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CAPE Ratio as a Prediction Tool for the Stock Exchange of Thailand (SET)

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Abstract
This study investigates the predictability of the Cyclically Adjusted Price-Earning (CAPE) ratio (or Shiller PE ratio) on the returns of the Stock Exchange of Thailand (SET), currently the second largest capital market in South-East Asia. Most empirical research studies on the CAPE ratio performance focus on the U.S. equity market and very few on the Thai capital market; hence this research study. Using regression models and cointegration analyses, this paper examines the ability of the CAPE ratio to forecast returns as compared to the ability of the price-earnings ratio and the book-to-value ratio, respectively. The regression estimation shows no significant relationship between the CAPE ratio and the real future returns on the SET. The cointegration analysis, however, reveals a significant long-term cointegration relation between the ratio and the returns on the SET. Among the three ratios considered in the study, the price-earnings ratio is the only one that has a significant relationship with the returns in the regression model. All three ratios show a significant cointegration relation with SETs returns.

Keywords: Shiller PE, Cyclically Adjusted PE, CAPE ratio, The Stock Exchange of Thailand.

1. Introduction

Since the inception of capital markets as a source of funding and investment opportunities for investors, there have been a number of studies seeking to understand the behavior of stock prices (Waser, 2021; Keimling, 2016; Hodge, 2011; Khan, 2009; Ang, Bekaert, & Liu, 2005; Bierman, 2002; Harasy & Roulet, 2000; Campbell & Shiller, 1988; Lamont, 1998; Ding, Granger, & Engle, 1993). Economists and academics have long sought to come up with tools capable of predicting stock prices and market indices. As a result, security valuation tools used for capital markets have evolved continually to effectively evaluate the intrinsic value of securities as compared with market prices. Among these valuation tools, two approaches have been widely adopted for securities valuation: the discounted cash flow method and the relative valuation method. The discounted cash flows method adjusts the cash flows received from securities investment to their present value. This method requires a prediction of future cash flows and an appropriate discount rate. As to the valuation of securities by a relative method, it compares the price of securities with variables that show their ability to operate in the market at that time.

These variables range from sales, book values, to earnings, and profits. One of the most widely used approaches among these relative valuation methods is the price-earnings (hereinafter referred to as the 'P/E ratio') (Bierman, 2002; Rahman & Shamsuddin, 2019). The P/E ratio owes its wide use to its simplicity both in terms of calculation and interpretation. It can be applied to both individual stocks and stock indices. In 1998, John Y. Campbell, an assistant professor at Princeton university, and Robert J. Shiller, a lecturer at Yale University and 2013 Nobel Prize winner in Economics, introduced the Cyclically Adjusted Price-to-Earnings ratio (hereinafter referred to as the 'CAPE ratio' or 'CAPE'). Also commonly known as the Shiller P/E or PE10, the CAPE ratio is based on the notion that short-term earnings are highly susceptible to economic cycles and stock returns are mean reversion. According to Campbell and Shiller (1988, 2001), the CAPE ratio mitigates short-term instability in security returns by replacing one-year earnings in P/E with a ten-year average earning value. Since then, the CAPE application has been extensively employed to predict over- and undervaluation in stock markets (Raju, 2022; Lechner, 2021; Waser, 2021; Clare et al., 2017; Jivraj & Shiller 2017; Bunn & Shiller, 2014).

