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Jordan French

Faculty of Business Administration, Stamford Internantional University, Bangkok, Thailand

ABSTRACT
This paper tests five macroeconomic variables that have been both theorized to affect stock returns and been proven to do so in past empirical research. Those variables are risk premium, industrial production, term structure, expected inflation, and unexpected inflation. The variables are retested for their statistical significance using four years of monthly contemporary data for six different countries (developed and developing). The United States is used as a benchmark, in addition to the ASEAN-5 (Singapore, Thailand, Philippines, Malaysia, and Indonesia). This study finds that risk premium and industrial production were significant over the sample, but term structure, expected inflation, and unexpected inflation were not significant in explaining domestic market returns. Furthermore, principal component regressions outperformed cross-sectional ones, with factor analysis as the least statistically significant model. For the six countries tested, the arbitrage pricing theory was also found to be a less robust pricing tool than the capital asset pricing model.

KEYWORDS Economic factor models; arbitrage pricing theory; cross-sectional regression; principal components

Overview

The current capital asset pricing model (CAPM), which is studied by business master's students (MBAs) and used by Chief Finance Officers (CFOs) around the world, was devised by Sharpe (1964), Lintner (1965), and Black (1972) (henceforth the SLB model). The SLB model requires one single factor known as the beta to explain all cross-sectional variations of expected returns of an asset. The beta is the covariance of the market portfolio (used as the benchmark) with that of the investor’s portfolio, divided by the variance of the market portfolio. Implicitly the expected returns on securities have a linear relationship with beta when the market portfolio is mean-variance efficient. Early empirical tests of CAPM by Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973) supported

CONTACT Jordan French jordan.french@stamford.edu

the CAPM by finding positive relations between average stock returns and beta with pre-1969 data.

Since the early success of the CAPM, many researchers have found the SLB model to be lacking in stock return predicting power. Reinganum (1981) and Lakonishok and Shapiro (1986) found that the relationship between beta and average returns vanished during the more recent 1963–90 period. Jagannathan and Wang (1996) find beta does not remain constant from one period to the next and Lewellen and Nagel (2006) further investigate the inadequacy of SLB's beta factor. Ferson and Harvey (1999) and Akdeniz, Altay-Smith, and Caner (2003) propose that beta is a function of observable state variables. Fama and French have spearheaded the attack on the SLB model and propose a three-factor model (henceforth the FF model). In addition to using market returns, they also add a factor for market capitalization (small minus big) and the third factor is book-to-price ratio (high minus low). Jagadeesh and Titman (1993) found that short-term returns tend to be higher for stocks that had high returns for the previous 12 months (momentum). Carhart (1997) uses this information missed by the FF model and proposes a four-factor model that extends the FF model by including momentum. The supporters of multifactor models propose that the SLB CAPM does not capture value or price information. The CAPM is not able to explain why small stocks outperform large, or why returns are higher for high book-to-market (B/M) and lower for low B/M ratios, or finally why stocks with high returns continue to outperform those with low returns in the previous year.

Countless anomalies and factors have been found to explain cross-section variation as good as or better than the SLB model. In addition to the variables previously mentioned above, sales growth (Fama & French, 1996), labour income growth, and the calendar (French, 1980) have also been found to explain returns. Supporters of the CAPM have disputed their opponents' findings. Lewellen, Nagel, and Shanken (2010) show that even factors with weak correlation with the characteristic the portfolio was sorted on would explain differences in average returns across test portfolios regardless of economic merit underlying the factors.

Using a firm-specific characteristic model also leaves answers unsolved. If value ratios indicate higher returns, why would not all investors buy value and thus the value effect would be priced out of the market. Another paradox is with the market size effect (small caps earn higher returns than large caps). If small companies merge, their cumulative risk remains the same; however, the FF model would then weight them as a large cap. Also the three-factor model cannot explain the extension of short-term returns found by Jagadeesh and Titman (1993). The model also misprices small growth and does not work for non-size B/M portfolios. Daniel and

Titman's (1997) study suggests that the same arbitrage pricing theory (APT) model proposed by Fama and French (1993) does not hold for portfolios that are double-sorted based on the value and price factors. The FF model also does not incorporate behavioural finance, declining markets, or the results of Merton's (1973) Intertemporal Capital Asset Pricing Model (ICAPM) or Ross' (1976) APT. Lastly, using firm-specific characteristics in the FF model has been critiqued by Kothari, Shanken, and Sloan (1995) as suffering from survivor bias. The data source for book equity (COMPUSTAT) has a high number of high BE/ME firms that outlive financial downturns, so the average return for high-BE/ME firms is excessive.

Also those factors that are found to be the most significant in the literature (size, value, and momentum) are also the most difficult to explain using economic reasoning. For practitioners this represents an issue in their forecasting reliability of a model that is not well understood or linked to the fundamental risks investors must take on. This, along with the difficulties listed above, are the reasons why the focus of this paper will be macroeconomic factors.

Chen, Roll, and Ross (CRR) (1986) used monthly USA macroeconomic data and found five of the nine factors they tested to be significant in explaining portfolio returns. CRR's study found unexpected and expected inflation to be weakly explanatory and to become more significant when used during periods of high volatility. Industrial production was found to change in risk premiums with a twisting yield curve and was highly explanatory. Risk premiums had a positive sign, reflecting value on insuring against risk and term structure placed higher value on assets whose prices increase when long rates decline and carry negative premiums. Consumption was never found to be significant and oil became insignificant post-1968 The Organization of the Petroleum Exporting Countries (OPEC) was born.

Fama (1990), found in the USA that dividend yield, term spread (spreads high around business peaks), and default spread (high spread indicates a poor business climate) explain 33 percent of returns. By adding a fourth variable, industrial production growth, the explanatory power increases to 58 percent. The empirical results also found spread and dividend yield to capture the same variation in stock returns and to be serially correlated with each other.

