.7519	0.7158	0.4022	0.8814	0.3249	**0.0684**	**0.0000**	**0.0000**	**0.0000**

**sig at 0.1; **sig at 0.01.*

Table 8.
Brunei Darussalam estimation result.

h. Cambodia

Cambodian exchange rate during 1997–1998 had $\varnothing_0$ negative and significant parameter. During the Asian financial crisis period, Cambodian currency had a contrarian effect. The Cambodian Riel (KHR) had a $\varnothing_2$ positive and significant parameter. Hence, it indicated an asymmetric trading behavior during this period. In other words, a positive feedback trading was more intense during appreciation rather than depreciation. The lowest point of Cambodian exchange rate had been recorded at point 4015 on 24 July 1998. The GDP growth also declined from 5.61 in 1997 to 14.8 in 1998. Based on consumer price, the inflation climbed up from 7.96 in 1997 to 14.8 in 1998. The KHR had a $\varnothing_1$ (negative) and significant parameter during 2007–2008. During this period, the KHR termed as positive feedback trading behavior and had a big number in $\varnothing_1$ parameter. It was assessed as a positive feedback trading. Although it affected a small range of fluctuation. The Cambodia's economic system impacted the GDP growth. It sloped downward from 10.21 in 2007 to 6.69 in 2008. In 2007, the inflation based on consumer price was hitting 7.6 and increased to 24.9 in 2008 (**Table 9**).

Cambodia's current account balance went down from −4.9 (% of GDP) in 2007 to −7.9 (% of GDP) in 2008. In the end of 2010 until 2014, after financial crisis period, the KHR had a contrarian effect. It was demonstrated by a $\varnothing_0$ negative and significant parameter. The KHR was also valued $\varnothing_2$ negative and had a significant parameter. It showed an asymmetric trading behavior during that period and denoted that positive feedback trading was more intense during depreciation rather than appreciation. Cambodia's GDP growth indicated well because of the increase point from 5.9 in 2010 to 7.03 in 2014. But the Cambodia's current account balance sloped downward from −3.64 (% of GDP) in 2010 to −10.55 (% of GDP) in 2013.

i. Myanmar

Myanmar Kyat or MMK had no ARCH effect during Asian financial crisis (1997–1998). On April 2nd, 2012 until December 31st 2014, Myanmar already applied managed floating regime. But in fact, Myanmar still experienced no ARCH effect. Myanmar exchange rate was hitting its lowest point at 6.44002 on August 1st 1997. Myanmar GDP growth increased in very small range from 5.65 in 1997 to 5.86 in 1998. Meanwhile, the inflation based on consumer price increased from 29.69 in 1997 to 51.4 in 1998. After crisis period, during 2010–2014, the MMK indicated no ARCH effect. The economic growth in Myanmar was counted as stable. It had 8.24 point in 2013 and 8.49 point in 2014. But the current account balance sloped down from −1.68 in 2012 to −1.92 in 2013. After Myanmar exerted economic system from peg to SDR to managed floating system, the exchange rate moved from 6.41 to 818 Kyat on 2 April 2012.

j. Laos

Such as the Myanmar Kyat, the Laos Kip Rate (LAK) had not any ARCH effects during the Asian financial crisis 1997–1998. It also happened during 1995–2014. There was no ARCH effect in the LAK. Though the LAK sloped downward to its lowest with 4203.50 point on 11 December 1998.The GDP growth also decreased from 6.87 in 1997 to 3.96 in 1998. Meanwhile the inflation based on consumer price went higher from 27.5 in 1997 to 90.98 in 1998. There was ARCH effect in the LAK during 2007–2008 (**Table 10**).