However, whether the CAPE is powerful enough to replace the 12-month based traditional P/E is still controversial. This has prompted a number of academics and researchers to investigate and seek more tools to predict future equity markets (Lechner, 2021; Siegel, 2016; Campbell & Shiller, 2001). Most of the studies on an efficient prediction of CAPE ratio have been carried out in relation to the U.S. market (Bunn & Shiller, 2014; Weigand & Irons, 2007). Few papers have been found to focus on emerging markets, and none focuses specifically on the Thai equity market, the second largest stock market in the 10-member Association of South-East Asian Nations (ASEAN). The Stock Exchange of Thailand (SET) has grown steadily in recent decades. However, it has endured much variability due to both domestic and international factors such as the 1997 Asian Financial Crisis and the US-induced 2008 financial crisis (Apaitan, Luangaram, & Manopimoke, 2022; Korn & Sorasart, 2021; 2022; Talthip & Sukcharoensin, 2021; Nimkhunthod, 2007). Since the CAPE ratio is widely accepted as lessening the cyclical impact in predictions, it is therefore compelling to seek to examine whether it efficiently forecasts returns on the Thai market. This present study does just that. Specifically, it attempts to investigate the predictability of the CAPE ratio and compare the predictive power of three relative valuation tools in relation to the Thai stock market: (i) the CAPE ratio, (ii) the P/E ratio, and (iii) the price-to-book ratio (hereinafter referred to as the 'P/B ratio'). The findings are expected to benefit investors and academics in asset valuation as well as portfolio management.

2. Literature Review

- *The Search for Effective Predictive Tools*

The efficient market hypothesis (EFM) is premised on the notion that for a capital market to be efficient, all relevant information must reflect stock prices. In its weak form, the Efficient Market Hypothesis fails to make it possible for investors to gain abnormal profits based on historical price information alone (Fama 1970; Malkiel 2003). Furthermore, as implied by the Random-Walk theory, stock prices fluctuate independently over time and are not related to the historical price pattern (Van Horne & Parker, 1967). Both theories are classics in the literature on finance. Although there are many supporters, they have been questioned. While the EFM assumption of gradual price adjustment has convinced some analysists that an arbitrage profit opportunity exists for immediate transactions, opponents of the EMF and Random-Walk model have argued that security prices are biased as shown by the P/E ratio, which acts as an indicator of the biasedness (Basu, 1977; Kenourgios, Papathanasiou, & Bampili, 2021; Malkiel, 2003).

Both economists and academics have long been searching for prediction tools that will help them forecast markets (Abbas & Wang, 2020; Avramov & Chordia, 2006; Lee & Rui, 2000). The most sought-after predictions relate to the relationship between earnings, prices, and dividends. The aim is to average long-term earnings, weaken short-term volatility, and minimize the impact of business cycles. As far back as 1934, Graham and Dodd came up with the influential idea of replacing current earnings with long-term average earnings. They proposed that a sensible computation of securities should include average earnings that cover a minimum of five years and preferably seven to ten years. The concept was revisited by Campbell and Shiller in 1988 (Campbell & Shiller, 1988). when the real and excess returns on index were regressed on the dividend-price ratio, the dividend growth rate, the price-earnings ratio, and the additional two P/E ratios, based on 10-year and 30-year moving averages. The results provided early evidence that when returns are measured as moving average of their historical value, the E/P ratio serves as the most powerful predictor of stock returns. (Bunn & Shiller, 2014).

- ***The Cyclically Adjusted Price-to-Earnings (CAPE) Ratio***

The CAPE ratio initially received attention in early December 1996, when Campbell and Shiller explained to the U.S. Federal Reserve that, in their view, the stock index was overrated, which prompted the Irrational Exuberance Speech a week later by the Federal Reserve Chairman, Alan Greenspan (Siegel, 2016). In 2001, Campbell and Shiller introduced the CAPE ratio in an innovative article entitled "Valuation ratios and the long-run stock market outlook." The term ‘cyclically adjusted’ refers to the way earnings are spread over the long term. More specifically, the CAPE ratio is based on index prices divided by the ten-year moving average of the last earnings per share instead of the one-year trailing total earnings used in traditional price-earnings ratio so that it is not affected by the typical business cycle (Asness, 2012). Since the ratio employs ten-year moving average of earnings per share, it is also known as the ‘P/E 10.’ In 2001, Campbell and Shiller used 10-year average stock returns in the U.S. and in twelve other countries from 1871 to 2000 regressed against their CAPE ratios. They found that the CAPE ratio offers standout forecasting capability among its valuation peers. It has turned out to be an astounding tool to detect over- and under- pricing securities. CAPE-based future stock return predictions have been remarkable (Campbell & Shiller, 2001; Lechner, 2021; Siegel, 2016).

