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ARE GLOBAL SHOCKS LEADING INDICATORS OF A CURRENCY CRISIS IN VIET NAM?

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Abstract

This paper aims to identify leading indicators of a currency crisis in Viet Nam based on an early warning system for the period 1996–February 2016. This paper found that global financial shocks (e.g., regional and global financial crisis, unexpected changes in monetary policy of largest economies such as the United States and the People's Republic of China), and domestic credit growth rate are leading indicators of a currency crisis in Viet Nam in all three models. Deficits in trade balance, international reserves, and overvaluation of the dong are also good indicators. In addition, a model in which a currency crisis or turbulence in the foreign exchange market is defined based on the exchange market pressure and parallel market premium, with window length of 2 months, outperformed for predicting a currency crisis in Viet Nam. Empirical results suggested that probability of predicting a true currency crisis was 77.5%.

JEL Classification: F31, E52, C32

Contents

1. INTRODUCTION

The main objective of this paper is to identify leading indicators and a suitable early warning system (EWS) model of a currency crisis in Viet Nam. The EWS for currency crisis was built to aim at identifying abnormal fluctuations and recession in the foreign exchange market in advance to allow governments to adopt preemptive policy measures (Kaminsky et al. 1998). However, forecasting the exact time of a currency crisis is likely complicated not only for policy makers but also for researchers.

Almost all studies on the EWS for a currency crisis employ either parametric approach (i.e., regression-based) or non-parametric approach (or signal approach) (Comelli 2013). The signal approach for a currency crisis was developed by Kaminsky and Reinhart (1996), Frankel and Rose (1996), Kaminsky et al. (1998), Kaminsky and Reinhart (1999), Berg and Pattillo (1999), and Zhuang (2005). For a signal approach, vulnerability indicators were transformed into a weighted average of binary signals. The authors evaluated the validity of both macroeconomic and financial indicators in predicting a currency crisis in advance in which they compared the behavior of these variables in periods preceding crises. Deviations of these variables from their "normal" levels beyond a certain threshold value could issue warning signals of a currency crisis within a specified period of time (Kaminsky et al. 1998). According to the paper, 105 indicators were listed and classified into six groups, including the external sector, the financial sector, the real sector, the public finances, institutional and structural variables, and political variables. However, among them, export, money supply growth, deficits in current accounts, real overvaluation, gross domestic product (GDP) growth, fiscal deficits, international reserves to short-term debt ratio, as well as financial stability, were found to issue signals for a currency crisis within the next 24 months.

Unlike a signal approach, the parametric EWS is regression-based, typically logit or probit, where the crisis variable is regressed on a set of macroeconomic and financial indicators. It, therefore, could estimate probability of forecasting a true crisis. Based on a multivariate probit-based methodology, Berg and Pattillo (1999) found that this approach outperformed non-parametric in terms of scores and goodness-of-fit in forecasting the 1997 crisis. Bussiere and Fratzscher (2006) applied a multinomial logit regression-based EWS and argued that the model is outperformed binomial one in predicting episodes of a currency crisis in 32 emerging markets for the period 1993–2001. Moreover, the paper shed light on defining a currency crisis by employing exchange market pressure (EMP) in the parametric model. Similar to Bussiere and Fratzscher (2006), Aizenman and Hutchison (2012) focused on the extent that the global financial crisis caused external market pressure and found that emerging countries with higher total foreign liabilities had greater exposure and were much more vulnerable to the financial crisis.

EWS for a banking and currency crisis has also been studied by Vietnamese researchers such as Nguyen Thi Kim Thanh et al. (2008), Nguyen Ngoc Duy and Huynh Ngoc Huy (2009), Nguyen Xuan Trinh et al. (2010), and Ho Thanh Son (2012). Most of them employed the non-parametric methodology to identify indicators for a currency crisis. Nguyen Thi Kim Thanh et al. (2008) found that 39 macroeconomic and financial indicators, such as international reserves, short-term debt to international reserves ratio, and foreign currency liabilities to foreign currency assets in banking system, could issue signals of a crisis. On the other hand, an EWS study by Nguyen Xuan Trinh et al. (2010) found that current account to GDP ratio outperformed others in predicting a currency crisis in Viet Nam.

This paper contributes to the EWS existing literature in novel ways as follows. *First*, this is the first time global shock is considered as one of leading indicators in the EWS model for a currency crisis. The model found that this variable impacts negatively and significantly on probability of a crisis. *Second*, while most studies on EWS of a crisis in Viet Nam employed non-parametric models (Nguyen Thi Kim Thanh et al. 2008, Nguyen Ngoc Duy and Huynh Ngoc Huy 2009, Ho Thanh Son 2012), the author employed a combination of parametric and non-parametric approaches for identifying indicators and probability of a currency crisis in Viet Nam. Explanatory variables in this model could be in the absolute form (model 1) or be coded as "1" if its value exceeds the threshold and "0" otherwise (model 2). *Third*, to overcome limitations of model 2, this paper employs model 3 in which codes are written in Eviews program that could avoid manual converting explanatory variables into dummy ones. In this program, we set the maximum number of errors of 1000 and grid search of three. *Fourth*, unlike recent studies on EWS in Viet Nam, this paper uses real overvaluation as an explanatory variable of a currency crisis model instead of nominal exchange rates. *Lastly*, this research extends study period from 1996 to February 2016 so that it covers all recent crises (Asian financial crisis, the global financial crisis, European debt crisis, and unexpected shocks in monetary policies of large economies such as the United States [US] and the People's Republic of China [PRC]) that could cause negative impacts on Viet Nam's economy in general, and on the financial market in particular.

The main findings of this paper are as follows. *First*, this paper found that global financial shocks (e.g., regional and global financial crisis, unexpected changes in monetary policy of largest economies such as the US and the PRC), and domestic credit growth rate are leading indicators of a currency crisis in Viet Nam. Others, such as deficits in trade balance, international reserves in import's weeks and overvalue of dong, should be good signals of a currency crisis. *Second*, among three main models (including of six sub-models) with different window lengths, model 1 (in which dependent variable, currency crisis (CC), is defined based on the EMP and parallel market premium, and all explanatory variables are expressed in absolute values with a window length of 2 months) outperformed in predicting a currency crisis-hit period in Viet Nam. Empirical results of model 1 suggested that the probability of predicting a true currency crisis was 77.5%; probability of predicting a crisis-hit period with signal was 64.6%.

The remainder of this paper is structured as follows. Section 2 will give an overview of exchange rate policy developments in Viet Nam. Section 3 will give a definition of a currency crisis in Viet Nam based on the EMP index and other events in which the central bank, the State Bank of Viet Nam (SBV), launched their policy measure related to exchange rate. Section 4 employs parametric and non-parametric models to identify leading indicators and probability of a currency crisis in Viet Nam. In addition, Model 3 is also applied to check robustness of findings. The results obtained from models and comments on these will be presented in section 4. Section 5 presents the summary and conclusion.

2. EXCHANGE RATE POLICY DEVELOPMENTS IN VIET NAM

After the reunification of Viet Nam on 30 April 1975, the socialism model applied throughout the country and confidence among Vietnamese was at an all-time high. The dong was valued at only a little less than $1.00.[1] At that time, it was a centrally planned economy with government's intervention in all macro- and microeconomic policies. This model used to be very effective and efficient in wartime, but in the long run, it distorted and severed a supply–demand law in the market as well as caused many serious economic consequences. Obviously, market realities soon forced a change. On 14 September 1985, a new dong note was issued with denomination at 10 times the value of the old dong. This action led panic through the markets as people rushed to dump dong in favor of purchasing commodities and staples. This, in turn, sparked 4 years of spiralling inflation, which reached an all-time high of 600% in 1989.

