Testing Fisher Hypothesis in long horizons for G7 and several Asian countries

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Abstract

Using monthly data from G7 and eight Asian countries, we find support for Fisher Hypothesis, as well as a positive relation between long-horizon nominal stock returns and expected inflation but not between long-horizon nominal stock returns and contemporaneous inflation. Our empirical results complement and strenghten those of Boudoukh and Richardson (1993).

Keywords: Fisher Hypothesis, long-horizon regression, stock returns, inflation.

JEL classification: G0, E0

1 Introduction

Fisher Hypothesis is an important hypothesis in Economics and Finance and has often been used as an assumption in or derived as a side implication from theoretical models. The hypothesis

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postulates that nominal rate of stock returns reflects the market expectation about the real rate of stock returns and inflation rate; that is, one percentage increase in expected inflation should be associated with one percentage increase in nominal stock returns. The Fisher Hypothesis implies that investment in stocks may be used to hedge against inflation completely. Furthermore, the coefficient estimate from a regression of nominal stock returns on expected inflation should be close to unity statistically.

$$R_{t,k} = \alpha + \beta E(\pi_{t,k}|I_{t-k}) + \epsilon_{t,k} \tag{1}$$

where $R_{t,k}$ and $\pi_{t,k}$ are respectively the nominal stock returns and inflation rate from time $t-k$ to t; α is the expected real rate of stock returns; β equals one under Fisher Hypothesis; $E(\pi_{t,k}|I_{t-k})$ is the expectation of inflation from period $t-k$ to t ($\pi_{t,k}$) based on the information set I_{t-k} available at $t-k$; and $\epsilon_{t,k}$ is the residual.

Because expectation of inflation is not available in general, the estimation of the coefficients has to rely on a regression model of observables:

$$R_{t,k} = \alpha + \beta\pi_{t,k} + u_{t,k}. \tag{2}$$

Note that the residual is now $u_{t,k}$ instead of $\epsilon_{t,k}$. By simple calculation, we can see that $u_{t,k} \equiv \epsilon_{t,k} + \beta[E(\pi_{t,k}|I_{t-k}) - \pi_{t,k}]$ is correlated with $\pi_{t,k}$. Consequently, an ordinary least squares (OLS) estimation will yield inconsistent estimates of the coefficients. However, if we have a variable that is correlated with $\pi_{t,k}$ but uncorrelated with $u_{t,k}$, we may estimate the coefficient consistently using instrumental variables (IV) or generalized method of moments (GMM) estimation. Such variables, known as instrumental variables, are readily available because all information in I_{t-k} are uncorrelated with $u_{t,k}$ and some information in I_{t-k} (such as $\pi_{t-k,k}$) are known to be correlated with $\pi_{t,k}$. For a description of the estimation methods of instrumental variables and generalized method of moments, please refer to Campbell, Lo and MacKinlay (1997, Appendix 1).

Strictly speaking, Fisher Hypothesis should hold at all horizons. However, based on short-horizon data, most previous empirical studies found a negative relation — a miserable failure.

Examples include Fama (1975), Bodie (1976), Nelson (1976) and Fama and Schwert (1977).

Recently, Boudoukh and Richardson (1993) re-investigated the relation using annual United States and the United Kingdom data and found that long-horizon (five years) nominal stock returns are postively related to both *ex ante* (instrumental variables estimation) and *ex post* (ordinary least squares) long-term inflation. However, there is no evidence from other countries and data sets.

In this paper, we test the Fisher Hypothesis at short- and long-horizon using data from fifteen countries, including G7 and eight Asian countries.

2 Data

We use monthly data because long annual time series are often not available for most countries, except for the United States and United Kingdom. Monthly consumer price indices (CPIs) and stock indices (SIs) are drawn mainly from the International Financial Statistics and the Datastream database. The data appendix describes in details the sources of data and their series codes. Inflation rates and stock returns at various horizons (k) are calculated as

$$\pi_{t,k} = \frac{CPI_t - CPI_{t-k}}{CPI_{t-k}} \times 100\% \tag{3}$$

and

$$R_{t,k} = \frac{SI_t - SI_{t-k}}{SI_{t-k}} \times 100\%. \tag{4}$$

As in Boudoukh and Richardson (1993), we report the ordinary least squares (OLS) and instrumental variables (IV) regression results for $k = 12$ (one year) and $k = 60$ (five years). For each regression, we report the Newey and West (1987) standard errors to take into account of the serial correlation, and possible heteroskedasticity, in residuals due to the use of overlapping data.