Ferson and Harvey (1999) used USA economic variables to reject the FF three-factor model and the four-factor model of Elton, Gruber, and Blake (1995). The difference between the one-month lagged returns of a three-month and a one-month Treasury bill (Campbell, 1987; Harvey, 1989), the dividend yield of the Standard & Poor's (S&P) 500 index (Fama & French, 1988), the default spread between Moody's Baa and Aaa corporate bond yields (Keim & Stambaugh, 1986; Fama, 1990), the lagged value of a one-month Treasury bill yield (Fama & Schwert, 1977; Ferson, 1989; Breen, Glosten, & Jagannathan, 1989) were all variables used in Ferson and Harvey's (1999) paper.

This research expands on Chen et al. (1986), Fama (1990), and Ferson and Harvey (1999) by empirically testing the macroeconomic variables they found significant in explaining returns and applying them to contemporary US and Southeast Asian market returns. In addition to using cross-sectional regression, the multivariate factor analysis and principal component analysis are also used to compress the large amount of data and variables. The same economic variables found to be significant in the previous literature are retested using recent data for the US and five emerging markets. In order to verify the significance of past macroeconomic factors, not only should the factors be tested in different time periods, they should also be tested in different markets as well. The variables are analysed to see if they are correlated with the sets of components extracted from the principal component analysis and to see if they explain returns. Testing of the macro factors' robustness in the USA using the period of 2012 to 2016 and across five emerging economies is the added contribution this study makes. After testing the economic factors' ability to price market returns, this study also extends the CAPM versus APT debate by testing APT using a multivariate framework in the six different countries.

Data and Methodology

Data

Five macroeconomic monthly variables are used from six different countries to regress on their individual country market exchanges. This gives a total of 30 factors spanning from April 2012 to February 2016 (47 months). The variables tested are a set of economic variables theorized and empirically proven to be significant in capital market returns. The variables are expected inflation, unexpected inflation, industrial production, risk premiums, and term structure, which are believed to impact on future real cash flows from capital investments (see Table 1 for definitions and Table 2 for a data summary).

This study contributes to APT by investigating if the macro variables found by CRR (1986) are still predictors years later, or if the previous findings, now widely known, have changed the dynamics of the factors and returns. Along with the USA used as a benchmark, five Southeast Asian exchanges are also used to evaluate if the macro factors from

Table 1. Glossary and Definitions of Variable.

Symbol	Variable	Definition or Source
		Basic Series
I	Inflation	Log relative of CPI *(Central bank of each country)*
TB	Treasury bill rate	End-of-period return on one-month bills *(Central bank of each country)*
LGB	Long-term government bonds	Return on long-term government bonds *(Central bank of each country)*
IP	Industrial production	Industrial production during month *(Central bank of each country)*
Baa	Low-grade bonds	Corp senior unsecured fixed rate bonds issued by domestic companies with a BBG composite of Baa, Bbb+, Bbb and Bbb– *(Bloomberg)*
		Derived Series
IP(*t*)	Industrial production growth	Log[IP(t)/IP(t–1)]
E[I(*t*)]	Expected inflation	E[I(t–1)]
UI(*t*)	Unexpected inflation	I(t)–E[I(t)|t–1]
RP(*t*)	Risk premium	Baa(t)–LGB(t)
TS(*t*)	Term structure	LGB(t)–TB(t–1)
R(*t*)	Exchange returns	Log[P(t)/P(t–1)]

different developing economies on the opposite side of the world explain returns in their respective markets. Replicating the research methods in CRR (1986) for the study's 30th anniversary (1) to ensure that the factors are still explanatory of contemporary returns in the USA and (2) to check if the factors can be applied to the developing markets in Southeast Asia (ASEAN). A four-year window was chosen as companies and markets are constantly evolving and practitioners are more likely to use four years than 30 years of data in calculating the cost of capital or measuring a fund manager's performance. Today's foreign direct investment and big institutional traders make ultra-short bets. Also in the developing markets of Asia, data prior to 2012 is unattainable in many of the markets.

It is of value to see how robust the macroeconomic factors are when used in Asia as this may have policy implications for the development of their markets. For a macroeconomic variable to be considered meaningful for the multifactor literature studies, it should be significant within other samples and not a result of selection bias. For example, Burmeister, Roll, and Ross (1994) identified inflation to be significant in the US, Japan, Germany, the United Kingdom, and France over a long horizon. This study updates the previous research using contemporary data for the US and adds five new emerging markets (Thailand, Philippines, Malaysia, Singapore, and Indonesia). In addition to the cross-sectional and factor analysis methodology used by CRR (1986), this study also implements principal component analysis to test arbitrage pricing theory.

Table 2. Summary Statistics.