The CAPE ratio allows investors to expect profits from equity even when the returns plunge as long as the market is underpriced (Jivraj & Shiller, 2017). According to Weigand and Irons (2007), who studied the relationship between the market P/E and CAPE ratios and U.S. future stock returns, there is a robust relationship between both ratios and future earnings. However, it was found that there are differences in predictions when market P/E ratios are very high. This study convinced the authors of the present article that one of the crucial factors behind an elevated P/E is earnings. In 2014, Bunn and Shiller extended their prior research by exploring the robustness of CAPE ratios across various sectors in the U.S. and constructing the Total Return CAPE and Relative CAPE ratios. The Total Return CAPE ratio considers the effect of dividend policy. As a ratio of the current value of CAPE over its own twenty-year average, the Relative CAPE ratio helps to remove long-term trends and intermediate cycles inherent in the original CAPE ratio. It is powerful tool to signal over- and under- valuation of CAPE. Bunn and Shiller’s (2014) findings suggest that the CAPE ratio can be seen as a forecast that withstands inflation and variable corporate dividend policies. The predictability of CAPE was also confirmed in Bunn et al.’s (2014) study, in which the model was adjusted to account for accounting standards and growth expectations. The CAPE-based valuation was applied successfully in detecting an over- or undervaluation as well as for comparisons across sectors for rotation portfolio strategy.

As is the case with any measurement, the CAPE ratio has had its critics (Jivraj & Shiller, 2017; Keimling, 2016; Philips & Kobor, 2020; Siegel, 2016;). For one, the ratio has been found to be influenced by several factors more or less related to expected earnings. For example, stock prices can be suppressed when the movement does not reflect an overoptimistic expectation of earnings growth (Siegel, 2016). Moreover, the fall in stock returns caused by a decrease in real bond yield may lead the CAPE ratio upward and any changes in equity risk premium required by investors can impact the earnings and CAPE. Changes in accounting practice and reported earnings have been reported to affect the CAPE ratio (Siegel (2016) According to Hodge (2011), Siegel (2016) evaluated the predictive power of the CAPE ratio using corporate profit (NIPA) as defined by the Bureau of Economic Analysis (BEA) (2023). Hodge (2011) concluded that the NIPA profit-based CAPE ratio exhibits powerful predictions compared to the forecast using reported earnings computed by Standard & Poor's. Employing S&P500 reported earnings to calculate the CAPE ratio biases the ratio upward and leads to a downward forecast of real stock returns.

- CAPE Variations

There is a large body of literature on the CAPE ratio in addition to its critics. Interestingly, the CAPE ratio can also be restructured to capture various features of equity markets (Bunn & Shiller, 2014; Davis et al., 2018; Jivraj & Shiller, 2017; Keimling, 2016; Klement, 2015; Philips & Ural, 2016; 2017; Siegel, 2016; Waser, 2021). The forecast ability is examined across countries, accounting practices, and index construction (Aras & Yilmaz, 2008; Klement, 2012; 2015; Lleo & Ziemba, 2020; Radha, 2020). It is empirically discussed by Siegel (2016) that using a firm's cash flows or revenues can enhance the CAPE's predictions. In Seigel (2016), the classic CAPE ratio and its variety are more efficient in predicting nominal returns than the real returns recommended by several studies (Bunn & Shiller, 2014; Campbell & Shiller, 1988; 2001; Shiller, 2015).

Keimling (2016) comparatively examined the efficiency of the classic Campbell and Shiller's CAPE ratio and the dividend-adjusted CAPE ratio, P/B ratio, P/E ratio, and price-to-cash ratio using Morgan Stanley Capital International (MSCI) country indices over the period 1969-2015. The study confirmed the outstanding predictive capability of the Campbell and Shiller's CAPE ratio and showed that CAPE is not only remarkable in predicting future returns but also serves as a good predictor of risk exposure. Surprisingly, though, the dividend-adjusted CAPE indicator does not outperform the classic Campbell and Shiller's CAPE ratio. The P/B value ratio, however, offers prediction similar to or even more reliable than the classic Campbell and Shiller's CAPE ratio (Campbell & Shiller, 1988) in forecasting returns and risks. The more stable book value does not require long-term smoothing. But since historical data is rather limited, they (they for what? Who?) are not very popular. P/E and price-to-cash ratios offered weaker predictions as corporate earnings and cash flows are highly volatile.