3 Results

3.1 Contemporaneous (OLS) regressions

Table 1 reports the results of the one-year horizon ($k = 12$) OLS regressions. The results are disappointing but expected. Out of the fifteen cases, only four countries have positive slope estimates. Among these positive estimates, none of them differs significantly from zero at 5% level. In contrast, six out of the eleven negative slope estimates differ significantly from zero at 5% level. In ten cases (including six G7 countries), the Fisher Hypothesis (the null of $\beta = 1$) is rejected at 5% level. The model fits poorly for most countries. All fifteen countries have an R^2 less than 0.12.

Table 2 reports the results of the five-year horizon ($k = 60$) OLS regressions. The results improve somewhat over the short-horizon regression (Table 1). Six countries have positive slope estimates. Only one of them are significantly different from zero at 5% level. Six out of the nine negative slope estimates are significantly different from zero at 5% level. In ten cases (including six G7 countries), the Fisher Hypothesis (the null of $\beta = 1$) is rejected at 5% level. Based on R^2, the model fits slightly better using long-horizon data than short-horizon data for all countries except for France and Japan.

Thus, comparing the short-horizon (Table 1) and the long-horizon results (Table 2), long-horizon OLS regressions do not seem particularly promising. This finding differs from Boudoukh and Richardson (1993), who reported more positive and closer-to-one slope estimates from a five-year horizon OLS regression of the United States and the United Kingdom. However, we are not surprised to find that the Fisher Hypothesis is rejected for most countries when the model is estimated by OLS because an OLS regression of equation (2) has been shown to yield inconsistent estimate of β. Thus, investment in stock is not a hedge against contemporaneous inflation.

3.2 Instrumental variables regressions

In this section, we consider an IV estimation of the model. As explained earlier, an IV estimator of β will be consistent. Following Boudoukh and Richardson (1993), we use lagged inflation rate ($\pi_{t-13,12}$ and $\pi_{t-61,60}$ for one-year and five-year horizons respectively) as an instrument for the

right-hand-side variable (contemporaneous inflation rate). Tables 3 reports the one-year horizon results. As a whole the results are similar to that of a one-year horizon OLS regression. Only four slope estimates are positive, none of them significantly different from zero at 5% level, as in the short-horizon OLS regression. Eleven estimates are negative, with two of them significantly different from zero at 5% level. The null of Fisher Hypothesis is rejected at 5% level only in five cases; and only two of them are members of G7. This is a substantial improvement over the OLS estimation method which is known to be inconsistent in testing the hypothesis. Furthermore, the model fits poorly. None of the country has an R^2 higher than 0.134.[1]

Table 4 reports the five-year horizon results. The results are encouraging. Out of fifteen cases, eleven countries have positive slope estimates — six of them are significantly different from zero at 5% level. All negative slope estimates are insignificantly different from zero at 5% level. The null of Fisher Hypothesis is rejected at 5% level only in three cases (including Italy, a G7 country), a moderate improvement over the one-year horizon IV result and a substantial improvement over the five-year horizon OLS results. R^2 also improve substantially, the highest being 0.732 (Italy).

Comparing the results from G7 and Asian countries, we see slightly more support of Fisher Hypothesis, and a positive relation between stock returns and inflation, using long-horizon data from G7 countries than Asian countries. Thus, investment in stock may be used as a hedge against expected inflation.

4 Concluding remarks

In short, our results support that at long horizon the nominal returns are positively related to expected inflation but not with contemporaneous inflation. We also find more support of Fisher Hypothesis when the model is estimated by instrumental variables estimation method using long-horizon data than by OLS using short-horizon data. Our findings complement and strengthen those of Boudoukh and Richardson (1993). Future theoretical studies might want to explain why Fisher Hypothesis is rejected when short-horizon data is used but not when long-horizon data is used.

[1]The computation of R^2 for our IV regressions is based on Pesaran and Smith (1994).

One disturbing finding, though, is the negative estimates of the constant term (α) for some countries. If real stock returns is contant, the constant term may be interpreted as the real stock returns under the Fisher Hypothesis. Our finding might suggest that the real stock returns may in fact be time-varying. In our agenda we plan to investigate, statistically, whether real stock returns implied from the Fisher Hypothesis are time-varying.

