International Review of Business Research Papers
Vol. 9. No. 3. March 2013 Issue. Pp. 22 – 38

Test of Magnitude Asymmetry of Asian Stock Markets to the U.S. Treasury Bill Yields

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This paper investigates the relative impact of movements in the U.S. Treasury Bill yields on stock market returns four Asian countries. Studies suggest that increase (decrease) in the U.S. interest rate can cause greater capital outflows (inflows) from a foreign country thereby causing negative (positive) returns in stock prices of that country. The contribution of this paper is to analyze whether increase or decrease in U.S. Treasury Bill yields have significantly different impact on downturn than upturn in stock markets of Taiwan, Hong Kong, Singapore, and South Korea. We use the data in monthly intervals from January 1990 to December 2010 to examine the postulated relationships. The regression results suggests that in most of the cases, the magnitude and the duration of time in which the increase in the U.S. treasury Bill yields is fully reflected in equity markets of Asia are significantly different from that of the decrease in the U.S. Treasury Bill yields. These results corroborate the evidence that investors react differently to negative than positive shocks. A direct implication of is that if investment portfolios are formed based on average co-movements, which assume symmetry, the performance of the investment could be worse than expected in the down markets.

Keywords: Equity markets, Response Asymmetries, Asian Markets

JEL classification codes: G15, F30, F36

1. Introduction

The global contagion effects of 2008 housing or recent European crisis has reiterated the fragility of emerging financial markets to the shocks emanating from developed world. A possible default by Greece and Spain and stalemate in the U.S. congress has created widespread fear among the investors of emerging markets of Asia and Latin America. The dependence of these markets to developed countries (mainly U.S.) is well established in the literature. However, an area of research that has achieved little attention in the literature is whether emerging markets reacts differently in terms of speed and magnitude to increase and decrease in the U.S. interest rates. This issue is important because these emerging fragile equity markets could be vulnerable to asymmetric spillovers and contagion effects from the U.S. economy. As such, understanding the co-movement of these emerging markets with the U.S. economy in different market scenarios is important for portfolio management.

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We have choses the movements in U.S. Treasury Bill rates since they are one of the most closely watched economic indicators in international financial markets. Earlier studies provide empirical evidence suggesting Treasury Bill yield changes contain information relevant to the determination of security prices (Tandon and Urich, 1987; Doukas, 1989, Johnson and Jensen, 1993). According to these studies, Treasury Bill yield changes are important to investors as they provide signals about future economic performance. The impact of the Treasury Bill rate on an emerging equity market, however, can be different from industrialized country stock markets as they depend on the country specific differences in emerging financial market structure as well as the degree of linkages with the US equity market (Soydemir, 2002).

This study extends prior research by analyzing whether Asian equity markets react differently to the positive as opposed to negative shocks in the U.S. money market. Specifically, we investigate the existence of asymmetry in the case of equity markets of Taiwan, Hong Kong, Singapore and Korea. Answers to questions are important since the state of the U.S. money market (up and down) might play an important role in forecasting the Asian equity market movements. They also have important implications for policymakers that seek to reduce country spillover effects and investors who aim to improve their portfolio performance.

We use the data in monthly intervals from January 1990 to December 2010 to examine the postulated relationships. We estimate four set of regressions for each of these Asian markets with upturns, downturns in stock prices and increase, decrease in U.S. Treasury Bill yields. The results suggests that in most of the cases, the strength at which the increase in the U.S. treasury bill yields is fully reflected in equity markets of Asia is significantly different from that of the decrease in the U.S. Treasury Bill yields.

These results corroborate the evidence that investors react differently to negative than positive shocks. Specifically, reactions to increase in U.S. interest rates or downturns in Asian stock prices are more severe than upturns following a decrease in U.S. interest Treasury bill yields. A direct implication of this study is that if investment portfolios are formed based on average co-movements, which assume symmetry, the performance of the investment could be worse than expected in the down markets.

This paper is organized as follows: Section two discusses the theoretical background on response asymmetry and stock prices while sections three and four presents the econometric methodology and the data. Section five discusses the empirical results and this is followed by the concluding remarks provided in section six.