	Average	Median	Std Dev	Min	Max
Thailand					
TS	0.0152	0.0168	0.0042	0.0047	0.0202
RP	0.0133	0.0133	0.0020	0.0091	0.0185
IP	–0.0016	–0.0021	0.0831	–0.2292	0.1773
EI	0.0265	0.0290	0.0061	0.0095	0.0365
UI	–0.0258	–0.0270	0.0055	–0.0346	–0.0080
Returns	–0.0015	–0.0110	0.0408	–0.0640	0.1000
Philippines					
TS	0.0336	0.0327	0.0077	0.0176	0.0507
RP	–0.0501	–0.0500	0.0056	–0.0610	–0.0365
IP	0.0071	0.0104	0.0457	–0.1806	0.1006
EI	0.0337	0.0340	0.0034	0.0270	0.0450
UI	–0.0310	–0.0329	0.0043	–0.0372	–0.0217
Returns	–0.0025	–0.0080	0.0467	–0.0765	0.1179
Singapore					
TS	0.0217	0.0205	0.0047	0.0127	0.0314
RP	–0.0270	–0.0277	0.0037	–0.0342	–0.0199
IP	–0.0011	–0.0063	0.0402	–0.0802	0.1030
EI	0.0225	0.0260	0.0170	–0.0050	0.0470
UI	–0.0218	–0.0250	0.0162	–0.0498	0.0055
Returns	0.0032	–0.0044	0.0360	–0.0692	0.0965
Indonesia					
TS	–0.0021	–0.0046	0.0123	–0.0209	0.0337
RP	–0.0554	–0.0551	0.0074	–0.0731	–0.0427
IP	0.0048	0.0038	0.0317	–0.1003	0.0840
EI	0.0526	0.0510	0.0055	0.0440	0.0655
UI	–0.0478	–0.0479	0.0082	–0.0660	–0.0255
Returns	–0.0023	–0.0118	0.0407	–0.0713	0.0990
Malaysia					
TS	0.0116	0.0105	0.0033	0.0071	0.0186
RP	0.0690	0.0688	0.0032	0.0629	0.0742
IP	0.0009	–0.0008	0.0466	–0.0938	0.1203
EI	0.0287	0.0280	0.0056	0.0200	0.0400
UI	–0.0266	–0.0252	0.0073	–0.0493	–0.0131
Returns	–0.0005	–0.0050	0.0225	–0.0463	0.0685
USA					
TS	0.0288	0.0278	0.0047	0.0201	0.0385
RP	–0.0047	–0.0061	0.0046	–0.0115	0.0039
IP	0.0010	0.0012	0.0048	–0.0179	0.0089
EI	0.0159	0.0210	0.0088	0.0010	0.0240
UI	–0.0150	–0.0190	0.0087	–0.0250	0.0010
Returns	–0.0062	–0.0104	0.0308	–0.0766	0.0668

Note: TS = term structure, RP = risk premiums, IP = industrial production growth, EI = expected inflation, UI = unanticipated inflation, and the returns are country's stock exchange. The percent data are all in decimal format.

Expected Inflation

$$E[I(t-1)]$$

The expected inflation was captured from Bloomberg's consumer price forecast index. The data is extracted from the individual country's Treasury bill rates and follows the methodology of Fama and Gibbons (1984).

Inflation was theorized to impact on the market as it influences future cash flows and the discount rate.

Unexpected inflation

$$UI(t) = I(t) - EI[(t) \parallel t - 1]$$

$I(t)$ is the natural log relative of the Consumer Price Index for the current and previous period. $EI[(t) \parallel t - 1]$ is the expected inflation of period t, forecast on period t-1.

Industrial Production

$$IP = Ln[IP(\mathrm{t})] - \mathrm{Ln}[\mathrm{IP}(\mathrm{t} - 1)]$$

IP is industrial production during the month. To derive the monthly industrial production growth (*IP*), apply the natural log to industrial production of the current period [IP (t)] and subtract with the natural log of the previous period [*IP* (t-1)]. Another way to calculate this is to do natural log of the relative industrial production of the current and previous periods. Industrial production was theorized to impact on the market as it affects future firm cash flows and employment.

Risk Premiums

$$RP(t) = Baa\ and\ under\ bond(t) - \ LGB(t)$$

Data on Baa and under bond (t) was obtained from the Baa bond index. Bloomberg uses a different rating system, though Bloomberg's BBB rating is equivalent to the Baa used in the previous literature. The data for Philippines, Singapore, and Indonesia were not available; therefore, a portfolio of bonds was constructed which included all the active Baa (BBB). For Indonesia the BB+ and BBB- rates are used since Baa (BBB) rated bonds are not available for the period.

The long-term government bond (LGB) is the local government bond rates with 20 years' maturity. The difference between the riskier and safer bond rates are used to establish the influence risk has on the market.

Term Structure

$$Term(t) = LGB(t) - TB(t - 1)$$

Long-term government bond is the same data used to calculate *risk premiums*, which may increase the correlation between the two variables. The current LGB period is used and subtracted by the Government Treasury Bill of the previous period. The standard Treasury Bill with one-year maturity is used. The difference between the rates on long-term and short-term maturities indicates the market's valuing of payments far in the future versus in the near term.

Stock Exchange Return

$$Rj(t) = Ln\left[\frac{Pj(t)}{Pj(t-1)}\right]$$

In the market return calculation, R is the market return, j is the exchange, and P is the closing price. Market return data is weighted by the standard market capitalization method. This may be a limitation of this study because using equally weighted portfolios, instead of market capitalization, was found by Bartholdy and Peare (2004) to increase the significance of multifactor pricing models. There are six country market indexes used for the dependent variables in their separate country regressions. The country indexes are United States of America's (USA) Wilshire5000, Thailand's (TH) SET, Philippines' (PH) PSE, Malaysia's (MA) MYX, Singapore's (SI) SES, and Indonesia's (IN) IDX. The monthly prices are calculated by using the last trading period of the data and converting it to monthly. The latest date is used in instances where the last day of the month is not available. Then, the natural log of current over the previous period is used to get the portfolio (time continuous) returns.

The correlations of each market's five economic variables, market index, and multivariate derived component are shown in Table 3. The components are 31 to 33 percent correlated with index returns in the US, Thailand, and Singapore. Risk premium (RP) correlations overall do well with index returns. Expected inflation (EI) and unexpected inflation (UI) are highly correlated, as expected, since they are derived using shared data. This is also true of risk premium and term structure (TS). The collinearity present within these series may weaken the individual significance of a factor. The regressions are also modelled with stepwise omissions to see if it impacts on factor significance.

Table 4 displays the autocorrelations (serial correlations) of the economic variables for each of the six markets tested. Based on the Box and Pierce (1970) statistics all the macro variables except industrial production exhibit serial correlation. The IP series was strongly found to have independent residuals. For the most part the size of the estimates are largest at the first two lags and again at the last two lags. This creates a wide U-shape effect and is suggestive of seasonally correlated time series data. The

Table 3. Correlation Matrices for Economic Variables.

