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# Counts Examination in Extremes for Foreign Institutional Investors

**Jer-Shiou Chiou*** **Pei-Shan Wu**

**Abstract**

Distinct from any existing literatures, this study proposes a brand new signaling system in the economy to examine the extent of volatility of financial markets in the behaviors of foreign institutional investors, domestic investment trust, and domestic dealers. Other than Markov-Switching GARCH model, binomial integer-valued model with financial count time series data, model of NBINGARCH (1,1) with switching consideration is adopted, while the counts of the market index rose/fell within per minute is used. Through the data generation examination, we found, in a small economy of which when the market shares of foreign funds are vast, the over bought in domestic investment trust and domestic dealers may result in rising counts when market's return is uprising, while foreign institutional investors are oppositely over sold in the market. The behavior of foreign institutional investors and domestic dealers are statistically significant in opposite direction.

**Keywords:** Markov-switching GARCH, NBINGARCH with regime Time-based of Counts
**JEL Classification**: C22, G20

## I. Introduction

Beginning in 1990's, the rapid developments in technology and promising financial market return in Asia have drawn international investors' attention. Volume of transactions consequently flowed into the capital markets. The supporters of financial liberalization claim that the well-informed foreign institutional investors are helpful to the market microstructure. However, in contrast, the dissenters stress that foreign investment is a source of market instability and volatility in addition to boosting stock prices in the short term. The theories related to contemporaneous relationship between net inflows of foreign institutional investment and market return has been developed consequently. However, the interpretation of this relationship in emerging markets still remains unsettled.

Despite the market segmentation theories argued that broadening the investor base for a given stock and an extension of an emerging equity market may raise equity prices through risk pooling. It has been argued that those same foreign investors became culprits contributing to the financial market crisis by rapidly withdrawing their funds.

Distinct from any existing literatures, this study proposes a brand new signaling system in the economy to examine the extent of volatility of financial markets by complementing binomial integer-valued model with financial count time series data.

In general practice, the majority of the existing empirical studies are mainly based on quarterly or monthly data; however, transactions take place on a daily basis or even shorter time intervals. In this study, counts arise in market microstructure with transaction within per minute in which the price process is a sum of discrete price changes. The statistical distributions of the counts are generally skewed, and hence not normally distributed, nor are variances constant across samples. Techniques to measure abundance of the presents of certain event vary from intended sampling data to estimates of relative abundance, density, or population size. Generally, the specific technique used depends on the questions being asked, several authors (e.g., Kendeigh 1944, Verner 1985) have reviewed various counting techniques. Most of existing applications involve relatively rare events which make the use of the normal distribution questionable.

In addition to model of NBINGARCH(1,1) with switching, Markov-Switching GARCH model is adopted for the reason of comparison, while the counts of the market index rose/fell within per minute is used. This study examines the dynamic relation between counts of stock returns' up and down per minute and the behaviors of buy and sells among foreign institutional investors, domestic investment trust, and domestic dealers in each up and down.

## II. Literatures review

In explaining the relationship between foreign institutional investment flows and equity market returns in emerging economies, several competing hypotheses were proposed. Because the trading volumes of foreign investors are very high for the size of emerging markets, the price pressure hypothesis of Warther (1995) had been proposed. Froot *et al.* (2001), and Griffin *et al.* (2002) have found evidence of positive feedback trading strategies in emerging Asian equity markets and that the foreign flows have significant short-term impacts on emerging markets. However, the cause and benefit of foreign investment varies from country to country. Given its short-term nature, FII can have bidirectional causation with the returns of domestic financial markets, i.e. Ananthanarayanan *et al.* (2005). Empirical evidence on this relationship remained mixed. Umutlu, Akdeniz, and Altay-Salih (2010) find no significant increase or decrease in volatility following market liberalization, while Bae, Chan, and Ng (2004) document a positive relationship between foreign investment restrictions and local firm stock return volatility. Lin and Swanson (2004) also found significant evidence that foreign inflows have a short-term positive impact on local market returns for the eight emerging Asian markets, In contrast, Clark and Berko (1997) failed to evaluate price pressure hypothesis by foreign investors in Mexico, but neither do Dahlquist and Robertsson (2004) failed in Swedish market.

