國立交通大學

經營管理研究所

碩士論文

美國對台灣股市外溢效果之分量迴歸分析

Quantile Regression Analysis of the Spillover Effect of US-Taiwan Stock Markets

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中華民國九十八年六月

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經營管理研究所
碩士論文

A Thesis
Submitted to Institute of Business and Management
College of Management
National Chiao Tung University
in Partial Fulfillment of the Requirements
for the Degree of
Master of Business Administration

June 2009
Taipei, Taiwan, Republic of China
中華民國 九十八 年 六 月

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摘　　要

本篇使用分量迴歸模型 (Quantile Regression) 來探討美國股市對台灣股票市場的外溢效果是否存在，美股以S&P 500為代表，台股則分別取台股加權指數和店頭市場加權指數為代表，並區分為close-to-open, open-to-close和close-to-close三階段報酬來探討，實證結果發現：1. 美股對台股在close-to-open報酬具有外溢效果，此外，透過分量迴歸我們發現1995年到1997年在漲跌幅大時才具有外溢效果。2. 美股對台股在close-to-close報酬亦具有外溢效果，除了在1995年到1997年，當股價達最大跌幅時，美股對台股不但不具有外溢效果，反而為負向的影響。3.本篇論文證實，美股對台股在open-to-close報酬確實具有過度反應效果，且除了1995年到1997年過度反應效果僅存在於股價漲跌幅極大外，金融海嘯時期，當股價達致最大跌幅則亦不具有過度反應效果。

關鍵詞：外溢效果、過度反應效果、普通最小平方法、最小絕對離差法

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ABSTRACT

This paper employs quantile regression model to investigate if the price change spillover effect exists from U.S. to Taiwan. We discuss three market segments of Taiwan stock which comprise close-to-open, open-to-close and close-to-close returns respectively. We find that: Firstly, the price change spillover effect exists from U.S. to the close-to-open returns of Taiwan stock market. Furthermore, the price change spillover effect exists when stock price goes up or down greatly from 1995 to 1997. Secondly, the price change spillover effect exists from U.S. to the close-to-close returns of Taiwan stock market. However, there is no price change spillover effect when price goes down greatly and there is even negative effect from U.S. to Taiwan from 1995 to 1997. Thirdly, the overreaction effect exists from U.S. to the open-to-close returns of Taiwan except from 1995 to 1997. The overreaction effect only exists when price goes up or down greatly from 1995 to 1997, and there is no overreaction effect when price goes down greatly in Financial Tsunami.

Keywords : Spillover effect, Overreaction effect, Ordinary least squares method, Least absolute deviations method

誌　　謝

我的研究所生活以及本篇論文能夠順利完成，最感謝的，是我的指導老師－周雨田教授，周老師不但時時給予我建議，也耐心地指導我。在我們面臨不景氣的求職期間，也給予我們很大的空間，讓我們能夠安心地找工作，在找工作和寫論文中取得平衡，這一切都歸功於周雨田教授！此外，初稿的審查委員胡均立所長、丁承教授的意見，另外兩位口試委員林常青、巫春洲教授的指教，都協助了我能夠順利完成此篇論文，學生在此非常感謝。

在論文撰寫的期間，學長姐們和同學們之間的幫忙也是最大的助力。感謝致宏學長在當兵時還抽空幫我解答、念青學長從碩一開始對於我選課與論文方向的建議、炳麟學長幫忙我解決 E-Views 上的問題、新風學長提供軟體、孫蕾學姐提供簡報上的指導，周家班的昱如、琬珈、泰佑、信國的彼此打氣、小白提供研究室讓我抓 data、憲堂幫忙我修改圖……等，很多很多的感謝。

最後需要感謝我的家人，這兩年來一直支持著我，常常幫我補身體，擔心我的體力不夠，也常常包容我的小任性。對於大家的感謝我會一直放在心中，將此篇論文獻給最親愛的你們！

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1. Introduction

With the decrease in government imposed formal barriers to the flow of capital across countries, the integration of each country's capital market has increased over the last several years. Recent studies examine the interdependence of price change spillover effects across developed and emerging markets. Eun and Shim (1989) used simulated responses of the estimated VAR system and found that there is a multi-lateral interaction among national stock markets. Innovations in the U.S. are quickly transmitted to other markets in a clearly recognizable fashion.

Moreover, much of the literature shows that US stock market is the important factor which influences the return of Taiwan stock market. They found that the spillover effect of stock prices exists from the United States to Taiwan. Wei, Liu, Yang and Chaung (1995) found that the stock prices of Taiwan stock market are more sensitive than Hong Kong stock market, although Taiwan is not as open as Hong Kong and Taiwanese dollar is not connected with the US dollar while the Hong Kong dollar is. Wang and Nguyen (2007) used NYSE, S&P 500 and NASDAQ to test the transmission between Taiwan and US stocks under asymmetry. The data period is from 1 January 1997 to 31 October 2001, and they proved that there is the contagion between Taiwan and US stock markets. Chou, Lin and Wu (1999) suggested the spillover effects occur for both the mean and the variance of the Taiwan stock returns. And Chang (2008) also revealed that Taiwan stock market is influenced by the stock

prices of the US, and the price change spillover effect from the US to Taiwan is significant. Miyakoshi (2003) used EGARCH and GARCH to investigate the return spillover effects.

However, these previous works mostly used ARCH, GARCH, EGARCH and M-GARCH models to examine the spillover effects of the stock market. They found the spillover effects are in the mean and conditional variance, but the mean and conditional variance could not represent the whole behaviors of these distributions, especially when they are heterogeneous. In order to concern about the spillover effects of the entire distributions in different price periods, the paper employs quantile regression model to investigate the price change spillover effects completely. We also use close-to-open, open-to-close and close-to-close returns to avoid the sample overlap problems.

The purpose of this study is (1) to examine price change spillover effects across US and Taiwan stock markets then see if there is any difference when stock price goes up or down, and (2) to investigate the overreaction effect in open-to-close returns of Taiwan stock market and detect how the degree in different quantiles.

This paper is organized as follows. In the first part of Section II, we review the literature related to cross-market spillover effects. In the second part of Section II, we introduce literature related to overreaction effect. And in the last part of Section II, we also introduce literature about quantile regression models. Section III introduces the data used in this paper and descriptive statistics of data. Section IV presents the empirical results in this paper.

Finally, the conclusion is provided in Section V.

2. Literature Review

2.1 Cross-Market Spillover Effect

Over the past several years, there has been ample research on the price change spillover effects. Wang, Liao and Shyu (2000) investigated the interactions and the factors of determining returns and volatility among Asian markets. They found that the return of the Taiwan stock market is influenced by U.S., Japan, Korea and Singapore. Lee, Rui and Wang (2004) considered the transmission between the Nasdaq and Asian second board markets, such as Hong Kong, Japan, South Korea, Singapore and Taiwan. They found that there is strong evidence of lagged returns and volatility spillover effects from the NASDAQ market to the Asian second board markets when excluding contemporaneous main board market returns. Arshanapalli, Doukas and Lang (1995) revealed that there are common stochastic trends in the US and the Asian stock markets after October 1987 because of a number of stock market disasters. They also found that the integration degree between Asian stock markets and the US stock market is higher than it between Asian stock markets and Japan.

Some researches directly examine the price change spillover effects between Taiwan and the US. Chou, Lin and Wu (1999) used ARCH and M-GARCH to examine the price and volatility linkages between the US and Taiwan stock market. Spillover effects in price changes and volatility are found from the US stock market to the Taiwan stock market. Wei, Liu, Yang and Chaung (1995) examined open-to-close, close-to-open, and intraday stock

price. The result is that the spillover effects should not be observed in the open-to-close returns under the efficient market hypothesis, since all available information from previous foreign markets should be fully reflected in opening prices. Moreover, the Taiwanese market is more sensitive than the Hong Kong market to the price and volatility behaviors of the advanced markets. We conclude that there are price change spillover effects from the US stock market to Asian stock markets, including Taiwan.

2.2 Overreaction effect

The first research about overreaction effect is raised by J. M. Keynes. He suggested day-to-day fluctuations in the profits of existing investments have an altogether excessive, and even an impossible, influence on the markets.

Fama (1970) thought that if the price changes of capital market have no correlation, it's a efficient market. He also divided the market into weak-form of the efficient market hypothesis, semi-strong form of the efficient market hypothesis and strong form of the efficient market hypothesis.

Roll (1988) looked at the R-squared for regressions of daily and monthly stock returns on CAPM and APT factors and found that much of the variance in returns can not be explained.

Shiller (1981) revealed that measures of stock price volatility over the past century appear to be too high to be attributed to new information about future real dividends if there is uncertainty about future dividends. He concluded that stock prices are too volatile to be explained by dividend changes and suggested that investors overreact to unobserved stimuli.

Kleidon (1982) found the movement of stock price to be strongly correlated with expected changes in earnings for the following year and that it is a pattern of overreaction. Investors seem to overestimate the importance to short-term economic developments.

De Bondt and Thaler (1985) found that investors overreact to short-term (i.e., a few years) earnings movements. They suggested that most people overreact to the unexpected events, and the performances of the portfolio of past "losers" are better than past "winners'" under the overreaction hypothesis. Furthermore, there are large positive returns in losers' portfolios every January, and the effect can be observed as long as five years after portfolio formation. Fama and French (1987) revealed the negative serial correlation in stock returns, and found significant negative serial correlation in stock returns.

Cutler, Poterba and Summers (1989) estimated the fraction of the variance in aggregate

stock returns that can be attributed to various kinds of news. They found that it is difficult to explain more than one third of the return variance from macroeconomic news, and concluded that neither economic variables nor news stories can fully explain extreme aggregate price movements.

Chan (2003) used monthly stock returns after two sources of stimuli. The first is public news, which is identifiable from headlines and extreme concurrent monthly returns. The second is large price movements unaccompanied by any identifiable news. He found that investors seem to react slowly to valid information, causing drift. Moreover, investors overreact to price shocks, causing excess trading volume and volatility and leading to reversal.

2.3 Quantile regression

We usually use regression models to analysis the behavior of explained variables when the dependent variable is known. In order to explain the model more, there are two ways to make the error of the model smaller: First, we can use the ordinary least squares method (OLS) to minimize the error sum of square. Secondly, we can use the least absolute deviations method (LAD) to minimize the absolute value of error. Quantile regression is the extended conception of LAD, and it corresponds to fitting the conditional median of the response variable.

Quantile regression, developed by Koenker and Bassett (1978), is an extension of the classical least squares estimation of the conditional mean to a collection of models for different conditional quantile functions (Barnes and Hughes, 2002). By using quantile regression, we don't have to make any assumptions to the original distribution, it is nonparametric. It is useful to analysis the data when the conditional distribution does not have a normal distribution or standard shape, such as an asymmetric or fat-tailed distribution. Koenker and Bassett (1982) suggest that given the regression parameter, if we don't change the plus and minus signs of the residual, the estimate won't change even the distance between sample and quantile is changed. In other words, no matter the outlier is large or small, quantile regression is robustness.

Let y_t be a dependent variable, χ_t be an independent variable, and the liner regression

can be supposed as follows:

$$y_t = x'_t \beta + e_t, \qquad t = 1,.....,\mathrm{T}. \tag{1}$$

Given the data $(y_t, x_t')'$ for $t = 1,.....,\mathrm{T}$, where x_t is $k \times 1$, β includes regression coefficient of each variable, and e_t is error term.

Quantile regression which is suggested by Koenker and Bassett(1982) extends the concept to calculate the quantile:

$$\hat{\beta}_\theta = \arg\min\left[\theta \sum_{y_t \geq x_t'\beta} |y_t - x_t'\beta| + (1-\theta) \sum_{y_t < x_t'\beta} |y_t - x_t'\beta|\right], \tag{2}$$

where θ is the quantile, and $0 < \theta < 1$. When θ is 0.5, (2) equation can be written in $\hat{\beta}_\theta = \sum_{t=1}^{\mathrm{T}} |y_t - x_t'\beta|$, and it is exactly the objective function for LAD estimation.

The θth quantile regression estimator of β can be obtained by minimizing the weighted average of the absolute value of error:

$$V_t(\beta;\theta) = \frac{1}{\mathrm{T}}\left[\theta \sum_{t:y_t \geq x_t'\beta} |y_t - x_t'\beta| + (1-\theta) \sum_{t:y_t < x_t'\beta} |y_t - x_t'\beta|\right], \tag{3}$$

if θ is smaller (bigger) than 0.5, the positive error of weight of function is smaller (bigger), and the negative error of weight is bigger (smaller). So it is the left of the distribution. When θ is 0.5, we can two times (3): $V_{\mathrm{T}}^m(\beta) = 2V_{\mathrm{T}}(\beta;0.5) = \frac{1}{\mathrm{T}}\sum_{t=1}^{\mathrm{T}} |y_t - x_t'\beta|$, so we can say a regression estimated via the method of LAD which is referred as a “median regression is a special case of conditional quantile regression.

In order to minimize (3), the first order condition of (3) is as follows:

$$\frac{1}{\mathrm{T}}\sum_{t=1}^{\mathrm{T}}\varphi_\theta\left(y_t - x_t'\beta\right) = \frac{1}{\mathrm{T}}\sum_{t=1}^{\mathrm{T}} x_t\left(\theta - 1_{\{y_t - x_t'\beta<0\}}\right) = 0, \qquad (4)$$

we can obtain the θ_{th} quantile regression estimator of β ($\hat{\beta}_\theta$) by solving (4).

Because we can't find out the closed form solution of (4), we have to find another way to solve the equation.

Nonlinear optimization, the traditional method of solution, can't be used to solve the equation. Koenker and Machado (1999) suggest the equation (4) is also the quasi-maximum likelihood estimator which is used asymmetric Laplace (double exponential) density:

$$f(e;\theta) = \theta(1-\theta)\exp\{\rho_\theta(e)\}$$

3. Data

3.1 Sample

In this section, we examine daily stock prices of Taiwan and the United State from 7 November 1995 to 26 March 2009. In the case of the Taiwan stock market, we use the Taiwan Weighted Stock Index and Over-the-Counter index. For the United States we use S&P500. Because of different closing hours, we delete the data which only has partial market information. There are 3178 daily returns included finally.

We retrieve the raw data of the Taiwan Weighted Stock Index and Over-the-Counter index for the entire period from TEJ, and S&P500 from Yahoo Finance (www.yahoo.com/finance).

In this paper, we use close-to-close returns of US to investigate whether the former returns of US effects the returns of Taiwan. We discuss three market segments of Taiwan stock which comprise close-to-open, open-to-close and close-to-close returns respectively.

We wanted to discuss the influences of different periods, especially between the Asian Financial Crisis in 1997and recent Financial Tsunami recently, so we considered four periods as follows: The first period is before the Asian Financial Crisis, because Over-the-Counter index of TEJ starts from November 1995, we choose the data from 7 November1995 to 30 June 1997. According to Cheung, Cheung and Ng (2007) and Chang, M. C. (2008), the second period is during the crisis from 2 July 1997 to 30 June 2000. We defined Financial

Tsunami starts from the bankruptcy of New Century Financial Corporation in March 2007 by some research (Ashcraft and Schuermann, 2008) and the international financial news of Yahoo. The third period is between the crisis and Financial Tsunami from 3 July 2000 to 27 February 2007. The last period is during the tsunami from 1 March 2007 to 26 March 2009.

We use the following picture to understand the trading periods between US and Taiwan easily. The "O_t" represents the opening stock price of t day, and the "C_t" represents the closing stock price of t day. Because the trading dates of US are later than Taiwan's, we can say that t day of Taiwan stock market is influenced by t-1 day of US stock market. For example, the return of US's t day (the period from C_{t-1} to C_t) affects three periods of Taiwan stock market: (1).The period from the closing price of t day to the opening price of t+1 day (from C_t to $O_{t+1.}$) (2). The period from the opening price of t+1 day to the closing price of t+1 day (from $O_{t+1\ to}$ $C_{t+1.}$) (3).The period from the closing price of t day to the closing price of t+1 day (from C_t to $C_{t+1,}$) and so on.

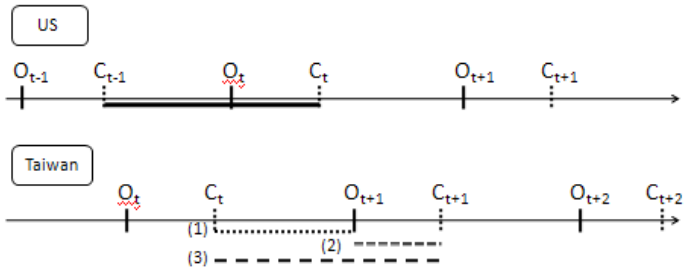

Figure 1: The trading periods between US and Taiwan stock markets

3.2 Descriptive Statistics

In Table 1, we show the descriptive statistics of the returns of Taiwan and US stock markets from 1995/11/7 to 2009/3/26. Panel A shows the descriptive statistics for the close-to-open returns of Taiwan stock markets and close-to-close returns of US stock markets. The daily close-to-open returns are calculated by $100\times\log(P_t^{Open}/P_{t-1}^{Close})$.