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Table 1: Short-horizon (One Year) OLS regression of stock returns on inflation rate

Country	Sample period (# observations)	$\hat{\alpha}$ (std. error)	$\hat{\beta}$ (std. error)	R-square
Canada	1958:1 to 1999:3 (495)	9.421 (2.786)	-0.385** (0.649)	0.006
France	1958:1 to 1999:4 (496)	14.889 (4.024)	-0.919** (0.594)	0.027
Germany	1966:1 to 1999:3 (399)	20.948 (5.546)	-3.475** (1.222)	0.101
Italy	1958:1 to 1998:12 (492)	11.708 (6.701)	0.148 (0.905)	0.001
Japan	1958:1 to 1999:3 (495)	13.316 (3.404)	-0.741** (0.414)	0.022
United Kingdom	1965:12 to 1999:3 (400)	11.792 (5.037)	0.127 (0.802)	0.001
United States	1958:1 to 1999:4 (496)	16.584 (2.791)	-1.656** (0.606)	0.114
Hong Kong	1970:1 to 1999:4 (352)	22.462 (9.912)	0.157 (1.354)	0.000
Indonesia	1984:4 to 1998:12 (177)	34.158 (12.064)	-1.080** (0.273)	0.056
Korea	1976:1 to 1999:3 (279)	19.284 (7.058)	-0.854** (0.434)	0.032
Malaysia	1981:2 to 1999:2 (217)	0.914 (11.343)	2.167 (2.882)	0.018
Philippines	1987:2 to 1999:4 (147)	76.982 (41.301)	-4.730 (3.390)	0.068
Singapore	1974:2 to 1999:2 (301)	10.948 (4.107)	-1.390** (0.673)	0.053
Taiwan	1972:2 to 1998:11 (322)	30.503 (8.277)	-0.574** (0.649)	0.010
Thailand	1976:5 to 1999:4 (276)	26.140 (7.590)	-2.242** (0.866)	0.050

Notes:

1. The results are based on the OLS regression of $R_{t,k} = \alpha + \beta\pi_{t,k} + u_{t,k}$, where $R_{t,k}$ and $\pi_{t,k}$ are respectively the nominal stock returns and inflation rate from time $t-k$ to t. Here $k = 12$.
2. "**" denotes a rejection of Fisher Hypothesis at 5% level.

Table 2: Long-horizon (five-year) OLS regression of stock returns on inflation rate

Country	Sample period (# observations)	$\hat{\alpha}$ (std. error)	$\hat{\beta}$ (std. error)	R-square
Canada	1962:1 to 1999:3 (447)	34.639 (7.247)	0.211** (0.281)	0.011
France	1962:1 to 1999:4 (448)	50.339 (13.385)	-0.004** (0.264)	0.000
Germany	1970:1 to 1999:3 (351)	128.615 (18.076)	-4.303** (0.708)	0.371
Italy	1962:1 to 1998:12 (444)	13.440 (17.283)	1.006 (0.370)	0.121
Japan	1962:1 to 1999:3 (447)	66.192 (18.572)	-0.005** (0.410)	0.000
United Kingdom	1969:12 to 1999:3 (352)	90.391 (13.266)	-0.363** (0.260)	0.040
United States	1962:1 to 1999:4 (448)	76.303 (8.833)	-1.090** (0.254)	0.165
Hong Kong	1974:1 to 1999:4 (304)	79.625 (41.982)	0.898 (0.798)	0.017
Indonesia	1988:4 to 1998:12 (129)	402.127 (79.896)	-3.609** (0.984)	0.138
Korea	1980:1 to 1999:3 (231)	211.942 (51.758)	-1.868** (0.516)	0.152
Malaysia	1985:2 to 1999:2 (169)	27.349 (26.515)	1.841 (1.498)	0.025
Philippines	1991:2 to 1999:4 (99)	-3.415 (83.539)	2.561 (1.347)	0.082
Singapore	1978:2 to 1999:2 (253)	29.065 (15.195)	1.308 (0.961)	0.055
Taiwan	1976:2 to 1998:11 (274)	321.090 (76.148)	-4.032** (1.285)	0.143
Thailand	1980:5 to 1999:4 (228)	239.654 (44.060)	-3.872** (0.807)	0.203

Notes:

1. The results are based on the OLS regression of $R_{t,k} = \alpha + \beta\pi_{t,k} + u_{t,k}$, where $R_{t,k}$ and $\pi_{t,k}$ are respectively the nominal stock returns and inflation rate from time $t-k$ to t. Here $k = 60$.
2. "**" denotes a rejection of Fisher Hypothesis at 5% level.

