

## Early-Warning Indicator of Currency Crisis

02502650, University of Tsukuba, \*Masahiro Fukuhara  
01206100, University of Tsukuba, Yasufumi Saruwatari

### 1. Introduction

Asian crisis left severe damage on its emerging countries; it has been the lack of capital in these regions from international financial institutions while its regions still require investment to develop its infrastructure and many business opportunities. The problem is that international financial institutions are still reluctant to invest in these regions. However, there are not enough papers focusing on its problems from currency management perspective. Therefore, our objective is to enhance investment in emerging countries for sustainable growth through risk and portfolio management of emerging country currencies. This research especially focuses on predicting currency crisis ex-ante followed by our next research of its optimization tools.

There are some efforts to make early-warning signals for currency crisis, which occurs infrequently but affects economy very seriously. The challenge is whether we can predict it ex-ante in a reasonable time rather than analyzing them ex-post. Some approach the problem from macro economic perspective by evaluating economic condition before the crisis. The focus is on reserve adequacy, short-term debt, real exchange rate, and so on. Another approach is more focusing on market condition. They analyze momentum type behavior called as herding and channel through which a market shock is propagated, called as contagion,

Our approach is to make an early-warning signal by focusing on real market data as well as macro economic variables since it can detect recent market oriented crisis such as herding and contagion as well as traditional crisis caused by the failure of macro economic policy. Also, we focus on more high frequent currency movement, since recent crisis occurs in a very short time period. We believe that these new attempt help predict currency crisis more accurately than previous approaches.

The method for our early warning signal is the application of Markov-switching regime shift model [Abiad 2003]. The advantages of using it are that it can show the endogenous regime change, which means crisis period, and use information more efficiently without the loss compared with threshold currency indicator [Kaminsky and et. al. 1997]. The contribution of the paper is to make Markov-switching regime shift model incorporating herding and contagion efforts as well as macro economic condition and estimate it in a daily frequency in order to make an early-warning signal.

### 2. Model

At first, we define a currency crisis as the large depreciation of emerging country currency against the US dollars denoted by  $y_t$ . Next, we define a latent variable,  $s_t$ , in the model which follows a first order and two state

Markov chain. The probability that  $s_t = j$  depends not only on the value  $s_{t-1}$  but also on a vector of other observed variables. We are going to consider two state Markov chain  $\{s_t\}_{t=1}^T$ , where  $s_t = 0$  states a normal condition and  $s_t = 1$  denote a crisis condition. When the process is in regime 0, the observed variable,  $y_t$ , is assumed to be drawn from a  $N(\mu_0, \sigma_0^2)$  distribution. If the process is in regime 1, the observed variable,  $y_t$ , is presumed to be drawn from a  $N(\mu_1, \sigma_1^2)$  distribution. Hence, the density of  $y_t$

conditional on the random variable  $s_t$  taking on the value  $j$  is

$$f(y_t | s_t; \theta_t) = \frac{1}{\sqrt{2\pi}\sigma_s} \exp\left\{-\frac{(y_t - \mu_{s_t})^2}{2\sigma_{s_t}^2}\right\}$$

for  $j=0$  and  $1$ . Here,  $\theta$  is a vector of population parameters that includes  $\mu_0, \mu_1$ , and  $\sigma_0^2, \sigma_1^2$ .

And transition matrix is:

$$P_t = \begin{bmatrix} p_t^0 = P(s_t=0 | s_{t-1}=0, \theta_t) = F(\theta_t, \beta) & 1-p_t^0 \\ 1-p_t^1 & p_t^1 = P(s_t=1 | s_{t-1}=1, \theta_t) = F(\theta_t, \beta) \end{bmatrix}$$

$$= \begin{bmatrix} P(\text{or } A, C) & 1 - P(\text{or } A, C) \\ 1 - Q(\text{or } B, D) & Q(\text{or } B, D) \end{bmatrix}$$

$F$  is a cumulative distribution function and shown as logistic CDF. The elements of the  $k \times 1$

vector  $x_{t-1}$  are the early-warning indicators that can affect the transition probabilities.

$p_t^{00}, p_t^{11}$  are dependent on  $\beta_0, \beta_1$  rather than setting it at a constant value in the paper. In order to ascertain whether contagion has large effects or not, we apply a reference probability transition model [Ang and Bekaert 1999] A, B, C, and D, which we suppose to include contagion effects. We use

$$P = p(s_{t+1}^\alpha = 1 | s_t^\alpha = 1), Q = p(s_{t+1}^\alpha = 0 | s_t^\alpha = 0) \\ A = p(s_{t+1}^\delta = 1 | s_t^\alpha = 1), B = p(s_{t+1}^\delta = 0 | s_t^\alpha = 0) \\ C = p(s_{t+1}^\eta = 1 | s_t^\alpha = 1), D = p(s_{t+1}^\eta = 0 | s_t^\alpha = 0)$$

where  $p(s_{t+1}^\delta = 1 | s_t^\alpha = 1)$  shows contagion probability and  $\alpha, \delta, \eta$  show a emerging country currencies.

### 3. Estimation Results (in OR seminar)

We will show these estimation results for a set of emerging country currencies whether we can predict currency crisis or not and the probability transition matrix partially showing herding and contagion effects in the coming Operation Research Society seminar.

### 4. Reference

- A. Abiad, "Early-Warning Systems; A Survey and a Regime-Switching Approach", IMF Working Paper, WP/03/32, February 2003.
- A. Ang and G. Bekaert, "International Asset Allocation with Time-Varying Correlations", NBER Working Paper 7056, March 1999.
- G. Kaminsky, S. Lizondo, and C. Reinhart, "Leading Indicators of Currency Crisis", IMF Staff Papers, 45(1), pp. 1-48, March 1997.