＜Panel A is inserted about here＞

Panel B shows the descriptive statistics for the open-to-close returns of Taiwan stock markets and close-to-close returns of US stock markets. The daily open-to-close returns are calculated by $100\times\log(P_t^{Close}/P_t^{Open})$.

＜Panel B is inserted about here＞

Panel C shows the descriptive statistics for the close-to-close returns of Taiwan stock markets and close-to-close returns of US stock markets. The daily close-to-close returns are calculated by $100\times\log(P_t^{Close}/P_{t-1}^{Close})$. And all the descriptive statistics of the returns of the series are given in Table1.

＜Panel C is inserted about here＞

In Table 1, we can know the difference between close-to-open, open-to-close and close-to-close returns of TAIEX and OTC over the sample period from 1995/11/7 to 2009/3/26. The means of close-to-open returns of TAIEX and OTC are positive (Panel 1), while the means of open-to-close of TAIEX and OTC are negative (Panel 2). The means of

close-to-close returns of TAIEX is positive, however, OTC's is negative (Panel 3).

For volatility, it is shown that the standard deviation of TAIEX and OTC are the smallest in close-to-open returns. And the standard deviation of TAIEX and OTC are the highest in close-to-close returns.

Close-to-open and close-to-close returns of TAIEX and OTC are negatively skewed, so we know they shift to the left. And open-to-close returns of TAIEX and OTC are positively skewed, so we know they shift to the right. Moreover, all moments of the returns have excess kurtosis.

The means of close-to-close returns of NASDAQ, Dow Jones and S&P 500 are positive and have excess kurtosis. Dow Jones and S&P 500 are negatively skewed and shift to the left. However, NASDAQ is positive and shifts to the right.

In Panel 1, it is indicated that the volatility of NASDAQ return is the highest and the close-to-open return of TAIEX is the smallest. In Panel 2, the volatility of NASDAQ return is the highest and the Dow Jones is the smallest. And it is shown that the volatility of OTC return is the highest and the Dow Jones is the smallest in Panel 3.

All the variables we use are returns, so we will not have any spurious regression. We can use quantile regression directly.

4. Estimation Results

We regard S&P 500 as the independent variable, TAIEX and OTC as the dependent variables. We use E-VIEWS to consider the quantile regression between the returns of S&P 500 and the returns of TAIEX and OTC respectively. Every 0.05 quantile from 0.05 to 0.95 (left to right) for each sample was chosen. Moreover, 0.01 and 0.99 quantiles are chosen, because we want to know the highest and the lowest stock prices. The interception and slope estimates are under 95% confidence interval and there are 21 results of quantile regression in each sample period.

Table 2 to Table 11 document the empirical results of the influences from the returns of US stock market to the returns of close-to-open stock market of Taiwan over the sample period from 1995 to 2009.

Table 2 presents the results from 1995/11/7 to 1997/6/30, and most of the coefficients of slope are significant positive at 5% or 10% significant level, except for θ = 0.05, 0.55, 0.6, 0.75, 0.8, 0.9. Moreover, it becomes non significant negative correlation where θ = 0.01. After 1997/7/2 (Table 3 to Table 5), there are significant positive correlations at 5% significance level. And Table 6 shows that there is significant positive correlation between the returns of US stock market and the close-to-open returns of TAIEX at 5% significance level from 1995 to 2009.

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Table 7 to Table 11 present the correlations between US stock market and the close-to-open returns of OTC from1995/11/7 to 2009/3/26. In Table 7, there is non significant positive correlation except for θ = 0.05, 0.9, 0.95 at 5% significance level and θ = 0.35 at 10% significance level. After 1997/7/2 (Table 8 to Table 10), there are significant positive correlations at 5% significance level. Table 11 shows that there is significant positive correlation between the returns of US stock market and the close-to-open returns of OTC at 5% significance level from 1995 to 2009.

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Table 12 to Table 21 document the empirical results of the influences from the returns of US stock market to the returns of open-to-close stock market of Taiwan over the sample period from 1995 to 2009. Table 12 shows all of the coefficients of slope are significant

negative. Moreover, we find that there are significant negative at $\theta = 0.05$ at 5% significance level, and at $\theta = 0.15, 0.85, 0.9, 0.95, 0.99$ at 10% significance level. We know that there are negative correlations between the returns of US stock market and the returns of open-to-close stock market of TAIEX from 1995/11/7 to 1997/6/30, though significant negative correlations only occurred at the highest or lowest price.

< Table 12 is inserted about here >

Table 13 shows all of the coefficients of slope are significantly negative. Moreover, we find that half of the quantiles are significant negative correlations. When $\theta = 0.01, 0.05, 0.1, 0.25, 0.8, 0.85$, there are significant negative correlations at 5% significance level, and there are significant negative correlations at $\theta = 0.15, 0.35, 0.75$ at 10% significance level.

< Table 13 is inserted about here >

After 2000/7/3, almost all the coefficients of slope are significant negative, except for $\theta = 0.99$ from 2000/07/03-2007/02/27 and $\theta = 0.05, 0.1, 0.15$ from 2007/3/1 to 2009/3/26. There seems to be a significant negative trend when time goes by. Table 16 shows that there is significant negative correlation between the returns of US stock market and the open-to-close returns of TAIEX at 5% significance level from 1995 to 2009.

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Table 17 shows that all the coefficients of slope are negative, and we find that there are significant negative at θ = 0.01, 0.05 at 5% significance level, and at Q= 0.45, 0.9, 0.95 at 10% significance level. In Table 18, Table 19 and Table 20, almost all the coefficients of slope are significant negative at 5% significance level, except for θ = 0.2, there is non significant at 10% level of significance from 1997/7/2 to 2000/6/30 (Table 18), and there is non significant at θ = 0.1 at 10% level of significance from 2007/03/01-2009/03/26 (Table 20). Table 21 shows that there is significant negative correlation between the returns of US stock market and the open-to-close returns of OTC at 5% significance level from 1995 to 2009.

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Table 22 to Table 31 are documented the empirical results of the influences from the returns of US stock market to the returns of close-to-close stock market of Taiwan over the sample period from 1995 to 2009. Table 22 shows that most of the coefficients of slope are non significant positive correlations, however, the coefficients of slope are non significant negative correlations when θ = 0.1, 0.01, 0.8, 0.85, 0.9, 0.95. There is significant negative correlation at θ = 0.01 at 5% significance level, but there is significant positive correlation at

θ = 0.99 at 10% significance level. After 1997/7/2 (Table 23, Table 24 and Table 25), there are almost significant positive correlations between the returns of US stock market and the returns of TAIEX at 5% or 10 % significance level, except for θ = 0.95, 0.99 from 1997/7/2 to 2000/6/30 (Table 23) is non significant at 10% level of significance. Table 26 shows that there is significant positive correlation between the returns of US stock market and the close-to-close returns of TAIEX at 5% significance level from 1995 to 2009.

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In Table 27, most of the coefficients of slope are non significant positive correlations between the returns of S&P 500 and the close-to-close returns of OTC from 1995/11/06 to 1997/06/30, except when θ = 0.01, 0.05, 0.35, 0.6, 0.8, 0.9, 0.95, there are non significant negative effects. Furthermore, there is significant negative correlation at θ = 0.01 at 5% significance level. After 1997/7/2, there is significant positive correlation at 5% significance level, except for θ = 0.95 and 0.99, there are non significant positive effects at 10% significance level. Table 31 shows that there is significant positive correlation between the returns of US stock market and the close-to-close returns of OTC at 5% significance level

from 1995 to 2009.

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< Table 31 is inserted about here >

We analyze how US stock mark influences Taiwan stock market at different quantiles by using the quantile regression. And it can give us the suggestion what we should react as the price goes up or down. This paper not only confirms the prior studies that Taiwan stock market is influenced by the stock price of the US, but also discovers the overreaction effect. We summarize the results in Table 32, 33, 34, 35, 36, 37, 38, 39, 40 and our findings are as follows:

1. For the close-to-open returns, there is significant positive effect from US to Taiwan stock markets from 1995/11/7 to 2009/3/26. However, the price change spillover effect exists when the stock price goes up or down greatly from 1995/11/7 to 1997/6/30 (Table 32 and 33). There seems to be a significant positive trend not only in TAIEX but also in OTC as time goes by. In other words, we can say that there is the spillover effect from US stock market to the close-to-open return of Taiwan stock market. Table 35 reports the slope estimate of both the quantile regression and ordinary least squares method from 1995 to

2009. We can know that both of the slope estimates are positive. In other words, there are positive correlations not only between S&P 500 and close-to-open returns of TAIEX, but also between S&P 500 and close-to-open returns of OTC. Moreover, we can find that the slope estimates are different in most of the quantiles. OLS might underestimate the slope estimate when price goes down but overestimate it when price goes up.

2. For the open-to-close returns, there is significant negative correlation between US and Taiwan stock markets from 1995/11/7 to 2009/3/26. In other words, there are overreaction effects both in TAIEX and OTC. For TAIEX, the negative effect is stronger when the stock price goes up greatly from 1995/11/7 to 1997/6/30, however, the negative effect is stronger when the stock price goes down greatly from 1997/7/2 to 2000/6/30. From 2000/7/3 to 2009/3/26, the negative effect is significant. For OTC, the negative impact is stronger when the stock price goes up or down greatly from 1995/11/7 to 2000/6/30. From 2000/7/3 to 2009/3/26, the negative effect is significant. Table 37 reports the slope estimate of both the quantile regression and ordinary least squares method from 1995 to 2009. We can know that both of the slope estimates are negative. In other words, there are negative correlations not only between S&P 500 and open-to-close returns of TAIEX, but also between S&P 500 and open-to-close returns of OTC. Moreover, we can find that the slope estimates are different in most of the quantiles. OLS might overestimate the slope estimates when price goes up or down greatly, but otherwise

OLS underestimates the slope estimates.

3. For the close-to-close returns, there is significant positive correlation between US and Taiwan stock markets from 1995/11/7 to 2009/3/26, except for the returns from 1995/11/7 to 1997/6/30. There is a negative effect from U.S. to Taiwan when the stock price goes down greatly from 1995/11/7 to 1997/6/30. Furthermore, there seems to be a significant positive trend not only in TAIEX but also in OTC as time goes by. And we can conclude there is the spillover effect from US stock market to the close-to-close return of Taiwan stock market. Table 40 reports the slope estimate of both the quantile regression and ordinary least squares method from 1995 to 2009. We can know that both of the slope estimates are positive. In other words, there are positive correlations not only between S&P 500 and close-to-close returns of TAIEX, but also between S&P 500 and close-to-close returns of OTC. Moreover, we can find that the slope estimates are different in most of the quantiles. OLS might underestimate the slope estimate when price goes down greatly, but otherwise overestimates the slope estimates.

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5. Conclusion

In this paper, we use quantile regression and learn that both spillover effects and overreaction effect exist from US stock market to Taiwan stock market, and we separate time period from 1995/11/7 to 1997/6/30, 1997/6/30 to 2000/6/30, 2000/7/3 to 2007/2/27, and from 2007/3/1 to 2009/3/26 to know the spillover effects and overreaction effect respectively. We not only demonstrate the past research that there are spillover effects in close-to-open and close-to-close returns (Chou, Lin, Wu, 1999 and Chang, 2008), but also find that there is a overreaction effect in open-to-close returns. Furthermore, both of spillover effects and overreaction effect become stronger over time.

We find that if we use OLS, we can only know there is positive or negative correlation between U.S. and Taiwan on average. And OLS overestimates or underestimates the slope estimate at different quantiles. Quantile regression makes us know the whole behavior of the distribution, no matter the stock price goes up or down.

Because the spillover and overreaction effects exist from US stock market to Taiwan stock market, there are some suggestions for investors. Firstly, because of the spillover effects, we can judge whether tomorrow's opening price or closing price of Taiwan stock market will goes up by today's closing price of US. Secondly, because of the overreaction effect, if the closing stock price of US goes down and the opening stock price of Taiwan goes down greatly, we can earn profit by buying at the opening price and selling at the closing price except

during Financial Tsunami. So investors should be more cautious as TAIEX stock prices go down during Financial Tsunami.

In this paper, we didn't take the limit regulation of stock price into consideration. The price limit regulation delays stock price discovery process if the limits are hit (Wang, L. H., 2000), so it could be a factor that influences overreaction from US to Taiwan. After 1989, the price limit regulation changes from 5% to 7%, and there are seven times that the down limits adjust to 3.5% in our time period. The seven times are as follows:

1. 1999/9/27~1999/10/9: 921 earth quake.
2. 2000/3/20~2000/3/24: the turnover of the regime.
3. 2000/10/4~2000/10/11: the resignation of Premier.
4. 2000/10/20~2000/11/7: the discontinuity of the fourth nuclear power plant.
5. 2000/11/21~2000/12/31: the falling of Taiwan stock market by 320 points.
6. 2001/9/19~2001/9/21: September 11 attacks.
7. 2008/10/13~2008/10/17: financial tsunami. Because each time period of these is short, we didn't take into account in this paper, the following researchers can expand in this direction.

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TABLE 1
Descriptive Statistics

Panel A : Descriptive Statistics for Taiwan and US Stock Markets' Returns and ADF Unit Root Test, 1995/11/7 to 2009/3/26

	Close-to-open		Close-to-close
	TSE	OTC	S&P 500
Mean	0.001839	0.000692	0.000101
Median	0.002634	0.001556	0.000615
Maximum	0.081902	0.079184	0.102457
Minimum	-0.155686	-0.162348	-0.094695
Std. Dev.	0.011864	0.013015	0.013371
Skewness	-1.193241	-0.892372	-0.133385
Kurtosis	18.76169	15.14800	10.23191
Observations	3178	3178	3178

Panel B : Descriptive Statistics for Taiwan and US Stock Markets' Returns and ADF Unit Root Test, 1995/11/7 to 2009/3/26

	Open-to-close		Close-to-close
	TSE	OTC	S&P 500
Mean	-0.001806	-0.000757	0.000101
Median	-0.001873	-0.001043	0.000615
Maximum	0.067319	0.079807	0.102457
Minimum	-0.074804	-0.079415	-0.094695
Std. Dev.	0.013219	0.015338	0.013371
Skewness	0.083763	0.246014	-0.133385
Kurtosis	5.275018	5.034203	10.23191
Observations	3178	3178	3178

Panel C : Descriptive Statistics for Taiwan and US Stock Markets' Returns and ADF Unit Root Test, 1995/11/7 to 2009/3/26

	Close-to-close		Close-to-close
	TSE	OTC	S&P 500
Mean	3.22E-05	-6.48E-05	0.000101
Median	1.76E-05	-0.000109	0.000615
Maximum	0.085198	0.097454	0.102457
Minimum	-0.126043	-0.140420	-0.094695
Std. Dev.	0.016723	0.019004	0.013371
Skewness	-0.247889	-0.080337	-0.133385
Kurtosis	6.323649	5.694679	10.23191
Observations	3178	3178	3178

TABLE 2

Quantile Regression, 1995/11/07-1997/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of TAIEX

TAIEX 1995-1997 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0170	0.0000	0.500	0.0048	0.0000
	(slope)	-0.1359	0.3265		0.0954	0.0808
	0.050	-0.0096	0.0000	0.550	0.0055	0.0000
		0.0928	0.2255		0.0868	0.1132
	0.100	-0.0051	0.0000	0.600	0.0060	0.0000
		0.2102	0.0009		0.0924	0.1045
	0.150	-0.0028	0.0000	0.650	0.0068	0.0000
		0.2694	0.0000		0.1103	0.0837
	0.200	-0.0007	0.2416	0.700	0.0073	0.0000
		0.2227	0.0000		0.1305	0.0558
	0.250	0.0007	0.1775	0.750	0.0080	0.0000
		0.1716	0.0023		0.1045	0.1528
	0.300	0.0015	0.0038	0.800	0.0089	0.0000
		0.1652	0.0043		0.0734	0.3317
	0.350	0.0023	0.0000	0.850	0.0107	0.0000
		0.1590	0.0058		0.1386	0.0790
	0.400	0.0034	0.0000	0.900	0.0123	0.0000
		0.1205	0.0249		0.1182	0.1205
	0.450	0.0042	0.0000	0.950	0.0178	0.0000
		0.0934	0.0802		0.3763	0.0623
				0.990	0.0261	0.0000
					0.5785	0.0000