With an unstable macroeconomic background before 1988, Viet Nam applied a regime in which the exchange rate was determined by comparing internal and external purchasing power of currencies and then set by multi-parties agreements among communist countries. In other words, the exchange rate was totally determined by the Government of Viet Nam, ignoring the currency's supply and demand factors. Another characteristic of Viet Nam's exchange rate regime at that time was a multi-exchange rate which consisted of official or trade exchange rate, non-trade exchange rate, internal exchange rate, and parallel market rate. The regime, therefore, caused serious consequences for Viet Nam's economy, including (i) the overvaluation of the dong in comparison with hard currencies such as US dollar, pound sterling, French franc, Deutch mark, and yen; (ii) a wider gap between official and black market exchange rate (parallel market premium) caused loss of public confidence in dong's value; and (iii) Viet Nam's competitiveness was harmed, which led to a heavy deficit in both the trade account and the current account.

As part of its economic renovation program, Viet Nam reformed the financial and banking sector by establishing a two-tier banking system in 1988 under which the SBV, as the central bank, was separated from the four state-owned commercial banks (Rosegard and Huynh 2008, Tien N.V. 2012). Moreover, the two-tier banking system did not function as expected because the SBV was still a part of the state bureaucracy. To create a favorable legal environment for the operations of the central bank, the government approved the *Ordinance on the State Bank of Viet Nam* in which the term "monetary policy" was formally used for the first time. Although the SBV at the time was still following the old operating mechanism, the law clarified the objective of monetary management as that of stabilizing prices and the exchange rates.

During the Asian financial crisis, while most currencies in Asia (such as Thai baht, Indonesian rupiah, Malaysian ringgit, etc.) suffered from large devaluations against the US dollar and other hard currencies, the SBV kept the US dollar/dong exchange rate stable. This would lead to a large real overvaluation of the dong against the US dollar and harmed competitiveness of Viet Nam's goods and services. Therefore, severe deficits in trade balance were observed during 1996–1999. To avoid unexpected consequences of the Asian financial crisis, Viet Nam implemented a "cautious" exchange rate policy that allowed a gradual devaluation in dong, combined with strict

[1] Brahm, Laurence J, Nhi, Le Trong, Jul/Aug 1993. pp.194.

exchange controls. It was known as an adjustable (or effective) pegged exchange rate regime that could help the country stabilize real effective exchange rate (REER) (Ohno 1999) and, therefore, improve trade balances to be positive for the first time ever in 1999.

To overcome economic and financial problems caused by the Asian financial crisis, stabilize exchange rates, and enhance economic reform, the SBV's Governor approved Decision No. 64/1999/QD-NHNN7 and Decision No. 65/1999/QD-NHNN7 on exchange management. Since 25 February 1999, the SBV has followed the practice of announcing, on each working day, an official US dollar exchange rate of the dong, along with a trading band, on the basis of the average actual exchange rates of preceding days in the interbank market. The trading rate at commercial banks is determined freely among the licensed banks, subject to the requirement that buying and selling rates remain within the ceilings and floors established around the official rate of + 0.1%, then ±0.25% (effective on 1 July 2002). Therefore, instead of fixed exchange rate regime, in early 1999, Viet Nam followed a type of crawling peg exchange rate system, which the International Monetary Fund (IMF) classifies as a "de facto managed floating regime (managed floating with no pre-announced path for exchange rate)." While Viet Nam officially announced to follow a managed floating exchange rate system,[2] the current exchange rate system functions like a category of conventional pegged arrangement against a single currency (2005–2007).[3] In addition, since 2004, the Governor of the SBV has announced the exchange rate targets at the beginning of each year. It is suggested that the SBV use the exchange rate as a nominal anchor in implementing its monetary policy.

However, due to negative impacts in 2007, turbulences were seen on the foreign exchange market, such as exchange rate reached the top of 19,800 in June 2008 (about 16% higher than the official rate). Moreover, public confidence in dong value was harmful, significantly leading to an increase in deposit dollarization index. Therefore, the SBV had to implement exchange rate policy measures to stabilize both official and parallel markets, such as (i) devaluing the official exchange rate, (ii) widening the trading band on either sides of the official exchange rate, (iii) increasing interest rates, and (iv) and administrative measures that are summarized in Tables 1 and 2. After the stabilization period of 2012–2014, turbulences emerged in the foreign exchange due to unexpected changes in monetary policies of large economies such as the PRC and the US in 2015. In response, the central bank had to devalue the dong three times and widen the trading band on either side of the official rate from ±1% to ±3%.

[2] See Decree 63/1998/ND-CP on foreign exchange management and Ordinance on Foreign exchange for more details.

[3] IMF has reclassified the exchange rate regime of Viet Nam to the category of conventional pegged arrangement, from the category of managed floating with no predetermined path for the exchange rate (effective on 1 January 2005)- Annual Report on Exchange Arrangements and Exchange Restrictions, 2006 (AREAER).

Table 1: Events of Devaluing the Dong and Widening of Trading Band, 1996–2015

	Policy Measure	Announcement Date	Effective Date
	Change in the Official Exchange Rate (dong per US dollar)		
1	Devalued by 5.23%	Feb 1998	11 Jun 2008
2	Devalued by 3.92%	Aug 1998	
3	Devalued by 5.3%	Dec 1998	
4	Devalued by 6.51%	25 Feb 1999	
5	Devalued by 2% (from 16,134 to 16,461)	11 Jun 2008	11 Jun 2008
6	Devalued by 2.9% (from 16,494 to 16,989)	25 Dec 2008	25 Dec 2008
7	Devalued by 5.16% (from 17,034 to 17,961)	25 Nov 2009	26 Nov 2009
8	Devalued by 3.36% (from 17,941 to 18,544)	10 Feb 2010	11 Feb 2010
9	Devalued by 2.09% (from 18,544 to 18,932)	17 Aug 2010	18 Aug 2010
10	Devalued by 9.3% (from 18,932 to 20,693)	10 Feb 2011	11 Feb 2011
11	Devalued by 1% (from 20,828 to 21,036)	28 Jun 2013	28 Jun 2013
12	Devalued by 1% (from 21,036 to 21,246)	19 Jun 2014	19 Jun 2014
13	Devalued by 1% (from 21,246 to 21,458)	6 Jan 2015	7 Jan 2015
14	Devalued by 1% (from 21,458 to 21,673)	6 May 2015	7 May 2015
15	Devalued by 1% (from 21,673 to 21,890)	18 Aug 2015	19 Aug 2015
	Change in the Width of the Trading Band (on either side of the official rate)		
1	Widened to 1% (from 0.5% previously)	Nov 1996	
2	Widened to 5%	Feb 1997	
3	Widened to 10%	Oct 1997	
4	Widened to 0.25% (from 0.1% previously)	Jul 2002	
5	Widened to 0.75%	24 Dec 2007	24 Dec 2007
6	Widened to 1%	7 Mar 2008	10 Mar 2008
7	Widened to 2%	26 Jun 2008	27 Jun 2008
8	Widened to 3%	6 Nov 2008	7 Nov 2008
9	Widened to 5%	24 Mar 2009	25 Mar 2009
10	Narrowed to 3%	25 Nov 2009	26 Nov 2009
11	Narrowed to 1%	10 Feb 2011	11 Feb 2011
12	Widened to 2%	11 Aug 2015	12 Aug 2015
13	Widened to 3%	18 Aug 2015	19 Aug 2015

Source: The State Bank of Vietnam and extracted from Takagi and Pham (2011).

Table 2: Foreign Exchange Controls in Viet Nam, 1988–2015

Policy Measures	Details	Objectives
Foreign exchange position to equity ratio	– SBV imposed limits in foreign exchange position not to exceed 30% of a commercial bank's equity in both long and short sides (September 1998). This ratio decreased to 20% in March 2012.	– Limiting speculative activities by commercial banks during period of turbulences in the FOREX market – Increasing supply of US dollar in the FOREX
Foreign exchange surrender requirements	– In August 1998, SBV imposed foreign exchange surrender requirements of up to 80% of available balances (Decision 173/QD-TTg), reduced to 50% (August 1999), and fully relaxed them in May 2003. – In November 2009, surrender requirements were applied for seven state-owned corporations;[a] and extended to all state-owned corporations.	– Increasing supply of US dollar in the FOREX
Administrative measures on the parallel market	- The government send polices and other authorities to stop parallel market operations – They imposed very strict punishments on illegal activities in foreign exchange and gold market	– Limiting activities by speculators in the parallel market during period of turbulences in the FOREX – Increasing supply of US dollar and decreasing demand for US dollar in the FOREX

FOREX = foreign exchange, SBV = State Bank of Vietnam, US = United States.

