Stock Prices and Inflation: Evidence from the Four Asian Tigers

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Abstract

Using monthly data from 1980s to 2010 for the Four Asian Tigers (Hong Kong, Singapore, South Korea, and Taiwan), this study finds the existence of the long-run Fisher effect via Johansen cointegration tests. However, the elasticities of stock prices with respect to consumer price indexes range from 1.895 for Singapore to 3.060 for Taiwan, which are significantly greater than one. The time path of the response of stock prices to unexpected movement in consumer price indexes exhibits an initial negative response for South Korea only but not for the other countries in the Four Asian Tigers.

Key words: Fisher effect, stock prices, consumer price indexes, Cointegration

Introduction

The nominal interest rate comprises the expected constant real interest rate and expected inflation (Fisher, 1930). This proposition implies that the nominal interest rate has a one-to-one relation with inflation, and therefore inflation has no long-run effect on the real interest rate. The one-to-one relationship between nominal interest rate and inflation is typically referred to as the Fisher effect. Transposing the Fisher effect to the stock market implies the one-to-one relationship between stock returns and inflation. Thus, stock returns may serve as a hedge against inflation.

Hong Kong, Singapore, South Korea, and Taiwan are known as the Four Asian Tigers because of their rapid economic growth between the early 1960s and 1990s. By the early 21st century, Hong Kong and Singapore have specialized in the financial industry whereas South Korea and Taiwan have specialized in manufacturing electronic components and devices. This study examines if the economies of the Four Asian Tigers reveal common Fisher effects. We examine monthly data of stock prices and consumer price indexes for the Four Asian Tigers from the 1980s to 2020. Our estimates of the long-run elasticities of stock prices with respect to consumer price indexes significantly exceed 1 and range from 1.895 to 3.060. We also examine the time path of the relation between stock prices and consumer price indexes. Only in South Korea, the initial response of stock price is negatively significant and thereafter becomes positive and permanent. The other three countries illustrate an insignificant initial response of stock price but also become positive and permanent.

Theoretical framework

The relationship among real interest rate (r_t), nominal interest rate (i_t) and inflation (π_t) can be written as:

$$1 + r_t = \frac{1 + i_t}{1 + \pi_t} \quad (1)$$

Solving for r_t:

$$r_t = \frac{i_t - \pi_t}{1 + \pi_t} \quad (2)$$

Assuming the real interest rate is constant; the value of the denominator is so small that can be ignored; inflation is based on inflation expectation (π_t^e). The nominal interest rate can be written as:

$$i_t = r + \pi_t^e \quad (3)$$

Assuming efficient markets (Fama, 1975), inflation can be decomposed into two parts: inflation expectation and a forecast error, u_t.

$$\pi_t = \pi_t^e + u_t \quad (4)$$

Rewriting this in regression equation:

$$i_t = \beta_0 + \beta_1 \pi_t + e_t \quad (5)$$

where e_t is the error term. If the Fisher hypothesis is accepted, β_1 is equal to one which is also referred to as the Fisher Effect. (Mishkin, 1992). However, when stock return is used as a proxy for nominal interest rate, the coefficient (β_1) could exceed unity because the stock return is subject to taxes.

Data and Empirical Results

This study covers the equity markets in the Four Asian Tigers: Hong Kong, Singapore, South Korea, and Taiwan. Monthly stock prices and consumer price indexes (CPIs) are used. The stock price indexes are obtained from the Yahoo.finance website, and the CPIs of Hong Kong, Singapore, and South Korea are obtained from the International Financial Statistics (IFS database). The CPI of Taiwan is obtained from the Taiwanese government website[1]. Table 1 lists the time periods studied for the four markets. Table 2 provides a brief descriptive analysis of the variables that are expressed in the original form. All the variables apply logarithms transformation for further analyses.

Table 1.

Hong Kong	Hang Seng Index (HIS)	Dec. 1986 – Oct. 2020
Singapore	Straits Times Index (STI)	Feb. 1996 – Oct. 2020
South Korea	Korea Composite Stock Price Index (KOSPI)	Jul. 1997 – Oct. 2020
Taiwan	Taiwan Capitalization Weighted Stock Index (TAIEX)	Jul. 1997 – Sep. 2020

[1] https://eng.stat.gov.tw

Table 2. Descriptive statistics

		Hong Kong	Singapore	South Korea	Taiwan
Stock prices (SP)	Mean	14999.70	2522.33	1473.83	7845.76
	Std. Dev.	8040.42	687.41	636.41	1908.03
	Skewness	0.06	-0.32	-0.27	0.07
	Kurtosis	1.89	1.91	1.62	2.47
Consumer price indexes (CPI)	Mean	94.72	97.95	94.77	92.72
	Std. Dev.	23.95	12.47	15.63	6.53
	Skewness	-0.36	0.21	-0.21	0.05
	Kurtosis	2.68	1.29	1.61	1.52

The long-run relationship between stock prices and CPIs depends on the integration and stationarity properties for the two time series. To check stationarity in individual time series, we employ two unit root tests: the Augmented Dickey-Fuller (ADF) (1979, 1981) test and Phillips-Perron (PP) (1990) test. The lag length in the ADF test regressions is determined by the Akaike Information Criterion (AIC). Tables 3a and 3b present the results of these tests for level and first difference, respectively. The stock prices and CPIs are generally nonstationary in the level but stationary in the first difference.