2. Theoretical Framework

Asymmetric behavior is a concept characterized by a greater impact of negative *versus* positive stimuli on a subject (Peeters and Czapiński, 1990). Asymmetry has an important role in asset valuation due to its impact on risk-return mechanism. The price of an asset is a function of the variation in its returns and consequently an understanding of time-varying movements in volatility is central to the decision making process. Studies such as Black (1976), Christie (1982), Nelson (1991), Pagan and

Schwert (1990), Sentena (1992), Campbell and Hentschel (1992) and Engle and Ng (1993) suggest that negative shocks to stock prices can potentially generate greater volatility than a positive shock of equal magnitude causing asset price to respond asymmetrically to bad versus good news. An examination of asymmetry also provides insight into stock market efficiency around announcements of significant exogenous variables and how market participants respond differently to good and bad news (Chulia-Soler, Martens and Van Dijk, 2010).

Asymmetries may arise from differences in return expectations among investors about the potential international impact of changes in foreign stock markets (Erb, Harvey and Viskanta, 1994; Odier and Solnik, 1993). For example, a small downturn in the U.S. financial markets could trigger relatively larger downturn in the Latin American markets due to widespread earnings disappointment among investors rather than as a result of the particular magnitude of the U.S. market decline. Recent evidence suggest that the return distributions are not symmetric for the U.S. (Fama, 1965; Richardson and Smith, 1993); for developed markets (Harvey and Zhou, 1993) and for the emerging markets (Harvey, 1995).

The importance of examining asymmetry in Asian equity markets in rooted in arguments provided in previous studies (such as Ng, 1998; Iorio and Faff, 2000; Peltzman, 2000; Laopodis, 2001; Pagan and Soydemir, 2001; Bahng and Shin, 2003; Verma and Verma, 2005) which suggests that asymmetry represents behavioral biases as investors not only consider changes in security prices but also the satisfaction and/or disappointment derived from such changes. The magnitude and the length of time in which upturn in an exogenous indicator is fully reflected in security prices can be significantly different from that of the downturn. Investors might react differently to upturns in U.S. Treasury bill yields than to downturns while examining its impact on the Asian markets.

Asymmetries may occur due to the investment strategies based on incomplete and irrelevant information. Such information set could lead to biased investments leading to irrational buying or selling. In such cases the effect of capital flows on equity markets could be dissimilar for upturn than downturn. Aitken (1996) suggest that institutional investor sentiments towards emerging markets can help determine equity prices in these markets. The institutional investors lacking local knowledge about each individual country's fundamentals may treat these markets as if they belong to a unique class. However, the importance of local information is increasing due to the segmented nature of emerging markets (Harvey, 1995). Therefore investment strategies based on biased information could lead to asymmetric responses.

Asymmetries may also occur due to the unidentified component of risk which is priced in equity markets. Fama and French (1992) suggest the existence of multidimensional risks associated with any stock. One dimension of risk is the unidentified risk which is nonetheless reflected in stock prices. However, the relationship between the unidentified components of risk with stock returns may not be linear and therefore may lead to dissimilar positive and negative returns to investors. Downs and Ingram (2000) provide evidence in support of this argument and find that up market betas are not equal to down market betas in absolute terms. Similarly, there is evidence in support of

positive (negative) relationship between beta and returns in up market (down market) for the U.S. market by Pettengill, Sudaram and Mathur (1995) and for international equity markets by Fletcher (2000).

The economic rationale for asymmetric response can also be explained from the behavioral standpoint of investor psychology. Investors, in general, are more concerned about market downturns than upturns, partly due to their risk-aversion. Thus, this tendency towards risk-aversion will be reflected in market prices, causing greater market responses to downturns in other markets. The evidence on momentum profitability and reversals suggest the effect of investor sentiments on the stock market may be asymmetric (Hong, Lim and Stein, 2000; Hong and Stein, 1999). The asymmetric effect of sentiments on the stock market is attributed to the limits to arbitrage (Brown and Cliff, 2005) and overconfidence (Gervais and Odean, 2001; Daniel, Hirshleifer and Subrahmanyam, 1998).