The research found that the LAK was in $\varnothing_1$ (negative) and $\varnothing_2$ (negative) significant parameter. It exhibited a positive feedback trading during this period. A $\varnothing_2$ parameter showed that an asymmetric trading behavior and a positive feedback trading was more intense during depreciation rather than appreciation. It impacted to the GDP growth. The GDP growth was relatively increasing from 7.59 in 2007to 7.82 in 2008. The

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No	Countries	Periods	Model	*a*	*k*	Φ_0	Φ_1	Φ_2	$\alpha0$	$\alpha1$	$\beta1$	*r*
8	Cambodia	02/01/1995–31/12/1996	No arch effect									
		1/1/1997–31/12/1998	GARCH (1,1)	$9.E^{-15}$	$2.22E^{-10}$	−0.0000000184*	−0.00000346	0.0000000245*	$5.55E^{-10}$	0.011988**	0.988011**	0.092395**
	Prob			0.9882	0.5163	**0.085**	0.1641	**0.02**	—	**0.0000**	**0.0000**	**0.0000**
		2007–2008	GARCH (1,1)	−0.000000849	174.176	0.004716	−1389.412**	0.005051	0.000000255**	0.420766**	0.722673**	0.575157**
	Prob			0.9692	0.5025	0.6307	**0.0000**	0.5011	**0.0073**	**0.0006**	**0.0000**	**0.0000**
		After global crisis	GARCH (1,1)	$1.19E^{-07}$	−0.391192	−0.201847*	204.7175	−0.04108*	$1.01E^{-07}$	0.386119	0.721907	0.590749
	Prob	December 2010–2014		0.9966	0.8898	**0.0000**	0.4182	**0.0782**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

**sig at 0.1; **sig at 0.01.*

Table 9.
Cambodia estimation result.

No	Countries	Periods	a	k	Φ_0	Φ_1	Φ_2	$\alpha 0$	$\alpha 1$	$\beta 1$	r
10	Laos	02/01/1995–31/12/1996									
		01/01/1995–31/12/2014									
	Prob										
		1/1/1997–31/12/1998									
	Prob										
		2007–2008	0.000152**	−194.9292**	−0.092729	−142721.6	−0.075832**	0.000000223*	0.22251**	0.770992**	0.562965**
	Prob		**0.0000**	**0.0000**	0.1978	0.0531	**0.0000**	**0.0366**	**0.0063**	**0.0000**	**0.0000**
	Prob	After global crisis									
		December 2010–2014									

**sig at 0.1; **sig at 0.01.*

Table 10.
Laos estimation result.

inflation rate (based on consumer price) climbed up from 4.52 in 2007 to 7.62 in 2008. During the period 2010–2014, ARCH effect did not show in the LAK. It indicated the currency had not volatility during this period. The Laos GDP growth obtained 8.52 point in 2010 but slowly downward to 7.45 in 2014. The Laos current account balance also sloped down from 0.4 in 2010 to −3.36 (% of GDP) in 2013. At the end, the LAK exchange rate fluctuated from 7500 until 8100 in this period.

4.2 Exchange rate volatility spillover in the ASEAN countries

In addition to analyzing the influence of positive and negative feedback trading on ASEAN exchange rate volatility, we are also very keen to analyze the exchange rate volatility spillover across the countries. For this purpose, we developed the six-variable VAR model consisting of countries' exchange rate volatility. In its operations, we exclude three ASEAN countries, namely Brunei Darussalam, Cambodia and Myanmar because of constraints on the data's availability. However, this exclusion does not significantly reduce the validity of the estimation, since the six countries used, namely Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam have greatly represented the ASEAN economy. To be noticed, the contribution of these six countries reaches 95% relative to the ASEAN economy [21].

Following Diebold and Yilmaz [22]; Hubbansyah and Husodo [23], we adapt the generalized VAR framework in identifying the spillover condition of the exchange rate in the ASEAN region. This method allows us to identify the relative contributions of own variables and other variable shocks to the forecast error variance decomposition (FEVD) of each variable in the VAR model which is calculated and displayed in tabular form [24].

In **Table 11**, we show spillover indices estimation for each variable based on 10-days ahead of the FEVD. For information, the ij^{th} entry is an estimated contribution to the fevd of variable i derived from innovation or shock to variable j. The diagonal element ($i = j$) represents the own-variable spillovers, while the off-diagonal element measures the cross-variable spillovers. The total spillover index (TSI) is equal to the sum of off-diagonal elements relative to the sum of total column (including the diagonal elements) that is expressed in percentage [22, 23, 25].