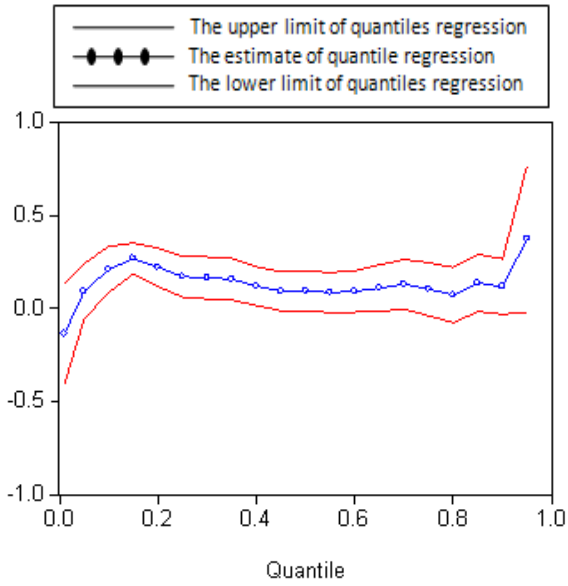


Figure 2: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 3

Quantile Regression, 1997/07/02-2000/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of TAIEX

TAIEX 1997-2000 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0267	0.0000	0.500	0.0033	0.0000
	(slope)	0.5180	0.0000		0.4322	0.0000
	0.050	-0.0130	0.0000	0.550	0.0040	0.0000
		0.4778	0.0000		0.4206	0.0000
	0.100	-0.0083	0.0000	0.600	0.0045	0.0000
		0.4961	0.0000		0.4223	0.0000
	0.150	-0.0050	0.0000	0.650	0.0055	0.0000
		0.4872	0.0000		0.3953	0.0000
	0.200	-0.0027	0.0000	0.700	0.0063	0.0000
		0.4266	0.0000		0.3764	0.0000
	0.250	-0.0014	0.0007	0.750	0.0074	0.0000
		0.4292	0.0000		0.3710	0.0000
	0.300	-0.0002	0.4817	0.800	0.0085	0.0000
		0.4102	0.0000		0.3434	0.0000
	0.350	0.0007	0.0294	0.850	0.0102	0.0000
		0.4191	0.0000		0.3378	0.0000
	0.400	0.0015	0.0000	0.900	0.0125	0.0000
		0.4115	0.0000		0.3142	0.0000
	0.450	0.0023	0.0000	0.950	0.0169	0.0000
		0.4239	0.0000		0.3055	0.0001
				0.990	0.0286	0.0000
					0.5718	0.1739

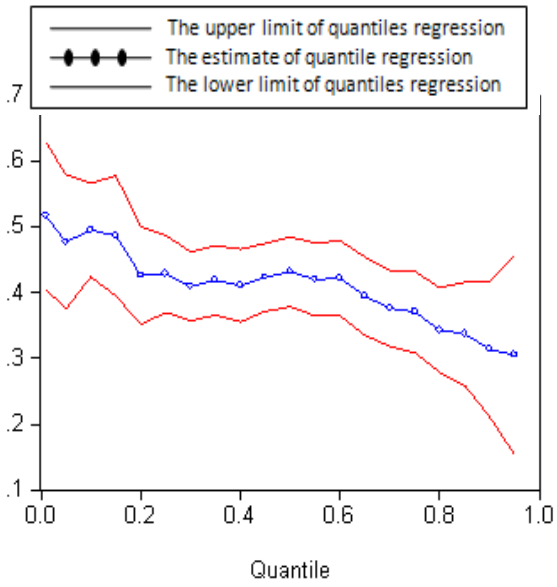


Figure 3: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 4

Quantile Regression, 2000/07/03-2007/02/27

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of TAIEX

TAIEX 2000-2007 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0270	0.0000	0.500	0.0016	0.0000
	(slope)	0.4987	0.0000		0.5728	0.0000
	0.050	-0.0111	0.0000	0.550	0.0021	0.0000
		0.5772	0.0000		0.5623	0.0000
	0.100	-0.0060	0.0000	0.600	0.0027	0.0000
		0.5706	0.0000		0.5561	0.0000
	0.150	-0.0041	0.0000	0.650	0.0034	0.0000
		0.6010	0.0000		0.5537	0.0000
	0.200	-0.0027	0.0000	0.700	0.0040	0.0000
		0.6065	0.0000		0.5513	0.0000
	0.250	-0.0017	0.0000	0.750	0.0047	0.0000
		0.5857	0.0000		0.5591	0.0000
	0.300	-0.0009	0.0000	0.800	0.0055	0.0000
		0.5771	0.0000		0.5545	0.0000
	0.350	-0.0002	0.1977	0.850	0.0067	0.0000
		0.5705	0.0000		0.5677	0.0000
	0.400	0.0005	0.0028	0.900	0.0085	0.0000
		0.5615	0.0000		0.5779	0.0000
	0.450	0.0011	0.0000	0.950	0.0122	0.0000
		0.5709	0.0000		0.5584	0.0000
				0.990	0.0215	0.0000
					0.5902	0.0000

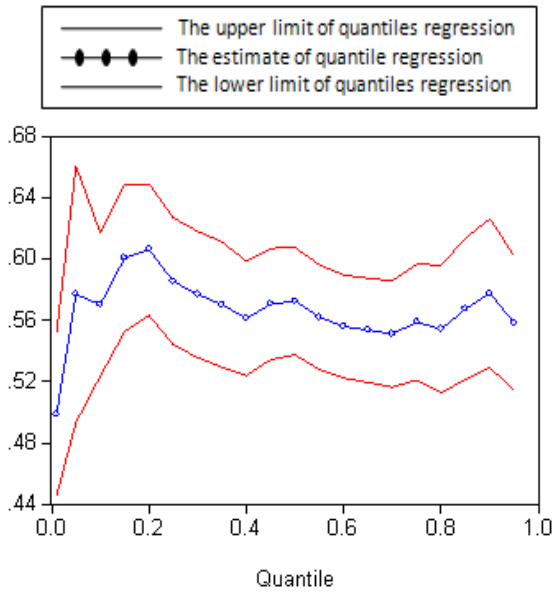


Figure 4: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 5

Quantile Regression, 2007/03/01-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of TAIEX

TAIEX 2007-2009 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0338	0.0000	0.500	0.0017	0.0000
	(slope)	0.4514	0.0000		0.5213	0.0000
	0.050	-0.0186	0.0000	0.550	0.0024	0.0000
		0.5968	0.0000		0.5165	0.0000
	0.100	-0.0110	0.0000	0.600	0.0031	0.0000
		0.5845	0.0000		0.5191	0.0000
	0.150	-0.0068	0.0000	0.650	0.0039	0.0000
		0.5477	0.0000		0.5037	0.0000
	0.200	-0.0047	0.0000	0.700	0.0046	0.0000
		0.5432	0.0000		0.5089	0.0000
	0.250	-0.0030	0.0000	0.750	0.0054	0.0000
		0.5494	0.0000		0.4950	0.0000
	0.300	-0.0015	0.0007	0.800	0.0064	0.0000
		0.5734	0.0000		0.4707	0.0000
	0.350	-0.0003	0.3988	0.850	0.0081	0.0000
		0.5395	0.0000		0.4662	0.0000
	0.400	0.0005	0.2028	0.900	0.0109	0.0000
		0.5220	0.0000		0.4780	0.0000
	0.450	0.0012	0.0006	0.950	0.0150	0.0000
		0.5227	0.0000		0.4942	0.0000
					0.0336	0.0000
					0.6357	0.023

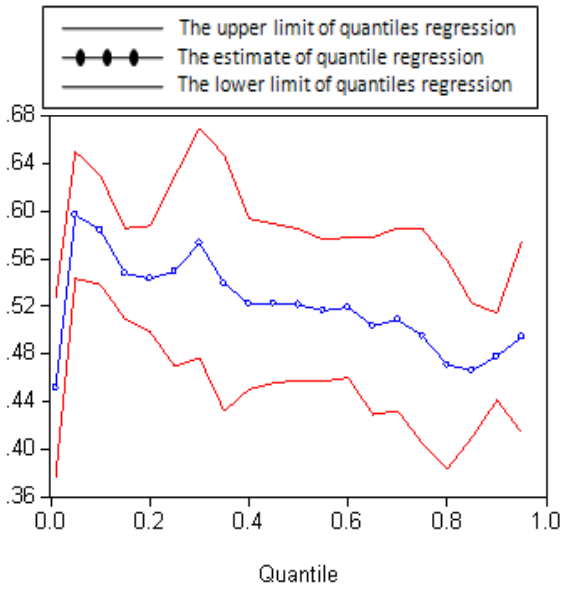


Figure 5: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 6

Quantile Regression, 1995/11/07-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of TAIEX

TAIEX 1995-2009 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0275	0.0000	0.500	0.0021	0.0000
	(slope)	0.5049	0.0000		0.4972	0.0000
	0.050	-0.0122	0.0000	0.550	0.0028	0.0000
		0.5446	0.0000		0.4927	0.0000
	0.100	-0.0070	0.0000	0.600	0.0035	0.0000
		0.5371	0.0000		0.4904	0.0000
	0.150	-0.0045	0.0000	0.650	0.0042	0.0000
		0.5319	0.0000		0.4898	0.0000
	0.200	-0.0030	0.0000	0.700	0.0049	0.0000
		0.5319	0.0000		0.4981	0.0000
	0.250	-0.0017	0.0000	0.750	0.0058	0.0000
		0.5181	0.0000		0.4836	0.0000
	0.300	-0.0008	0.0000	0.800	0.0070	0.0000
		0.5128	0.0000		0.4554	0.0000
	0.350	0.0001	0.3543	0.850	0.0082	0.0000
		0.5041	0.0000		0.4494	0.0000
	0.400	0.0009	0.0000	0.900	0.0106	0.0000
		0.5029	0.0000		0.4674	0.0000
	0.450	0.0016	0.0000	0.950	0.0146	0.0000
		0.4963	0.0000		0.4831	0.0000
				0.990	0.0260	0.0000
					0.4844	0.0000

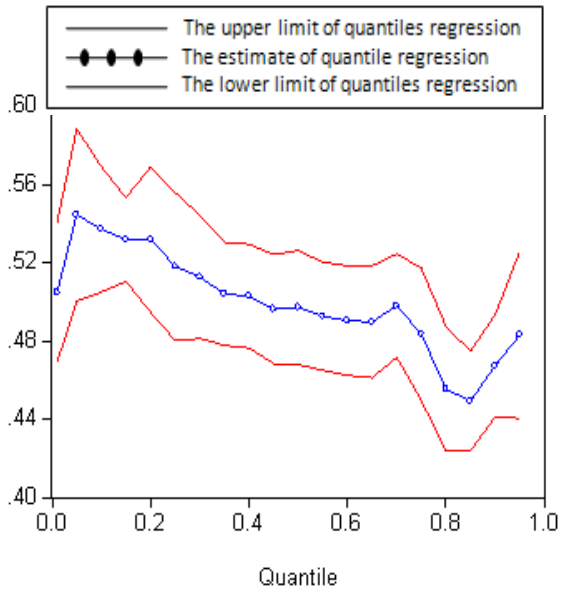


Figure 6: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 7

Quantile Regression, 1995/11/07-1997/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of OTC

OTC 1995-1997 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0267	0.1702	0.500	0.0004	0.2025
	(slope)	0.1296	0.9891		0.0428	0.2876
	0.050	-0.0117	0.0000	0.550	0.0013	0.0002
		0.2380	0.0038		0.0737	0.1063
	0.100	-0.0069	0.0000	0.600	0.0022	0.0000
		0.0499	0.5338		0.0661	0.2235
	0.150	-0.0041	0.0000	0.650	0.0030	0.0000
		0.0663	0.2924		0.0960	0.1605
	0.200	-0.0026	0.0000	0.700	0.0044	0.0000
		0.0559	0.1378		0.1133	0.1729
	0.250	-0.0020	0.0000	0.750	0.0060	0.0000
		0.0569	0.1055		0.0754	0.4628
	0.300	-0.0010	0.0005	0.800	0.0075	0.0000
		0.0710	0.0370		0.1800	0.2481
	0.350	-0.0005	0.0772	0.850	0.0107	0.0000
		0.0601	0.0940		0.1628	0.1190
	0.400	-0.0003	0.4126	0.900	0.0132	0.0000
		0.0585	0.1194		0.2628	0.0236
	0.450	0.0000	0.8901	0.950	0.0190	0.0000
		0.0360	0.3635		0.3675	0.0301
				0.990	0.0383	0.0000
					0.6022	0.2791

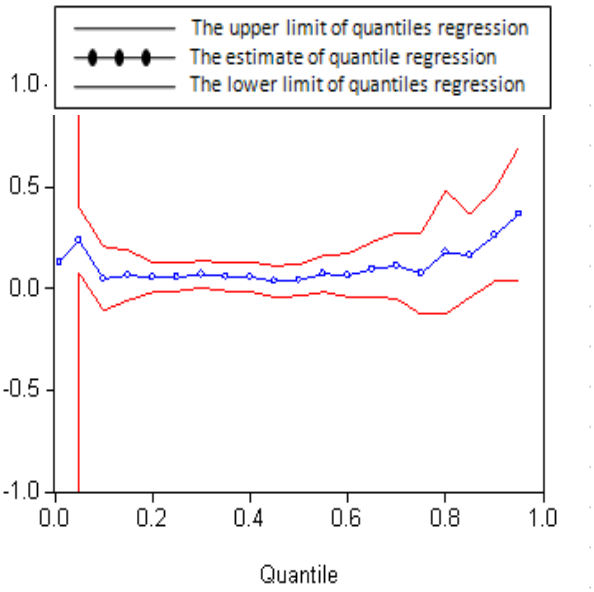


Figure 7: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 8

Quantile Regression, 1997/07/02-2000/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of OTC

OTC 1997-2000 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0335	0.0000	0.500	0.0000	0.9375
	(slope)	0.4777	0.0000		0.4777	0.0000
	0.050	-0.0192	0.0000	0.550	0.0015	0.0005
		0.6085	0.0000		0.4851	0.0000
	0.100	-0.0128	0.0000	0.600	0.0025	0.0000
		0.6072	0.0000		0.4846	0.0000
	0.150	-0.0103	0.0000	0.650	0.0036	0.0000
		0.5945	0.0000		0.4965	0.0000
	0.200	-0.0080	0.0000	0.700	0.0048	0.0000
		0.5658	0.0000		0.5026	0.0000
	0.250	-0.0064	0.0000	0.750	0.0062	0.0000
		0.5556	0.0000		0.4669	0.0000
	0.300	-0.0048	0.0000	0.800	0.00787	0.0000
		0.5233	0.0000		0.4673	0.0000
	0.350	-0.0036	0.0000	0.850	0.0101	0.0000
		0.5133	0.0000		0.4704	0.0000
	0.400	-0.0020	0.0000	0.900	0.0138	0.0000
		0.4770	0.0000		0.4601	0.0000
	0.450	-0.0009	0.0510	0.950	0.0199	0.0000
		0.4573	0.0000		0.4191	0.0033
				0.990	0.0352	0.0002
					0.3104	0.5940

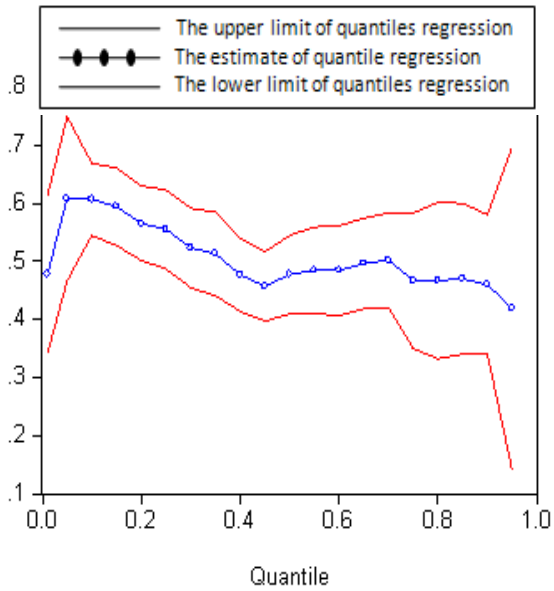


Figure 8: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 9

Quantile Regression, 2000/07/03-2007/02/27

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of OTC

OTC 2000-2007 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0350	0.0000	0.500	0.0013	0.0000
	(slope)	0.5999	0.0006		0.5723	0.0000
	0.050	-0.0147	0.0000	0.550	0.0019	0.0000
		0.6637	0.0000		0.5723	0.0000
	0.100	-0.0079	0.0000	0.600	0.0025	0.0000
		0.5846	0.0000		0.5632	0.0000
	0.150	-0.0057	0.0000	0.650	0.0030	0.0000
		0.5853	0.0000		0.5706	0.0000
	0.200	-0.0039	0.0000	0.700	0.0038	0.0000
		0.5873	0.0000		0.5857	0.0000
	0.250	-0.0025	0.0000	0.750	0.0045	0.0000
		0.5797	0.0000		0.5865	0.0000
	0.300	-0.0015	0.0000	0.800	0.0055	0.0000
		0.5815	0.0000		0.5954	0.0000
	0.350	-0.0006	0.0006	0.850	0.0065	0.0000
		0.5823	0.0000		0.5755	0.0000
	0.400	0.0000	0.8924	0.900	0.0080	0.0000
		0.5814	0.0000		0.5627	0.0000
	0.450	0.0006	0.0002	0.950	0.0116	0.0000
		0.5694	0.0000		0.6019	0.0000
				0.990	0.0206	0.0000
					0.4986	0.0000