Jivraj and Shiller (2017) reexamined the validity of the CAPE ratio from various perspectives. Refuting Siegel's (2016) use of corporate profit as defined by NIPA profits; they argued that actual reported earnings per share is already a good proxy for earnings. There is no need to transform earnings into NIPA profit. However, Jivraj and Shiller (2017) suggested operating profit per share as an alternative proxy of earnings in the CAPE calculation. Their study confirmed that, in addition to the general value signal, the CAPE ratio offers remarkably consistent predictions in different time horizons and is a good measure of under- or over-pricing. The study lent support to Bunn and Shiller's (2014) study for the efficacy of CAPE at a sectoral level. Philips and Kobor (2020) introduced a variation of CAPE that requires one-year earnings instead of ten. The idea is to discard the noise in each operating year and use the sales-to-price ratios as a proxy for temporal profit margin variation. The results are statistically significant. The new model provided a statistically significant forecast and was superior to the original CAPE model in terms of prediction. In addition, several research studies addressed the impact of economic variables on CAPE estimations. Klement (2015) introduced a macroeconomically fair CAPE that considers interest inflation and growth rates. The paper examined the difference among CAPE ratios from different countries and concluded that when the domestic currency depreciates, exports and domestic growth are likely to pick up and domestic firms' earnings will eventually rise. Therefore, in addition to the CAPE ratios' ability to predict expected returns, the differences in CAPE between countries can offer predictions of foreign exchange rates, especially when CAPE and Earnings are highly correlated.

Davis et al. (2018) proposed a fair-value CAPE approach that conditions the mean reversion on bond yields, expected inflation rates, and financial volatility in the Vector Auto Regressive (VAR) model. The method provides an efficient forecast of real and nominal returns as forecast errors were less frequent than that in the traditional CAPE model. Lechner (2021) used CAPE-based valuations to forecast S&P 500 following the March 2020 Covid-19-induced deep plunge. An overvaluation and the continuing rise of the CAPE ratio at the time of the study suggest that a new high is likely be reached; one that will surpass the 1999 historical peak. The rise of CAPE indicator was explained by the concept of 'irrational exuberance' mentioned above (Shiller, 2015). Waser (2021) revisited the predictability of the CAPE ratio relative to economic variables. The study suggested that more than 90 percent of the variation in the CAPE ratio coexist with economic fundamentals.

- CAPE and Markets around the World

The world economy has been growing in the last decades and so have equity markets. In addition to the U.S. Market, the initial CAPE ratio and its subsequent variations have been found to effectively predict stock returns in emerging countries. Aras and Yilmaz (2008) investigated the predictive power of the P/E ratio, market-to-book ratio, and dividend yield. Compared to the market-to-book ratio and the dividend yield, the P/E ratio was found to be insignificant in predicting stock returns in emerging market environments. The market-to-book ratio, however, could provide an efficient one-year period forecast. Klement (2012, 2015) examined the capacity of the CAPE ratio to forecast emerging markets, including Thailand. The study combined the data of the 35 countries to validate the finding. It was found that the CAPE ratio is an efficient measure to predict stock market returns over five years. The CAPE ratio has become actively used to measure the stock exchange performance in Asian markets.

The CAPE ratios of the Tokyo Stock Exchange and the Shanghai Stock Market are regularly disclosed to the public. The acceptance of CAPE in emerging markets is consistent with Lleo and Ziemba's (2020) study, which stated that both the P/E and the CAPE ratio performed successfully in predicting crashes in the Shanghai and Shenzhen stock markets. Radha (2020) applied CAPE valuation to develop medium-term country yield forecast (CY-M) in countries other than the U.S. using Morgan Stanley Capital International All Countries World Index Excluding USA (MSCI ACWI ex USA Index) in an empirical study, it was concluded that CAPE is useful in estimating medium-term real return expectations in non-U.S. market. A country rotation international equity portfolio can therefore be constructed. Shiller, Black, and Jivraj (2020) extended the estimate of Excess CAPE Yield, as expounded by Shiller (2015) in his 2015 book entitled "Irrational Exuberance," to show investors the expected real returns during the COVID-19 pandemic across regions. They investigated excess real returns of equity over bonds during the pandemic in relation to excess real returns before the pandemic in the U.S., U.K., Europe, Japan, and China. Since interest rates are a significant component in stock valuation, the returns on stocks are influenced by the CAPE ratio and long-term interest rates (Shiller, 2015). The *Excess Cape Yield* is an inverse of CAPE minus the ten-year real interest rate. It reflects investors' desire to invest in stocks as opposed to treasury bonds.