Table 3: Short-horizon (one-year) IV regression of stock returns on inflation rate

Country	Sample period (# observations)	$\hat{\alpha}$ (std. error)	$\hat{\beta}$ (std. error)	R-square
Canada	1959:1 to 1999:3 (483)	8.329 (3.470)	-0.077 (0.883)	0.000
France	1959:1 to 1999:4 (484)	8.116 (4.445)	0.366 (0.746)	0.003
Germany	1966:1 to 1999:3 (399)	17.135 (7.211)	-2.316 (1.841)	0.022
Italy	1959:1 to 1998:12 (480)	9.874 (7.761)	0.421 (1.081)	0.003
Japan	1959:1 to 1999:3 (483)	14.094 (4.087)	-0.868** (0.533)	0.013
United Kingdom	1965:12 to 1999:3 (400)	8.853 (4.992)	0.514 (0.677)	0.008
United States	1959:1 to 1999:4 (484)	11.004 (3.070)	-0.360** (0.655)	0.003
Hong Kong	1971:1 to 1999:4 (340)	88.537 (52.290)	-8.117 (6.476)	0.059
Indonesia	1984:4 to 1998:12 (177)	6.992 (39.664)	1.329 (3.556)	0.002
Korea	1976:1 to 1999:3 (279)	19.857 (10.385)	-0.920** (0.826)	0.018
Malaysia	1981:2 to 1999:2 (217)	16.639 (19.099)	-2.158 (4.943)	0.006
Philippines	1987:2 to 1999:4 (147)	204.258 (109.239)	-18.050 (11.125)	0.134
Singapore	1974:2 to 1999:2 (301)	18.712 (6.329)	-3.810** (1.536)	0.076
Taiwan	1972:2 to 1998:11 (322)	88.662 (43.945)	-10.032 (6.123)	0.059
Thailand	1976:5 to 1999:4 (276)	48.547 (14.422)	-6.016** (1.906)	0.095

Notes:

1. The results are based on the IV regression (with $(1, \pi_{t-61,60})$ as instruments) of $R_{t,k} = \alpha + \beta\pi_{t,k} + u_{t,k}$, where $R_{t,k}$ and $\pi_{t,k}$ are respectively the nominal stock returns and inflation rate from time $t-k$ to t. Here $k = 12$.
2. "**" denotes a rejection of Fisher Hypothesis at 5% level.

Table 4: Long-horizon (five-year) IV regression of stock returns on inflation rate

Country	Sample period (# observations)	$\hat{\alpha}$ (std. error)	$\hat{\beta}$ (std. error)	R-square
Canada	1967:1 to 1999:3 (387)	-36.734 (27.033)	2.501 (0.824)	0.250
France	1967:1 to 1999:4 (388)	-116.721 (63.772)	4.739 (1.920)	0.448
Germany	1970:1 to 1999:3 (351)	-434.422 (3278.876)	25.550 (174.091)	0.005
Italy	1967:1 to 1998:12 (384)	-278.141 (105.727)	6.135** (1.714)	0.723
Japan	1967:1 to 1999:3 (387)	29.378 (29.900)	1.445 (0.808)	0.021
United Kingdom	1969:12 to 1999:3 (352)	-133.080 (99.059)	4.080 (1.875)	0.353
United States	1967:1 to 1999:4 (388)	-46.850 (52.536)	3.254 (1.880)	0.141
Hong Kong	1979:1 to 1999:4 (244)	145.233 (47.103)	-0.056 (0.912)	0.000
Indonesia	1988:4 to 1998:12 (129)	607.082 (365.671)	-7.421 (6.658)	0.036
Korea	1980:1 to 1999:3 (231)	63.944 (83.075)	0.968 (1.644)	0.005
Malaysia	1985:2 to 1999:2 (169)	-136.616 (49.412)	11.580** (2.625)	0.469
Philippines	1991:2 to 1999:4 (99)	-60.826 (308.202)	3.476 (5.134)	0.027
Singapore	1978:2 to 1999:2 (253)	-45.007 (35.871)	6.103** (2.191)	0.107
Taiwan	1976:2 to 1998:11 (274)	215.297 (169.762)	-0.840 (4.838)	0.000
Thailand	1980:5 to 1999:4 (228)	418.995 (181.158)	-9.290 (5.663)	0.088