In the theory of asymmetry information, Brennan and Cao (1997) claimed the existence of

positive correlation between stock market returns and foreign portfolio flows. Grinblatt and Keloharju (2000) find that foreigners are better able to select winners in Finnish stocks than domestic individuals. Dvorak (2005) uses transactions data and finds the evidence of foreign institutions that have strategic information advantage over domestic investors. Several studies also supported the argument of information asymmetries between local and foreign investors cause the bias, among which, Chakravarty (2001), Barron and Ni (2008), Brennan et al., (2005), and Hatchondo (2008). They have shown that institutions are informed traders which have a disproportionately large cumulative price impact.

In the area of finance, besides the applications mentioned in Cameron and Trivedi (1996), counts arise in market microstructure as soon as one starts looking at per minute's data. A commonly used model for count time series with overdispersion is the integer-valued generalized autoregressive conditional heteroscedastic (INGARCH) model with Poisson deviates, Ferland *et al.* (2006). The price process for a stock can be viewed as a sum of discrete price changes. The daily number of these price changes constitutes a time series of counts. Hence, we depart from the existing literatures by examining the dynamic relation between minutes stock returns data (the daily number of these changes constitutes a time series of counts) and explore the behaviors of foreign institutional investors, domestic investment trust, and domestic dealers. Taking the number of the market index rose/fell within per minute as our primarily objective, Markov-Switching GARCH model is used. Binomial integer-valued model with financial count time series data, model of NBINGARCH (1,1) with switching consideration is adopted too.

## III. The Methodology

In investigating the volatility of financial markets, the most widely used class of models is certainly that of GARCH models (Bollerslev, Engle, and Nelson (1994)). These models usually indicate a high persistence of the conditional variance (i.e. a nearly integrated GARCH process). Mikosch and Starica (2004), show that modeling GARCH model with the presents of structure changes does create an integrated GARCH process. Models in which the parameters are allowed to change over time may be more appropriate for modeling volatility.

### III.1 The Regime Switching

Schwert (1989) consider a model in which returns can have a high or low variance, and switches between these states are determined by a two state Markov process. The Markov switching models are useful because of the potential it offers for capturing occasional but recurrent regime shifts in a simple dynamic econometric model. Two-state model is considered as

$$y_t = x_t^{'} \cdot \beta_{s_t} + e_t, \quad t = 1,2,...,T, \quad e_t \sim N(0, \sigma_{s_t}^2) \qquad (1)$$

$$\beta_{s_t} = \beta_0(1-s_t) + \beta_1 \cdot s_t \quad (2)$$

$$\sigma^2_{s_t} = \sigma^2_0(1-s_t) + \sigma^2_1 \cdot s_t \quad (3)$$

Then, the log-likelihood function is

$$\ln L = \sum_{t=1}^{T} \ln f(y_t \mid s_t), \quad (4)$$

where $f(y_t \mid s_t) = \frac{1}{\sqrt{2\pi}\sigma_{s_t}} \exp\left(\frac{-(y_t - x_t'\beta_{s_t})^2}{2\sigma^2_{s_t}}\right)$. (5)

The GARCH(1,1) model can be defined by

$$y_t = \mu_t + \sigma_t u_t \quad (6)$$

$$\sigma^2_t = \omega + \alpha \cdot \varepsilon^2_{t-1} + \beta \cdot \sigma^2_{t-1}, \quad (7)$$

where $\sigma_t$ and $\mu_t$ are measurable functions of $y_{t-\tau}$ for $\tau \le t-1$, $\varepsilon_t = y_y - \mu_t$, and the error term $u_t$ is *i.i.d.* with zero mean and unit variance. In order to ensure easily the positivity of the conditional variance we impose the restrictions $\omega > 0$, $\alpha \ge 0$ and $\beta \ge 0$. For simplicity, we assume that $\mu_t$ is constant. The sum $\alpha + \beta$ measures the persistence of a shock to the conditional variance. Let $\{s_t\}$ be an ergodic Markov chain on a finite set $S = \{1,...,n\}$, with transition probabilities $\eta_{ij} = P(s_t = i \mid s_{t-1} = j)\}$ and invariant probability measure $\{\pi_i\}$.

