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An analysis of contagion in emerging currency markets by using multivariate extreme value theory

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1. Introduction

The objective of this paper is to analyze the first stages of contagion effect in emerging currency markets by using multivariate extreme value theory. Our focus in currency contagion is on the brokers' perspective rather than macro economic perspective.

2. Survey

We conducted a survey to eight large currency brokers in order to reveal the microstructure of emerging currency markets. We expect to reveal cases where brokers believe that if price of a currency X collapses, which would trigger selling pressure on a currency Y, motivated either to take profit or to hedge exposure to Y. Based on our analysis of the survey results, we found that graph is a valuable tool for illustrating the microstructure of emerging currency markets (Bondy and Murty[1976]).

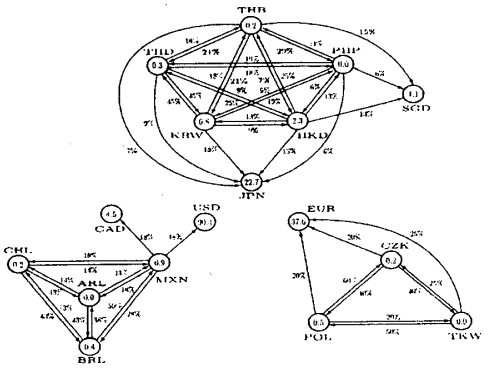

Fig. 1. Survey results

Figure 1 contains complete graphs as its subgraphs. Since an arc from a currency X to a currency Y exists if Y is used to hedge X, a complete subgraph indicates a deep interdependence between any pair of currencies in the subgraph. However, a currency in a subgraph is not related to currencies in other subgraphs with small number of exception.

3. Empirical Results

We conducted an empirical test of contagion with high frequency spot data of emerging currency (data of hourly and daily return) in order to verify our survey results. It is, however, difficult to filter high frequency data into i.i.d. data, which is sufficient condition for extreme value measure, because of the leptokurtosis and higher order autocorrelation. Several GARCH models, GARCH with normal distribution, general error distribution, and t-distribution, and EGARCH with normal distribution, can be used in order to filter data.

Since contagion usually starts with an abrupt depreciation of a currency (or currencies), it is interesting to see dependence among currencies in a short period of time. Linear correlation captures the relationship in the whole distribution of two series. Therefore, it is not a good measure if dependence characteristics for the extreme realizations, which are characterized as contagion in

currency data, differ from other sample cases. Multivariate extreme value theory provides with a good measure for analyzing these effects.

We have used the same methodology as Poon, Rockinger and Tawn[2001], who analyze the extreme multivariate dependence of pairs of international equity return series. The methodology is as follows.

1. Distinguish asymptotic dependence and asymptotic independence by using the measure of $\bar{\chi}$ defined by Coles, Heffernanand Tawn [1999]. We call it asymptotic dependence measure.

$$\bar{\chi} = \frac{2}{n_u}\{\sum_{j=1}^{n_u} \ln \frac{z(j)}{u}\} - 1,$$

where $z(1)$, $z(2)$,....,$z(\ n_u\ )$ are the n_u observations of variable Z that exceeds u, threshold.

$\bar{\chi} > 0$ ~ Positive dependence with extreme.

$\bar{\chi} < 0$ ~ Negative dependence with extreme.

$\bar{\chi} = 0$ ~ Independence with extreme.

2. If the asymptotic dependence is not rejected, the degree of asymptotic dependence, χ, is calculated by assuming $\bar{\chi} = 1$.

$$\chi = \frac{u\, n_u}{N},$$

where N is the number of observations. Note that $0 < \chi \leq 1$ indicates asymptotic dependence. Thus, the pair of χ and $\bar{\chi}$ is the complete measure of extreme dependence.

We empirically identified contagion at an hourly and daily frequency within a group of currencies respectively defined in our survey but not between groups determined by our survey (Figure 2 and Figure 3).

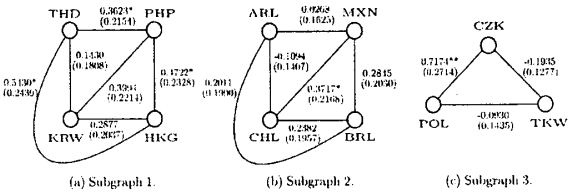

Fig.2. Asymptotic dependence measure of daily data

* : we can reject $\bar{\chi} = 0$ with 90% confidence level.

** : we cannot reject $\bar{\chi} = 1$ and we can reject $\bar{\chi} = 0$ with 90% confidence level.

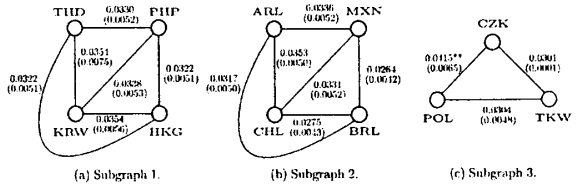

Fig. 3. Dependence degree measure of daily data

** : asymptotic dependence statistically with 90% confidence level.

4. Conclusion

We were able to empirically validate our survey results by studying certain currency pairs at both hourly and daily data using multivariate extreme value theory. Our results suggest that the dependence of hourly return data in the tail is generally higher than the dependence of daily return, and that tail dependence exists, although asymptotic dependence is rare.

References

Bondy, J.A., and U.S.R. Murty, *Graph Theory with Applications*, North Holland, New York, 1976.

Coles, S., J. Heffernan, and J. Tawn, "Dependence Measure for Extreme Value Analyses," *Extremes*, Vol.2, pp.339-365, 1999.

Poon, S.H., M. Rockinger, and J. Tawn, "New Extreme Value Dependence Measures and Finance Applications," Working Paper No.719/2001, HEC