Symbol	Comp	Index	TS	RP	IP	EI
	A. United States					
Index	−0.3080					
TS	0.7782	−0.2878				
RP	−0.9195	0.3535	−0.8603			
IP	0.5888	−0.1935	0.2781	−0.3600		
EI	0.9274	−0.2360	0.5554	−0.7470	0.4037	
UI	−0.8765	0.1979	−0.5177	0.6899	−0.4041	−0.9687
	B. Thailand					
Index	−0.3091					
TS	−0.6164	0.2391				
RP	−0.4311	0.2198	−0.0164			
IP	−0.0306	0.1470	−0.1516	0.0011		
EI	0.9282	−0.2777	−0.1089	−0.3980	−0.0084	
UI	−0.9271	0.2187	0.0674	0.4173	0.0254	−0.9033
	C. Philippines					
Index	0.1974					
TS	0.6340	0.0945				
RP	−0.6550	0.1857	−0.3764			
IP	−0.2309	−0.7797	−0.0057	−0.1491		
EI	−0.6753	−0.1253	−0.0290	0.1733	−0.0261	
UI	0.8339	0.2385	0.2452	−0.2555	−0.1611	−0.6355
	D. Malaysia					
Index	0.1308					
TS	0.7821	0.0748				
RP	−0.5557	−0.2359	−0.7566			
IP	−0.0733	−0.1319	−0.0343	−0.0981		
EI	−0.8108	−0.0109	−0.3813	0.1046	−0.0109	
UI	0.7723	0.0997	0.2736	−0.0224	0.0171	−0.8193
	E. Singapore					
Index	0.3258					
TS	−0.2969	−0.0110				
RP	−0.5951	−0.2567	−0.5262			
IP	−0.0807	−0.0234	0.1698	−0.0368		
EI	−0.9789	−0.2872	0.4047	0.4085	−0.0094	
UI	0.9855	0.3407	−0.3808	−0.4519	0.0281	−0.9649
	F. Indonesia					
Index	0.0832					
TS	−0.0296	0.2538				
RP	−0.8376	−0.2793	−0.0996			
IP	0.0043	−0.0184	−0.0097	0.1051		
EI	0.9178	−0.0133	0.0045	−0.6931	0.0026	
UI	−0.7765	0.0456	0.0968	0.4038	0.0636	−0.5799

Note: Comp = principal component, Index = market index, TS = term structure, RP = risk premiums, IP = industrial production growth, EI = expected inflation, and UI = unanticipated inflation.

autocorrelation in the variables will bias the loadings of index returns on these variables and will reduce their statistical significance.

Methodology of Arbitrage Pricing Theory

The arbitrage pricing theory is a replacement for the capital asset pricing model that was developed by Ross (1976). It is a one-period model that

Table 4. Autocorrelations of the Economic Variables.

Symbol	ρ1	ρ2	ρ3	ρ4	ρ5	ρ6	ρ7	ρ8	ρ9	ρ10	ρ11	ρ12	B/P (24)
A. United States													
TS	0.8695	0.1924	−0.1161	0.0056	0.0306	0.0963	−0.1287	−0.0014	0.0168	−0.1293	0.1007	−0.0557	206.77
RP	1.0113	0.2001	−0.4617	0.3067	−0.1799	0.0809	0.3238	−0.4961	0.2113	0.0904	−0.0885	−0.0284	237.84
IP	−0.1951	0.0052	0.3524	0.2461	0.0040	0.3486	0.2105	0.2537	−0.1323	−0.2304	−0.4511	−0.2525	21.60
EI	1.3563	0.2107	−0.7418	−0.1672	0.4136	−0.0164	−0.1989	0.0853	0.1878	−0.0884	−0.1568	0.1185	205.47
UI	1.0960	−0.1994	0.1904	0.0182	−0.1843	−0.1670	0.0958	0.1223	−0.1343	0.2590	0.0133	−0.1499	154.76
B. Thailand													
TS	0.9926	−0.1054	−0.1737	−0.1699	0.1837	0.1203	−0.2653	−0.1132	0.3473	−0.2067	0.0438	0.0129	116.18
RP	0.6797	0.2127	−0.1652	−0.1585	0.1467	−0.1258	−0.0914	0.2009	−0.0622	−0.1768	0.1346	−0.1148	76.95
IP	−0.5144	−0.5316	−0.3777	−0.2369	−0.2276	−0.1072	−0.0957	−0.2046	−0.1984	−0.3212	−0.4199	0.4124	120.03
EI	1.0115	0.0225	−0.0832	0.0707	−0.0221	−0.0657	−0.0107	0.0370	−0.1908	0.3185	0.0197	−0.0133	97.51
UI	0.7565	−0.1318	0.3354	0.3473	−0.1420	0.0786	−0.2531	−0.2484	−0.1176	0.2186	0.1058	0.1587	74.76
C. Philippines													
TS	1.4338	−1.0862	0.7557	−0.5284	0.2887	0.0491	0.0957	−0.2065	0.0939	−0.2123	0.1656	−0.0121	93.32
RP	0.8675	−0.1412	−0.2951	−0.0756	0.0318	0.0787	0.2700	−0.5680	0.0429	0.2877	−0.3328	0.0430	93.31
IP	−0.3402	−0.2510	0.2297	0.0408	0.0601	−0.2710	−0.1787	−0.1559	0.0359	−0.0906	0.0760	0.1223	11.42
EI	0.9222	0.0112	0.1128	−0.1745	−0.2290	0.1894	−0.1522	0.0481	−0.0773	0.1408	−0.0091	−0.0210	57.66
UI	0.7220	−0.2545	0.2526	−0.1288	0.0256	−0.0011	0.0371	−0.2376	−0.0188	0.0279	−0.1643	0.1229	45.73
D. Malaysia													
TS	−0.2931	−1.2872	−0.6486	−1.3995	−0.1958	1.0986	0.9586	−0.6862	−0.3961	−0.5435	−1.2054	−2.3286	167.27
RP	0.8161	−0.0840	−0.1534	0.1552	−0.0666	0.3098	−0.2206	−0.1133	0.4475	−0.5311	−0.0437	0.0833	99.41
IP	−1.1704	−1.1578	−1.1309	−1.1545	−1.1508	−1.0181	−0.8816	−0.8991	−0.7730	−0.7483	−0.7920	−0.0517	57.54
EI	1.1427	−0.0757	−0.1924	0.0296	−0.1008	−0.0380	0.1065	0.1123	−0.1649	0.0633	0.1397	−0.3214	180.84
UI	1.4579	−1.0531	0.3725	0.3722	−0.7467	0.3916	0.1945	−0.3735	0.1170	0.0416	−0.1432	−0.0475	95.00
E. Singapore													
TS	0.8505	−0.0118	0.0989	−0.2333	0.4002	0.1037	−0.5044	0.2761	0.0841	−0.0367	−0.3080	0.0041	202.99
RP	0.5948	0.0665	−0.0521	−0.1853	0.2709	0.1902	−0.5118	0.2997	0.0203	−0.0135	−0.3294	0.1309	142.16
IP	−0.5991	−0.5258	0.0582	0.0965	0.1571	0.0633	−0.2005	−0.1569	0.2983	0.0198	0.1696	0.3442	18.03
EI	0.9663	−0.1214	0.3038	0.0360	−0.2538	0.1925	−0.1903	−0.1380	0.2314	−0.1840	0.1867	−0.0083	200.55
UI	0.4157	0.3490	0.3199	−0.1906	0.0358	0.2468	−0.2683	−0.1748	−0.0609	0.1866	−0.1451	0.3495	34.60