The MS-GARCH model is given by

$$y_t = \mu_{s_t} + \sigma_t \cdot u_t \quad (8)$$

$$\sigma^2_t = \omega_{s_t} + \alpha_{s_t} \cdot \varepsilon^2_{t-1} + \beta_{s_t} \cdot \sigma^2_{t-1} \quad (9)$$

where $\omega_{s_t} > 0,\ \alpha_{s_t} \ge 0,\ \beta_{s_t} \ge 0$ for $s_t \in \{1,2,...,n\}$, and $\varepsilon_t = y_t - \mu_{s_t}$. These assumptions on the GARCH coefficients entail that $\sigma^2_t$ is almost surely strictly positive. Conditions for the weak stationarity and existence of moments of any order for the Markov-switching GARCH(*p*,*q*) model with zero means $\mu_{s_t}$, in which the discrete Markov chain of the latent states is initiated from its stationary probabilities.

**III.2. The negative binomial integer-valued GARCH model**

In the case of binary regression the fact that probability lies between 0-1 imposes a constraint. The normality assumption of multiple linear regression is lost, and so also is the assumption of constant variance. When the response variable is in the form of a count we face a yet different constraint. Counts are all positive integers and for rare events the Poisson distribution is more appropriate.

Modeling time series count data have been proposed in many different approaches. Good reviews can be found both in Cameron and Trivedi (1996), and in MacDonald and Zucchini (1997). In general, models of counts can be generally classified into two types, thinning operator and regression type models. Weiß (2008) gave a review for thinning operator models. Kedem and Fokianos (2002) give a comprehensive account. To accommodate the overdispersion, many researchers have turned to binomial regression models, in particular, the negative binomial (NB) distribution. In specific, the integer-valued generalized autoregressive conditional heteroscedastic (INGARCH) model with Poisson deviates (Ferland *et al*., 2006) is commonly used. Recently, Davis and Wu (2009) proposed a NB logit regression model for count time series, which is a generalization of Poisson log-linear regression models.

Following Zhu (2011), let $\{X_t\}$ be a time series counts. We assume that conditional on $F_{t-1}$, the random variables $X_1, \ldots, X_n$ are independent and the conditional distribution of $X_t$ is specified by a NB(negative binomial) distribution. To be specific, we consider the following model:

$$X_t \mid F_{t-1} : NB(r, p_t) \tag{10}$$

where $F_{t-1}$ is the $\sigma-$field generated by $\{X_{t-1}, X_{t-2}, \ldots\}$, $r$ is positive number and $p_t$ satisfies the model

$$\frac{1-p_t}{p_t} = \lambda_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i X_{t-i} + \sum_{j=1}^{q} \beta_j \lambda_{t-j} \ . \tag{11}$$

with $\alpha_0 > 0,\ \alpha_i \geq 0,\ \beta_j \geq 0,\ i = 1,\ldots, p,\ j = 1,\ldots, q,\ p \geq 1,\ q \geq 0.$ The above model will be denoted by NBINGARCH(*p*,*q*).

The conditional probability density functions of $X_t$ then has the form

$$P(X_t = x_t \mid F_{t-1}) = \binom{x_t + r - 1}{r - 1} p_t^r (1-p_t)^{x_t} \tag{12}$$

for $x_t = 0, 1, \ldots$ with

$$p_t = \frac{1}{1+\lambda_t}, \quad q_t = 1 - p_t = \frac{\lambda_t}{1+\lambda_t}. \tag{13}$$

The conditional mean and variance of $X_t$ are given by

$$E(X_t \mid F_{t-1}) = \frac{r \cdot (1-p_t)}{p_t} = r \cdot \lambda_t \ , \tag{14}$$

$$\text{var}(X_t \mid F_{t-1}) = \frac{r \cdot (1-p_t)}{p_t^2} = r \cdot \lambda_t (1+\lambda_t) \tag{15}$$

respectively. This indicates that $\text{var}(X_t \mid F_{t-1}) > E(X_t \mid F_{t-1})$. That is, models (11) and (12) allow integer-valued time series with overdispersion. And model (10) can also account for overdispersion.

## IV. The Empirical Results

In comparison with the model of Markov-switching, model of NBINGARCH(1,1) is adopted to study the impacts of over bought over sold of foreign institutional investors($F_1$), domestic investment trust($F_2$), and domestic dealers($F_3$), changes of Taiwan stock market(*RTSE*), and the changes of S&P500(*RSP500*) on the counts of increasing/decreasing in return for Taiwan stock market(*UP or DOWN*) are collected. The selected period ran from January 1, 2006 to June 30, 2009, which includes the financial crisis of 2008.