[a] The seven state-owned corporations included PetroVietnam, Vietnam National Coal-Mineral Industries Group, Vietnam National Chemical Group, Southern Airport Corporations, Vietnam Northern Food Corporation, Vietnam Southern Food Corporation, and Vietnam Machinery Erection Corporation. They were required to sell immediately 30% of the foreign currency term deposits they held (as of 31 December 2009), and the remaining 70% within the first 2 months of 2010.

Source: Author's compilation from the SBV's website.

3. MODEL SPECIFICATIONS

3.1 Currency Crisis or Foreign Exchange Market Turbulences in Viet Nam

The EWS of a currency crisis could be valuable for policy makers in the sense that it could be used for detecting underlying economic weakness and vulnerabilities, and allowing the adoption of preemptive measures to reduce the risks of experiencing a crisis (Bussiere and Fratzscher 2006). Currency crisis usually refers to a situation in which the economy is under pressure of a sharp depreciation in local currency value. Therefore, in most papers, currency crisis is defined as (i) large devaluations adjusted for interest rate differentials, and (ii) large devaluations which exceed the devaluation in the previous period by some multiple (Kumar et al. 2003). In this case, the monetary authorities have to defend the domestic currency by selling foreign exchange reserves or raising the domestic interest rate (Glick and Hutchison 2011).

Since the official foreign exchange market was established in 1994, Viet Nam has experienced several "currency crises." However, unlike most countries, the magnitude of Viet Nam's currency crisis is not large as those of other currency crises such as the Asian financial currency crisis, the Russian Federation financial crisis (1998 and 2014), etc. In practice, currency crises in Viet Nam happened and lasted for a shorter period such as weeks, 1 month, or 2 months. Based on definition of currency crisis suggested by Kaminsky et al. (1997), Kumar et al. (2003), Goldstein et al. (2000), and Bussiere and Fratzscher (2006), the paper sheds light on new approach of currency crisis definition in which Viet Nam could suffer from a currency crisis or exchange rate turbulences if

(i) Exchange market pressure (EMP) at time i is above its country average EMP and two standard deviations (SD)

(ii) Parallel market premium is 5% above the targeted trading band set by the SBV;

Parallel market premium = $\frac{PER-OER}{OER} * 100$

in which: PER is exchange rate at Ha Noi parallel exchange market

OER: average weighted interbank exchange rate

We choose parallel market premium as a measure of currency crisis because the parallel market is illegal but has emerged in response to the tight control of foreign exchange transactions in the official market. In practice, parallel rate is totally determined by demand and supply conditions, and is, in principle, not subject to regulations by the SBV, while official rate seemed to be constant overtime (set by the SBV). Therefore, parallel rate will immediately react to any unexpected changes in demand and supply leading to a gap (parallel market premium) between parallel and official rate. If parallel market premium is becoming larger, the SBV should sell international reserves to stabilize FOREX and launch a comprehensive package of policy measures to stabilize the market (see more in Tables 1 and 2).

3.2 Parametric or Non-parametric Model

The EWS of financial crisis, banking crisis, and currency crisis could be based on parametric (i.e., regression based) and non-parametric approach (crisis signal extraction). By using regression methodology of discrete variables such as logit and probit, parametric approach to EWS of financial crises is employed to estimate the probability of crisis. Based on the non-parametric approach, Kaminsky et al. (1998) argue a set of leading indicators that could issue good signal of a currency crisis in the next 24 months. In that study, the authors employed event study to find out developments of macroeconomic indicators as well as financial variables (i.e., domestic credit growth rate, money supply growth rate, deficits in state budget and current accounts, real overvaluation, international reserves) before a crisis-hit period. The similar model and findings could be found in some studies, such as Frankel and Rose (1996), and Kaminsky and Reinhart (1999), where they used annual data on a set of countries to estimate causes of a financial crisis. However, it was not suitable for predicting probability of a financial crisis.

To overcome this problem, recent studies, such as Berg et al. (2005) with the developing country studies division (DCSD) model, Beckmann et al. (2006), and Comelli (2013), used monthly data to calculate the probability of a currency crisis in real time. In the non-parametric EWS, the crisis probability Pt is calculated as a weighted average of crisis signals issued by a set of selected macroeconomic

indicators. To establish when an indicator is issuing a crisis signal, there is a need to choose a threshold. If an indicator exceeds the threshold, it is considered to issue a crisis signal.

Non-parametric EWS is very simple, but its limitation is that it assumes linearity relationship between indicators of a currency crisis. On the other hand, the parametric approach to EWS helps in identifying probability of a currency crisis. In terms of performance, Beckmann et al. (2006) and Comelli (2013) suggested that the parametric EWS achieves superior out-of-sample results compared with the non-parametric EWS. Moreover, this approach combines all variables simultaneously and disregards variables that do not contribute information to the model (Kaminsky et al. 1998). However, it still has some limitations such as (i) not providing a quantitative ranking measure for indicators based on their ability of predicting a currency crisis, and (ii) not providing a transparent reading of where and how widespread macroeconomic problems are (Kaminsky et al. 1998).

In this research, I, therefore, will combine both parametric and non-parametric methods to identify leading indicators as well as probability of a currency crisis in Viet Nam. The probit model of discrete variable is as follows:

$$y_i^* = \alpha_0 + \beta_i X_i + u_i \quad (1)$$

In which X_i: vector of explanatory variables

β_i: Coefficient vector of explanatory variables

u_i: Error term that is normal distributed

y_i^* are unobservable variables, but y_i (CC) is observable variables, in which:

$y_i = 1$ if $y_i^* > 0$

$y_i = 0$ if $y_i^* \leq 0$

3.3 Model Variables

3.3.1 Dependent/Explained Variable-Currency Crisis

As mentioned in section 2, unlike other studies on EWS, currency crisis in Viet Nam is defined based on two criteria: exchange market pressure and parallel market premium.

a. Exchange Market Pressure (EMP)

Exchange market pressure (EMP) was first introduced by Girton and Roper (1977) who argued that the status of money market disequilibrium must be removed either through international reserves ($\Delta\log\mathrm{RES_t}$ or $\Delta\mathrm{RES_t}/\mathrm{MS_{t-1}}$) or exchange rate changes ($\Delta\log\mathrm{H_t}$). The EMP could be calculated as follows:

(i) EMP is defined as a simple sum of a change in exchange rate at time *t* in comparison with time *(t-1)* and a change in international reserves at time *t* in comparison with time *(t-1):*

$$\mathrm{emp1} = \Delta\log\mathrm{EMP1_t} = \Delta\log\mathrm{H_t} + \Delta\log\mathrm{RES_t} \quad (1a)$$

(ii) It is calculated by taking a simple sum of a change in exchange rate at time *t* in comparison with time *(t-1)* and a ratio of international reserves at time *t* over money supply *at* time *t:*

$$\text{emp2} = \Delta\text{logEMP2}_t = \Delta\text{logH}_t + \Delta\text{RES}_t/\text{MS}_{t-1} \quad (1b)$$

(iii) It is also identified by an weighted average of three components: (1) a change in exchange rate at time *t* in comparison with time *(t-1)*; (2) a change in domestic interest rate at time *t* in comparison with time *(t-1)*; and (3) a change in international reserves at time *t* in comparison with time *(t-1)* [Bussiere and Fratzscher (2006)]:

$$emp3 = \omega_{RER}\left(\frac{RER_t - RER_{t-1}}{RER_{t-1}}\right) + \omega_r(r_t - r_{t-1}) + \omega_{RES}\left(\frac{RES_t - RES_{t-1}}{RES_{t-1}}\right) \quad (1c)$$

In which RES_t: In most recent studies, data on international reserves is used in the formula to calculate exchange market pressure. However, the author argues that data on international reserves does not seem to reflect perfectly the amount of foreign currency denominated assets in a dollarized economy like Viet Nam. Therefore, this study employs data on Net Foreign Asset (NFA) in the banking system collected from the IMF's International Financial Statistics.