The evidence of high Excess CAPE Yield in various markets during the pandemic points to investors' preference for stocks over bonds as stocks offer positive real returns and can be expected to withstand inflation. Kenourgios et al. (2021) studied the FTSE/ASE Large Cap Stock Index, which consists of the 25 largest and most liquid firms' stocks traded on the Athens Stock Exchange, during the period 1997-2018, a time during which Greece went through a severe economic crisis, major transformations, and eventually recovery. These events made its financial market a good candidate for an empirical study. The findings indicate that the CAPE ratio was superior to the P/E ratios and P/B ratios in forecasting the market. Finally, a recent study by Raju (2022) examined the relationship between CAPE valuation and forward excess return in relation to the Indian S&P BSE 100 index. The author used monthly data from 1990 to 2022. The study concluded that the Indian stock index also follows the mean reversion as seen in other markets. There is an inverse relationship between CAPE and forward returns that ensures the predictability of the CAPE ratio. As with Jivraj and Shiller (2017), Raju (2022) found it difficult to apply CAPE ratio precisely in market timing.

- The Price-earnings (P/E) Ratio, and Price-to-Book (P/B) Ratios

The Price-earnings (P/E) ratio is one of the most popular tools used to determine whether the company's stock price is reasonably valued (Anderson & Brooks, 1996; Huang & Wirjanto, 2012; Molodovsky,1995; Penman, 1996). According to Basu (1977), the P/E can be a powerful predictor and is an indicator of bias in security price. The P/E ratio is calculated by dividing the market value per share by the earnings per share. There are two kinds of P/E ratio: the trailing and the forward P/E (Wu, 2014). The trailing P/E is the standard form of P/E calculation that uses past earnings in estimation while the forward P/E requires earnings forecast in the estimation. Among prediction tools, the price-to-book (P/B) ratio is also one of the most widely accepted valuation matrices (Agirman & Yilmaz, 2018; Aras & Yilmaz, 2008; Keimling (2016; Kusmayadi, Rahman, & Abdullah, 2018). It is a ratio of the market price per share to the book value per share of the company. While the P/E is shareholders' vindication, the P/B ratio draws together both internal and external factors that affect stock prices (Block, 1995). Since the ratio can offer predictions that are as efficient as those of the CAPE ratio and the stable book value means, there is no need for long-term average as in P/E (Keimling, 2016). Because the P/E and the P/B ratios are both well-known prediction tools, they are selected as alternative predictors in this present research. Their predictions will be analyzed and compared to the predictions offered by the CAPE ratio.

- The Stock Exchange of Thailand

The Stock Exchange of Thailand (SET) is the second largest stock exchange in ASEAN. The SET was founded in 1975. At its inception in 1975, there were 8 listed companies on the first day of trading. In December 2022, more than 800 companies were listed, a clear indication of the remarkable growth of the SET. Despite its high potential as an emerging investment destination, the market has been susceptible to several risk factors such as floods, droughts, and epidemics. Market anomalies are highly influenced by both domestic and global impact (Apaitan et al., 2022; Khanthavit, 2020; Korn & Sorasart, 2021; 2022; Nimkhunthod, 2007; Wongbangpo & Sharma, 2002). As a small open economy, Thailand is highly vulnerable to external shocks as well as global financial cycles, let alone domestic political turmoil. The country has endured several military coups, gone through constitutional reforms, and been torn by riots (Prukumpai, Sethapramote, & Luangaram, 2022). It has also been through many economic crises, most notably beside mentioned above, the 1997 ASIAN Financial crisis. The very nature of the SET and the environment in which it operates make it compelling for additional research on CAPE ratio to effectively predict future (Talthip & Sukcharoensin, 2021).