Price movement asymmetries have been found in Asian markets (Bahng and Shin, 2003); Australian equity market (Iorio and Faff, 2000); EMS exchange rates (Laopodis, 2001); commodity markets (Karrenbrock, 1991); goods market (Peltzman, 2000) and real and underground output in New Zealand (Giles, 1999). In the light of the above theoretical propositions and empirical findings, we can expect asymmetric responses of Asian equity markets to external positive and negative shocks. Specifically, upturns and downturns in the U.S. market could lead to asymmetry since the U.S. business condition is the major global factor affecting these markets (Taylor and Sarno, 1997).

Recent study such as Kolb (2010) suggests that there are growing dominant effects of the U.S. economy on the Asian markets. The dynamic conditional correlations between shocks from the U.S. to Asian markets have increased substantially during the last few years. In fact the effects of 2008 crisis originating from the U.S. on Asian markets were much higher than the Asian financial crisis. Forecasting the dynamic asymmetric correlation between economic indicators in the U.S. and Asian markets are relevant for both policy makers and international investors as it could be useful for predicting financial contagion during crisis.

The finance literature extensively explores asymmetric security market reactions to various types of news announcements; a partial list consists of Jain (1988), McQueen et al. (1996), Henry (1998); Conrad et al. (2002), Busse and Green (2002), Chan (2003), Chen et al. (2003), Marcucci and Quagliariello (2009), Chuliá et al. (2010), Kurov (2010), Li (2010), May (2010), and Akhtar et al. (2011).

3. Econometric Methodology

Returns in equity market *i* (R_i) are defined to have a asymmetric impact if the magnitude of the effects from the upturns and downturns in the equity market *j* (R_j) changes over time (see Ng, 1998; Iorio and Faff, 2000; Peltzman, 2000; Laopodis, 2001; Pagan and Soydemir, 2001; Bahng and Shin, 2003; Verma and Verma, 2005). We undertake the approach suggested by these studies to examine the presence/absence of asymmetric response of Asian stock prices to the U.S. treasury bill yields.

Returns in equity market *i* (R_i) are defined to have a magnitude asymmetric impact if an increase in the equity market *j* (R_j) affects equity market *i* differently than a decrease of equal magnitude. The statistical model takes the following form (Eqs.1-3). The statistical model captures contemporaneous relationships of equity returns between the markets (see Karoyli and Stulz, 1996).

$$RI_{it} = \alpha_0 + \alpha_1 RI_{jt} + \alpha_2 RD_{jt} + \alpha_3 RI_{it-k} + \varepsilon_t \quad (1)$$

$$RD_{it} = \alpha_0 + \alpha_1 RI_{jt} + \alpha_2 RD_{jt} + \alpha_3 RD_{it-k} + \varepsilon_t \quad (2)$$

$RI_t = P_t - P_{t-1}$, if $P_t - P_{t-1} > 0$ and = 0 otherwise, and (3)

$RD_t = P_t - P_{t-1}$, if $P_t - P_{t-1} < 0$ and = 0 otherwise. (4)

where α_0 is a constant term, ε_t is error term and α_1, α_2, α_3 are the parameters to be estimated. P_t and P_{t-1} are expressed in logarithms so that returns are continuously compounded returns (Tsay, 2002). All RI_t are positive or zero and all RD_t are negative and zero. In Eq.(1), we test the null hypothesis that the upturns and downturns in market *j* have the same effect on the changes in equity market *i.* For example, if the Mexican market (R_i) responds symmetrically to the U.S. treasury bill yield upturn (RI_j) and downturn (RD_j), then one would expect to find $\alpha_1 = \alpha_2$. The lag appropriate length of *k* may be sufficient to characterize the model dynamics and capture the return generating process. In order to obtain unbiased and efficient parameter estimates, we also assume that the constant α_0 captures the average influence of factors that are not explained by changes in the U.S. market.