Table 3a. Unit root tests

Country	SP_a	SP_b	SP_c	CPI_a	CPI_b	CPI_c
Hong Kong						
ADF	-1.95	-2.48	1.32	-2.35	-3.73**	0.33
PP	-1.94	-2.46	1.49	-4.34***	-2.91	4.19
Singapore						
ADF	-1.94	-3.27**	-0.06	-0.76	-1.97	1.49
PP	-2.03	-3.14*	-0.08	-0.39	-1.17	3.83
South Korea						
ADF	-1.23	-2.78	0.78	-2.31	0.83	0.89
PP	-1.31	-3.11	0.71	-3.51***	-0.78	6.99
Taiwan						
ADF	-0.59	-2.66	0.67	-0.45	-2.15	3.16
PP	-1.93	-3.52**	0.12	-0.45	-4.38**	3.84

Note: SP and CPI denote stock prices and consumer price indexes. The ADF and PP are the Augmented Dickey Fuller and Phillips-Perron unit root tests with intercept (a), with trend and intercept (b), and with neither trend nor intercept (c), respectively. ***, **, * denotes significance at the 1%, 5% and 10% respectively.

Table 3b. Unit root tests

Country	SR_a	SR_b	SR_c	INF_a	INF_b	INF_c
Hong Kong						
ADF	-19.90***	-19.92***	-19.82***	-1.50	-1.60	-1.58
PP	-20.02***	-20.14***	-19.83***	-21.42***	-21.54***	-21.77***
Singapore						
ADF	-15.99***	-15.96***	-16.01***	-2.32	-2.29	-1.74*
PP	-16.03***	-16.01***	-16.06***	-19.92***	-19.89***	-19.72***
South Korea						
ADF	-14.54***	-14.51***	-14.52***	-1.69	-3.28*	-0.96
PP	-14.47***	-14.44***	-14.49***	-11.10***	-11.59***	-9.96***
Taiwan						
ADF	-5.33***	-5.49***	-5.30***	-5.63***	-5.62***	-4.58***
PP	-15.61***	-15.66***	-15.64***	-25.55***	-25.48***	-20.33***

Note: SR and INF denote stock returns and inflation rates. The ADF and PP are the Augmented Dickey Fuller and Phillips-Perron unit root tests with intercept (a), with trend and intercept (b), and with neither trend nor intercept (c), respectively. ***, **, * denotes significance at the 1%, 5% and 10% respectively.

A Vector Autoregression (VAR) and a Vector Error Correction Model (VECM) and are used to examine the short-run and long-run relationship between stock prices (SP) and CPIs. The VAR model of order k:

$$X_t = C + \sum_{k=1}^{n} A_k X_{t-k} + u_t \tag{6}$$

where C is a 2 × 1 vector of constant, A_k are 2 × 2 matrices of coefficients to be estimated, and vector u_t, represents the unexpected movements in SP and CPI. The order of lag is selected by the Final Prediction Error (FPE) and Akaike Information Criterion (AIC), and the order of lag is applied in both VAR and VECM. Table 4 shows the lag length selections. Anari and Kolari (2001) show if there exists a long-run relationship between the two variables, the VECM can be written for stocks as:

$$\Delta SP_t = \sum_{k=1}^{n-1} a_k \Delta SP_{t-k} + \sum_{k=1}^{n-1} b_k \Delta CPI_{t-k} + e(SP_{t-1} - c - dCPI_{t-1}) \tag{7}$$

where the error corrections term e represents the speed of adjustment of stock prices to unexpected changes in inflation. The term in parentheses is the vector of deviations from the long-run relationship between stock prices and consumer price indexes, and it can be normalized and expressed as:

$$SP_t = c + dCPI_t \tag{8}$$

If the variables are in log terms, the coefficient d in the equation is the elasticity of stock prices with respect to consumer price indexes, otherwise known as the Fisher coefficient (Anari and Kolari, 2001).

Table 4. Lag length selection.