F. Indonesia													
TS	1.2640	−0.6486	0.3620	−0.2323	0.2106	0.0611	−0.2575	0.0632	0.0921	−0.1061	−0.0688	0.1704	128.96
RP	0.7405	−0.4167	0.5848	−0.6968	0.7910	−0.4880	0.4067	−0.5906	0.3452	−0.2074	−0.0546	−0.0657	191.96
IP	−0.7615	−0.9669	−0.7864	−0.8529	−0.8289	−0.6245	−0.4869	−0.5705	−0.5695	−0.4704	−0.2831	0.0331	19.90
EI	1.0099	−0.1706	−0.0852	0.2056	−0.2717	−0.0303	0.1969	−0.0129	0.0550	−0.0854	0.0417	−0.1728	194.34
UI	0.7871	−0.7075	0.4562	−0.3214	0.3896	−0.2612	0.4301	−0.3871	0.2673	−0.3721	0.1985	−0.1834	41.68

Notes: TS = term structure, RP = risk premiums, IP = industrial production growth, EI = expected inflation, and UI = unanticipated inflation. The Box–Pierce X^2 statistic is also given based on the traditional 24 lag autocorrelation coefficients.

assumes a linear relation between an asset's expected return and its covariance with some random variables. This is the same design as the CAPM, and in the CAPM the covariance is with the market portfolio's return. A weakness in empirical tests of APT is that the theory does not specify what factors to use. Despite this, APT may be used for asset allocation, determining cost of capital, and gauging the performance of fund managers. In application, however, the APT is often not used in favour of the CAPM. For example, the Utility Commission of New York State denied the proposals of various APT models and opted to use the simpler CAPM. The US Federal Reserve Board also declined to use APT to compute the cost of equity for various priced services at Federal Reserve Banks. According to DiValentino (1994) and Green, Lopez, and Wang (2003) the abovementioned government organizations did not use APT because the current research uses a wide array of factors and the results are consequently non-conclusive.

There are three prominent approaches for finding factors to test APT. The first is the utilization of economic theory to find a set of macroeconomic factors to then test if they may affect returns. Chan, Chen, and Hsieh (1985) and Chen et al. (1986) used this approach. The second approach begins with estimating correlation/covariance matrices of factors with the asset returns, then using judgement to select the factors — as used by Chan, Hamao, and Lakonishok (1991) and Fama and French (1993). The third and most technical approach is using multivariate analysis, such as factor or principal component analysis (FA or PCA). These multivariate models reduce the dimensionality and serial correlation of the data, and then use random scores data as the independent variables. This third approach was used by Roll and Ross (1980) and Chen (1983), and PCA is recommended over FA in APT studies by Connor and Korajczyk (1986). In the selection of the factors used in this study, previous empirical findings, economic theory, correlations, and multivariate analysis conditions were all met.

The multifactor return-generating process can be described as:

$$R_i = a_i + \sum_{j=5}^{J} b_{ij} I_j + e_i \quad (1)$$

The APT model that stems from the above return generating process can be defined as:

$$\bar{R}_i = R_f \sum_{j=5}^{J} b_{ij} \lambda_j \quad (2)$$

Equation (1) is used to estimate the b_{ij}s (component loadings) using regression analysis with the I_js being the components. The I_j used for each country's model is the weighted average of the macroeconomic factors on which the analysis is performed. The APT model is then estimated in

Equation (2) via attainment of the λ_js. If factor or principal component analysis is not used to estimate the b_{ij}s for testing APT, then the test is really a simultaneous test of the APT and the significance of the hypothesized macroeconomic factors. This study relies on both methods. The multivariate approach tests APT and cross-sectional regression is used to test both APT and the macroeconomic factors simultaneously.

Traditionally, the second step in testing the APT (Equation 2) comes from the two-stage Fama and Macbeth (1973) methodology. The cross-sectional test of each of the 47 time periods produces the λ_js and variances that are then averaged. This is the same process followed by Roll and Ross (1980). This process is not without limitations as it suffers from error-in-variables. Because the loadings (b_{ij}s) from the first-step regression (Equation (1)) are estimated with error, this in turn causes the λ_js to be only asymptotically accurate.