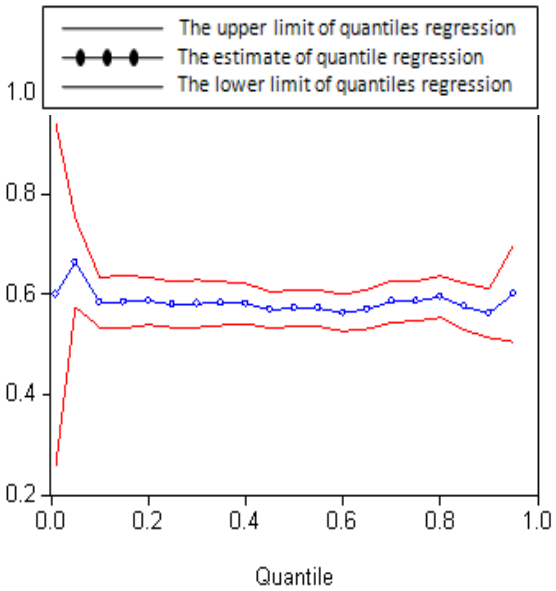


Figure 9: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 10

Quantile Regression, 2007/03/01-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of OTC

OTC 2007-2009 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0313	0.0000	0.500	0.0030	0.0000
	(slope)	0.6102	0.0000		0.4765	0.0000
	0.050	-0.0178	0.0000	0.550	0.0036	0.0000
		0.5582	0.0000		0.4826	0.0000
	0.100	-0.0114	0.0000	0.600	0.0042	0.0000
		0.5371	0.0000		0.4617	0.0000
	0.150	-0.0071	0.0000	0.650	0.0049	0.0000
		0.5503	0.0000		0.4413	0.0000
	0.200	-0.0041	0.0000	0.700	0.0056	0.0000
		0.5447	0.0000		0.4523	0.0000
	0.250	-0.0022	0.0011	0.750	0.0063	0.0000
		0.5218	0.0000		0.4592	0.0000
	0.300	-0.0004	0.3683	0.800	0.0073	0.0000
		0.4873	0.0000		0.4511	0.0000
	0.350	0.0005	0.2287	0.850	0.0082	0.0000
		0.4833	0.0000		0.4513	0.0000
	0.400	0.0013	0.0006	0.900	0.0102	0.0000
		0.4799	0.0000		0.4259	0.0000
	0.450	0.0022	0.0000	0.950	0.0140	0.0000
		0.4789	0.0000		0.4344	0.0000
				0.990	0.0296	0.0000
					0.6305	0.0000

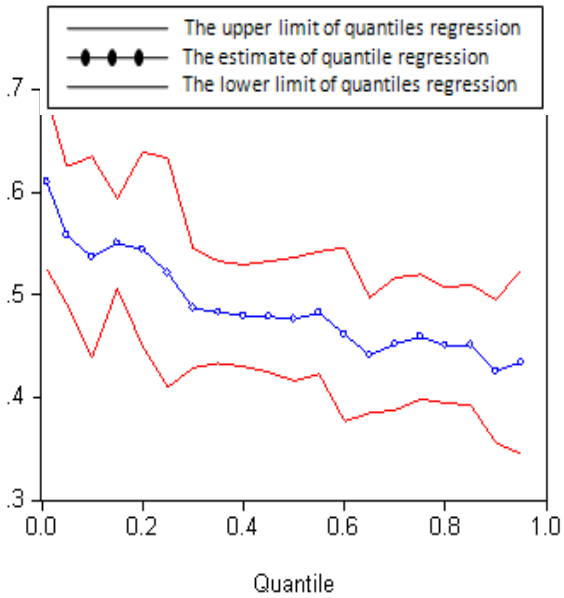


Figure 10: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 11

Quantile Regression, 1995/11/07-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-open Stock Price of OTC

OTC 1995-2009 Close-to-open	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0324	0.0000	0.500	0.0014	0.0000
	(slope)	0.5698	0.0000		0.4973	0.0000
	0.050	-0.0166	0.0000	0.550	0.0021	0.0000
		0.5638	0.0000		0.4964	0.0000
	0.100	-0.0101	0.0000	0.600	0.0028	0.0000
		0.5628	0.0000		0.4968	0.0000
	0.150	-0.0071	0.0000	0.650	0.0035	0.0000
		0.5439	0.0000		0.4999	0.0000
	0.200	-0.0052	0.0000	0.700	0.0044	0.0000
		0.5391	0.0000		0.5067	0.0000
	0.250	-0.0035	0.0000	0.750	0.0053	0.0000
		0.5168	0.0000		0.4913	0.0000
	0.300	-0.0022	0.0000	0.800	0.0065	0.0000
		0.4987	0.0000		0.4866	0.0000
	0.350	-0.0012	0.0000	0.850	0.0079	0.0000
		0.4996	0.0000		0.4824	0.0000
	0.400	-0.0002	0.1678	0.900	0.0100	0.0000
		0.4979	0.0000		0.4786	0.0000
	0.450	0.0005	0.0001	0.950	0.0154	0.0000
		0.4973	0.0000		0.4815	0.0000
				0.990	0.0303	0.0000
					0.5690	0.0001

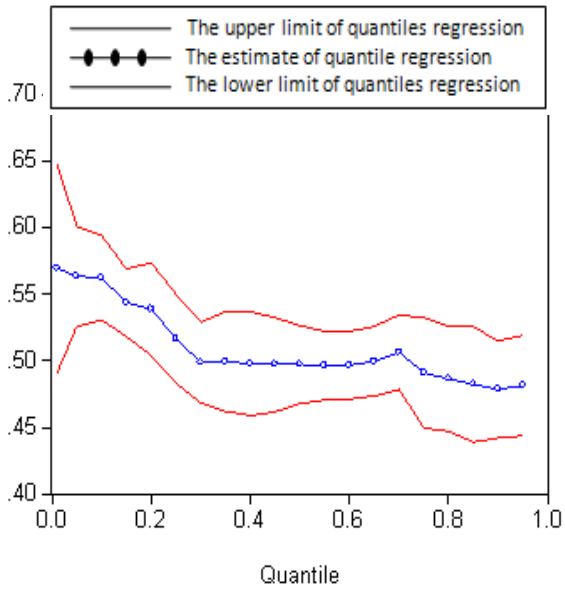


Figure 11: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 12

Quantile Regression, 1995/11/07-1997/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of TAIEX

TAIEX 1995-1997 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0334	0.0000	0.500	-0.0027	0.0000
	(slope)	-0.4097	0.3987		-0.0713	0.3788
	0.050	-0.0223	0.0000	0.550	-0.0016	0.0049
		-0.4918	0.0007		-0.0715	0.3623
	0.100	-0.0149	0.0000	0.600	-0.0005	0.4260
		-0.1558	0.1438		-0.0146	0.8406
	0.150	-0.0109	0.0000	0.650	0.0007	0.2274
		-0.1263	0.0935		-0.0451	0.5517
	0.200	-0.0094	0.0000	0.700	0.0020	0.0027
		-0.0795	0.2319		-0.0904	0.2424
	0.250	-0.0079	0.0000	0.750	0.0033	0.0000
		-0.0323	0.5994		-0.1031	0.1738
	0.300	-0.0069	0.0000	0.800	0.0048	0.0000
		-0.0318	0.6086		-0.1123	0.1055
	0.350	-0.0057	0.0000	0.850	0.0069	0.0000
		-0.0956	0.1828		-0.1488	0.0269
	0.400	-0.0044	0.0000	0.900	0.0097	0.0000
		-0.0617	0.4047		-0.2799	0.0338
	0.450	-0.0037	0.0000	0.950	0.0148	0.0000
		-0.0257	0.7170		-0.4418	0.0067
				0.990	0.0202	0.0000
					-0.7269	0.0000

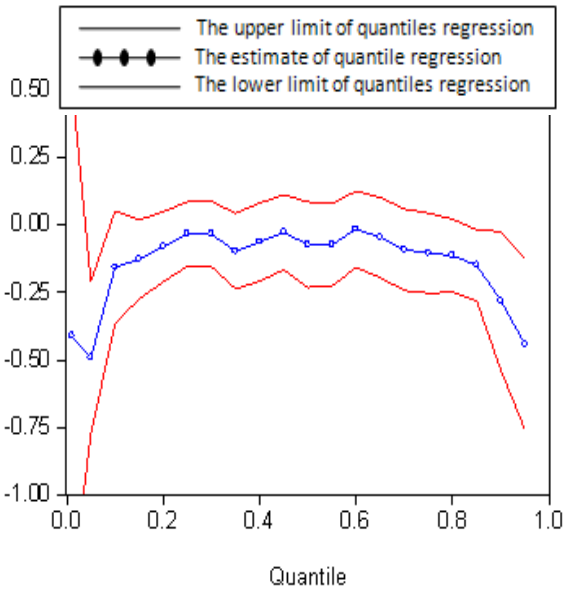


Figure 12: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 13

Quantile Regression, 1997/07/02-2000/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of TAIEX

TAIEX 1997-2000 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0384	0.0000	0.500	-0.0038	0.0000
	(slope)	-0.3009	0.0079		-0.0552	0.2499
	0.050	-0.0259	0.0000	0.550	-0.0025	0.0000
		-0.2264	0.0001		-0.0850	0.1110
	0.100	-0.0199	0.0000	0.600	-0.0008	0.1829
		-0.1634	0.0126		-0.0944	0.1072
	0.150	-0.0161	0.0000	0.650	0.0015	0.0304
		-0.0990	0.0550		-0.0982	0.1143
	0.200	-0.0140	0.0000	0.700	0.0029	0.0000
		-0.0726	0.1435		-0.0728	0.2660
	0.250	-0.0119	0.0000	0.750	0.0052	0.0000
		-0.1048	0.0288		-0.1078	0.0705
	0.300	-0.0098	0.0000	0.800	0.0076	0.0000
		-0.0747	0.1096		-0.1375	0.0071
	0.350	-0.0081	0.0000	0.850	0.0104	0.0000
		-0.0815	0.0874		-0.0982	0.0399
	0.400	-0.0068	0.0000	0.900	0.0150	0.0000
		-0.0740	0.1231		-0.0417	0.5100
	0.450	-0.0051	0.0000	0.950	0.0210	0.0000
		-0.0639	0.1801		-0.0658	0.5623
				0.990	0.0331	0.0000
					-0.1762	0.1561

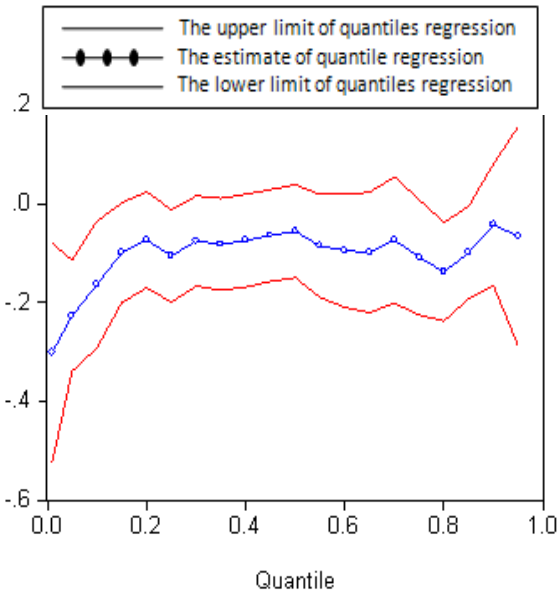


Figure 13: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 14

Quantile Regression, 2000/07/03-2007/02/27

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of TAIEX

TAIEX 2000-2007 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0341	0.0000	0.500	-0.0013	0.0000
	(slope)	-0.4318	0.0038		-0.2106	0.0000
	0.050	-0.0239	0.0000	0.550	-0.0001	0.6979
		-0.2757	0.0006		-0.1953	0.0000
	0.100	-0.0157	0.0000	0.600	0.0010	0.0009
		-0.2053	0.0004		-0.1951	0.0000
	0.150	-0.0119	0.0000	0.650	0.0025	0.0000
		-0.1986	0.0000		-0.1870	0.0000
	0.200	-0.0098	0.0000	0.700	0.0035	0.0000
		-0.1999	0.0000		-0.1879	0.0000
	0.250	-0.0078	0.0000	0.750	0.0054	0.0000
		-0.1908	0.0000		-0.1970	0.0000
	0.300	-0.0062	0.0000	0.800	0.0073	0.0000
		-0.1651	0.0000		-0.2057	0.0000
	0.350	-0.0050	0.0000	0.850	0.0097	0.0000
		-0.1746	0.0000		-0.1912	0.0000
	0.400	-0.0037	0.0000	0.900	0.0133	0.0000
		-0.1872	0.0000		-0.1787	0.0000
	0.450	-0.0024	0.0000	0.950	0.0204	0.0000
		-0.2093	0.0000		-0.2238	0.0013
				0.990	0.0354	0.0000
					-0.1377	0.2467

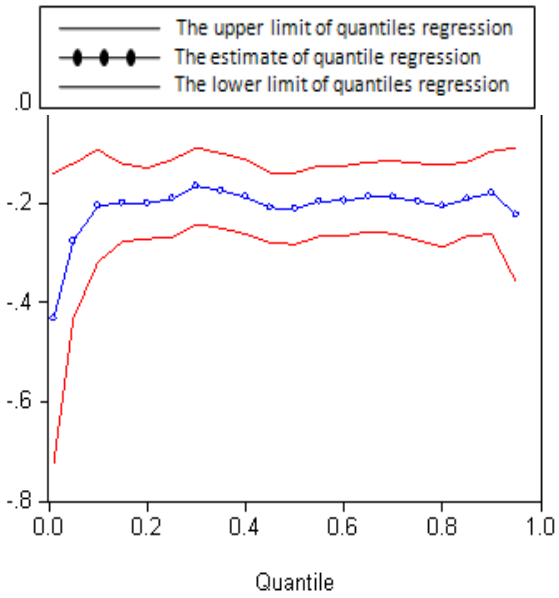


Figure 14: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 15

Quantile Regression, 2007/03/01-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of TAIEX

TAIEX 2007-2009 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0358	0.0000	0.500	-0.0007	0.1958
	(slope)	-0.1179	0.0018		-0.1460	0.0002
	0.050	-0.0245	0.0000	0.550	0.0004	0.4520
		0.0128	0.8936		-0.1560	0.0001
	0.100	-0.0186	0.0000	0.600	0.0021	0.0005
		-0.0302	0.7324		-0.1592	0.0003
	0.150	-0.0138	0.0000	0.650	0.0030	0.0000
		-0.1012	0.1028		-0.1629	0.0004
	0.200	-0.0110	0.0000	0.700	0.0047	0.0000
		-0.1268	0.0051		-0.1549	0.0001
	0.250	-0.0077	0.0000	0.750	0.0060	0.0000
		-0.1323	0.0005		-0.1643	0.0000
	0.300	-0.0054	0.0000	0.800	0.0085	0.0000
		-0.1274	0.0011		-0.1889	0.0000
	0.350	-0.0043	0.0000	0.850	0.0107	0.0000
		-0.1512	0.0001		-0.1857	0.0000
	0.400	-0.0030	0.0000	0.900	0.0143	0.0000
		-0.1455	0.0002		-0.2418	0.0000
	0.450	-0.0019	0.0010	0.950	0.0195	0.0000
		-0.1544	0.0002		-0.2649	0.0000
				0.990	0.0367	0.0000
					-0.4469	0.0000

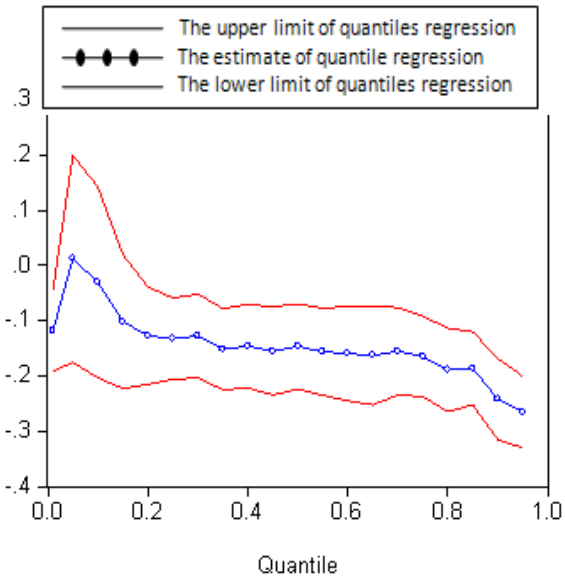


Figure 15: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 16

Quantile Regression, 1995/11/07-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of TAIEX