Based on the information presented in **Table 11**, it is known that the average value of exchange rate volatility spillover across countries—as indicated by the value of TSI—is 14.5%. It means that approximately 14.5% of the fevd of the variables comes from spillovers. The TSI, which receive a value of more than 10%, shows that exchange rate volatility spillover among the ASEAN countries to be relatively high.

Indonesia and Thailand have the largest directional spillover to others with value of 31.8% and 46.2% respectively. This means that the spillover of exchange rate volatility from both countries has a relatively greater contribution to the exchange rate volatility of other countries in ASEAN. In the case for Indonesia, part of its total directional spillover to others is contributed from the value of directional spillover to Thailand. Meanwhile, for Thailand, its total value of directional to others is largely contributed by the spillover which is transmitted to Indonesia and Singapore.

Directional including own, which shows a value greater than 100% in Indonesia and Thailand, is indicating that both countries are responsible for the magnification of exchange rate spillovers across the countries. It means that the exchange rate volatility spillovers originating in both countries have a substantial impact on the dynamics of exchange rate volatility in other country in ASEAN. Fundamentally, this could be happened due to the economic size of Indonesia and Thailand are bigger than the other four countries that are being analyzed [21].

	From (*j*)						
To (*i*)	**Vol_Ina**	**Vol_Thb**	**Vol_Php**	**Vol_Sgd**	**Vol_Myr**	**Vol_Vnd**	**From others**
Vol_Ina	77.74	19.55	0.67	0.61	0.69	0.73	22.3
Vol_Thb	19.05	79.15	0.45	0.19	0.77	0.39	20.9
Vol_Php	1.53	2.40	95.40	0.31	0.34	0.02	4.6
Vol_Sgd	7.41	17.79	1.34	72.55	0.91	0.01	27.4
Vol_Myr	2.36	3.73	0.16	1.11	92.59	0.04	7.4
Vol_Vnd	1.44	2.69	0.01	0.19	0.03	95.65	4.4
Directional to oOthers	31.8	46.2	2.6	2.4	2.7	1.2	86.9
Directional including Own	109.5	125.3	98.0	75.0	95.3	96.8	14.5% (TSI)

Source: data processed (1995–2014).

Table 11.
Exchange rate volatility spillover index.

Furthermore, although the average calculation of exchange rate volatility spillovers has provided good insight regarding the exchange rate volatility in the region, however this approach may mask interesting findings related to the pattern of the spillovers evolution under particular situation. Related to this concern, we are interested to analyze how total spillovers evolve over time and whether they are affected by major economic events, such as economic crisis. For this purpose, following Diebold and Yilmaz [22]; Antonakakis et al. [25] and Hubbansyah and Husodo [23], we do a rolling window estimation. In our case, we will estimate the six-variable VAR model using 200-days rolling window in order to obtain the variance decompositions, so that we have the total spillover indices in a time-varying fashion.

The estimation results are shown in the **Figure 1**.

The value of the spillover index of exchange rate volatility in ASEAN with 200-days of rolling window is found to vary over time. Although varied, the trend of time-varying of total spillovers is relatively high. An interesting fact that is known from the estimation results of time varying total spillovers is that there is a tendency of exchange rate volatility spillovers to increase in certain economic conditions, such as the Asian financial crisis and the US financial crisis. This indicates that there is a strong tendency of interaction among the countries' exchange rate volatility spillovers during the crisis period. This research finding that showed there was an increasing interconnectedness

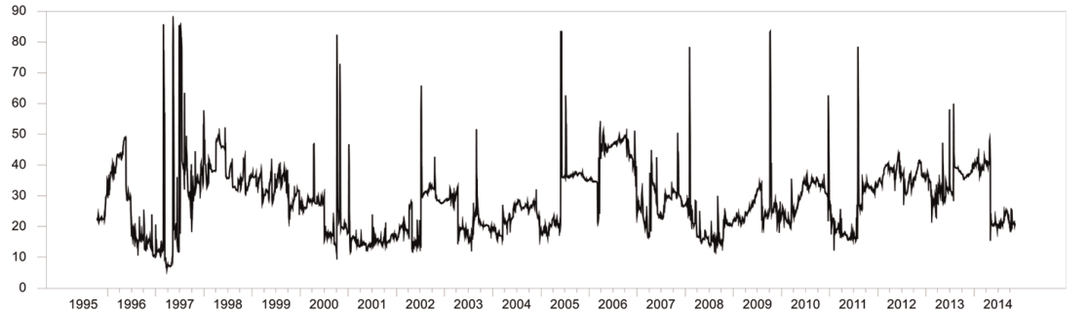

Figure 1.
Plots of the time-varying exchange rate volatility spillover indices based on 200-days rolling window estimation. [Source: Data processed (2018).]