MS_t: Money supply (M2) at time *t*.

RER: real effective exchange rate

H: A weighted average of interbank exchange rate announced by the SBV between US dollar and the dong.

Among them, the third methodology could be considered as the most accurate way of EMP because it takes into account the weight of each component. It is very difficult to assign suitable weights for each component. Therefore, EMP is calculated based on the first and the second methodologies. Then, this study defines a CC that will happen if EMP at time *t* is more above its country average EMP and two standard deviations (SD) [Bussiere and Fratzscher (2006)].

$$CC = \begin{cases} 1 \; if \; emp > \overline{emp} + \; 2SD(emp) \\ 0 \; if \; otherwise \end{cases}$$

In which CC: currency crisis

b. Parallel Market Premium:

Currency crisis in Viet Nam will happen if the parallel market premium is 5% higher than the official trading band. For calculating parallel market premium, exchange rate of US dollar/dong is collected at the Ha Noi parallel market around 11 a.m. of working days (for parallel exchange rate) and from the SBV's official website (for official exchange rate).

3.2.2 Independent/Explanatory Variables

According to Kaminsky et al. (1998) and the overall macroeconomic background in Viet Nam, I will use explanatory variables that could be considered as a signal of a currency crisis as follows:

(i) Overvaluation (OVERVALUE) is calculated by the formula:

OVERVALUE = – (RER-1)*100;

in which RER – Bilateral real exchange rate between US dollar and Vietnamese dong at the base year of 1995. Exchange rate is collected from the SBV's website;[4] consumer price index for the US (CPI_t^{US*}) and Viet Nam (CPI_t^{VN}) is extracted from the IMF's International Financial Statistics. RER is calculated using the following formula:

$$\mathrm{RER}_{\mathrm{VND,t}} = \mathrm{NER}_{\mathrm{VND,t}} * \frac{\mathrm{CPI}_t^{US}}{\mathrm{CPI}_t^{VN}}$$

(i) International reserves in import's weeks (RES);

(ii) Domestic credit growth (DC);

(iii) Deficits in trade balance per GDP ratio (TB) (in percent);

(iv) Shock in the global financial market (GLO_SHOCK): Viet Nam is a small open economy in terms of openness index [5] as well as financial integration. Therefore, Viet Nam's financial market was considered to be negatively affected by shocks such as the Asian financial crisis, the global financial crisis, the European debt crisis, and devaluation events in the PRC, etc. This variable was assigned as "1" in a period in which the crisis happened or unexpected changes in monetary policies of largest economies were implemented; otherwise, it was coded as "0."

All data are collected on a monthly basis for the period 1996–Feb 2016 and collected from the IMF's International Financial Statistics. Explanatory variables in the non-parametric model will not be in absolute value, they are usually coded as "1" if its value is above the threshold, otherwise the contrary outcome as "0." Therefore, the most important thing in the EWS model of currency crisis is to determine the optimal threshold of each explanatory variable so that the forecasting error would be reduced. It is very difficult because a lower threshold may lead to the fact that some non-crisis events are considered as a crisis (Type 2 error—issuing a false alarm); and a higher threshold may ignore some actual crisis (Type 1 error—missing a crisis because the threshold has been set too high).

Based on the macroeconomic background in Viet Nam, this paper assigns thresholds for each explanatory variable (Table 3). However, to check robustness of findings, I also employ Model 3 written in Eviews software (in subsection 4.2). This program will help to identify suitable thresholds for explanatory variable and make converting process smoother.

[4] www.sbv.gov.vn.

[5] Openness ratio is calculated by taking sum of export and import over GDP.

Table 3: Threshold of Independent Variables in Early Warning System Model for a Currency Crisis in Viet Nam

Variables	Threshold	Signal
Overvaluation	5%	+
International reserves in import's weeks	10 weeks	
Trade balance per gross domestic	15%	–
Domestic credit growth	25%	+

Note: (+) indicates the higher the variable's value, the higher the probability of currency crisis; (–) indicates the higher the variable's value, the lower the probability of currency crisis.

3.2.3 Identifying the Window Length of Currency Crisis

In the EWS model, window length of currency crisis is usually 12 months or 24 months (Kaminsky et al, 1998, Commelli 2013). However, as mentioned earlier, the magnitude of Viet Nam's currency crisis is not large: it happened and lasted for a shorter period such as weeks, 1 month, or 2 months. Therefore, instead of 12 or 24 months, I will choose window lengths of 1 month and 2 months for the EWS model of currency crisis in Viet Nam.

To check the effectiveness of probit model in identifying leading indicators of currency turbulences in Viet Nam, I use two types of models. The first model (Model 1) is a linear probit in which all explanatory variables are expressed in its absolute values, while the second model (Model 2) is also a linear probit, but all explanatory variables are coded as "1" if its value is above the threshold, otherwise coded as "0." Moreover, each model is tested for different lengths of window such as 1 month and 2 months. It, therefore, gives a total of four models for checking the robustness of leading indicator of a currency crisis in Viet Nam.

4. EMPIRICAL RESULTS AND COMMENTS

4.1 Empirical Results

4.1.1 Model 1

A linear probit in which all explanatory variables are expressed in its absolute values, and CC is defined by EMP and parallel market premium with window lengths of 1 month and 2 months.

Table 4: Impacts of Explanatory Variables on Currency Crisis in Viet Nam, Window Length of 1 Month Extracted from the Early Warning System Models

Variables	Coefficient	Standard Errors	Z-Statistics	P-value
C	–1.493307	0.353806	–4.220698	0.0000
DC***	0.034761	0.009076	3.830219	0.0001
GLO_SHOCK***	0.911579	0.214058	4.258557	0.0000
OVERVALUE***	0.019623	0.007346	2.671299	0.0076
RES	–0.010926	0.030023	–0.363915	0.7159
TB	0.004376	0.005231	0.836647	0.4028

C = constant in regression function, DC = domestic credit growth, GLO_SHOCK = global shock, RES = international reserves in import's weeks, TB = deficits in trade balance per GDP ratio.

Notes: ***indicates coefficient is significant at the 1% level, ** indicates coefficient is significant at the 5% level, and * indicates coefficient is significant at the 10% level.

Table 5: Evaluation of Probit Model at Different Probability Cutoff Points

	No Signal	Signal	Total
a./ Probability cutoff point (p) = 0.5			
Non-crisis-hit period	154	35	189
Crisis-hit period	14	39	53
Total	168	74	242
Probability of true observations		(154+39)/242 = 79.75%	
Probability of predicting a true currency crises		39/53 = 73.6%	
Probability of wrong signal over total signals		35/74 = 47.3%	
Probability of currency crises with signals		39/74 = 52.7%	
Probability of currency crises without signals		14/168 = 8.3%	
b./ Probability cutoff point (p) = 0.3			
Non-crisis-hit period	135	24	159
Crisis-hit period	33	50	83
Total	168	74	242
Probability of true observations		(135+50)/242 = 76.44%	
Probability of predicting a true currency crises		50/83 = 60.24%	
Probability of wrong signal over total signals		24/74= 32.43%	
Probability of currency crises with signals		50/74 = 67.57%	
Probability of currency crises without signals		33/168 = 19.64%	

Table 6: Impacts of Explanatory Variables on Currency Crisis in Viet Nam, Window Length of 2 Months Extracted from the Early Warning System Models

Variables	Coefficient	Standard Errors	Z-Statistics	P-value
C	–1.089733	0.348155	–3.130021	0.0017
DC***	0.041250	0.009332	4.420492	0.0000
GLO_SHOCK***	0.956439	0.216516	4.417417	0.0000
OVERVALUE***	0.018579	0.006956	2.671038	0.0076
RES	–0.038363	0.030068	–1.275858	0.2020
TB	0.004685	0.005251	0.892136	0.3723

C = constant in regression function, DC = domestic credit growth, GLO_SHOCK = global shock, RES = international reserves in import's weeks, TB = deficits in trade balance per GDP ratio.