TAIEX 1995-2009 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0352	0.0000	0.500	-0.0018	0.0000
	(slope)	-0.2010	0.0329		-0.1610	0.0000
	0.050	-0.0241	0.0000	0.550	-0.0005	0.0189
		-0.2018	0.0000		-0.1552	0.0000
	0.100	-0.0171	0.0000	0.600	0.0007	0.0037
		-0.1424	0.0000		-0.1562	0.0000
	0.150	-0.0132	0.0000	0.650	0.0022	0.0000
		-0.1273	0.0000		-0.1559	0.0000
	0.200	-0.0109	0.0000	0.700	0.0035	0.0000
		-0.1338	0.0000		-0.1639	0.0000
	0.250	-0.0088	0.0000	0.750	0.0052	0.0000
		-0.1319	0.0000		-0.1543	0.0000
	0.300	-0.0069	0.0000	0.800	0.0078	0.0000
		-0.1387	0.0000		-0.1747	0.0000
	0.350	-0.0055	0.0000	0.850	0.0099	0.0000
		-0.1304	0.0000		-0.1639	0.0000
	0.400	-0.0044	0.0000	0.900	0.0131	0.0000
		-0.1374	0.0000		-0.1933	0.0000
	0.450	-0.0030	0.0000	0.950	0.0193	0.0000
		-0.1470	0.0000		-0.2405	0.0000
				0.990	0.0345	0.0000
					-0.2713	0.0000

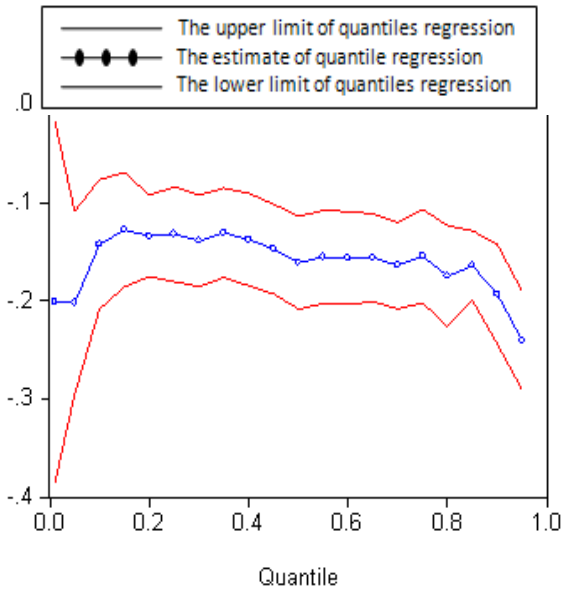


Figure 16: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 17

Quantile Regression, 1995/11/07-1997/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of OTC

OTC 1995-1997 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0371	0.0000	0.500	-0.0012	0.0677
	(slope)	-0.8424	0.0000		-0.1173	0.1342
	0.050	-0.0213	0.0000	0.550	-0.0004	0.5993
		-0.3392	0.0473		-0.0725	0.3859
	0.100	-0.0146	0.0000	0.600	0.0012	0.0909
		-0.1250	0.2648		-0.0769	0.3821
	0.150	-0.0109	0.0000	0.650	0.0024	0.0010
		-0.1040	0.2226		-0.0960	0.2958
	0.200	-0.0087	0.0000	0.700	0.0044	0.0000
		-0.0763	0.2915		-0.1376	0.1691
	0.250	-0.0069	0.0000	0.750	0.0062	0.0000
		-0.0593	0.3772		-0.0428	0.6785
	0.300	-0.0057	0.0000	0.800	0.0089	0.0000
		-0.0409	0.5565		-0.1338	0.4014
	0.350	-0.0045	0.0000	0.850	0.0121	0.0000
		-0.0826	0.2530		-0.3308	0.1911
	0.400	-0.0034	0.0000	0.900	0.0189	0.0000
		-0.0928	0.2127		-0.5640	0.0770
	0.450	-0.0023	0.0002	0.950	0.0279	0.0000
		-0.1326	0.0856		-0.5913	0.0705
				0.990	0.0554	0.0000
					-0.2442	0.8229

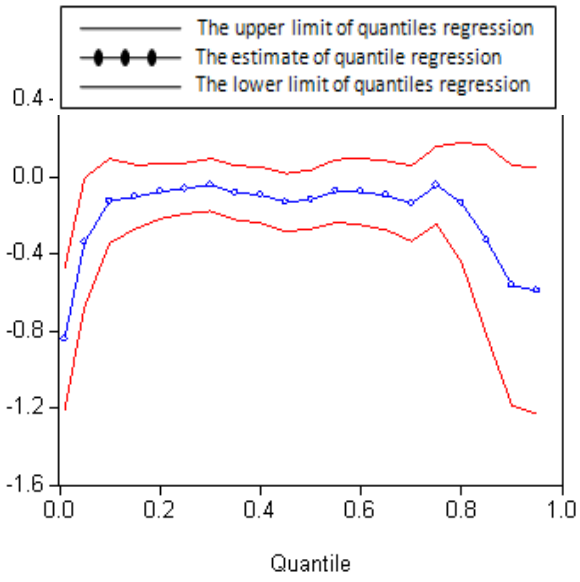


Figure 17: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 18

Quantile Regression, 1997/07/02-2000/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of OTC

OTC 1997-2000 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0406	0.0000	0.500	-0.0017	0.0135
	(slope)	-0.4578	0.0000		-0.1371	0.0250
	0.050	-0.0261	0.0000	0.550	-0.0000	0.9919
		-0.2871	0.0000		-0.1587	0.0129
	0.100	-0.0197	0.0000	0.600	0.0020	0.0052
		-0.1622	0.0391		-0.1438	0.0326
	0.150	-0.0149	0.0000	0.650	0.0043	0.0000
		-0.1366	0.0151		-0.1388	0.0492
	0.200	-0.0124	0.0000	0.700	0.0063	0.0000
		-0.0720	0.1249		-0.1748	0.0104
	0.250	-0.0104	0.0000	0.750	0.0088	0.0000
		-0.0893	0.0450		-0.1689	0.0115
	0.300	-0.0081	0.0000	0.800	0.0112	0.0000
		-0.1082	0.0272		-0.2060	0.0025
	0.350	-0.0062	0.0000	0.850	0.0139	0.0000
		-0.0932	0.0692		-0.1934	0.0169
	0.400	-0.0048	0.0000	0.900	0.0198	0.0000
		-0.1165	0.0412		-0.2072	0.0016
	0.450	-0.0033	0.0000	0.950	0.0267	0.0000
		-0.1391	0.0199		-0.315	0.0029
				0.990	0.0422	0.0000
					-0.4184	0.0159

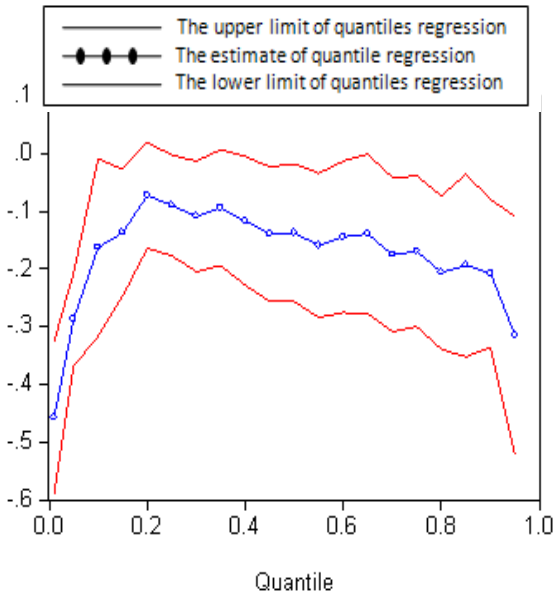


Figure 18: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 19

Quantile Regression, 2000/07/03-2007/02/27

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of OTC

OTC 2000-2007 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0346	0.0000	0.500	-0.0010	0.0023
	(slope)	-0.4563	0.0001		-0.2610	0.0000
	0.050	-0.0237	0.0000	0.550	0.0004	0.3082
		-0.2921	0.0000		-0.2895	0.0000
	0.100	-0.0180	0.0000	0.600	0.0017	0.0000
		-0.2268	0.0001		-0.3049	0.0000
	0.150	-0.0135	0.0000	0.650	0.0034	0.0000
		-0.2236	0.0000		-0.3187	0.0000
	0.200	-0.0106	0.0000	0.700	0.0049	0.0000
		-0.2407	0.0000		-0.3017	0.0000
	0.250	-0.0083	0.0000	0.750	0.0067	0.0000
		-0.2325	0.0000		-0.3072	0.0000
	0.300	-0.0063	0.0000	0.800	0.0090	0.0000
		-0.2703	0.0000		-0.3149	0.0000
	0.350	-0.0048	0.0000	0.850	0.0125	0.0000
		-0.2573	0.0000		-0.2595	0.0000
	0.400	-0.0033	0.0000	0.900	0.0161	0.0000
		-0.2617	0.0000		-0.2715	0.0000
	0.450	-0.0022	0.0000	0.950	0.0222	0.0000
		-0.2587	0.0000		-0.2007	0.0005
				0.990	0.0428	0.0000
					-0.6627	0.0000

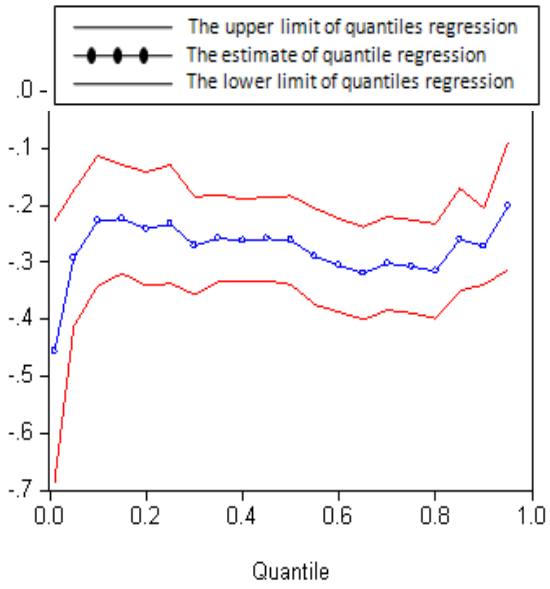


Figure 19: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 20

Quantile Regression, 2007/03/01-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of OTC

OTC 2007-2009 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0423	0.0000	0.500	-0.0015	0.0485
	(slope)	-0.2383	0.0150		-0.2129	0.0006
	0.050	-0.0313	0.0000	0.550	0.0002	0.7536
		-0.2309	0.0001		-0.2101	0.0007
	0.100	-0.0222	0.0000	0.600	0.0017	0.0215
		-0.1467	0.3292		-0.2269	0.0003
	0.150	-0.0182	0.0000	0.650	0.0032	0.0000
		-0.1921	0.0002		-0.2130	0.0005
	0.200	-0.01378	0.0000	0.700	0.0049	0.0000
		-0.1710	0.0000		-0.2103	0.0003
	0.250	-0.0108	0.0000	0.750	0.0067	0.0000
		-0.1435	0.0000		-0.2278	0.0001
	0.300	-0.0086	0.0000	0.800	0.0095	0.0000
		-0.1391	0.0000		-0.2347	0.0000
	0.350	-0.0069	0.0000	0.850	0.0120	0.0000
		-0.1696	0.0001		-0.2587	0.0000
	0.400	-0.0050	0.0000	0.900	0.0165	0.0000
		-0.2025	0.0006		-0.3044	0.0000
	0.450	-0.0036	0.0000	0.950	0.0227	0.0000
		-0.2146	0.0005		-0.3836	0.0000
				0.990	0.0407	0.0000
					-0.3502	0.0000

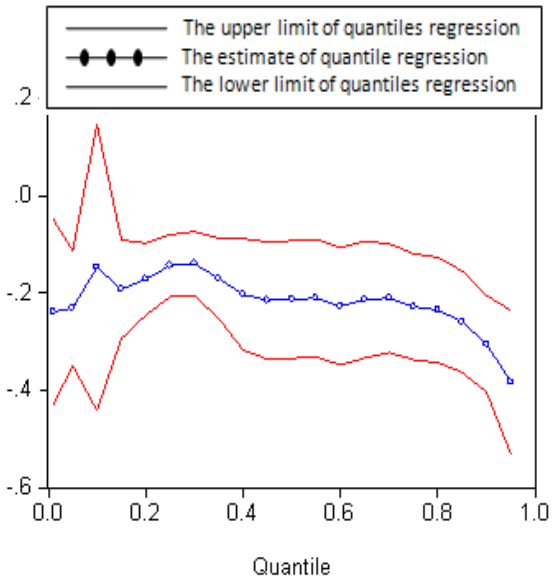


Figure 20: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 21

Quantile Regression, 1995/11/07-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Open-to-close Stock Price of OTC

OTC 1995-2009 Open-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0383	0.0000	0.500	-0.0011	0.0000
	(slope)	-0.3213	0.0004		-0.2131	0.0000
	0.050	-0.0252	0.0000	0.550	0.0002	0.5502
		-0.2463	0.0000		-0.2195	0.0000
	0.100	-0.0188	0.0000	0.600	0.0018	0.0000
		-0.2094	0.0000		-0.2351	0.0000
	0.150	-0.0142	0.0000	0.650	0.0034	0.0000
		-0.1592	0.0000		-0.2232	0.0000
	0.200	-0.0112	0.0000	0.700	0.0052	0.0000
		-0.1473	0.0000		-0.2271	0.0000
	0.250	-0.0089	0.0000	0.750	0.0072	0.0000
		-0.1572	0.0000		-0.2459	0.0000
	0.300	-0.0071	0.0000	0.800	0.0098	0.0000
		-0.1679	0.0000		-0.2323	0.0000
	0.350	-0.0053	0.0000	0.850	0.0127	0.0000
		-0.1879	0.0000		-0.2522	0.0000
	0.400	-0.0038	0.0000	0.900	0.0171	0.0000
		-0.2027	0.0000		-0.2585	0.0000
	0.450	-0.0025	0.0000	0.950	0.0240	0.0000
		-0.2137	0.0000		-0.2564	0.0000
				0.990	0.0430	0.0000
					-0.3741	0.0000

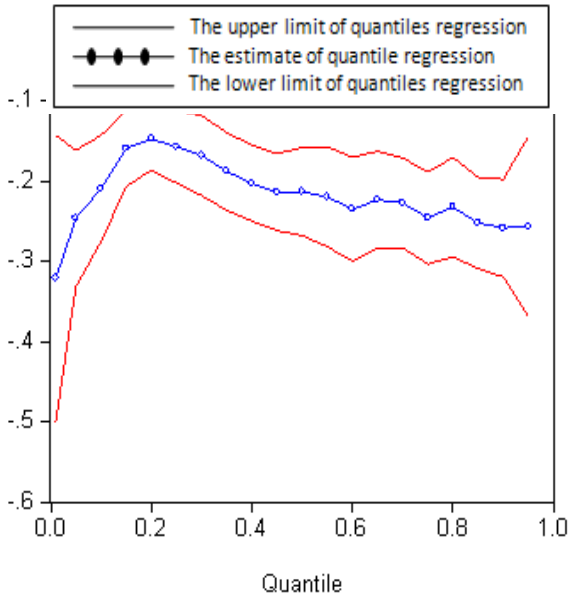


Figure 21: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 22

Quantile Regression, 1995/11/07-1997/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of TAIEX

TAIEX 1995-1997 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0342	0.0000	0.500	0.0012	0.0845
	(slope)	-0.4623	0.0058		0.1414	0.0901
	0.050	-0.0167	0.0000	0.550	0.0023	0.0009
		0.0960	0.2145		0.1365	0.0973
	0.100	-0.0128	0.0000	0.600	0.0034	0.0000
		-0.0164	0.8671		0.1591	0.0529
	0.150	-0.0096	0.0000	0.650	0.0048	0.0000
		0.0375	0.7475		0.1570	0.0554
	0.200	-0.0074	0.0000	0.700	0.0065	0.0000
		0.1247	0.3141		0.0909	0.3148
	0.250	-0.0058	0.0000	0.750	0.0090	0.0000
		0.1493	0.1905		0.0571	0.6354
	0.300	-0.0043	0.0000	0.800	0.0114	0.0000
		0.1093	0.3166		-0.0278	0.8653
	0.350	-0.0025	0.0004	0.850	0.0131	0.0000
		0.0537	0.5861		-0.1140	0.4086
	0.400	-0.0007	0.2829	0.900	0.0176	0.0000
		0.0802	0.3612		-0.0939	0.5880
	0.450	0.0005	0.4893	0.950	0.0242	0.0000
		0.1202	0.1532		-0.0856	0.8232
				0.990	0.0330	0.0000
					0.4920	0.0559