	Hong Kong		Singapore		South Korea		Taiwan	
Lag	FPE	AIC	FPE	AIC	FPE	AIC	FPE	AIC
1	2.90×10^{-7}	-9.38	8.70×10^{-8}	-10.58	6.65×10^{-8}	-10.85	2.15×10^{-7}	-9.68
2	2.89×10^{-7}	-9.38	8.26×10^{-8}	-10.63	6.19×10^{-8}	-10.92	2.10×10^{-7}	-9.70
3	2.84×10^{-7}	-9.40	8.18×10^{-8}	-10.64	5.80×10^{-8}	-10.99	2.05×10^{-7}	-9.73
4	2.84×10^{-7}	-9.40	7.38×10^{-8}*	-10.75*	5.66×10^{-8}	-11.01	2.01×10^{-7}	-9.74
5	2.76×10^{-7}	-9.43	7.57×10^{-8}	-10.72	5.72×10^{-8}	-11.00	2.05×10^{-7}	-9.72
6	2.77×10^{-7}	-9.43	7.73×10^{-8}	-10.70	5.78×10^{-8}	-10.99	2.05×10^{-7}	-9.73
7	2.79×10^{-7}	-9.42	7.74×10^{-8}	-10.70	5.56×10^{-8}*	-11.03*	2.06×10^{-7}	-9.72
8	2.79×10^{-7}	-9.42	7.72×10^{-8}	-10.70	5.69×10^{-8}	-11.01	1.94×10^{-7}	-9.78
9	2.73×10^{-7}	-9.44	7.81×10^{-8}	-10.69	5.81×10^{-8}	-10.99	1.92×10^{-7}*	-9.79*
10	2.78×10^{-7}	-9.42	7.71×10^{-8}	-10.70	5.85×10^{-8}	-10.98	1.96×10^{-7}	-9.77
11	2.77×10^{-7}	-9.42	7.88×10^{-8}	-10.68	5.80×10^{-8}	-10.99	1.95×10^{-7}	-9.78
12	2.69×10^{-7}*	-9.45*	7.84×10^{-8}	-10.69	5.86×10^{-8}	-10.98	2.00×10^{-7}	-9.75

Note: * Indicates lag order selected by the Final Prediction Error (FPE) and Akaike Information Criterion (AIC).

Table 5 presents the results of a standard cointegration test based on the Johansen's trace test. The results suggest the existence of one cointegrating vector between the two variables in 2 countries: Singapore and Taiwan. The evidence indicates 2 cointegrating vectors in Hong Kong and South Korea. The conclusion from Table 5 that stock prices and consumer price indexes are cointegrated can be used to test if stock prices have a relationship in the long run with consumer price indexes.

Table 5. Johansen trace test.

Hypothesized No. of Cointegrating Vectors	Likelihood Ratio			
	Hong Kong	Singapore	South Korea	Taiwan
None	22.22***	21.43***	36.26***	14.85*
	[0.0042]	[0.0056]	[0.0000]	[0.0623]
At most one	7.70***	0.28	10.71***	0.03
	[0.0055]	[0.5986]	[0.0011]	[0.8611]

Note: Trace test probability in [ ]. p-values are from MacKinnon-Haug-Michelis (1999); ***, **, * denotes significance at the 1%, 5% and 10% respectively. Lag lengths are based on Table 4.

Based on equation (3), Table 6 reports the estimates of long-run relations between stock prices and consumer price indexes. As shown in Table 6, the estimated Fisher coefficients (d) range from 1.895 to 3.060. The signs of the estimated coefficients are positive and statistically significant for all countries. Since all variables are in logarithm, the estimated coefficient in each equation shows the elasticity of the stock price with respect to the consumer price index. For example, in Hong Kong, for every 1% increase in the consumer price index, the stock price is expected to increase by 2.797% over the sample period. These results are consistent with the literature about the positive long-run relationship between stock price and consumer price index (Anari and Kolari, 2001; Al-Khazali and Pyun, 2004; Luintel and Paudyal, 2006; Alagidede and Panagiotidis, 2010). Table 6 also provides the estimates of the speed-of-adjustment coefficients range from -0.025 to -0.092. These coefficients indicate how quickly the stock prices return to the equilibria following a shock from the consumer price indexes.

Table 6. Long-run relationship between stock prices and consumer price indexes $SP_t = c + dCPI_t$

	Cointegrating vectors	Speed of Adjustment (e)
Hong Kong	$SP_t = -3.232 + 2.797_{(9.805)***}$	-0.025*
Singapore	$SP_t = -0.885 + 1.895_{(6.735)***}$	-0.047**
South Korea	$SP_t = -5.885 + 2.877_{(12.768)***}$	-0.092***
Taiwan	$SP_t = -4.931 + 3.060_{(5.232)***}$	-0.079***

t-values are in parentheses. ***, **, * denotes significance at the 1%, 5% and 10% respectively.