We follow Pagan and Soydemir (2001), in order to test the hypotheses that the stock markets of Taiwan, Hong Kong, Singapore and South Korea respond symmetrically to increase and decrease in the U.S. Treasury Bill rate. We examine the magnitude asymmetry by testing the hypotheses $\alpha_1 = \alpha_2$ in both equations (1) and (2). If both these two parameters are significantly different then it would mean that there is a significant difference between upturns than downturns in these four Asian markets in response to decrease and increase in the U.S. Treasury Bill rate.

In an efficient financial market, one would expect the reaction of stock market only to *unanticipated* component of macroeconomic variables. Elton and Gruber (1991) argue that all the variables in a multi index model needs to be *surprises* or *innovations* and therefore should not be predicted from their past values. Thus, asset pricing models such as APT employ the unexpected component (innovations) of explanatory variables, while modeling expected returns. Since, equations (1) - (4) are multi index models; direct estimation in its present form would only give the relationships between *anticipated* components of U.S. Treasury Bill rate and Asian markets. Such estimation would mean ignoring the effect of changes in *unanticipated* components of the U.S. Treasury Bill rates on Asian markets and therefore could be misleading. To overcome such potential problem of misspecification, we compute residuals from ARIMA models fitted to the independent variable (Gangemi et al. 2000, Bilson et al. 2001, Singh, 1993, Tan, 1992). Another advantage of using the unexpected components of the variables is that the potential problem of multicollinearity is minimized. We identify the most appropriate ARIMA model for U.S. Treasury Bill rate by examining the Durbin Watson of

the estimation and autocorrelation and partial autocorrelation of the residual (Diebold, 2003).

4. Data

We use the data in monthly intervals from January 1990 to December 2010 from DataStream. We include the stock market returns of the following four Asian countries in our study: Taiwan, Hong Kong, Singapore and South Korea. Eun and Resnick (2012) suggest that the liquidity in these markets have been improving significantly. Further, these markets have been found to be significantly affected by the U.S. stock market and the U.S. economy by varying degrees. In order to examine the asymmetric response of these markets, we include the movements in monthly yield of 3 months U.S. treasury bill in our study. The data for this variable is obtained from the Federal Reserve Economic Database.

We have chosen these four markets in our study since they are fairly good representation of developing stock markets in Asia. The market capitalization of these four stock markets is over 4 trillion dollars which is approximately 50% of the total market capitalization of Asia. The turnover ratio, the measure of liquidity is approximately 621 which is approximately 60% of the total turnover ratios of Asian markets. Moreover the concentration ratio has steadily declined for these markets suggesting that they are less concentrated in few stocks. Lastly, studies suggest that these markets have been found to be significantly affected by the U.S. stock market and the U.S. economy by varying degrees. Overall these four stock markets are ideal candidates for generalizing the results for Asian markets on their asymmetric behavior to movements in U.S. Treasury bill movements.

The market variable identified for these countries are the major indexes in their respective stock markets. Specifically, we include the following indexes in our study: U.S. treasury bill rate (TB), Hang Seng Price Index (HK), Singapore Straits Times Price Index (Sing), Korea SE Composite Price Index (KO), and Taiwan SE Weighted Price Index (TAI. We take the first difference of natural logarithm of all the indexes to obtain the continuously compounded return series (Tsay, 2002).

Table 1 reports the descriptive statistics for the continuously compounded monthly returns for the above mentioned five variables. The Hong Kong stock market has the highest mean (0.0089) and the highest standard deviation (0.1088) suggesting that investors are compensated for bearing higher risk. In all the cases, the mean values are substantially different from the median values indicating the possible existence of asymmetry. For example the mean value for Hong Kong 0.0089 while the median is 0.104. Similarly the mean and medians for Taiwan are 0.0021 and -0.0033 respectively. Interestingly, the average return of the 3 months U. S. Treasury bill yields are greater than the monthly returns of these four Asian markets. A possible reason could be the sharp downturn in these markets following the crisis. Also, the yields reported for the treasury bills are annualized while those of the stock markets are in monthly returns form. The standard deviation of the U.S. Treasury Bill rate is 0.0180 which is low compared to its mean of 0.0407 suggesting it be extremely low risk (risk free) security.