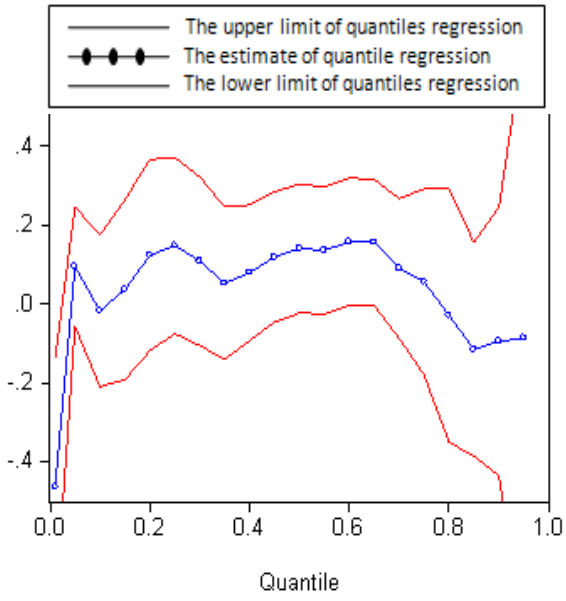


Figure 22: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 23

Quantile Regression, 1997/07/02-2000/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of TAIEX

TAIEX 1997-2000 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0442	0.0000	0.500	-0.0007	0.3359
	(slope)	0.2351	0.0300		0.2835	0.0000
	0.050	-0.0278	0.0000	0.550	0.0010	0.1666
		0.3829	0.0000		0.2963	0.0000
	0.100	-0.0213	0.0000	0.600	0.0031	0.0000
		0.2898	0.0001		0.3257	0.0000
	0.150	-0.0160	0.0000	0.650	0.0053	0.0000
		0.3797	0.0000		0.3748	0.0000
	0.200	-0.0120	0.0000	0.700	0.0074	0.0000
		0.3136	0.0000		0.3672	0.0000
	0.250	-0.0099	0.0000	0.750	0.0096	0.0000
		0.3210	0.0000		0.3422	0.0000
	0.300	-0.0079	0.0000	0.800	0.0118	0.0000
		0.3136	0.0000		0.3526	0.0000
	0.350	-0.0062	0.0000	0.850	0.0151	0.0000
		0.2716	0.0000		0.3771	0.0001
	0.400	-0.0044	0.0000	0.900	0.0204	0.0000
		0.2430	0.0001		0.3342	0.0005
	0.450	-0.0025	0.0002	0.950	0.0277	0.0000
		0.2481	0.0001		0.2770	0.1246
				0.990	0.0499	0.0000
					0.0129	0.9765

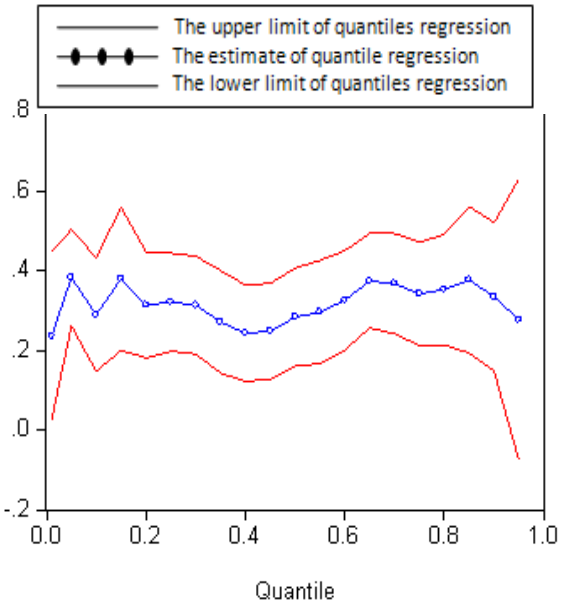


Figure 23: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 24

Quantile Regression, 2000/07/03-2007/02/27

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of TAIEX

TAIEX 2000-2007 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0432	0.0000	0.500	0.0001	0.7226
	(slope)	0.2951	0.0874		0.3478	0.0000
	0.050	-0.0251	0.0000	0.550	0.0014	0.0001
		0.3617	0.0000		0.3738	0.0000
	0.100	-0.0171	0.0000	0.600	0.0027	0.0000
		0.3849	0.0000		0.3893	0.0000
	0.150	-0.0125	0.0000	0.650	0.0042	0.0000
		0.4102	0.0000		0.3847	0.0000
	0.200	-0.0097	0.0000	0.700	0.0060	0.0000
		0.4016	0.0000		0.3990	0.0000
	0.250	-0.0076	0.0000	0.750	0.0082	0.0000
		0.4022	0.0000		0.4023	0.0000
	0.300	-0.0057	0.0000	0.800	0.0103	0.0000
		0.3743	0.0000		0.3890	0.0000
	0.350	-0.0044	0.0000	0.850	0.0129	0.0000
		0.3642	0.0000		0.3885	0.0000
	0.400	-0.0027	0.0000	0.900	0.0168	0.0000
		0.3655	0.0000		0.4135	0.0000
	0.450	-0.0014	0.0000	0.950	0.0246	0.0000
		0.3588	0.0000		0.4545	0.0000
				0.990	0.0469	0.0000
					0.4034	0.0313

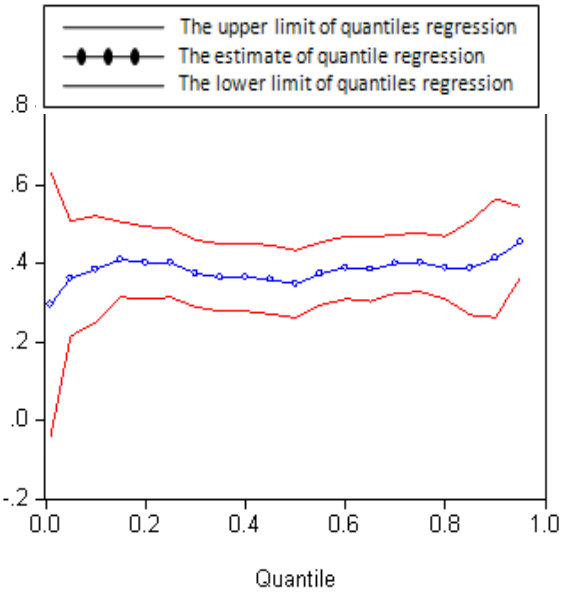


Figure 24: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 25

Quantile Regression, 2007/03/01-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of TAIEX

TAIEX 2007-2009 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0419	0.0000	0.500	0.0001	0.9039
	(slope)	0.4236	0.0000		0.3655	0.0000
	0.050	-0.0307	0.0000	0.550	0.0021	0.0054
		0.4958	0.0000		0.3543	0.0000
	0.100	-0.0221	0.0000	0.600	0.0040	0.0000
		0.5524	0.0000		0.3452	0.0000
	0.150	-0.0171	0.0000	0.650	0.0051	0.0000
		0.4893	0.0000		0.3280	0.0000
	0.200	-0.0129	0.0000	0.700	0.0070	0.0000
		0.4632	0.0000		0.3476	0.0000
	0.250	-0.0091	0.0000	0.750	0.0093	0.0000
		0.4195	0.0000		0.3748	0.0000
	0.300	-0.0062	0.0000	0.800	0.0121	0.0000
		0.4225	0.0000		0.3493	0.0000
	0.350	-0.0042	0.0000	0.850	0.0153	0.0000
		0.4007	0.0000		0.3265	0.0000
	0.400	-0.0028	0.0005	0.900	0.0185	0.0000
		0.3952	0.0000		0.3603	0.0000
	0.450	-0.0015	0.0485	0.950	0.0259	0.0000
		0.4016	0.0000		0.3515	0.0000
				0.990	0.0430	0.0000
					0.3401	0.0001

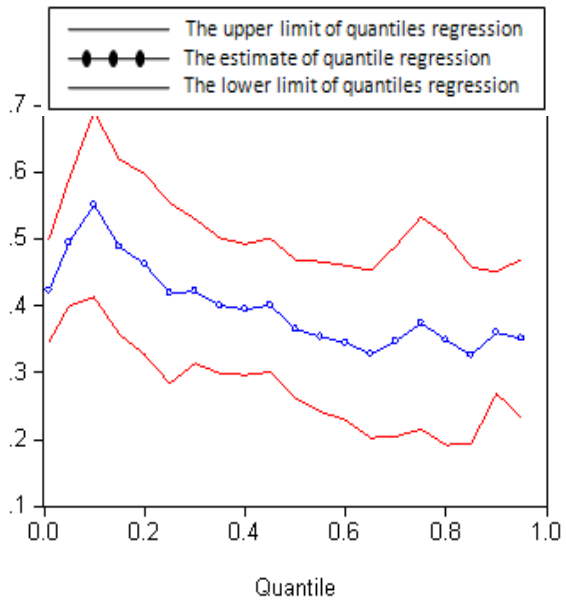


Figure 25: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 26

Quantile Regression, 1995/11/07-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of TAIEX

TAIEX 1995-2009 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0419	0.0000	0.500	0.0001	0.6389
	(slope)	0.3901	0.0000		0.3323	0.0000
	0.050	-0.0268	0.0000	0.550	0.0015	0.0000
		0.4049	0.0000		0.3364	0.0000
	0.100	-0.0187	0.0000	0.600	0.0030	0.0000
		0.3964	0.0000		0.3443	0.0000
	0.150	-0.0136	0.0000	0.650	0.0046	0.0000
		0.4049	0.0000		0.3504	0.0000
	0.200	-0.0101	0.0000	0.700	0.0065	0.0000
		0.3636	0.0000		0.3689	0.0000
	0.250	-0.0080	0.0000	0.750	0.0085	0.0000
		0.3606	0.0000		0.3626	0.0000
	0.300	-0.0062	0.0000	0.800	0.0110	0.0000
		0.3525	0.0000		0.3445	0.0000
	0.350	-0.0045	0.0000	0.850	0.0138	0.0000
		0.3432	0.0000		0.3261	0.0000
	0.400	-0.0029	0.0000	0.900	0.0181	0.0000
		0.3298	0.0000		0.3649	0.0000
	0.450	-0.0014	0.0000	0.950	0.0253	0.0000
		0.3353	0.0000		0.3759	0.0000
				0.990	0.0454	0.0000
					0.2671	0.0309

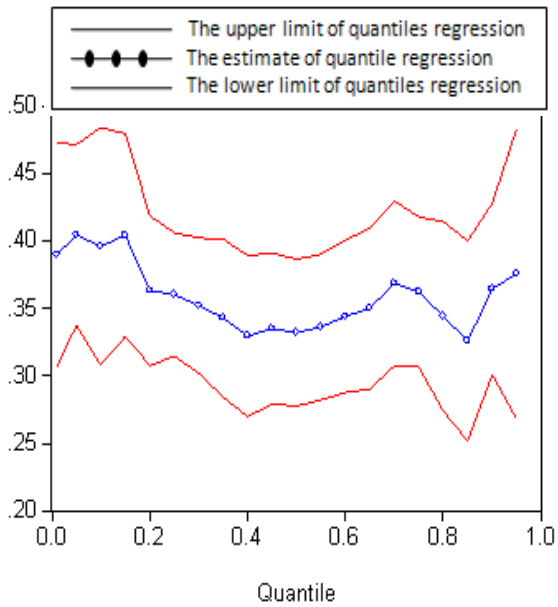


Figure 26: The slope estimate of the quantile regression between S&P 500 and TAIEX under 95% confidence interval.

TABLE 27

Quantile Regression, 1995/11/07-1997/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of OTC

OTC 1995-1997 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0555	0.0000	0.500	-0.0000	0.9593
	(slope)	-1.3262	0.0009		0.0001	0.9992
	0.050	-0.0260	0.0000	0.550	0.0016	0.0269
		-0.1332	0.6405		0.0068	0.9497
	0.100	-0.0148	0.0000	0.600	0.0033	0.0000
		0.0852	0.3752		-0.0008	0.9947
	0.150	-0.0112	0.0000	0.650	0.0051	0.0000
		0.0909	0.2247		0.0310	0.8021
	0.200	-0.0085	0.0000	0.700	0.0064	0.0000
		0.0671	0.4077		0.0007	0.9957
	0.250	-0.0066	0.0000	0.750	0.0081	0.0000
		0.1044	0.2089		0.0713	0.6344
	0.300	-0.0042	0.0000	0.800	0.0131	0.0000
		0.0357	0.7061		-0.1721	0.5382
	0.350	-0.0034	0.0000	0.850	0.0199	0.0000
		-0.0004	0.9970		0.1062	0.6883
	0.400	-0.0024	0.0007	0.900	0.0289	0.0000
		0.0486	0.6434		-0.3395	0.2884
	0.450	-0.0013	0.0649	0.950	0.0433	0.0000
		0.0561	0.6098		-0.3127	0.2804
				0.990	0.0677	0.0000
					0.9649	0.2762

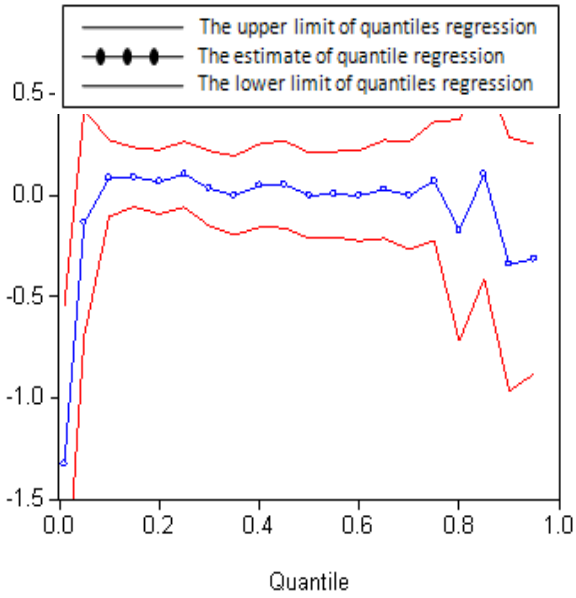


Figure 27: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 28

Quantile Regression, 1997/07/02-2000/06/30

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of OTC

OTC 1997-2000 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0499	0.0000	0.500	-0.0012	0.1471
	(slope)	0.5029	0.0011		0.3618	0.0000
	0.050	-0.0304	0.0000	0.550	0.0011	0.1917
		0.3767	0.0000		0.3949	0.0000
	0.100	-0.0250	0.0000	0.600	0.0033	0.0001
		0.4836	0.0000		0.4171	0.0000
	0.150	-0.0201	0.0000	0.650	0.0051	0.0000
		0.3753	0.0003		0.4424	0.0000
	0.200	-0.0157	0.0000	0.700	0.0084	0.0000
		0.3592	0.0000		0.4467	0.0000
	0.250	-0.0122	0.0000	0.750	0.0108	0.0000
		0.3047	0.0000		0.4203	0.0000
	0.300	-0.0098	0.0000	0.800	0.0150	0.0000
		0.2528	0.0000		0.3868	0.0000
	0.350	-0.0075	0.0000	0.850	0.0189	0.0000
		0.2698	0.0000		0.3218	0.0001
	0.400	-0.0052	0.0000	0.900	0.0242	0.0000
		0.2467	0.0001		0.3972	0.0001
	0.450	-0.0035	0.0000	0.950	0.0337	0.0000
		0.3110	0.0000		0.2419	0.2353
				0.990	0.0549	0.0000
					0.5306	0.1580

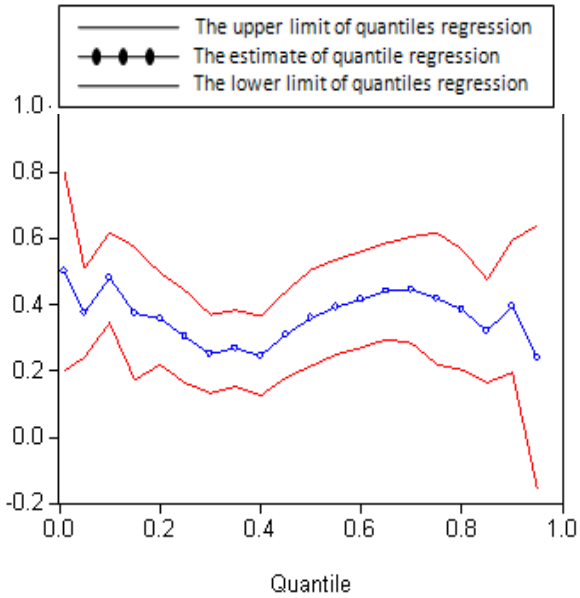


Figure 28: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 29

Quantile Regression, 2000/07/03-2007/02/27

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of OTC

OTC 2000-2007 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0479	0.0000	0.500	-0.0001	0.8755
	(slope)	0.4370	0.0018		0.2806	0.0000
	0.050	-0.0287	0.0000	0.550	0.0015	0.0002
		0.4080	0.0022		0.2947	0.0000
	0.100	-0.0201	0.0000	0.600	0.0034	0.0000
		0.4208	0.0000		0.3051	0.0000
	0.150	-0.0148	0.0000	0.650	0.0054	0.0000
		0.3622	0.0000		0.3133	0.0000
	0.200	-0.0113	0.0000	0.700	0.0067	0.0000
		0.3480	0.0000		0.3051	0.0000
	0.250	-0.0086	0.0000	0.750	0.0090	0.0000
		0.3148	0.0000		0.3353	0.0000
	0.300	-0.0067	0.0000	0.800	0.0113	0.0000
		0.2961	0.0000		0.2959	0.0000
	0.350	-0.0047	0.0000	0.850	0.0139	0.0000
		0.2567	0.0000		0.3352	0.0000
	0.400	-0.0027	0.0000	0.900	0.0182	0.0000
		0.2585	0.0000		0.3529	0.0000
	0.450	-0.0013	0.0008	0.950	0.0266	0.0000
		0.2665	0.0000		0.4419	0.0000
					0.0473	0.0000
					0.2049	0.0482