Notes: ***indicates coefficient is significant at the 1% level, ** indicates coefficient is significant at the 5% level, and * indicates coefficient is significant at the 10% level.

Table 7: Evaluation of Probit Model at Different Probability Cutoff Points

	No Signal	Signal	Total
a./ Probability cutoff point (p) = 0.5			
Non-crisis-hit period	128	34	162
Crisis-hit period	18	62	80
Total	146	96	242
Probability of true observations		78.5%	
Probability of predicting a true currency crises		77.5%	
Probability of wrong signal over total signals		35.4%	
Probability of currency crises with signals		64.58%	
Probability of currency crises without signals		12.32%	
b./ Probability cutoff point (p) = 0.3			
Non-crisis-hit period	85	28	113
Crisis-hit period	61	68	129
Total	146	96	242
Probability of true observations		63.22%	
Probability of predicting a true currency crises		52.7%	
Probability of wrong signal over total signals		29.1%	
Probability of currency crises with signals		70.9%	
Probability of currency crises without signals		41.78%	

4.1.2 Model 2

A linear probit in which all explanatory variables are coded as “1” if its value is above the threshold, otherwise coded as “0”, and CC is defined by EMP and parallel market premium with window lengths of 1 month and 2 months.

Table 8: Impacts of Explanatory Variables on Currency Crisis in Viet Nam, Window Length of 1 Month Extracted from the Early Warning System Models

Variables	Coefficient	Standard Errors	Z-Statistics	P-value
C	–0.999425	0.176947	–5.648169	0.0000
T_DC**	0.453377	0.199150	2.276555	0.0228
GLO_SHOCK***	0.987276	0.219630	4.495190	0.0000
T_OVER	0.202854	0.202131	1.003573	0.3156
T_RES*	0.443608	0.258217	1.717967	0.0858
T_TB**	–0.417342	0.205789	–2.028005	0.0426

Notes: ***indicates coefficient is significant at the 1% level, ** indicates coefficient is significant at the 5% level, and * indicates coefficient is significant at the 10% level.

Table 9: Evaluation of Probit Model at Different Probability Cutoff Points

	No Signal	Signal	Total
a./ Probability cutoff point (p) = 0.5			
Non-crisis-hit period	153	40	193
Crisis-hit period	15	34	49
Total	168	74	242
Probability of true observations		77.2%	
Probability of predicting a true currency crises		69.38%	
Probability of wrong signal over total signals		54.05%	
Probability of currency crises with signals		45.95%	
Probability of currency crises without signals		8.9%	
b./ Probability cutoff point (p) = 0.3			
Non-crisis-hit period	141	33	174
Crisis-hit period	27	41	68
Total	168	74	242
Probability of true observations		75.2%	
Probability of predicting a true currency crises		61.2%	
Probability of wrong signal over total signals		44.6%	
Probability of currency crises with signals		55.4%	
Probability of currency crises without signals		16.07%	

Table 10: Impacts of Explanatory Variables on Currency Crisis in Viet Nam, Window Length of 2 Months Extracted from the Early Warning System Models

Variables	Coefficient	Standard Errors	Z-Statistics	P-value
C	–0.584690	0.171976	–3.399836	0.0007
T_DC**	0.385199**	0.192505	2.000981	0.0454
GLO_SHOCK***	1.103495*	0.219797	5.020526	0.0000
T_OVER	–0.059322	0.197741	–0.299997	0.7642
T_RES***	0.688916*	0.262114	2.628304	0.0086
T_TB***	–0.517143*	0.198478	–2.605546	0.0092

Notes: ***indicates coefficient is significant at the 1% level, ** indicates coefficient is significant at the 5% level, and * indicates coefficient is significant at the 10% level.

Table 11: Evaluation of Probit Model at Different Probability Cutoff Points

	No Signal	Signal	Total
a./ Probability cutoff point (p) = 0.5			
Non-crisis-hit period	127	49	176
Crisis-hit period	19	47	66
Total	146	96	242
Probability of true observations		71.9%	
Probability of predicting a true currency crises		71.2%	
Probability of wrong signal over total signals		51%	
Probability of currency crises with signals		49%	
Probability of currency crises without signals		13.01%	
b./ Probability cutoff point (p) = 0.3			
Non-crisis-hit period	99	29	128
Crisis-hit period	47	67	114
Total	146	96	242
Probability of true observations		68.6%	
Probability of predicting a true currency crises		58.8%	
Probability of wrong signal over total signals		30.2%	
Probability of currency crises with signals		69.8%	
Probability of currency crises without signals		32.2%	

4.2 Robustness Check

In Model 2, the explanatory variables are converted into binaries according to the pre-specified threshold values (Table 3). However, we realized that we may be throwing away some useful information that can lead to less precise estimates of the coefficients. In order to verify the adequacy of these values, we have conducted a grid search over different values of thresholds (Table 12). This program will help to identify suitable thresholds for explanatory variables and make converting smoother. In addition, we want to check if thresholds in Model 2 are reasonable or not.

Table 12: Choosing Grid and Grid Width to Identify Thresholds for Variables

	Grid	Grid Width	Threshold in Model 2
DC	20, 25, 30, …, 50	5	25
OVERVALUE3	0.0, 2.5, 5.0, …, 20.0	2.5	5
RES	6, 8, 10, 12	2	10
TB	–20, –15, –10, –5	5	–15

DC = domestic credit growth, RES = international reserves in import's weeks, TB = deficits in trade balance per GDP ratio.

Total number of combinations amounts to 1008. In order to choose the best model for predicting a currency crisis, we have sorted the model into three criteria: (i) probability of predicting a true currency crisis (criterion-1); and (ii) probability of currency crises with signals (criterion-2); and (iii) Akeike Information Criterion (AIC) (Appendix 1).

In terms of the probability of predicting a true currency crisis (criterion-1), models with thresholds of DC=35 percent, RES=10 weeks, TB=-15 percent, and OVERVALUE=15 percent or 17.5 percent are selected as the best, with the probability 77.77%. The values of "RES" and "TB" match with the thresholds in Model 2. On the other hand, this result suggests use of slightly higher thresholds for "DC" and "OVERVALUE". However, the performance of these models worsens in terms of criterion-2.