between variables during the period of crises is consistent with the findings of Claessens et al. [26], Antonakakis et al. [25] and Hubbansyah and Husodo [23].

4.3 Structural breaks test

It's called a structural break when a time series abruptly changes at a point in time. This change could involve a change in mean or a change in the other parameters of the process that produce the series. Being able to detect when the structure of the time series changes can give us insights into the problem we are studying. Structural break tests help us to determine when and whether there is a significant change in our data. We made structural breaks test of the return and the result is given in **Figures 2–11**.

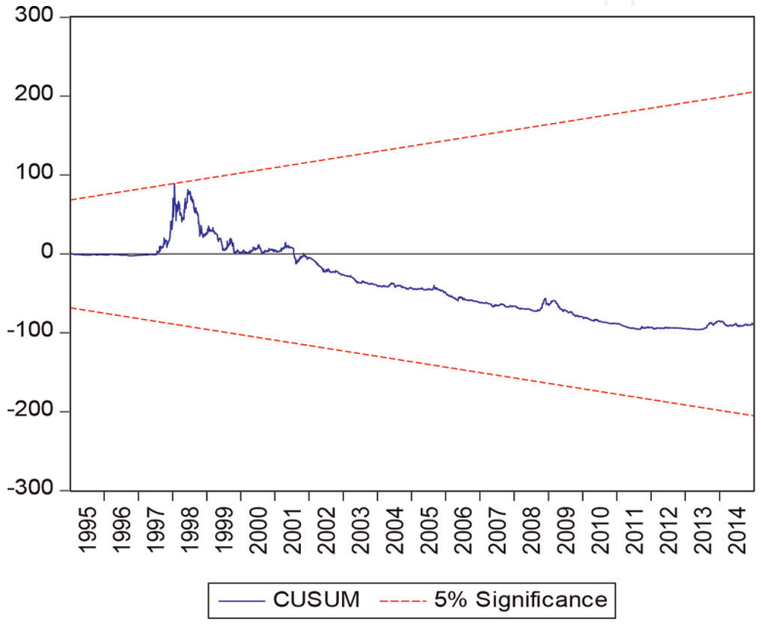

Figure 2.
USD-IDR