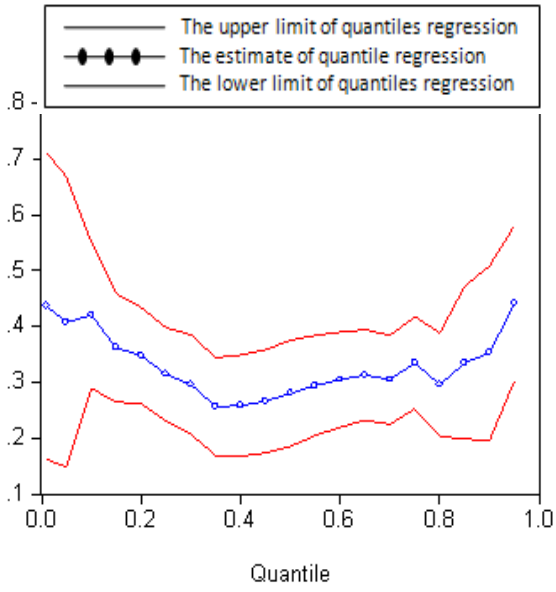


Figure 29: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 30

Quantile Regression, 2007/03/01-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of OTC

OTC 2007-2009 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0487	0.0000	0.500	0.0001	0.9224
	(slope)	0.2956	0.0000		0.3187	0.0000
	0.050	-0.0360	0.0000	0.550	0.0026	0.0034
		0.3258	0.0000		0.3260	0.0000
	0.100	-0.0277	0.0000	0.600	0.0048	0.0000
		0.4478	0.0000		0.3502	0.0000
	0.150	-0.0214	0.0000	0.650	0.0065	0.0000
		0.4211	0.0002		0.3295	0.0000
	0.200	-0.0143	0.0000	0.700	0.0080	0.0000
		0.4169	0.0000		0.2762	0.0030
	0.250	-0.0109	0.0000	0.750	0.0098	0.0000
		0.3693	0.0000		0.2757	0.0015
	0.300	-0.0077	0.0000	0.800	0.0127	0.0000
		0.3781	0.0000		0.2893	0.0006
	0.350	-0.0054	0.0000	0.850	0.0156	0.0000
		0.3257	0.0000		0.2563	0.0042
	0.400	-0.0033	0.0006	0.900	0.0200	0.0000
		0.3592	0.0000		0.1882	0.0380
	0.450	-0.0014	0.1272	0.950	0.0281	0.0000
		0.3280	0.0000		0.2632	0.0000
					0.0438	0.0000
					0.1725	0.0009

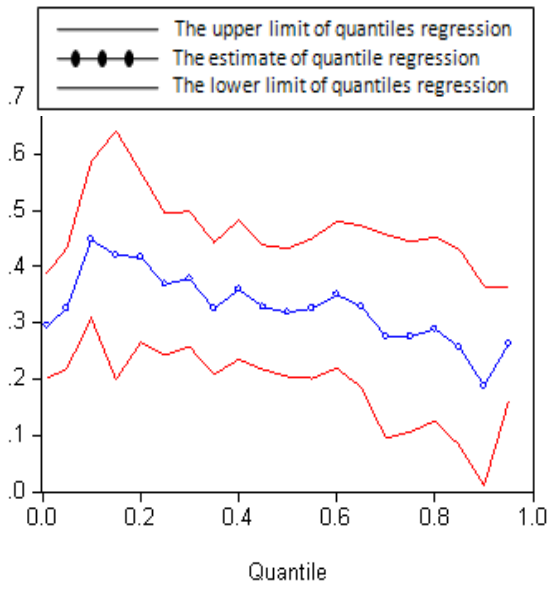


Figure 30: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 31

Quantile Regression, 1995/11/07-2009/03/26

Independent Variable: The Returns of Close-to-close Stock Price of S&P 500

Dependent Variable: The Returns of Close-to-close Stock Price of OTC

OTC 1995-2009 Close-to-close	Quantile	Coefficient	P-value	Quantile	Coefficient	P-value
	0.010(interception)	-0.0496	0.0000	0.500	-0.0004	0.2411
	(slope)	0.3215	0.0000		0.2985	0.0000
	0.050	-0.0302	0.0000	0.550	0.0015	0.0000
		0.4050	0.0000		0.3142	0.0000
	0.100	-0.0221	0.0000	0.600	0.0034	0.0000
		0.4237	0.0000		0.3174	0.0000
	0.150	-0.0167	0.0000	0.650	0.0054	0.0000
		0.3792	0.0000		0.3239	0.0000
	0.200	-0.0126	0.0000	0.700	0.0072	0.0000
		0.3427	0.0000		0.3126	0.0000
	0.250	-0.0092	0.0000	0.750	0.0096	0.0000
		0.3004	0.0000		0.3110	0.0000
	0.300	-0.0072	0.0000	0.800	0.0120	0.0000
		0.2907	0.0000		0.3019	0.0000
	0.350	-0.0051	0.0000	0.850	0.0159	0.0000
		0.2642	0.0000		0.3145	0.0000
	0.400	-0.0034	0.0000	0.900	0.0209	0.0000
		0.2772	0.0000		0.3104	0.0000
	0.450	-0.0016	0.0000	0.950	0.0298	0.0000
		0.2925	0.0000		0.2846	0.0000
				0.990	0.0516	0.0000
					0.1539	0.0857

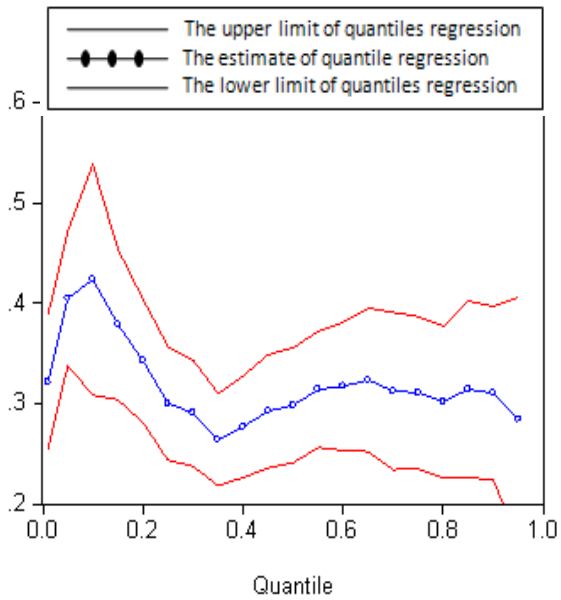


Figure 31: The slope estimate of the quantile regression between S&P 500 and OTC under 95% confidence interval.

TABLE 32: The slope estimate of the quantile regression between S&P 500 and close-to-open returns of TAIEX under 95% confidence interval from 1995 to 1997, 1997 to 2000, 2000 to 2007 and 2007 to 2009.

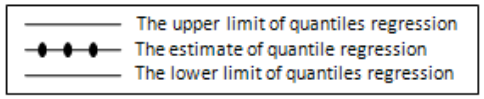
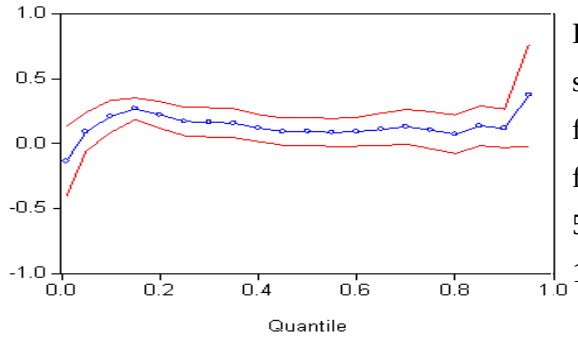
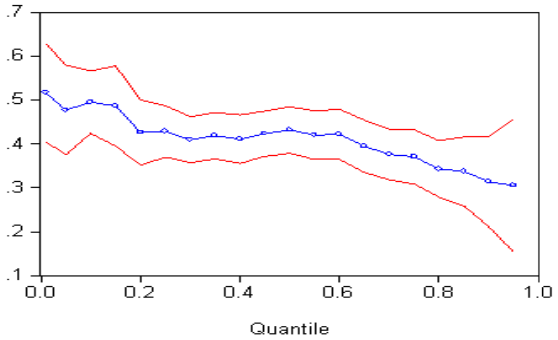


Figure 2: 1995-1997



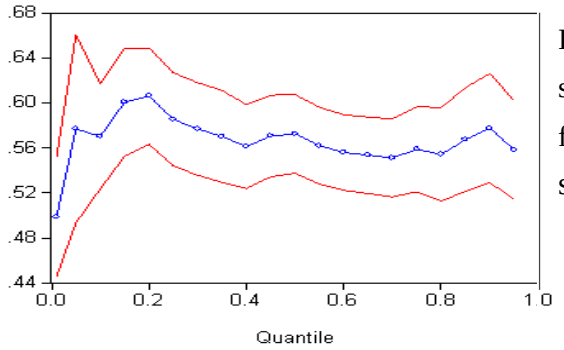
In figure 2, there are significant positive effects from US to TAIEX at following quantiles :
5%: θ =0.1~0.4, 0.99
10%: θ = 0.65, 0.7, 0.85,

Figure 3: 1997-2000



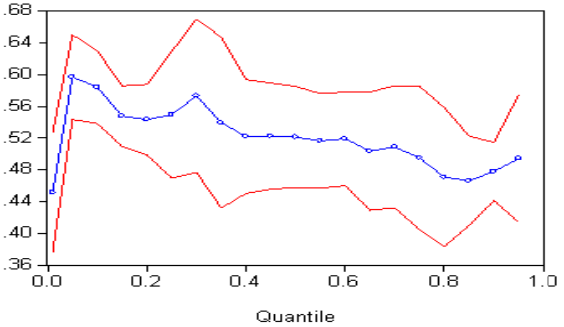
In figure 3, there are significant positive effects from US to TAIEX at 5% significance level. (except when θ = 0.99)

Figure 4: 2000-2007



In figure 4, there are significant positive effects from US to TAIEX at 5% significance level.

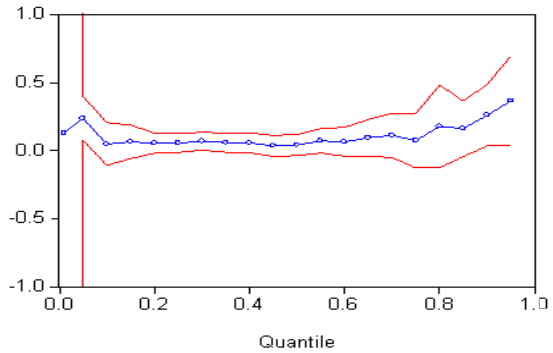
Figure 5: 2007-2009



In figure 5, there are significant positive effects from US to TAIEX at 5% significance level.

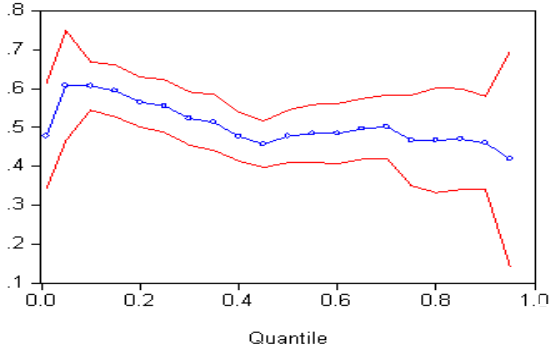
TABLE 33: The slope estimate of the quantile regression between S&P 500 and close-to-open returns of OTC under 95% confidence interval from 1995 to 1997, 1997 to 2000, 2000 to 2007 and 2007 to 2009.

Figure 7: 1995-1997



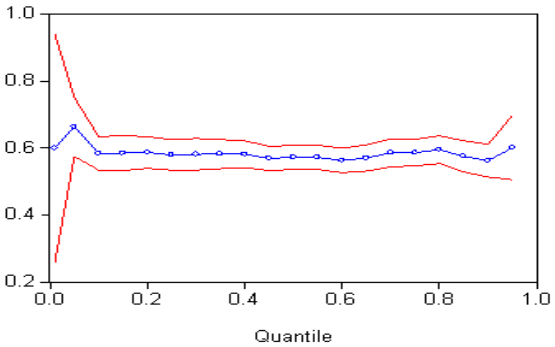
In figure 7, there are significant positive effects from US to OTC at following quantiles :
5%: θ =0.05, 0.9, 0.95
10%: θ = 0.35

Figure 8: 1997-2000



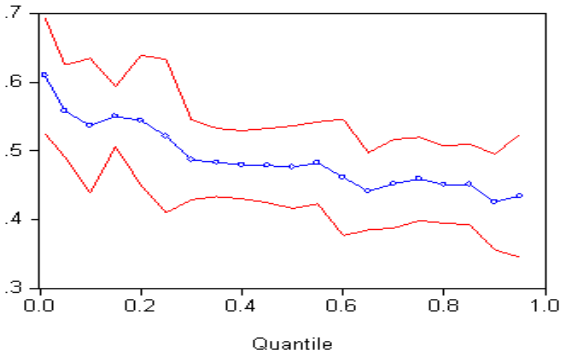
In figure 8, there are significant positive effects from US to OTC at 5% significance level.

Figure 9: 2000-2007



In figure 9, there are significant positive effects from US to OTC at 5% significance level.

Figure 10: 2007-2009



In figure10, there are significant positive effects from US to OTC at 5% significance level.

TABLE 34: The slope estimate of the quantile regression between S&P 500 and close-to-open returns of TAIEX and OTC under 95% confidence interval from 1995 to 2009.

This table reports the slope estimate of both the quantile regression and ordinary least squares method from 1995 to 2009. We can know that both of the slope estimates are positive. In other words, there are positive correlations not only between S&P 500 and close-to-open returns of TAIEX, but also between S&P 500 and close-to-open returns of OTC. Moreover, we can find that the slope estimates are different in most of the quantiles.

Figure 6: 1995-2009

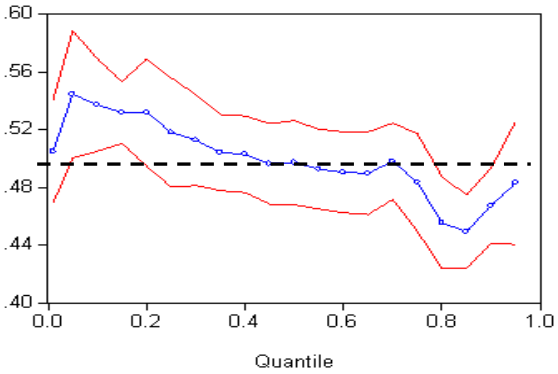
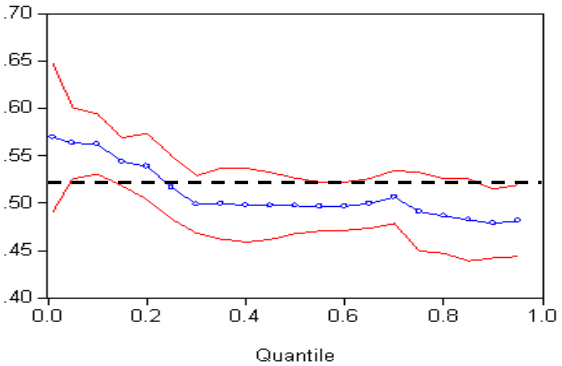


Figure 11: 1995-2009



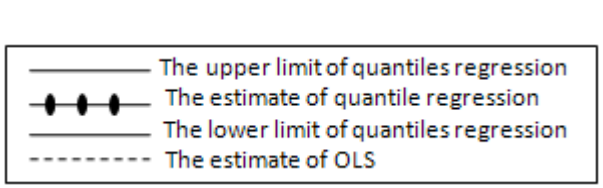
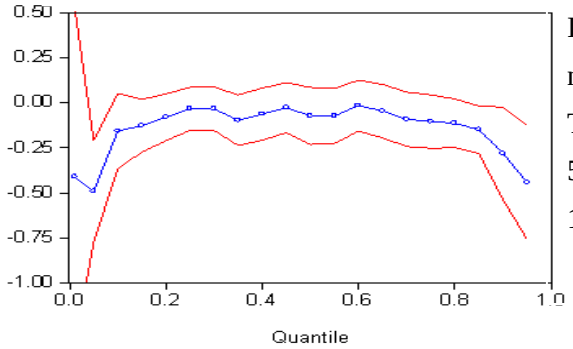


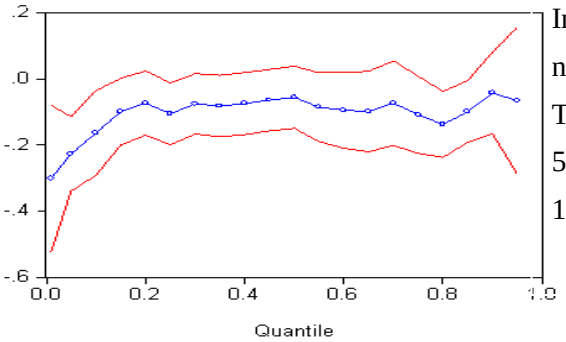
TABLE 35: The slope estimate of the quantile regression between S&P 500 and open-to-close returns of TAIEX under 95% confidence interval from 1995 to 1997, 1997 to 2000, 2000 to 2007 and 2007 to 2009.

