Stock Prices and Inflation: Evidence from the Four Asian Tigers

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Abstract

Using monthly data from the 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, all significantly greater than one. In the short run, the unexpected shock from the consumer price index has a significant negative impact on the stock price in South Korea, but the same type of impacts are not significant for the other three Asian Tigers countries.

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, but inflation and the real interest rate are not related in the long run. 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 had 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. Using monthly data, we examine the relationship between 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 change of the relationship over time between stock prices and consumer price indexes. Only in South Korea, the initial response of stock price is negatively significant and after that 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:

$$1 + r_t = \frac{1 + i_t}{1 + \pi_t} \tag{1}$$

Solving for r_t:

$$r_t = \frac{i_t - \pi_t}{1 + \pi_t} \tag{2}$$

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:

$$i_t = r + \pi_t^e \tag{3}$$

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

$$\pi_t = \pi_t^e + u_t \tag{4}$$

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

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

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

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 represent stock prices and consumer price indexes. The ADF stands for the Augmented Dickey-Fuller unit root test, and PP stands for the Phillips-Perron unit root test. Subscripts (a), (b), and (c) represent with intercept, with trend and intercept, and with neither trend nor intercept, 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 stands for the Augmented Dickey-Fuller unit root test, and PP stands for the Phillips-Perron unit root test. Subscripts (a), (b), and (c) represent with intercept, with trend and intercept, and with neither trend nor intercept, 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 if stock prices and CPIs are significantly related in the short-run and long-run. The VAR model of order k can be written as:

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

where C is constant terms, and it is a (2×1) vector; A_k are the estimated coefficients, a (2×2) matrix, and u_t is a (2×1) vector of shocks in stock price 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:

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

where SP is the stock price; ΔSP is the return on stock; ΔCPI is inflation, and the error corrections term e represents the speed of adjustment of stock price 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:

$$SP_t = c + dCPI_t \quad (8)$$

The coefficient d in equation (8) is the elasticity of stock price with respect to CPI if the variables are related in the long run. The coefficient d is also 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*** [0.0042]	21.43*** [0.0056]	36.26*** [0.0000]	14.85* [0.0623]
At most one	7.70*** [0.0055]	0.28 [0.5986]	10.71*** [0.0011]	0.03 [0.8611]

Note: The values inside [] are Trace test probability. p-values follows MacKinnon-Haug-Michelis (1999); ***, **, * represent significant level at the 1%, 5% and 10% respectively. The selections of lag lengths are according to the results in Table 4.

Table 6 shows the estimated coefficients of stock prices and consumer price indexes in the long run. The estimated values of Fisher coefficients (d) are between 1.895 are 3.060. The signs of (d) are positive and significant for all countries. All variables are in log transformation, so the Fisher coefficients are the elasticity of the stock price with respect to CPI. For example, in Hong Kong, for every 1% increase in CPI, the stock price increases by 2.797% in the observation period. Our findings 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). Furthermore, table 6 provides the estimated values about speed-of-adjustment coefficients, and they 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.

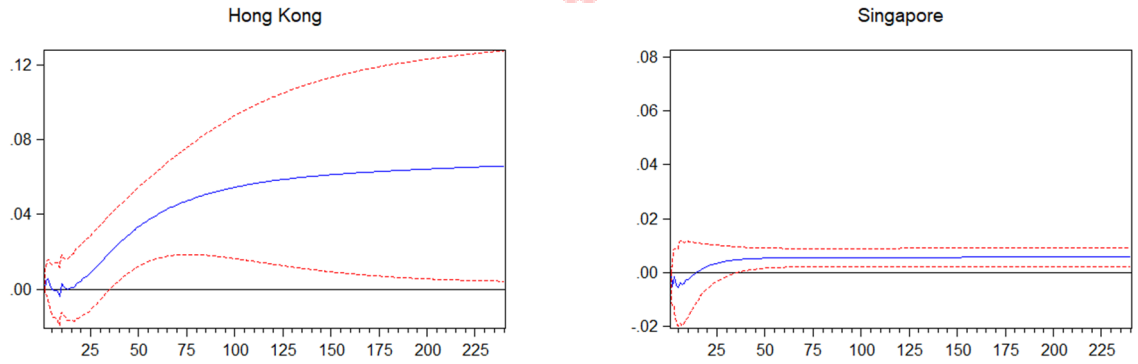
Table 6. Long-run relationship between stock prices and consumer price indexes $SP_t = c + dCPI_t$

	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 correlation between stock prices and CPIs. The impulse response functions from VAR models allow us to examine the response of stock prices to a shock in CPIs over time. Figure 1 shows the impulse response functions about shocks of CPIs on the stock prices for 240 months forecasting and the bands of ± 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 are positive and significant for the forecast period toward the end. 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).

Stock prices and consumer price indexes



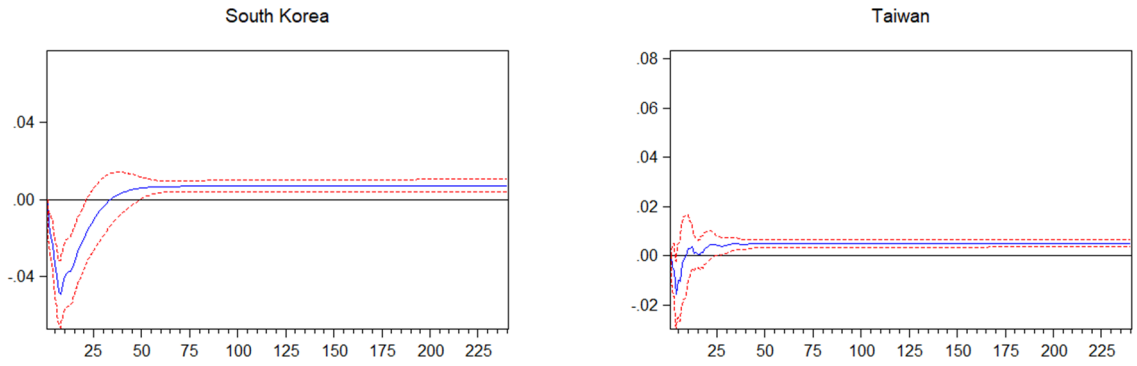


Figure 1. The graph of the impulse response functions illustrates stock prices response to a one-standard-deviation in CPIs using monthly data.

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 apply monthly data for stock prices and CPIs 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 cointegration test results support the long-run estimates that yield the results consistent with the Fisher effect for all four Asian countries. However, the estimated Fisher effect coefficients are significantly greater than one. Also, we find the response of stock prices to a shock in CPIs over time. Only the stock price in South Korea exhibits a significant negative response to its unexpected movement of consumer price index in the short-run.

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