Table 1: Descriptive Statistics: Returns

	HK	SING	KO	TAI	TB
Mean	0.0089	0.0018	0.0049	0.0021	0.0407
Median	0.0104	0.0000	0.0068	-0.0033	0.0453
Maximum	0.2645	0.3324	0.2484	0.3945	0.0790
Minimum	-0.3482	-0.2150	-0.2107	-0.3181	0.0088
Std. Dev.	0.1088	0.0870	0.0696	0.0928	0.0180
Skewness	-0.1512	0.5865	-0.0691	0.3926	-0.1622
Kurtosis	5.4971	4.0609	4.9307	4.7180	2.2924
Jarque-Bera	45.8684	18.1361	27.1629	25.8681	4.6966
Probability	0.0000	0.0001	0.0000	0.0000	0.0955
Sum	1.5466	0.3205	0.8481	0.3704	7.5669
Sum Sq. Dev.	1.0751	1.3090	0.8385	1.4892	0.0598
Jarque-Bera	45.8684	18.1361	27.1629	25.8681	4.6966

Table 2 reports the cross correlation between the four stock market returns variables and the U.S. treasury bill yields. The correlation between Hong Kong and Singaporean stock exchange is the strongest. While, the correlations between stock markets of Hong Kong with Korea and Taiwan is almost of the same magnitude. Similarly, the correlations between Singapore and Taiwan and Singapore and Korea are of similar magnitude. Consistent with theories that an increase (decrease) in interest rate causes a decrease(increase) in stock prices the correlations between treasury bill yield with stock markets of Korea, Singapore and Taiwan are negative. Interestingly, the relationship between the U.S. treasury bill yields with Hong Kong seems to be positive.

Table 2: Cross-Correlations of Variables

	HK	KO	SING	TAI	TB
HK	1.0000				
KO	0.4355	1.0000			
SING	0.7500	0.4269	1.0000		
TAI	0.3954	0.3530	0.4218	1.0000	
TB	0.0133	-0.0304	-0.0347	-0.0489	1.0000

Before proceeding with the main results, we first check the time series properties of each variable by performing unit root tests. Table 3 reports the results of unit root tests using Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979, 1981) and Kwiatkowski, Phillips, Schmidt, and Shin (1992) (KPSS test). Based on the consistent and asymptotically efficient *AIC* and *SIC* criteria (Diebold, 2003) and considering the loss in degrees of freedom, the appropriate number of lags is determined to be two. In the case of the ADF test, the null hypothesis of nonstationarity is rejected. In the KPSS test, the null hypothesis is that each series in stationary. We fail to reject the null hypothesis in the case of KPSS test. The inclusion n of drift/trend terms in the ADF and KPSS test equations does not change these results (Dolado, Jenkinson, and Sosvilla-Rivero, 1990).

Table 3: Augmented Dickey-Fuller Test Results

	Log levels	Log return
HK	0.0175	-21.7161
KO	-1.8629	-22.9927
SING	-2.2726	-18.0685
TAI	-2.7184	-19.7183
TB	1.0653	-22.4329
Critical level: 0.01	-3.4363	
Critical level: 0.05	-2.8633	
Critical level: 0.10	-2.5677	

5. Estimation Results

We test the existence of magnitude asymmetry in Asian stock markets in response to the U.S. treasury bill yields in the three steps.

First, in accordance with each (3), we extract the magnitude of upturns for each variable. Specifically, we identify all the positive returns in a series and recode all negative variables as zero i.e., the series (RI_t) contains either positive numbers or zero. Second, in accordance with equation (4) we generate a set of series, RDt which represents the downturn in each of the variable. Specifically, we extract all negative movements and give the value 0 to all the positive returns. By performing these two steps, we are able to capture the upturns and downturns in each of the four Asian markets as well as increase and decrease in the U.S. treasury bill yields. Overall, we generate a total of 10 variables representing the upturns and downturns to examine our postulated hypotheses.