Figure 12: 1995-1997



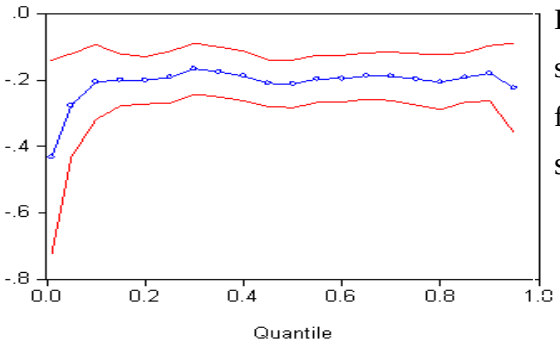
In figure 12, there are significant negative effects from US to TAIEX at following quantiles :
5%: θ =0.05
10%: θ = 0.15, 0.85, 0.9, 0.95

Figure 13: 1997-2000



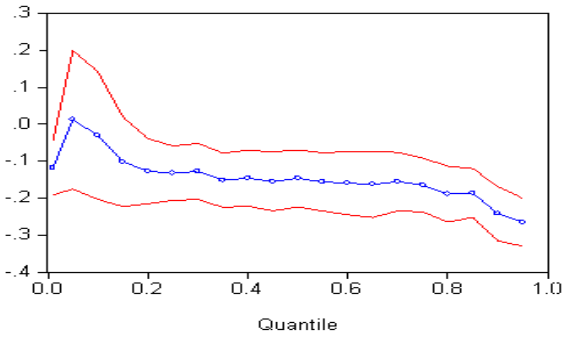
In figure 13, there are significant negative effects from US to TAIEX at following quantiles :
5%: θ =0.05
10%: θ = 0.15, 0.85, 0.9, 0.95

Figure 14: 2000-2007



In figure 14, there are significant negative effects from US to TAIEX at 5% significance level.

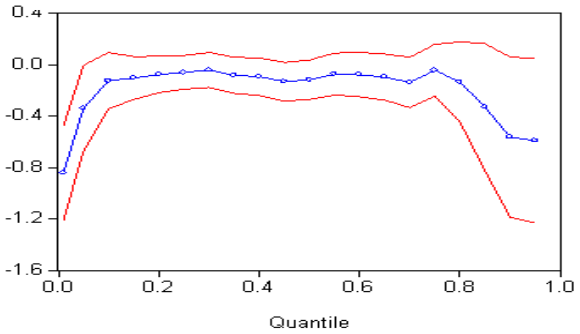
Figure 15: 2007-2009



In figure 15, there are significant negative effects from US to TAIEX at 5% significance level. (except when θ =0.05, 0.1, 0.15)

TABLE 36: The slope estimate of the quantile regression between S&P 500 and open-to-close returns of OTC under 95% confidence interval from 1995 to 1997, 1997 to 2000, 2000 to 2007 and 2007 to 2009.

Figure 17: 1995-1997

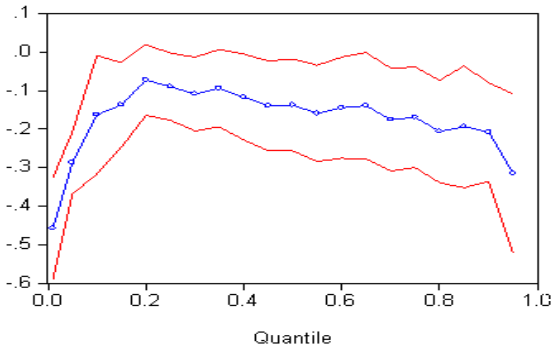


In figure 17, there are significant negative effects from US to OTC at following quantiles :

5%: θ =0.01, 0.05

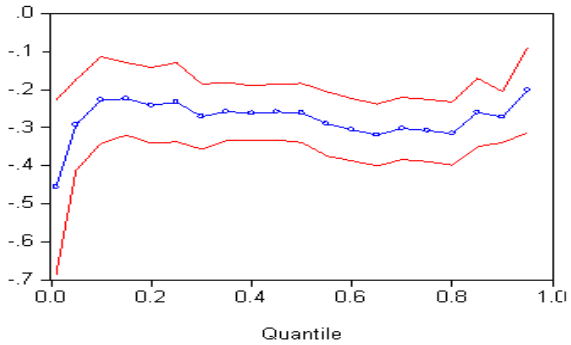
10%: θ = 0.45, 0.9, 0.95

Figure 18: 1997-2000



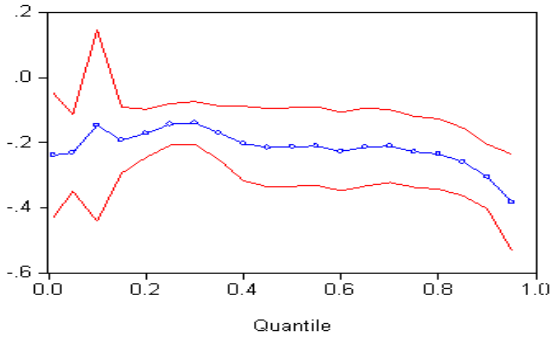
In figure 18, there are significant negative effects from US to OTC at 5% significance level. (except when θ =0.02)

Figure 19: 2000-2007



In figure 19, there are significant negative effects from US to OTC at 5% significance level.

Figure 20: 2007-2009



In figure 20, there are significant negative effects from US to OTC at 5% significance level. (except when θ =0.1)

TABLE 37: The slope estimate of the quantile regression between S&P 500 and open-to-close returns of TAIEX and OTC under 95% confidence interval from 1995 to 2009.

This table reports the slope estimate of both the quantile regression and ordinary least squares method from 1995 to 2009. We can know that both of the slope estimates are negative. In other words, there are negative correlations not only between S&P 500 and open-to-close returns of TAIEX, but also between S&P 500 and open-to-close returns of OTC. Moreover, we can find that the slope estimates are different in most of the quantiles.

Figure 16: 1995-2009

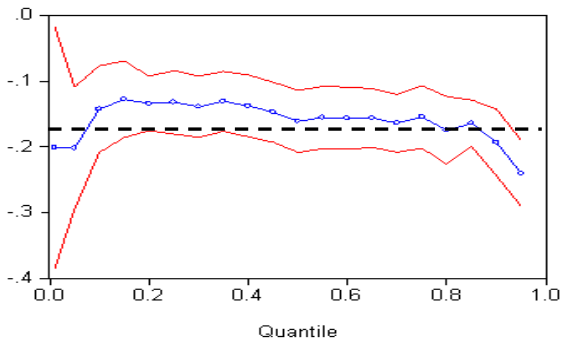
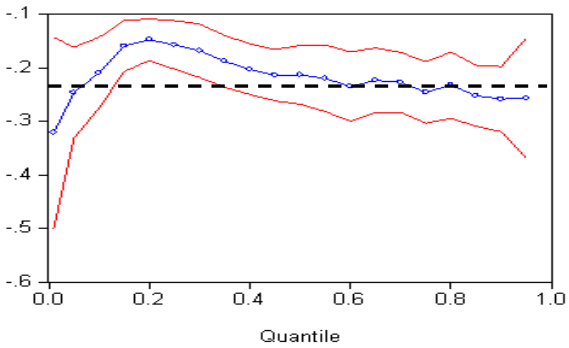


Figure 21: 1995-2009



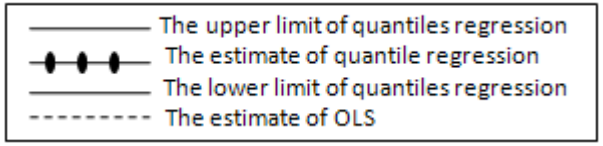
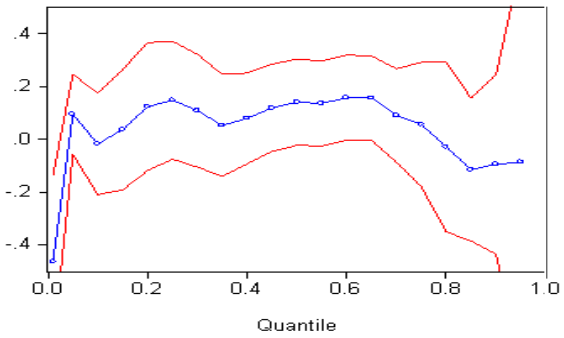


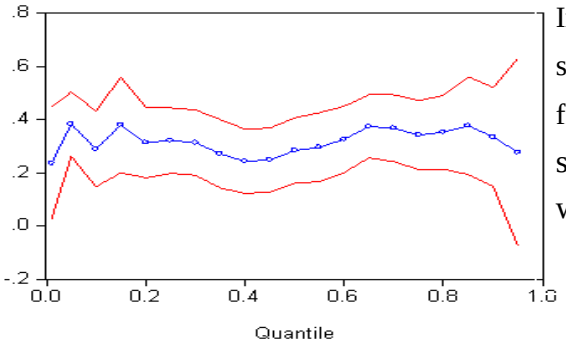
TABLE 38: The slope estimate of the quantile regression between S&P 500 and close-to-close returns of TAIEX under 95% confidence interval from 1995 to 1997, 1997 to 2000, 2000 to 2007 and 2007 to 2009.

Figure 22: 1995-1997



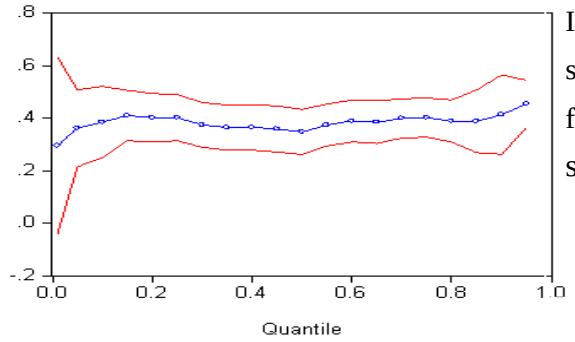
In figure 22, there are significant positive effects from US to TAIEX at following quantiles :
5%: θ =0.1
10%: θ = 0.5, 0.55, 0.6, 0.65
There is significant negative effect when θ =0.01 at 5% significance level.

Figure 23: 1997-2000



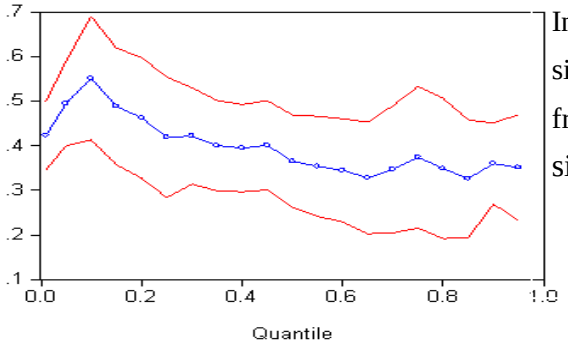
In figure 23, there are significant positive effects from US to TAIEX at 5% significance level (except when θ =0.95).

Figure 24: 2000-2007



In figure 24, there are significant positive effects from US to TAIEX at 5% significance level.

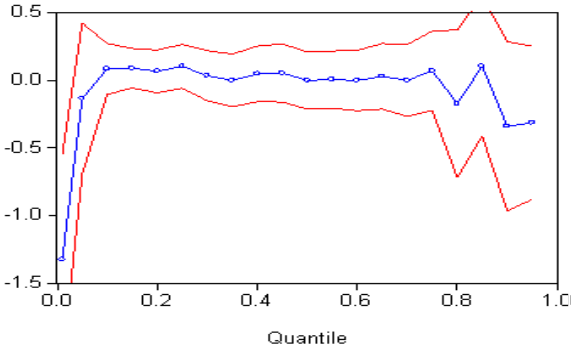
Figure 25: 2007-2009



In figure 25, there are significant positive effects from US to TAIEX at 5% significance level.

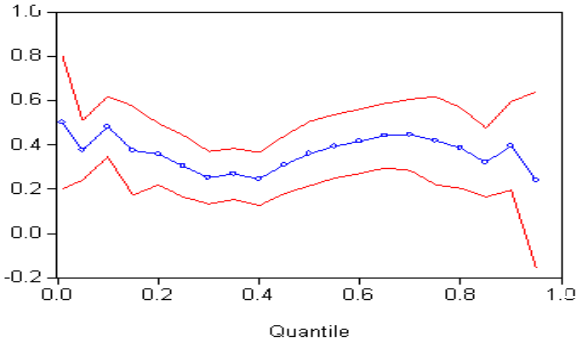
TABLE 39: The slope estimate of the quantile regression between S&P 500 and close-to-close returns of OTC under 95% confidence interval from 1995 to 1997, 1997 to 2000, 2000 to 2007 and 2007 to 2009.

Figure 27: 1995-1997



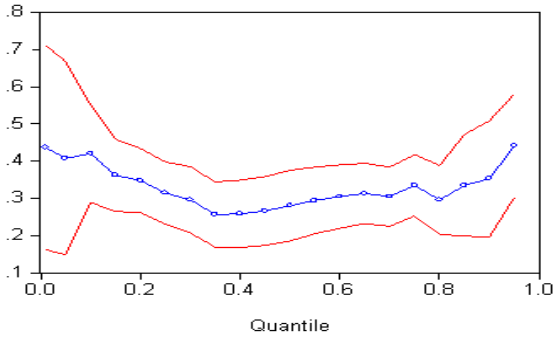
When θ =0.01, there is significant negative effect from US to OTC at 5% significance level.

Figure 28: 1997-2000



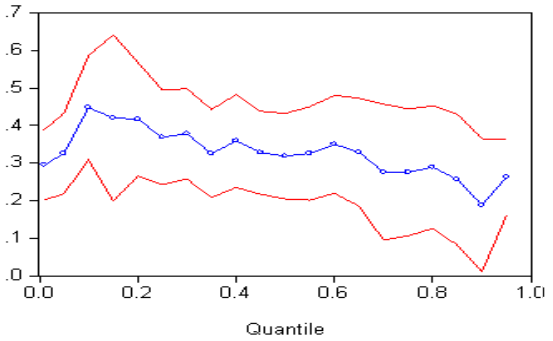
In figure 28, there are significant positive effects from US to OTC at 5% significance level (except when θ =0.95).

Figure 29: 2000-2007



In figure 29, there are significant positive effects from US to OTC at 5% significance level.

Figure 30: 2007-2009



In figure 30, there are significant positive effects from US to OTC at 5% significance level.

TABLE 40: The slope estimate of the quantile regression between S&P 500 and close-to-close returns of TAIEX and OTC under 95% confidence interval from 1995 to 2009.

This table reports the slope estimate of both the quantile regression and ordinary least squares method from 1995 to 2009. We can know that both of the slope estimates are positive. In other words, there are positive correlations not only between S&P 500 and close-to-close returns of TAIEX, but also between S&P 500 and close-to-close returns of OTC. Moreover, we can find that most of the slope estimates are different in most of the quantiles.

Figure 26: 1995-2009

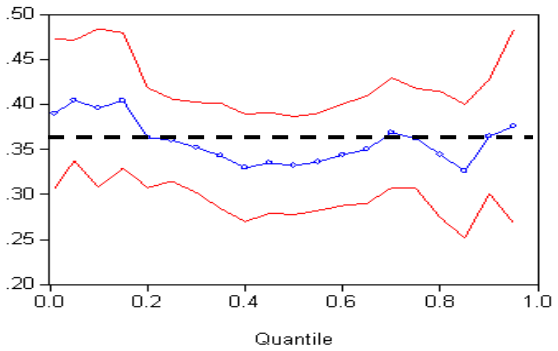


Figure 31: 1995-2009