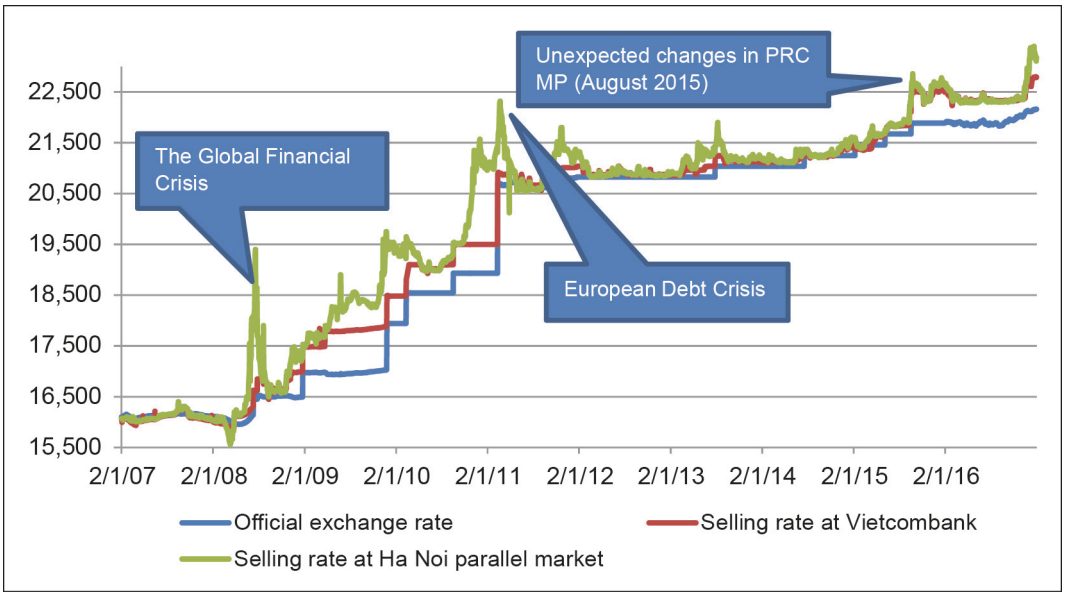
In terms of the probability of currency crises with signals (criterion-2), there are seven models which give the same probability. Again, the models suggest a slightly higher threshold for "DC". These models also suggest use of a slightly higher threshold for "TB". For "OVERVALUE" and "RES," though the predictabilities are the same for different combinations, they again suggest a slightly higher threshold for "OVERVALUE". Talking about the "RES," they are consistent with the setting of Model 2. Again, the performance of these models worsens in terms of criterion-1. Overall, the results confirm that the thresholds used in Model 2 are reasonable for "RES" and "TB". For "DC" and "OVERVALUE," though the analysis suggests slightly higher thresholds, the models with suggested thresholds cannot dominate Model 2 in terms of two criteria simultaneously. Therefore, we reconfirm that thresholds of explanatory variables in Model 2 are reasonable for predicting a currency crisis in Viet Nam.

4.3 Comments on Results

In general, we observed different roles of macroeconomic indicators in predicting a currency crisis in Viet Nam. Based on empirical results of the specified probit models with different window lengths, some main findings are as follows:

First, external shocks (e.g., regional or global financial crisis and unexpected changes in monetary policy) are proved to be the most important indicator of a currency crisis in Viet Nam which is significant at the 1% level for all tested models. In other words, Viet Nam's financial market, especially foreign exchange market, is easily vulnerable to external shock in the international financial market. This finding could be explained by a high openness ratio in Viet Nam's economy.

Figure 1: External Shocks and Foreign Exchange Market Turbulences, 2006–2015



Source: www.sbv.gov.vn; www.vangsaigon.com.vn; and www.vcb.com.vn.

Second, similar to external shock, our models find that high growth in domestic credit was also considered as an empirical reason of a currency crisis in Viet Nam at significance level of 1% in all four models. This finding is consistent with theory as well as empirical evidence suggested by Kaminsky (1998), Berg and Pattillo (1999), and Edison (2003). A high growth rate of domestic credit would lead to a decrease in soundness of commercial banks by increasing non-performing loan ratio, reducing the return on asset (ROA) and return on equity (ROE) ratios, etc.; in the worst-case scenario, it could lead to a banking crisis. The world economy has witnessed a series of banking crises as well as currency crises which resulted from a boom in domestic credit that happened not only in developed countries such as the US (the US subprime loan crisis in 2007–2008), Japan (in the early 1990s), but also in developing countries (East Asian countries in 1997). In some cases, banking and currency crises have tended to cluster and have come to be known as the "twin crises" (Kaminsky 1998).

Bank lending was proved to be the most effective channel in transmission mechanism of monetary policy in Viet Nam (Nguyen Thanh Nhan et al. 2013, Pham Thi Hoang Anh et al. 2013) so that the SBV has been employing domestic credit growth as an operating target. High credit growth rate of 25% was seen as a very important determinant of economic growth in Viet Nam (To Ngoc Hung et al. 2013, Pham Thi Hoang Anh et al. 2013). However, domestic credit growth rate above the threshold of 25% will be harmful to assets' quality of Viet Nam's banking system. By relaxing the condition for lending activities as a part of stimulus package in responses to negative impacts of the global financial crisis, domestic credit to the economy increased sharply from 25% in 2007 to more than 50% in 2008 and 2010 (Figure 2). This fact led Viet Nam's banking system to face many difficulties such as high nonperforming loan ratio,[6] liquidity deficits,[7] etc. The banking crisis and macroeconomic difficulties (high inflation rate, high unemployment, high deficit in trade balance, and tumble in the stock market) resulted in chaos in gold and foreign exchange market during 2010–2012. These findings suggest that the monetary authorities should set the target for domestic credit below 25%. Additionally, it could be inferred that the authorities also need to create a favorable environment for developing other channels of capital transfer such as stock market and bond market, and then reducing the economy's independence on the banking system.

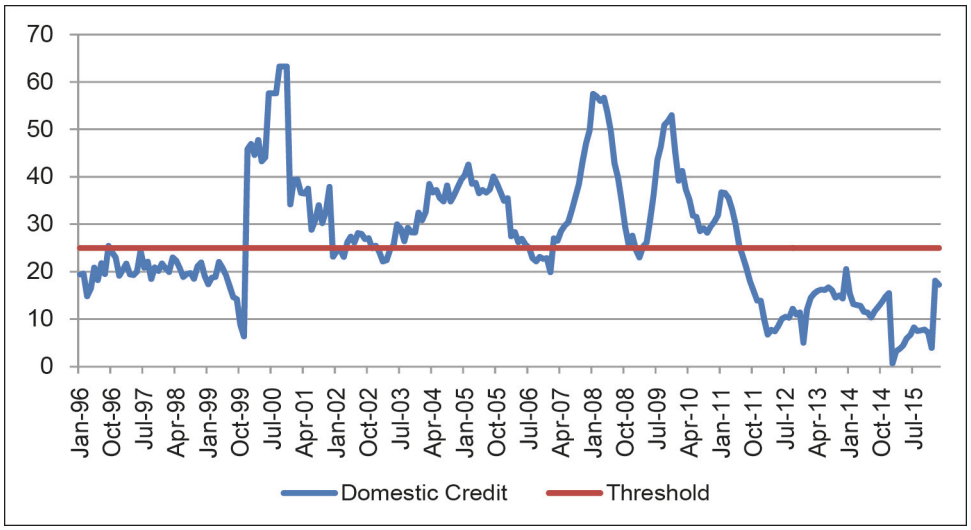
Third, overvaluation is found to be one of leading indicators of currency crisis in Viet Nam. In other words, the higher the overvaluation, the higher the probability of currency crisis in Viet Nam, which is significant at the 1% level for the first model in which all explanatory variables are expressed in its absolute values. This finding is consistent with those of Kaminsky et al. (1998) and Llaudes et al. (2010). According to international trade theory, overvaluation will diminish a country's competitiveness leading to an increase in import and a decrease in export. This movement will harm the trade balance[8] status resulting in depreciation pressure because of excess demand, even unexpected large fluctuations in the foreign exchange market.

[6] According to the SBV report, nonperforming loan ratio is 17.21% after the SBV revaluates loans in 2013.

[7] Because of liquidity shortage within Viet Nam's banking system, overnight and 1-month interbank interest rate reached the top of about 16% and more than 30% per year in 18 October 2011, respectively (http://kinhdoanh.vnexpress.net/tin-tuc/ebank/ngan-hang/lai-suat-lien-ngan-hang-len-30-ky-han-mot-thang-2715756.html).