Notes:

1. The results are based on the IV regression (with $(1, \pi_{t-61,60})$ as instruments) of $R_{t,k} = \alpha + \beta\pi_{t,k} + u_{t,k}$, where $R_{t,k}$ and $\pi_{t,k}$ are respectively the nominal stock returns and inflation rate from time $t-k$ to t. Here $k = 60$.
2. "**" denotes a rejection of Fisher Hypothesis at 5% level.

Data Appendix

The sources of data and their series codes.

Countries	Data items	Series Codes	Periods	Sources (Monthly data)
US	CONSUMER PRICES	11164...ZF...	57M1-99M4	IFS
	US STANDARD & POOR'S INDEX OF 500 COMMON STOCKS	US500STK	50M1-99M7	Datastream
UK	CONSUMER PRICES	11264...ZF...	57M1-99M3	IFS
	FTSE ALL SHARE - PRICE INDEX	UKFTALL	64M12-99M7	Datastream
France	CONSUMER PRICES	13264...ZF...	57M1-99M4	IFS
	SHARE PRICES	13262...ZF...	57M1-99M4	IFS
Germany	CONSUMER PRICES	13464...ZF...	57M1-99M3	IFS
	DAX 30 PERFORMANCE - PRICE INDEX	DAXINDX	65M1-99M8	Datastream
Japan	CONSUMER PRICES	15864...ZF...	57M1-99M3	IFS
	SHARE PRICES	15862...ZF...	57M1-99M4	IFS
Hong Kong	CONSUMER PRICE INDEX (A)		69M1-99M4	Data Source
	HANG SENG PRICE INDEX	HNGKNGI	69M1-99M8	Datastream
Singapore	CONSUMER PRICES	57664...ZF...	61M1-99M2	IFS
	STRAITS T. DS-CALCULATED	SNGPORZ	73M2-99M8	Datastream
South Korea	CONSUMER PRICES	54264...ZF...	70M1-99M3	IFS
	KOREA SE COMPOSITE (KOSPI)	KORCOMP	75M1-99M8	Datastream
Tai Wan	CONSUMER PRICES		59M1-98M11	Data Source
	TAIWAN SE WEIGHTED - PRICE INDEX	TAIWGHT	71M2-99M8	Datastream
Indonesia	CONSUMER PRICES	53664...ZF...	68M1-98M12	IFS
	JAKARTA SE COMPOSITE - PRICE INDEX	JAKCOMP	83M4-99M8	Datastream
Malaysia	CONSUMER PRICES	54864...ZF...	57M1-99M2	IFS
	KUALA LUMPUR COMPOSITE	KLPCOMP	80M2-99M8	Datastream
Philippines	CONSUMER PRICES	56664...ZF...	57M1-99M4	IFS
	PHILIPPINES SE COMPOSITE	MANCOMP	86M2-99M8	Datastream
Thailand	CONSUMER PRICES	57864...ZF...	65M1-99M4	IFS
	BANGKOK S.E.T. - PRICE INDEX	BNGKSET	75M5-99M8	Datastream
Italy	CONSUMER PRICES	13664...ZF...	57M1-99M3	IFS
	SHARE PRICES	13662...ZF...	57M1-98M12	IFS
Canada	CONSUMER PRICES	15664...ZF...	57M1-99M3	IFS
	CL.TORONTO STOCK PRICES 75=100	15662...ZF...	57M1-99M4	IFS
Australia	DS 'DEAD'CONSUMER G - PRICE INDEX	AZCONGD	73M1-99M4	Datastream
	AUSTRALIA SE ALL ORDINARY - PRICE INDEX	AUSTALL	71M3-99M8	Datastream

Notes:

1. Hong Kong's CPI (A) series are from various printed issues of Hong Kong Monthly Digest of Statistics and Consumer Price Index Report.
2. Taiwan's CPI series are from various printed issues of Directorate-General of Budget, Accounting and Statistcs, and Monthly Bulletin of Statistics of the Republic of China.