The fundamental Markov-switching model is as follows,

$$RTSE_t = a_{st} + b_{st} \cdot RSP500_{t-1} + c_{st} \cdot F_{1t} + d_{st} \cdot F_{2t} + e_{st} \cdot F_{3t} + \varepsilon_t \,, \tag{16}$$

while MS-GARCH (Markov-switching GARCH) model is

$$\begin{aligned} RTSE_t &= a_{st} + b_{st} \cdot RSP500_{t-1} + c_{st} \cdot F_{1t} + d_{st} \cdot F_{2t} + e_{st} \cdot F_{3t} + \varepsilon_t \\ h_t &= \alpha_{0,st} + \alpha_{1,st} \cdot h_{t-1} + \alpha_{2,st} \cdot \varepsilon_{t-1} \end{aligned} \,. \tag{17}$$

The model of NBINGARCH(1,1) without regimes consideration can be written as follows,

$$\begin{aligned} &UP_t(or\ DOWN_t) \mid F_{t-1} : NB(\gamma, p_t) \\ &UP_t(or\ DOWN_t) = a + b \cdot RTSE_t + c \cdot RSP500_{t-1} + d \cdot F_{1t} + e \cdot F_{2t} + f \cdot F_{3t} + \varepsilon_t \\ &\lambda_t = \alpha_0 + \alpha_1 \cdot UP_{t-1}(or\ DOWN_{t-1}) + \beta_1 \cdot \lambda_{t-1} \end{aligned} \tag{18}$$

; while the model of NBINGARCH(1,1) with regimes consideration can be written as follows,

$$\begin{aligned} & UP_t(or\ DOWN_t)\,|\,F_{t-1} : NB(\gamma, p_t) \\ & UP_t(or\ DOWN_t) = a + b_1 \cdot RTSE_t \cdot d1_t + b_2 \cdot RTSE_t \cdot d2_t + c \cdot RSP500_{t-1} \\ & \qquad\qquad + d \cdot F_{1t} + e \cdot F_{2t} + f \cdot F_{3t} + \varepsilon_t \\ & \lambda_t = \alpha_0 + \alpha_1 \cdot UP_{t-1}(or\ DOWN_{t-1}) + \beta_1 \cdot \lambda_{t-1} \end{aligned} \quad . \qquad (19)$$

Where, $UP_t$ ($DOWN_t$) is the counts of increasing/decreasing in return for Taiwan stock market, $0 \le UP_t\ (DOWN_t) \le 270$; since there are 270 minutes for trading per day. $F_{1t}$, $F_{2t}$, $F_{3t}$ are defined as OBOS(over bought over sold) for foreign institutional investors, domestic investment trust, and domestic dealers respectively. $RSP_t$ are the changes of S&P500. The followings are basic statistics for the series of $RSP_t$, the results shown that $RSP_t$ is not normally distributed.

*Table 1 The Basic Statistics of* $UP_t$ and $DOWN_t$

| | Samples | Mean | S.D. | Skew | Kurtosis | Min | Max | J.B. |
|---|---|---|---|---|---|---|---|---|
| counts of increasing | 864 | 132 | 12.34 | 0.0458 | 0.0132 | 89 | 169 | 0.3091 |
| counts of decreasing | 864 | 134 | 12.37 | -0.0366 | 0.0095 | 96 | 178 | 0.1967 |

Note: J.B. represents the statistics of Jarque-Beta normality test.

Taking Ljung–Box's Q test, in Table (2), this study confirmed the existent of ARCH effect of $UP_t$ and $DOWN_t$ in equation (16), which enable our adoption of NBINGARCH(1,1) applicable.

In Table 3, it can be seen that the three major institutional investors and RSP500 have the expected sign with statistically significance in influencing RTSE, and there are no major differences between with or without the consideration of GARCH effect in both regimes. Foreign institutional investors still play the significant factor in impacting the return of Taiwan stock market.