Table 4, panels A and B presents the descriptive statistics of the upturns and downturns in all the variables. The means of both upturns and downturns is almost same in magnitude (approximately ranges between 0.02 – 0.03) for four Asian markets suggesting that the upturns and downturns have been almost of similar magnitude over the period of time. However, in case of treasury bill yields, the downturns seem to be more severe (approximately 0.02) as compared to upturns (approximately 0.01) over the same duration. Similarly, the volatility suggested by standard deviations of positive and negative movements of Asian stock market variables are of similar magnitude (approximately ranges between 0.04 – 0.05). Consistent with the mean of treasury bill yields, the downturns seems to display greater volatility (approximately 0.04) compared to the upturns (approximately 0.02).

Table 4: Descriptive Statistics of Upturns and Downturns

Panel A: Upturns

	HK_U	KO_U	SING_U	TAI_U	TB_U
Mean	0.0338	0.0365	0.0271	0.0350	0.0136
Median	0.0104	0.0000	0.0065	0.0004	0.0000
Maximum	0.2645	0.3945	0.2484	0.3324	0.2192
Minimum	0.0000	0.0000	0.0000	0.0000	0.0000
Std. Dev.	0.0496	0.0597	0.0434	0.0567	0.0271
Skewness	2.1043	2.3831	2.3923	2.3564	3.7125
Kurtosis	8.2642	10.7132	9.5818	9.6395	22.9878
Jarque-Bera	327.4408	592.5922	477.2731	477.8651	3277.2080
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	5.8526	6.3074	4.6797	6.0487	2.3603
Sum Sq. Dev.	0.4231	0.6121	0.3235	0.5520	0.1263

Panel B: Downturns

	HK_D	KO_D	SING_D	TAI_D	TB_D
Mean	-0.0253	-0.0338	-0.0225	-0.0324	-0.0240
Median	0.0000	-0.0032	0.0000	0.0000	-0.0051
Maximum	0.0000	0.0000	0.0000	0.0000	0.0000
Minimum	-0.3482	-0.3181	-0.2107	-0.2150	-0.2504
Std. Dev.	0.0453	0.0507	0.0419	0.0451	0.0423
Skewness	-3.0497	-2.0709	-2.5866	-1.4817	-2.9386
Kurtosis	17.5449	8.8638	9.7026	4.6825	13.0098
Jarque-Bera	1793.1230	371.5059	516.7431	83.7072	971.2436
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	-4.3759	-5.8457	-3.8852	-5.6096	-4.1547
Sum Sq. Dev.	0.3522	0.4420	0.3024	0.3501	0.3077

In the third step, we employ equations (1) and (2) to test the magnitude asymmetry i.e., whether the upturns and downturns in Asian markets react differently to shocks originating from the increase and decrease in the treasury bill yield. Specifically, the third step involves a set of eight regressions, with upturns and downturns of the four Asian markets returns regressed against increase and decrease in treasury bill yields and lagged dependent variables.

Tables 5 (panels A and B) reports the estimation results for upturns and downturns respectively of Hong Kong stock market to increase and decrease in the U.S. treasury bill yields. The coefficients and *t*-statistics in panel A suggests that the TB_D (decrease in U.S. treasury bill yield) have a positive and significant effect on the upturns in Hong Kong stock market returns. However, there is an insignificant effect of increase in treasury bill yields (TB_U). The lagged stock market returns also seems to have an insignificant effect on the upturns. The panel B which examines the effects on the downturns in Honk Kong stock returns also seems to display similar relationships. A

decrease in the U.S. treasury bill yields have a negative and significant effect on downturns while there are insignificant impact of increase in treasury bill yields and the lagged market returns. The estimation results in panels A and B indicate that there is an asymmetric effect of increase and decrease in treasury bill yields on Hong Kong stock market.

Table 5: Estimation Results for the Magnitude Asymmetry of Hong Kong

Panel A: Upturns in Hong Kong

Variable	Coefficient	Std. Error	t-Statistic
TB_U	0.0443	0.1461	0.3033
TB_D	0.1101	0.0636	1.7302
HK_U(-1)	-0.0382	0.0764	-0.5002
C	0.0372	0.0057	6.4907
R-squared	0.0120		
Adjusted R-squared	-0.0056		
S.E. of regression	0.0497		
SSR	0.4180		
Log likelihood	275.7268		
F-statistic	0.6818		
Prob(F-statistic)	0.5643		