Fortunately, an alternative approach to testing the APT is possible if factors that are known to affect stock returns are used. There is a great debate within the literature where some researchers believe the factors should come from theory and the opposition believes that all the factors should be created from empirical studies (Roll & Ross, 1980). This study is able to appease both sides of the divide. The macroeconomic factors used in this study are quite promising as they were deduced from theory by Chen et al. (1986) and have been found to be empirically significant in CCR (1986), Fama (1990), and Ferson and Harvey (1999). Because the macroeconomic factors used are specified with a priori, then the estimates of these variables can be measured by Equation (3).

$$\bar{R}_i = \lambda_0 + \sum_{j=5}^{J} \lambda_j b_{ij} \tag{3}$$

This alternative approach is the direct equivalent of the second step of the Fama and MacBeth (1973) method and has been implemented in Sharpe's (1982) APT study. The J represents each of the five macroeconomic variables, the b_{ij}s are the monthly values of each variable, and the λ_js are the average extra return required by each of the variables.

The components of the multivariate approach are created by multiplying the loadings (weights) with the variance for each country's extracted variable. The data is extracted to explain the greatest amount of correlation. Scores are interpreted as the rearrangements of the data in a context that explains the dataset with fewer variables. A score represents each item related to the component. Loadings are a singular value decomposition that explains the principal components. The positive or negative loading of a specific variable indicates the contribution that variable has made to the component.

Of the five variables used in this study, all five are retained in the multivariate model, and correlations, lagged autocorrelations, and significance within the regression models are analysed. Principal component and factor analysis are used to reduce the data and multicollinearity of the factors. Based on the component loadings, the proportion of variance each component explains (eigenvalues), and Scree plots, the data is reduced to a parsimonious one component. For example, the USA eigenvalues decreased from 1.61 to 0.88 from component one to component two. A component with an eigenvalue less than 1 would explain less variation in the market returns than the original variables. In all the markets there were also large drops in the Scree plots (elbows) from component one to component two. The method of using eigenvalues to retain factors is based on the Kaiser Criterion (Kaiser, 1960). The method of plotting the eigenvalues and looking for an elbow break on the Scree plot is based on the method proposed by Cattel (1966). Anderson (1984) finds extracting a smaller number of the most relevant factors with the most information in the data set improves the prediction accuracy for macroeconomic variables. The first component regression of the scores on index returns are given in the results. This study used both factor and principal component analysis.

Results

Factor analysis was used in addition to the principal component technique. This study finds that factor correlations with returns and the significance of the regressions were inferior to those of the principal components. Within the sample used, principal component analysis is therefore found to support APT better than factor analysis. This is in agreement with a study by Connor and Korajczyk (1986) in which they found PCA results to be a significant improvement over factor analysis results. Thus, the factor analysis results have been omitted. Principal component analysis has been found to be analogous to factor analysis for arbitrage pricing studies but simpler to interpret the results. It is an easier technique in that it relies on variances, whereas factor analysis is covariance motivated. PCA extracts a set of components from the data that best explains the variance in the data set, though both approaches rely on the assumption of multivariate normality. Additional disadvantages of factor analysis are that there is no meaning of the signs produced, the scaling of the estimates is arbitrary, and the factors' order may be produced differently from sample to sample (Elton & Gruber, 1994).

The multivariate tests indicate that arbitrage pricing theory is not an effective asset pricing tool in the Malaysian and Indonesian markets. These two markets are also the least westernized markets out of the sample of six. In the remaining four markets, the principal component had a negative pricing effect with the market returns. This follows economic theory in that the unanticipated term structure, unanticipated risk premiums, and inflation forces contained within the component would have a negative impact on market returns. However, in a study by French (2016), tests of the CAPM using the Fama and MacBeth (1973) and generalized method of moments (GMM) revealed the CAPM to be significant within the Southeast Asian markets. The Fama-Macbeth $\hat{\alpha}$ t-statistic was 5.0064 and $\hat{\lambda}$ was 6.0998. The more robust GMM Gibbons, Ross and Shankaen (1989) (GRS) test had a chi-squared (x^2) statistic of 6.1097. The tests therefore reveal that the single-factor CAPM is empirically more robust than APT.

The results strongly support the multivariate components that stem from all five economic variables and somewhat weakly support the risk premium and industrial production variables as being priced in market returns. This is of importance for practitioners and contributes to the theoretical studies in asset pricing. Chen et al. (1986) also found the risk premium and industrial production to be their most noteworthy economic variables of significance. This study aids in validating these two variables. In Table 5 (Cross-sectional approach A) all the variables are used and only risk premiums and industrial production are ever found to be significant. Variations were also tested, omitting variables, in an effort to improve the two variables for inflation, but were never statistically significant. Variations modelling term structure improved slightly, or in many cases worsened, with the omission of the two inflation variables. In Table 5 (Cross-sectional approach B) only the two most significant variables were left in the model. This improved the significance of risk premiums in the US and Singapore (the two most developed markets), but had slight to detrimental effects on the other markets. For all of the markets, except Malaysia and Indonesia, the multivariate approach of extracting a single component from the five variables was a statistical improvement over the cross-sectional approach. In Malaysia and Indonesia the multivariate approach was not significant; however in Table 5 (Cross-sectional approach A) the risk premiums were found to be significant for both at the 5 percent level.

Risk is dynamic, with companies continually changing their holdings and the average chief executive officer (CEO) tenure being just three years. Therefore the use of the short four-year window, instead of a 30-year time span, is of more relevance for institutional investors and practitioners that are interested in how the macroeconomic factors price the market. The overall lack of strong support for the factors is an indication that macroeconomic forces are not significant in explaining market returns for the Asian markets during the 2012 to 2016 period.