*Table 2 Test of ARCH effect of* $UP_t$ and $DOWN_t$

| | counts of increasing | counts of decreasing |
|---|---|---|
| Q(60) of $\varepsilon_t$ | 62.494 | 59.590 |
| Q2(60) of $\varepsilon_t^2$ | 84.310*** | 80.824*** |
| LM test | 263.674*** | 303.575*** |

Note: *** represents 1% significant level

*Table 3 The result of Markov-switching*

| | Basic MS | | | MS with GARCH effect | | |
|---|---|---|---|---|---|---|
| | coefficient | $RTSE_t$ | | coefficient | $RTSE_t$ | |
| Regime1 | $a_{1t}$ | -110.7918 | *** | $a_{1t}$ | -100.2544 | *** |
| | $b_{1t}$ | 0.2567 | *** | $b_{1t}$ | 0.1063 | *** |
| | $c_{1t}$ | 7.1890 | *** | $c_{1t}$ | 6.7799 | *** |
| | $d_{1t}$ | 1.6244 | *** | $d_{1t}$ | 0.7211 | *** |
| | $e_{1t}$ | 1.4475 | *** | $e_{1t}$ | 1.6717 | *** |
| | | | | $\alpha_{0,1t}$ | 0.2037 | *** |
| | | | | $\alpha_{1,1t}$ | 0.0558 | * |
| | | | | $\alpha_{2,1t}$ | 0.0766 | * |
| | $a_{2t}$ | -102.8788 | *** | $a_{2t}$ | -112.1826 | *** |
| | $b_{2t}$ | 0.1098 | *** | $b_{2t}$ | 0.2665 | *** |
| | $c_{2t}$ | 7.0290 | *** | $c_{2t}$ | 7.2026 | *** |
| | $d_{2t}$ | 0.7396 | *** | $d_{2t}$ | 1.8441 | *** |
| | $e_{2t}$ | 1.6174 | *** | $e_{2t}$ | 1.3694 | *** |
| Regime2 | | | | $\alpha_{0,2t}$ | 0.9203 | *** |
| | | | | $\alpha_{1,2t}$ | 0.1036 | *** |
| | | | | $\alpha_{2,2t}$ | 0.5843 | *** |
| | | | | P(1,1) | 0.9780 | *** |
| | | | | P(1,2) | 0.0498 | *** |
| | | | | Func.-Val | -2635.0969 | |

In Table 4, it can be seen that over bought in domestic investment trust and domestic dealers may result in increasing counts in Taiwan stock market's uprising return. At the same time, in contrast, foreign institutional investors are over sold in the market. Remarkably, foreign institutional investors and domestic dealers are statistically significant in opposite direction. It can been also seen that the over sold in domestic investment trust and domestic dealers may result in decreasing counts in Taiwan stock market's uprising return, while in contrast, foreign institutional investors are over bought in the market. Foreign institutional investors and domestic dealers are statistically significant in opposite direction. There is an interesting founding that is when the return of SP500 is negative, the counts of trading in Taiwan stock market are increasing. When the return of SP500 is positive, the counts of trading in Taiwan stock market are decreasing. And, the phenomenon is just opposite in the case of Taiwan stock return.

*Table 4 The result of NBINGARCH(1,1)*

| | without regimes | | | | with regimes | | | |
|---|---|---|---|---|---|---|---|---|
| coe | $UP_t$ | | $DOWN_t$ | | coe | $UP_t$ | | $DOWN_t$ | |
| $a$ | 9.0671 | *** | 0.6689 | * | $a$ | 9.5018 | *** | 0.2493 | |
| $b$ | 0.0413 | *** | -0.0410 | *** | $b_1$ | 0.0383 | *** | -0.0380 | *** |
| | | | | | $b_2$ | 0.0541 | *** | -0.0536 | *** |
| $c$ | -0.0202 | *** | 0.0201 | *** | $c$ | -0.0197 | *** | 0.0196 | *** |
| $d$ | -0.3824 | *** | 0.3847 | *** | $d$ | -0.4102 | *** | 0.4117 | *** |
| $e$ | 0.0098 | | -0.0090 | | $e$ | 0.0056 | | -0.0047 | |
| $f$ | 0.0261 | *** | -0.0256 | *** | $f$ | 0.0177 | ** | -0.0178 | ** |
| $\alpha_0$ | 0.0713 | *** | 0.0237 | * | $\alpha_0$ | 0.0043 | *** | 0.0033 | *** |
| $\alpha_1$ | 0.0000 | *** | 0.0000 | *** | $\alpha_1$ | 0.0000 | *** | 0.0000 | *** |
| $\beta_1$ | 0.0105 | | -0.1125 | *** | $\beta_1$ | 0.0363 | ** | -0.1135 | ** |
| $\gamma$ | 1691.3798 | *** | 5830.4832 | *** | $\gamma$ | 27226.42 | *** | 41061.68 | *** |