Panel B: Downturns in Hong Kong

Variable	Coefficient	Std. Error	t-Statistic
TB_U	0.1164	0.1339	0.8697
TB_D	-0.0241	0.0057	-4.2029
HK_D(-1)	0.0498	0.0768	0.6477
C	-0.0262	0.0051	-5.1026
R-squared	0.0074		
Adjusted R-squared	-0.0102		
S.E. of regression	0.0455		
SSR	0.3496		
Log likelihood	291.1851		
F-statistic	0.4185		
Prob(F-statistic)	0.7400		

Table 6 (panels A and B) report the results of the Singaporean market upturns (SING_U) and downturns (SING_D) regressions to increase and decrease in treasury bill yields. In the first regression (panel A), the both increase (TB_U) and decrease (TB_D) in treasury bill yields have significant effect on the upturns. However, the coefficients related to decrease in treasury bills is higher (approximately 0.03) than the regression coefficient for similar increase (-0.02). The t-statistics for both these coefficients suggests significant relationships. In panel B, the estimation results are

similar to the ones obtained for the upturns. The coefficients for both increase and decrease in treasury bill yields are significant (t-statistics of 1.78 and 1.87 respectively). However, the magnitude of decrease coefficients is much higher than the increase suggesting an asymmetric response of Singapore stock market to increase and decrease in treasury bill yields.

Table 6: Estimation Results for the Magnitude Asymmetry of Singapore

Panel A: Upturns in Singapore

Variable	Coefficient	Std. Error	t-Statistic
TB_U	-0.0205	0.0103	-1.9963
TB_D	0.0333	0.0115	2.8950
SING_U(-1)	0.1410	0.0761	1.8523
C	0.0243	0.0049	4.9412
R-squared	0.0209		
Adjusted R-squared	0.0035		
S.E. of regression	0.0433		
SSR	0.3168		
Log likelihood	299.7249		
F-statistic	1.2015		
Prob(F-statistic)	0.3109		

Panel B: Downturns in Singapore

Variable	Coefficient	Std. Error	t-Statistic
TB_U	0.0182	0.0102	1.7824
TB_D	-0.0366	0.0195	-1.8784
SING_D(-1)	0.0066	0.0770	0.0855
C	-0.0248	0.0047	-5.2303
R-squared	0.0057		
Adjusted R-squared	-0.0119		
S.E. of regression	0.0422		
SSR	0.3007		
Log likelihood	304.2287		
F-statistic	0.3231		
Prob(F-statistic)	0.8086		

Table 7 reports the regression results using Equations (1) and (2) for South Korea's upturns and downturns. In panel A, the size of the coefficient for increase in treasury bill yields is 0.09 while the one for decrease is 0.04. However, the values of t-statistics indicate that relationship between only the decrease in treasury bill yield and Korea's stock return is significant. These results suggests an asymmetric impact of treasury bill

yields on stock returns in case of Korea. In panel B, we examine the existence of asymmetry in case of downturns. Similar to the earlier result the coefficient for only the decrease in treasury bill yield has significant effect suggesting an asymmetric response of Korea's market.

Table 7: Estimation Results for the Magnitude Asymmetry of Korea

Panel A: Upturns in Korea

Variable	Coefficient	Std. Error	t-Statistic
TB_U	0.0956	0.1761	0.5428
TB_D	0.0432	0.0128	3.3840
KO_U(-1)	0.0857	0.0766	1.1184
C	0.0331	0.0067	4.9088
R-squared	0.0102		
Adjusted R-squared	-0.0074		
S.E. of regression	0.0599		
SSR	0.6059		
Log likelihood	243.6287		
F-statistic	0.5814		
Prob(F-statistic)	0.6280		

Panel B: Downturns in Korea

Variable	Coefficient	Std. Error	t-Statistic
TB_U	0.2196	0.1462	1.5023
TB_D	-0.0359	0.0137	-2.6245
KO_D(-1)	0.2020	0.0747	2.7034
C	-0.0307	0.0057	-5.3808
R-squared	0.0530		
Adjusted R-squared	0.0362		
S.E. of regression	0.0498		
SSR	0.4186		
Log likelihood	275.6116		
F-statistic	3.1523		
Prob(F-statistic)	0.0264		