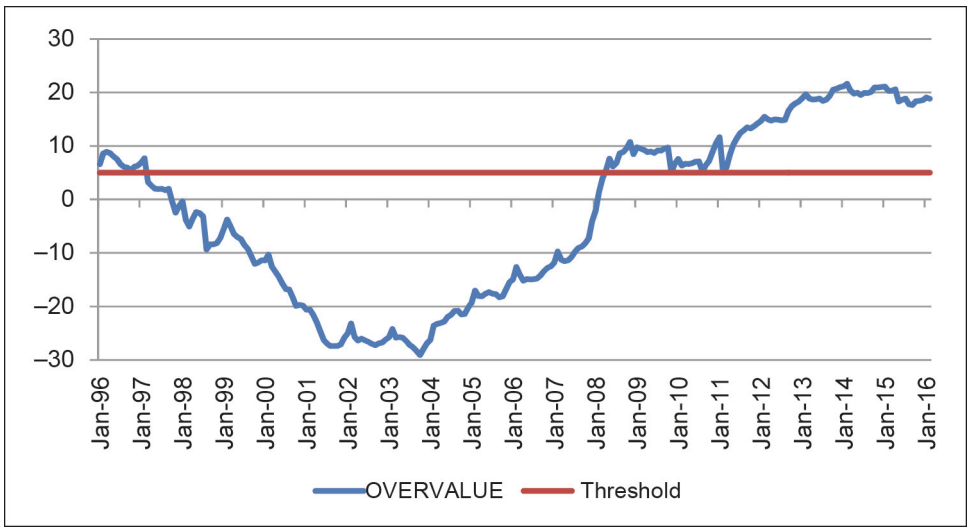
[8] Because of large overvaluation of the dong against the US dollar since 2008, the trade balance had begun to record a large deficit of $14.21 billion in the first 6 months of 2008.

Figure 2: Domestic Credit Growth, 1996–2016
(y-o-y, in %)



Source: Author's calculations from data extracted from the International Monetary Fund's International Financial Statistics.

Figure 3: Overvaluation of the Vietnamese Dong and its threshold, 1996–2015
(the base year of 1995) (in %)



Source: Author's calculations from data extracted from the State Bank of Vietnam and the International Monetary Fund's International Financial Statistics.

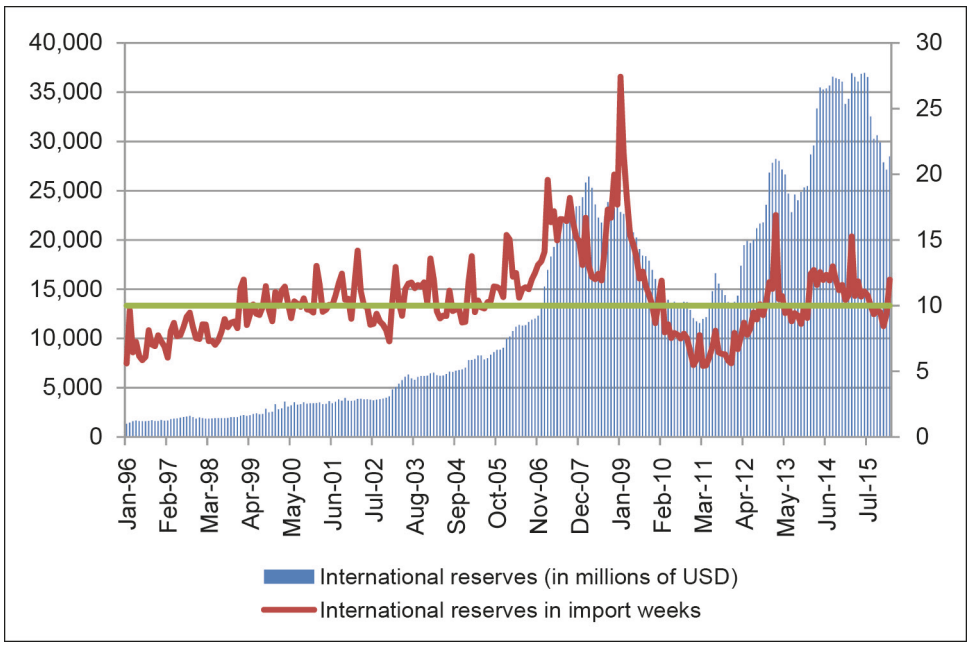
The Vietnamese dong has been largely overvalued since 2008 and exceeded its threshold of 5% (Figure 3). In addition, as market participants saw lurking problems for the prospects of Viet Nam's economy,[9] the dong began to depreciate from late May 2008, reaching a bottom of 16,522 per US dollar on 8 July in the interbank market and 19,400 per US dollar on 19 June 2008 in the parallel market (Takagi and Pham 2011). Morgan Stanley, for example, stated on 7 July 2008: "Vietnam will fail to halt declines in

[9] The rate of inflation had reached more than 28% (year-on-year) in August 2008, the highest in 17 years; equity and real estate prices had tumbled from the beginning of the year (the declines would amount to nearly 70% and 50%, respectively, from January to December); market interest rates had risen substantially (e.g., from 7.5% in January to 19% in July for 3-month deposits).

their currency by using intervention because their economy is slowing and trade deficits widening."[10] Around the same time, some observers believed that Viet Nam was facing a speculative attack on the currency.[11] In order to stabilize, the authorities have to implement policy measures including selling its international reserves and raising domestic interest rate, and other administrative measures such as a policy to seize the parallel market, imposing surrender requirements and foreign exchange position to bank's equity, etc. This finding implies that the SBV should keep the overvaluation index below 5%; otherwise, the country might face currency turbulences. However, for a country following the pegged regime and suffering from high inflation like Viet Nam, it seems to be very difficult for the monetary authorities to do so. In this case, the SBV should curb inflation pressures while maintaining the pegged regime.

Apart from the first model, results from the second model show that overvalue is underperformed in issuing a signal of currency crisis in Viet Nam. In practice, by taking an empirical test of the Marshall Lerner condition, Pham (2003) and Pham et al. (2013) found that exchange rate was not significant factor for enhancing the country's trade balance status. These could be the reasons for the unclear empirical results on impact of overvalue on currency crisis in Viet Nam.

Figure 4: International Reserves in Import's Week in Viet Nam, 2001–Feb 2016
(in millions of US dollar – the left axis; in weeks – the right axis)



Source: Author's calculations from data extracted from the General Statistics Office (GSO) and the International Monetary Fund's International Financial Statistics.

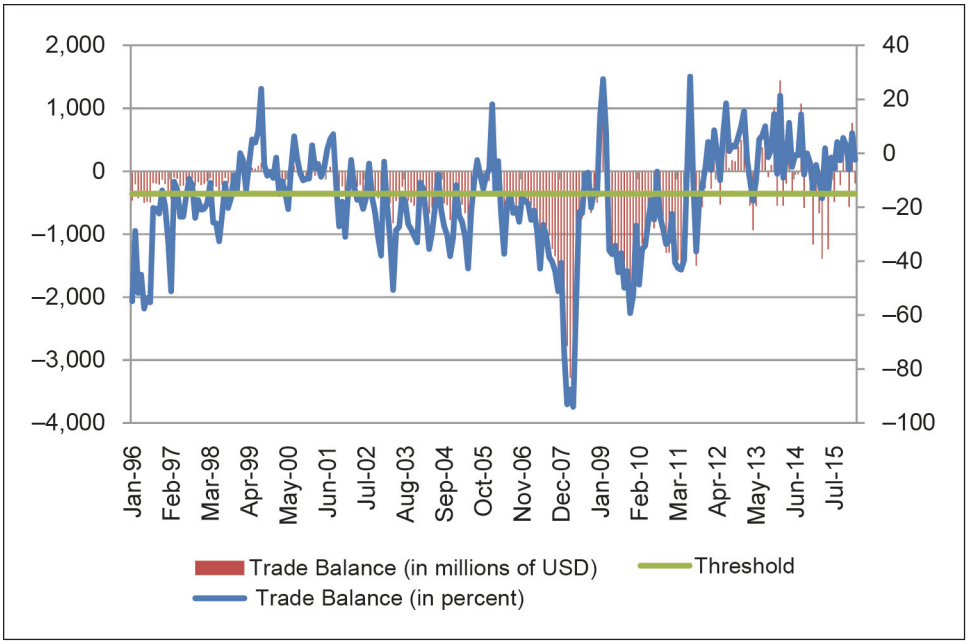
[10] AmCham Vietnam. Korea, India, Vietnam Currency Interventions May Fail – Morgan Stanley. http://www.amchamvietnam.com/korea-india-vietnam-currency-interventions-may-fail-morgan-stanley/ (accessed 28 February 2017).