## V. Conclusions

The cause and benefit of foreign investment varies from country to country. It can persuade the factor productivity of the recipient country and also shape the balance of payments. The existing studies on investor behavior have been developed and carried out mostly on well-developed stock markets. But empirical studies on foreign investor behavior in emerging markets are rare. Meanwhile, with equity markets increasingly seen as important sources of investment funds in many emerging economies, many countries take the development of such markets as a means to facilitate both foreign equity portfolio investment and foreign direct investment (FDI). Foreign investments provide a direction through which developing countries can gain access to foreign capital for their economic development, although come in two ways: foreign direct investment (FDI) and foreign institutional investment (FII).

Deregulation of foreign investment restriction is therefore taken as an important tool to increase the levels of investment and liquidity in financial markets. Taiwanese Overseas Chinese and Foreigner Investment Regulation in 1982 was one of the examples. These liberalization measures, together with the institutionalization of the global financial markets, have undoubtedly contributed to the expansion of international institutional investors into Taiwan. But foreign institutional investment is a short-term investment avenue, mostly in the financial markets. FII, given its short-term nature, can have bidirectional causation with the returns of other domestic financial markets such as money markets, foreign exchange markets and also stock markets. However, several studies argue that foreign investment indeed can boost stock prices in the short term, but is a source of market instability and volatility. To be more specific Huang and Chan (2010) find that foreign institutions have attempted to

influence the closing prices of Taiwanese stocks.

Unlike previous studies, this study complements binomial integer-valued model with financial count time series data. We propose a brand new signaling system in the economy to examine the extent of volatility of financial markets. Counts arise in market microstructure with per minute data. The statistical distributions of the counts of data are generally skewed, and hence not normally distributed, nor are variances constant across samples. Count time series are non-negative and often overdispersed.

We have found that over bought in domestic investment trust and domestic dealers may result in increasing counts in Taiwan stock market's uprising return. At the same time, in contrast, foreign institutional investors are over sold in the market. It's worth noticing that foreign institutional investors and domestic dealers are statistically significant in an opposite direction, while the over sold in domestic investment trust and domestic dealers may at the same time result in decreasing counts in Taiwan stock market's uprising return. In contrast, foreign institutional investors are over bought in the market, and foreign institutional investors and domestic dealers are statistically significant in an opposite direction.

In Markov-switching investigation, it can be seen that the three major institutional investors and RSP500 have the expected sign with statistically significance in influencing RTSE, and there are no major differences between with or without the consideration of GARCH effect in both regimes. Foreign institutional investors play the significant factor in impacting the return of Taiwan stock market.

Our NBINGARCH(1,1) approaches indeed provide novel empirical findings, which refers that foreign investors, while leading the market movements, are always better off to exaggerate the volatility of the market, despite unbiased long term predictions. The high volatility price movement histories are, thus, created and regarded as the norm for future prediction for the domestic investment trust and domestic dealers. In other words, the foreign investors created the high volatility history which forced the rationally domestic investment trust and domestic dealers to accept the irrationally volatile price history as a rational basis for future predictions. This will result in unnecessarily large risk in the capital markets and will, thus decrease efficiency.

Financial liberalization is helpful to the market microstructure, the dissenters' stress that foreign investors can create market instability and volatility should always be a concern for police maker. The volatility of the stock market is increased after opening to the inflow of foreign investment. Once a liberalization policy priority is undertaken, other appropriate

measures also need to be adopted by developing countries in order to withstand the impact of implementing that policy.

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**Authors**

**Jer-Shiou Chiou***

Department of Finance and Banking, Shih Chien University, Taiwan, jschiou@mail.usc.edu.tw

**Pei-Shan Wu**

Department of Finance, Chien Hsin University of Science and Technology, Taiwan.

*corresponding author