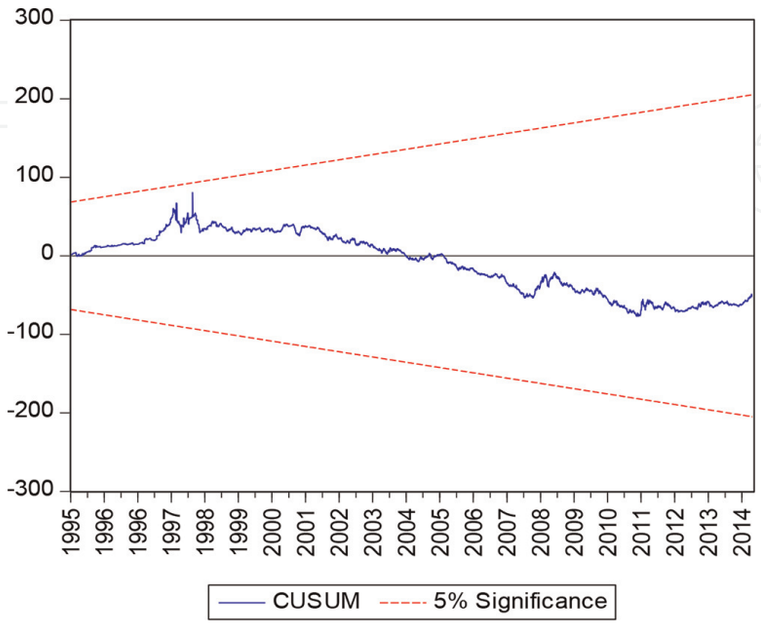

Figure 3.
USD-BND

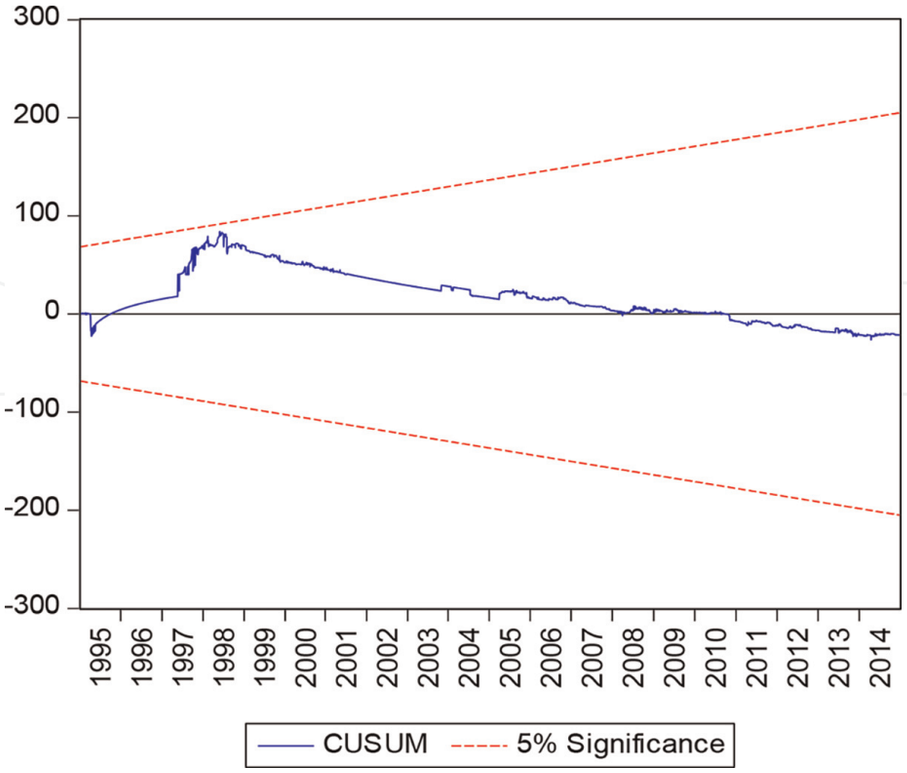

Figure 4.
USD KHR

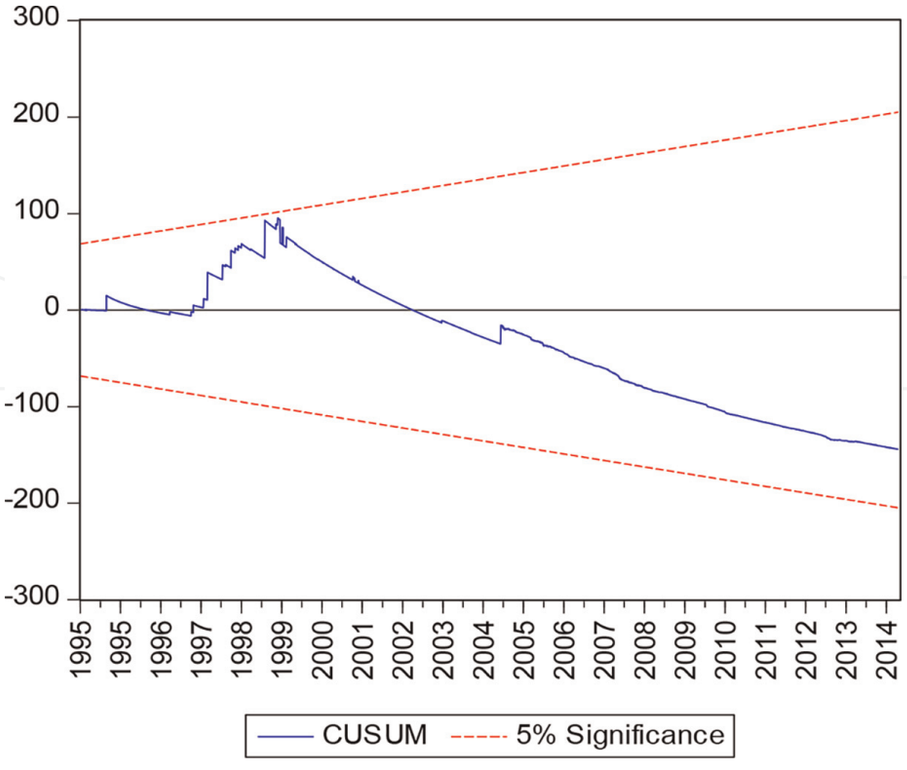

Figure 5.
USD LAK

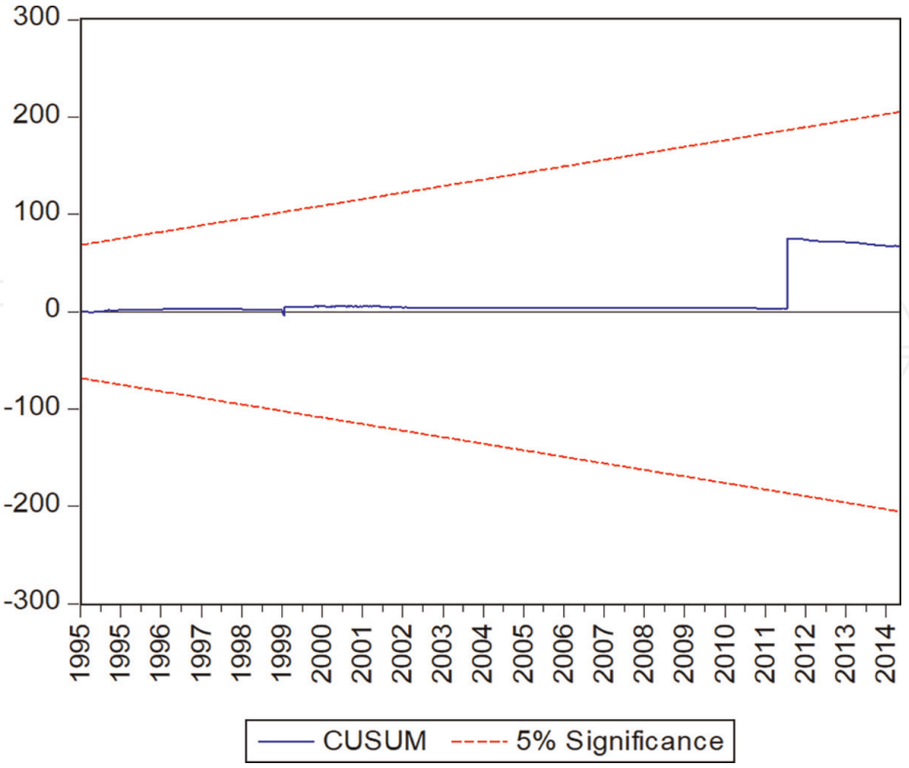

Figure 6.
USD MMK

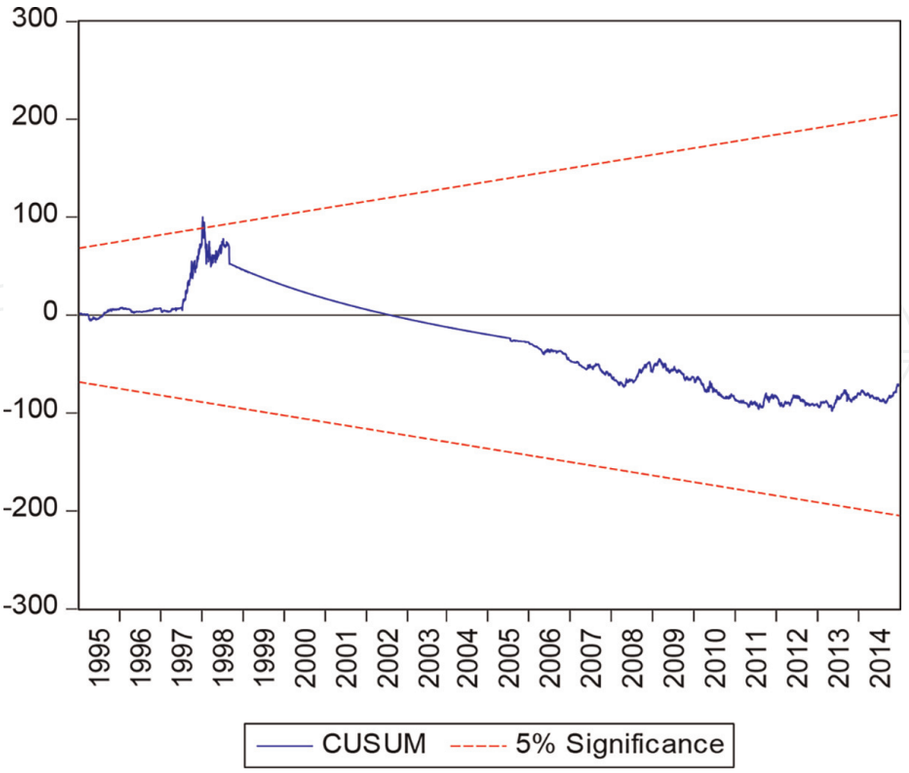

Figure 7.
USD MYR

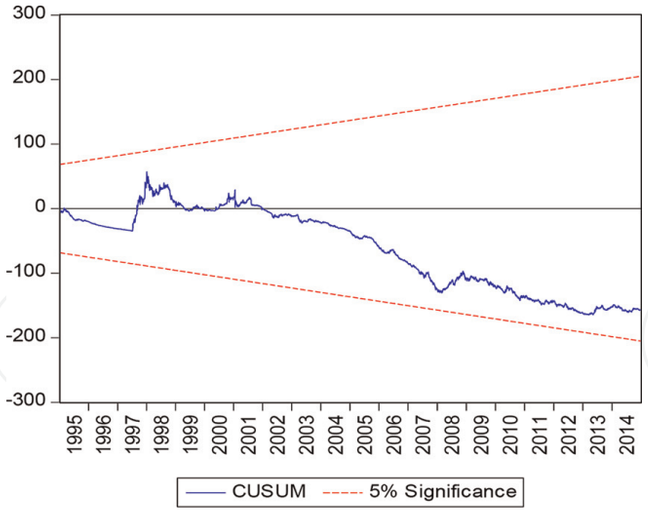

Figure 8.
USD PHP

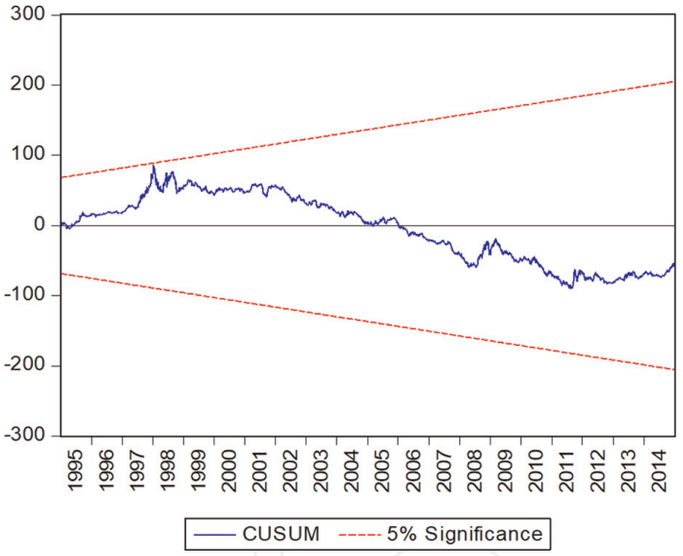

Figure 9.
USD SGD

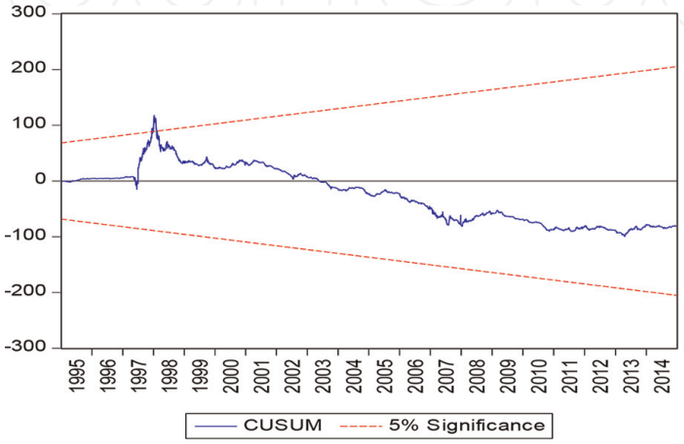

Figure 10.
USD THB

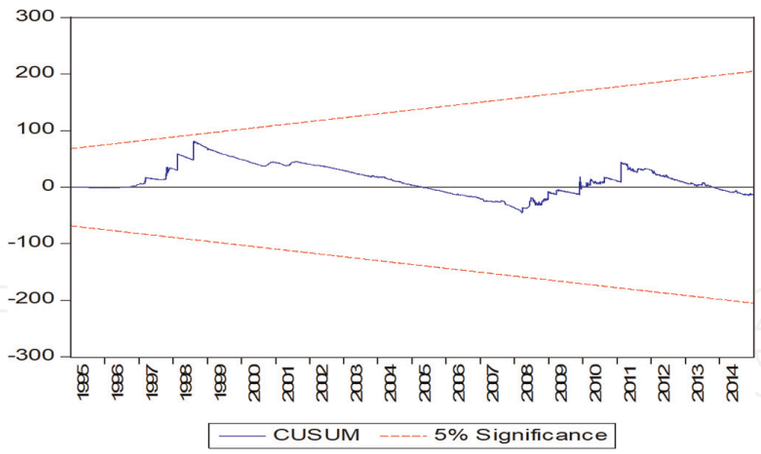

Figure 11.
USD VND

From **Figures 2–11**, we see that the IDR, MYR, SGD and THB have significance CUSUM test at 1998 which means the 1998 crisis have significantly changed the data.

5. Conclusion