Table 5. Economic Variables and Pricing.

$$\bar{R}_i = \lambda_0 + \lambda_j TS_{ij} + \lambda_j RP_{ij} + \lambda_j IP_{ij} + \lambda_j EI_{ij} + \lambda_j UI_{ij} + \varepsilon_i$$

Cross-sectional Approach (A)						
Country	Constant	TS	RP	IP	EI	UI
USA	–0.0177	0.7231	3.5445	–0.3997	0.4624	–0.0259
	(–0.743)	(0.723)	(0.216)	(0.707)	(0.844)	(0.99)
Thailand	–0.0536	1.2665	4.1896	0.0742	–2.8640	–2.0627
	(0.414)	(0.417)	(0.192)	(0.301)	(0.239)	(0.434)
Philippines	0.1183	0.3879	1.5081	–0.7496	–0.7533	0.8908
	(0.142)	(0.544)	(0.098)*	(4.15E–9)***	(0.616)	(0.498)
Malaysia	0.2751	–2.4216	–3.5184	–0.0969	1.0636	1.3135
	(0.046)**	(0.158)	(0.034)**	(0.182)	(0.3361)	(0.123)
Singapore	–0.0026	0.4875	–0.4220	0.0471	1.3897	2.1735
	(0.965)	(0.828)	(0.89)	(0.728)	(0.276)	(0.117)
Indonesia	–0.0148	0.6269	–2.9204	–0.0216	–2.7193	0.1011
	(0.789)	(0.192)	(0.012)**	(0.908)	(0.111)	(0.911)
Cross-sectional Approach (B)						
Country	Constant	RP	IP			
USA	0.0046	2.2288	–0.3226			
	(–0.467)	(0.039)**	(0.747)			
Thailand	–0.0660	4.8527	0.0818			
	(0.111)	(0.115)	(0.258)			
Philippines	0.0493	0.9240	–0.7862			
	(0.215)	(0.242)	(1.87E–10)***			
Malaysia	0.1129	–1.6422	–0.0614			
	(0.118)	(0.115)	(0.386)			
Singapore	–0.0632	–2.4599	–0.0159			
	(0.104)	(0.086)*	(0.903)			
Indonesia	–0.0877	–1.5419	–0.0034			
	(0.057)*	(0.061)*	(0.985)			
Multivariate Approach						
Country	Constant	Component				
USA	–0.0062	–0.0051				
	(0.156)	(0.035)**				
Thailand	–0.0015	–0.0082				
	(0.796)	(0.035)**				
Philippines	–0.0025	–0.0330				
	(0.583)	(1.37E–9)***				
Malaysia	–0.0005	0.0020				
	(0.876)	(0.381)				
Singapore	0.0032	–7.52E–03				
	(0.526)	(0.025)**				
Indonesia	–0.0023	0.0023				
	(0.701)	(0.578)				

Note: See Table 1 for the variables' derivation. Component = principal component, TS = term structure, RP = risk premiums, IP = industrial production growth, EI = expected inflation, and UI = unanticipated inflation. (p–values) *10% significance, **5% significance, and ***1% significance.

Conclusion

The stock exchange represents the pulse (leading indicator) for economic growth within each of the nations. Macroeconomic factors that are able to price the market empirically are thus able to influence the economy. This study finds support for the significance that risk premiums and industrial production had for stock returns. For development in the selected Asian countries, governments may therefore want to focus efforts on industrial growth and policy in open market trading of bonds (risk premium price control). Investors in Southeast Asia may do well to track these two economic forces. However, term structure and inflation were found not to be significant within the recent four-year sample over the six markets tested. The empirical results of the factor and principal component analysis also concur with Connor and Korajczyk's (1986) APT study that PCA is preferable over FA. However, the multivariate tests of APT find it to be an effective asset pricing tool in only four of the six markets (not in Malaysia or Indonesia), whereas the tests of CAPM found it to be significant in all six of the markets. With practitioners relying on a few years of data, not decades, in asset pricing, the use of macroeconomic factors may be of little significance in explaining market returns. Sometimes the best things are the simplest things, which would explain the staying power of the CAPM.

When empirically testing the APT model, the factors to use are unspecified. This is both a strength and a weakness of the model, and finding factors with an economic basis behind market returns presents a continual difficulty. Previous APT studies (Chen et al., 1986; Fama, 1990) had been criticized as regression formulas do not indicate predictive powers of the variables. Future research may explore the forecasting abilities of risk premiums, industrial production, and principal components. In addition, further tests of APT may explore the use of modelling in CAPM betas, firm characteristics, and/or a set of industry portfolios, which may enable better equilibrium models in the capital markets. Studies could test the variables on industrial goods, financial institutions, and other industry portfolio returns. The fact the multivariate component, risk premiums, and industrial production were found to be significant does not necessarily validate APT, but instead could mean that the wrong proxy for each country's market might have been used. It is still possible that the components and macroeconomic variables have been found to explain the market returns and that the CAPM theory is also significant.

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References

Akdeniz, L., Altay-Salih, A., & Caner, M. (2003). Time varying betas help in asset pricing: The threshold CAPM. *Studies in Nonlinear Dynamics and Econometrics*, *6*, 1–16.