Tables 8 (panels A and B) reports the estimation results for upturns and downturns respectively of Taiwan stock market to increase and decrease in the U.S. treasury bill yields. The coefficients and *t*-statistics in panel A suggests that the TB_D (decrease in U.S. treasury bill yield) have a positive and significant effect on the upturns in Hong Kong stock market returns. Similarly, there is a significant effect of increase in treasury bill yields (TB_U). However, the strength of the impact of decrease is much higher than that of the increase. The panel B which examines the effects on the downturns in Taiwan stock returns also seems to display similar relationships. A decrease in the U.S.

treasury bill yields have a negative and significant effect on downturns while there are lower but significant impact of increase in treasury bill yields. The estimation results in panels A and B indicate that there is an asymmetric effect of increase and decrease in treasury bill yields on Taiwan stock market.

Table 8: Estimation Results for the Magnitude Asymmetry of Taiwan

Panel A: Upturns in Taiwan

Variable	Coefficient	Std. Error	t-Statistic
TB_U	-0.1576	0.0669	-2.3571
TB_D	0.1833	0.0107	17.1122
TAI_U(-1)	0.0310	0.0765	0.4052
C	0.0392	0.0063	6.1978
R-squared	0.0119		
Adjusted R-squared	-0.0056		
S.E. of regression	0.0568		
SSR	0.5454		
Log likelihood	252.7171		
F-statistic	0.6810		
Prob(F-statistic)	0.5648		

Panel B: Downturns in Taiwan

Variable	Coefficient	Std. Error	t-Statistic
TB_U	0.1494	0.0333	4.4841
TB_D	-0.1625	0.0254	-6.4054
TAI_D(-1)	0.0163	0.0761	0.2141
C	-0.0343	0.0053	-6.5161
R-squared	0.0076		
Adjusted R-squared	-0.0100		
S.E. of regression	0.0453		
SSR	0.3474		
Log likelihood	291.7338		
F-statistic	0.4333		
Prob(F-statistic)	0.7295		

Overall the findings presented in tables 5-8 are consistent with the view that investors penalize downturns in emerging markets more heavily than reward such upturns. This contribution of this paper is to examine the asymmetric impact U.S. Treasury Bill rate on the upturns and downturns in the Asian stock markets. It is different from previous studies in two ways (a) unlike previous studies which have examined the asymmetric effect of stock market we have focused on the U.S. interest rates and (b) unlike previous studies which have examined Latin American markets, we have investigated the response of Asian stock market. Our findings are consistent in terms of direction but

different in terms of duration and magnitude. Specifically our results indicate that the negative responses of Asian markets are greater than those of the positive responses. However, the magnitude and the timing in which these effects are fully reflected in Asian markets are different from the ones seen in other markets.

6. Conclusion

This paper investigates the relative impact of positive and negative innovations in the U.S. Treasury Bill yields on stock market movements of four Asian countries. Theories suggest that greater increase in the U.S. interest rate can cause greater capital outflows from a foreign country thereby causing negative returns in stock prices of that country. Similarly, greater decrease in the U.S. interest rates is associated with higher inflows in the foreign country leading to positive movements in foreign stock market.

The contribution of this paper is to analyze whether such increase or decrease in U.S. Treasury Bill yields have significantly different impact on downturn than upturn in stock markets of Taiwan, Hong Kong, Singapore, and South Korea. We use the data in monthly intervals from January 1990 to December 2010 to examine the postulated relationships. The regression results suggests that in most of the cases, the magnitude and the duration of time in which the increase in the U.S. treasury Bill yields is fully reflected in equity markets of Asia is significantly different from that of the decrease in the U.S. Treasury Bill yields.

Our findings corroborate the evidence that investors react differently to negative than positive shocks. Specifically, reactions to increase in U.S. interest rates or downturns in Asian stock prices are more severe than upturns following a decrease in U.S. treasury bill yields. A direct implication of this study is that if investment portfolios are formed based on average co-movements, which assume symmetry, the performance of the investment could be worse than expected in the down markets.

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