The objective of this study is to analyze the autocorrelation in exchange rate parameters and volatility in key ASEAN markets to yield deeper understanding of inducted exchange rates induced by the actions of positive feedback traders. In addition to this concern, we also try to identify the exchange rate volatility spillover in the ASEAN. Related to the above, we found several important findings. First, the positive feedback trading is the main cause of the high volatility and weakening the exchange rate value. However, during 1995–2014, most of ASEAN currencies had not positive feedback trading except Singapore. But the condition is different when we analyze the data more detail by investigating the sub-periods where during the Asian financial crisis 1997/1998, most of all ASEAN currencies demonstrated a significant positive feedback trading. The crisis also affected the GDP growth and the inflation to almost all ASEAN countries. Second, the US financial crisis during 2007–2008 exhibited no significant impact through all ASEAN currencies. This impact can be seen from no ARCH sign such as in Indonesia, in Philippine, and in Myanmar. Meanwhile Malaysia, Singapore, Brunei, Cambodia, and Laos had a volatility in their exchange rate. Hence, their exchange rate indicated a positive feedback trading. Fluctuation also occurred in a small range. Thailand and Vietnam experienced a volatility without a sign of positive feedback trading. No ARCH effect in several periods affected by no volatility in currency movement of several countries. We do not exclude these countries because we want to show the characteristics of the exchange rates of each ASEAN country despite the different results of each country. For example, Myanmar and Laos applied a managed floating system. Third, in the context of exchange rate volatility spillover we found that Indonesia and Thailand play a dominant role as transmitter of exchange rate volatility in the ASEAN region. Fourth, in the context of time-varying fashion, the total spillovers tend to increase in a certain economic condition, such as economic crises. This research finding that showed there was an increasing interconnectedness between variables during period of crises is consistent with the findings of Claessens et al. [26], Antonakakis et al. [25] and Hubbansyah et al. [23].

Additional information

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