Anderson, T. W. (1984). *An introduction to multivariate statistical analysis* (2nd ed.). New York: Wiley.
Bartholdy and Peare (2004). Estimation of expected return: CAPM vs. Fama and French. *International Review of Financial Analysis*, 2005, *14*(4), 407–427.
Black, F. (1972). Capital market equilibrium with restricted borrowing. *Journal of Business*, *45*, 444–454.
Black, F., Jensen, M., & Scholes, M. (1972). The capital asset pricing model: Some empirical tests. In M. C. Jensen (Ed.), *Studies in the theory of capital markets* (pp. 79–121). New York: Praeger.
Breen, W., Glosten, L. R., & Jagannathan, R. (1989). Economic significance of predictable variations in stock index returns. *Journal of Finance*, *44*, 1177–1189.
Burmeister, E., Roll, R., & Ross, S. (1994). A practitioner's guide to arbitrage pricing theory. In *A practitioner's guide to factor models*, Charlottesville: The Research Foundation of the Institute of Chartered Financial Analysts. pp. 312–331.
Box, G. and Pierce, D. (1970). Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series Models. *Journal of the American Statistical Association*, *65*, 1509–1526.
Campbell, Y. J. (1987). Stock returns and the term structure. *Journal of Financial Economics*, *18*, 373–399.
Carhart, M. M. (1997). On persistence in mutual fund performance. *Journal of Finance*, *52*, 57–82.
Cattel, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research*, *1*, 245–276.
Chan, L., Chen, N., & Hsieh, D. (1985). An exploratory investigation of the firm size effect. *Journal of Financial Economics*, *14*, 451–471.
Chan, L., Hamao, Y., & Lakonishok, J. (1991). Fundamentals and stock returns in Japan. *Journal of Finance*, *46*, 1739–1764.
Chen, N. (1983). Some empirical tests of the theory of arbitrage pricing. *Journal of Finance*, *38*, 1393–1414.
Chen, N., Roll, R., & Ross, A. S. (1986). Economic forces and the stock market. *Journal of Business*, *59*, 383–403.
Connor, G., & Korajczyk, R. A. (1986). Performance measurement with the arbitrage pricing theory: A new framework for analysis. *Journal of Financial Economics*, *15*, 373–394.
Daniel, K., & Titman, S. (1997). Evidence on the characteristics of cross sectional variation in stock returns. *Journal of Finance*, *52*, 1–33.
DiValentino, L. (1994). Preface. Financial markets, *Institutions and Instruments*, *3*, 6–8.
Elton, E. J., & Gruber, M. J. (1994). Multi-index models using simultaneous estimation of all parameters. In *A practitioner's guide to factor models* (pp. 31–58). Charlottesville, VA: The Research Foundation of the Institute of Chartered Financial Analysts.
Elton, E. J., Gruber, M. J., & Blake, C. R. (1995). Fundamental economic variables, expected returns, and bond fund performance. *Journal of Finance*, *50*, 1229–1256.
Fama, E. F. (1990). Stock returns, expected returns, and real activity. *Journal of Finance*, *45*, 1089–1108.
Fama, E. and French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33:3.

Fama, E., & MacBeth, J. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy*, *81*, 607–636.
Fama, E. F., & French, K. R. (1988). Dividend yields and expected stock returns. *Journal of Financial Economics*, *22*, 3–25.
Fama, E. F., & French, K. R. (1996). Multifactor explanations of asset pricing anomalies. *Journal of Finance*, *51*, 55–84.
Fama, E. F., & Gibbons, M. (1984). A comparison of inflation forecasts. *Journal of Monetary Economics*, *13*, 327–348.
Fama, E. F., & Schwert, G. (1977). Asset returns and inflation. *Journal of Financial Economics*, *5*, 115–146.
French, R. K. (1980). Stock returns and the weekend effect. *Journal of Financial Economics (Impact Factor: 3.72)*, 03/1980, *8*, 55–69.
Ferson, W. E. (1989). Changes in expected security returns, risk, and the level of interest rates. *Journal of Finance*, *44*, 1191–1217.
Ferson, W. E., & Harvey, C. R. (1999). Conditioning variables and the cross section of stock returns. *Journal of Finance*, *54*, 1325–1360.
French, K. (1980). Stock returns and the weekend effect. *Journal of Financial Economics*, *8*, 55–69.
French, J. (2016). The time traveller's CAPM. *Investment Analysts Journal*, 1–16. DOI: 10.1080/10293523.2016.1255469.
Gibbons, Ross & Shankaen (1989). A Test of the Efficiency of a Given Portfolio. *Econometrica*, *57*(5), 1121–1152.
Green, E. J., Lopez, J. A., & Wang, Z. (2003). formulating the imputed cost of equity capital for priced services at federal reserve banks. *FRB New York Economic Policy Review*, *9*, 55–81.
Harvey, D. (1989). Geografiska annaler. Series B, Human geography. *The Roots of Geographical Change*, *71*, 3–17.
Jagadeesh, N., & Titman, S. (1993). Implications for stock market efficiency. *Journal of Finance*, *48*, 65–91.
Jagannathan, R., & Wang, Z. (1996). The conditional CAPM and the cross-section of expected returns. *Journal of Finance*, *51*, 3–53.
Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, *20*, 141–151.
Keim, D., & Stambaugh, R. (1986). Predicting returns in the stock and bond markets. *Journal of Financial Economics*, *17*, 357–390.
Kothari, S. P., Shanken, J., and Sloan, R. G. (1995). Another look at the cross-section of expected stock returns. *Journal of Finance*, *50*, 185–224.
Lakonishok, J., & Shapiro, A. (1986). Systematic risk, total risk, and size as determinants of stock market returns. *Journal of Banking and Finance*, *10*, 115–132.
Lewellen, J., & Nagel, S. (2006). The conditional CAPM does not explain asset-pricing anomalies. *Journal of Financial Economics*, *82*, 289–314.
Lewellen, J., Nagel, S., & Shanken, J. (2010). A skeptical appraisal of asset pricing tests. *Journal of Financial Economics*, *96*, 175–194.
Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics*, *47*, 13–37.
Merton, R. (1973). Theory of rational option pricing. *Bell Journal of Economics*, *4*, 141–183.

Reinganum, M. (1981). Misspecification of capital asset pricing: Empirical anomalies based on earnings' yields and market values. *Journal of Financial Economics*, *9*(1), 19–46.
Roll, R., & Ross, S. (1980). An empirical investigation of the arbitrage pricing theory. *Journal of Finance*, *35*, 1073–1103.
Ross, S. (1976). The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, *13*, 341–360.
Sharpe, W. (1964). A theory of market equilibrium under conditions of risk. *Journal of Finance*, *19*, 425–442.
Sharpe, W. (1982). Combining financial and actuarial risk: Simulation analysis: Discussion. *Journal of Finance*, *37*, 604–606.