[11] See, for example, Moody's Economy.com. 2008. Is Vietnam Facing a Currency Crisis? 13 June, http://futuresasia.blogspot.com/2008/06/is-vietnam-facing-currency-crisis.html (accessed 28 February 2017).

Fourth, the probit model does find significantly positive coefficients between a reduction in international reserves in import's weeks and probability of currency crisis especially for the second model. In other words, the country's foreign exchange reserves could be considered as a good signal of a currency crisis in Viet Nam in the sense that, if this indicator is below 10 import's weeks, the country should have a high probability of facing large fluctuations in the foreign exchange market. This variable does benefit from statistically significant findings in studies by Kaminsky (1998), Nguyen Thi Kim Thanh et al. (2008), Nguyen and Huynh (2009), and Comelli (2013).

There was difference between de jure and de facto exchange rate regimes in Viet Nam. Although Viet Nam's monetary authorities officially announced that the country follows a managed float exchange rate, [12] by looking at actual volatility of exchange rate (US dollar/dong) and empirical evidence from econometric models, it is considered as a simple dollar peg (Takagi and Pham 2011) or other conventional pegged regime and stabilized arrangement. [13] According to a monetary theory, international reserves play a very important role in stabilizing the foreign exchange market, especially in the pegged regime. A reduction in international reserves, for example below threshold, implies that the country does not have enough ability in intervening in the foreign exchange market in the case of devaluation pressure. It, therefore, might lead to a high probability of a currency crisis in Viet Nam. Figure 2 shows a significant drop in Viet Nam's international reserves from a top of 26 weeks (in 2008) to a bottom of 5 weeks of import (2011). This was also a period of sharp movements in exchange rate in Viet Nam, namely a currency crisis.

Figure 5: Trade Balance and Trade Balance to Gross Domestic Product Ratio in Viet Nam, 1996–2016
(in millions of US dollar-the left axis; in percent-the right axis)



Source: Author's calculations from data extracted from the General Statistics Office (GSO) and the International Monetary Fund's International Financial Statistics.

[12] Article 30, Ordinance on Foreign Exchange approved by national Assembly of Vietnam, took effect on 1 July 2006.

[13] Annual Report on Exchange Arrangements and Exchange Restrictions (IMF), various issues.

Fifth, this paper found that deficits in trade balance have negative impact on the probability of currency crisis as expected, especially for the second model. According to the balance of payment approach to exchange rate determination, a country with large deficit in trade balance would lead to an excess demand of foreign currency in the foreign exchange market. If this is the case, devaluation pressure in local currency's value could increase probability of a currency crisis. Viet Nam's trade balance has been in deficit for a long time, especially during 2007–2010 (Figure 4). The finding suggests that the country should improve its trade balance. Policies that would be beneficial toward this goal include (i) enhancing export competitiveness and shifting export pattern from raw materials to processed products, (ii) developing subordinating industries, etc.

Last but not the least*, empirical evidence collected from all probit models suggested that Model 1 with window length of 2 months outperformed in comparison with Model 2*. In other words, Model 1 could be the best model for predicting a currency crisis in Viet Nam. In this model, explained/dependent variable-CC is defined based on the EMP and parallel marker premium, and all explanatory variables are expressed in its absolute values with window length of 2 months. Empirical results suggested that probability of predicting a true currency crisis was 77.5%; probability of predicting a crisis-hit period with signal was 64.6%. However, we realized that, by converting each explanatory variable to a dummy (model 2), some useful information may be thrown away which can lead to less precise estimates of the coefficients. Therefore, this paper employs the Model 3 written in Eview software program, which will help to identify suitable thresholds for explanatory variable and make the converting process smoother. Empirical results from Model 3 provide robust evidence on leading indicators of a currency crisis in Viet Nam.

5. CONCLUDING REMARKS

This paper aims to identify leading indicators and a suitable EWS model of a currency crisis in Viet Nam based on a combination of parametric and non-parametric approaches with the exchange market pressure (EMP) index for the period 1996–Feb 2016. In this model, the dependent variable of currency crisis is not only determined by the EMP index, but is also based on parallel market premium. In this paper, external shocks (e.g., regional or global financial crisis and unexpected changes in monetary policy) are proved to be the most important indicator of a currency crisis in Viet Nam, which is significant at the 1% level for all tested models. In other words, Viet Nam's financial market, especially foreign exchange market, is easily vulnerable to external shock in the international financial market. This finding implies that the SBV should implement a more flexible exchange rate regime so that it could absorb external shocks effectively. In addition, with relatively small international reserves, the SBV should actively respond to external shocks so that it could avoid or eliminate negative impact of external financial shocks on Viet Nam's economy in general and on the financial market in particular.

This paper found that Model 1 (in which all explanatory variables are expressed in its absolute values except for global shocks with window length of 2 months) outperformed for predicting a currency crisis in Viet Nam. Empirical results of Model 1 suggested that probability of predicting a true currency crisis was 77.5%; probability of predicting a crisis-hit period with signal was 64.6%. However, there were minor limitations in our model in that capital flows were not included because of unavailability of monthly data on foreign direct investment (FDI) flows, foreign portfolio investment (FPI) flows, worker's remittance, and official development assistance (ODA) in

Viet Nam. In addition, this paper also applies Model 3, namely “EWS-Vietnam” written in Eviews software program that will help to identify suitable thresholds for explanatory variable and make the converting process smoother. This finding suggests that the SBV should use Model 1 and Model 3 to identify probability of a currency crisis in Viet Nam.

Empirical evidence obtained from the two types of EWS model for a currency crisis concluded that domestic credit growth rate is a leading indicator of a currency crisis in Viet Nam. In other words, these indicators issue a significant signal of a currency crisis in Viet Nam if they exceed their thresholds suggested in this paper. These findings suggest that the country should keep domestic credit growth rate at less than 25% so that probability of a currency crisis could be reduced. In addition, indicators such as deficits in trade balance, money supply growth rate, and international reserves in import’s weeks theoretically should be good indicators but are all statistically insignificant. One might infer that the country should improve its trade balance by (i) enhancing export competitiveness and shifting export pattern from raw materials to processed products and (ii) developing subordinating industries.

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APPENDIX: CHOOSING THE BEST MODEL AMONG DIFFERENT THRESHOLD BASED ON DIFFERENT CRITERIA

Sorted by True CC							
DC	**OVERVALUE3**	**RES**	**TB**	**R-square**	**AIC**	**Criterion-1**	**Criterion-2**
35	15	10	–15	0.17	1.06	77.77	37.83
35	17.5	10	–15	0.18	1.05	77.77	37.83
Sorted by Signal							
DC	**OVERVALUE3**	**RES**	**TB**	**R-square**	**AIC**	**Criterion-1**	**Criterion-2**
40	15	6	–5	0.22	1.01	59.52	67.56
40	15	12	–5	0.22	1.01	59.52	67.56
40	17.5	6	–5	0.23	0.99	59.52	67.56
40	17.5	12	–5	0.23	0.99	59.52	67.56
40	7.5	6	–5	0.19	1.04	58.13	67.56
40	7.5	10	–5	0.19	1.04	58.13	67.56
40	7.5	12	–5	0.19	1.04	58.13	67.56
Sorted by AIC							
DC	**OVERVALUE3**	**RES**	**TB**	**R-square**	**AIC**	**Criterion-1**	**Criterion-2**
40	17.5	8	–10	0.25	0.96	66.03	47.29