We now address the short-run relationship between stock prices and consumer price indexes. The impulse response functions from VAR models enable us to investigate the time path of response of stock prices to an unpredicted movement in consumer price indexes. Figure 1 shows the impulse response functions about an unexpected movement in the consumer price indexes affect the stock prices over a forecast horizon of 240 months, as well as their bands of plus and minus 2 standard errors. The initial short-run responses of stock prices are negative and significant for South Korea only but insignificant for the other three countries. After the initial reactions, the responses become positive and significant in a permanent long-run relation. Our findings are consistent with previous literature and the Fisher effect that it takes a long period of

time for inflation to be fully reflected in stock prices (Jaffe and Mandelker, 1976; Boudoukh and Richardson, 1993).

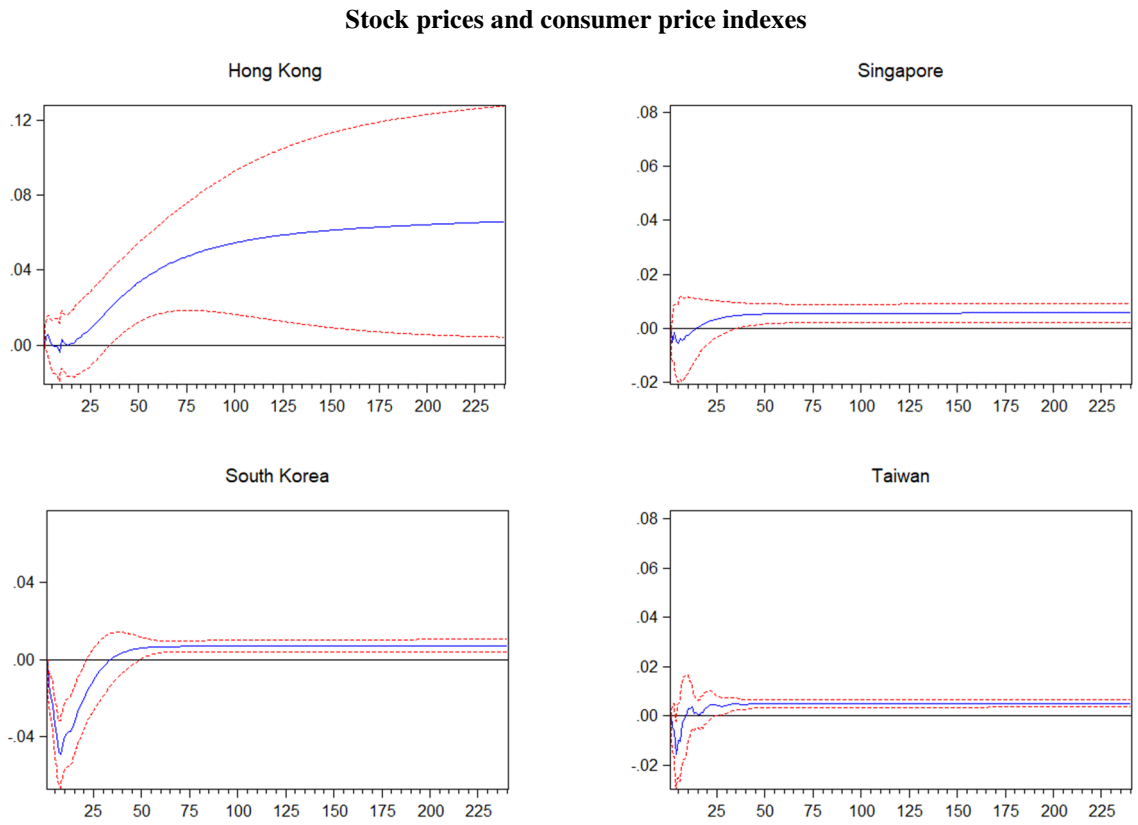

Figure 1. Graph of the impulse response functions illustrating the response of stock prices to a one-standard-deviation in the consumer price indexes using monthly data.

Conclusions

Boudoukh and Richard (1993) and Jaffe and Mandelker (1976) have demonstrated that the long-run Fisher effect needs to estimate by using the level of stock prices and goods prices instead of using the first differences of the two variables to avoid losing the crucial long-run information. In this regard, we examine monthly stock prices and consumer price indexes for four Asian countries.

This study examines the relationship between stock prices and consumer price indexes in the Four Asian Tigers: Hong Kong, Singapore, South Korea, and Taiwan. The results of the cointegration test support the long-run estimates that yield the results consistent with the Fisher effect for all four Asian countries However, the estimates Fisher effect coefficients are significantly greater than one. We also find the time path of the response of stock prices to a shock in consumer price indexes. Only the stock price in South Korea exhibits a negative significant response to its unexpected movement of consumer price index in the short-run.

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