In this recent study, we will evaluate how CAPE ratio can predict return in the Stock Exchange for Thailand compared to other valuation tools including P/E ratio, the P/BV ratio. The study and application of CAPE in Thailand are currently limited.

3. Data and Methodology

This study follows the regression models proposed by Klement (2012), Siegel (2016), Shiller and Jivraj (2017), Kenourgios et al. (2021), and Raju (2022) to evaluate the predictive power of the CAPE ratio regarding the SET. Real returns on the SET were regressed on their predictors including the CAPE, P/E, and P/BV) ratios, respectively. 416 monthly data was collected for the period April 1988-December 2022. Table 1 lists the sources of the data used in this study. In addition to the data gathered from listed sources, another required variable was calculated. That is 10-year inflation adjusted average earnings, calculated as the moving average of 120 months with window size of 120 samples starting from May 1988 to December 2012. There are 296 months data sample available for analys

Table 1: Sources of Data

Data	**Period** (Month)	**Source**
SET Index	April 1988 – December 2022	Stock Exchange of Thailand
SET Index P/E Ratio	April 1988 – December 2022	Stock Exchange of Thailand
SET Index P/BV	April 1988 – December 2022	Stock Exchange of Thailand
SET Index EPS	April 1988 – December 2022	Stock Exchange of Thailand
Consumer Price Index	April 1988 – December 2022	Bank of Thailand

- *Real Returns on SET Index*

The real return on SET index at time *t* (r_t) is calculated as a natural log of the ratio of real price at period (t) to real price in the period ($t-1$)

$$r_t = ln\frac{P_t}{P_{t-1}} \tag{1}$$

When the real returns on the SET Index are calculated for the future period *t*+*k*, the variable r_{t+k} represents returns on the SET Index in the *t*+*k* period.

- *CAPE Ratio*

This study follows Campbell and Shiller's approach to estimate CAPE ratios in each period (Campbell & Shiller, 2001; Siegal, 2016; Keimling, 2016; Shiller et al., 2020). The ratio is calculated using the following formula:

$$\text{CAPE Ratio} = \frac{Price}{Average\ earnings\ for\ 10\ years\ adjusted\ for\ inflation} \tag{2}$$

or

$$CAPE_t = \frac{P_t}{\frac{1}{120}(EARN_t + EARN_{t-1} + \cdots + EARN_{t-120})} \tag{3}$$

The analysis begins with an examination of the data series. They are first examined for stationarity, using the Augmented Dickey-Fuller (ADF) unit root test to ensure their qualification for the regression models (Dickey & Fuller, 1979). Any nonstationary data must be treated to ensure that it is stationary and does not cause spurious results.

Different regression models are then estimated. The real returns on the SET Index at time $t+k$ is regressed on the predictors at time t as recommended by Jivraj and Shiller (2017). The three estimations use three predictors, the CAPE ratio, the P/E ratio, and the P/BV ratio respectively, to determine which predictor is the best predictor of equity returns. The three regression models can be described as follows:

$$r_{t+k} = \beta_0 + \beta_k CAPE_t + \epsilon_{t+k,k} \quad (4)$$

$$r_{t+k} = \beta_0 + \beta_k P/E_t + \epsilon_{t+k,k} \quad (5)$$

$$r_{t+k} = \beta_0 + \beta_k P/BV_t + \epsilon_{t+k,k} \quad (6)$$

where $k = 120$

Once the regression estimations are completed, each estimation is examined for serial correlation to ensure model validity. Serial correlations can cause biased coefficients and may result in unreliable hypothesis testing. This study uses Breusch-Godfrey Serial Correlation LM Test to detect any serial correlation of the estimations (Verma & Bala, 2013).

Finally, to confirm the relationship between real returns on the SET Index and CAPE ratio as well as its predictor peers, this study follows Maharakkhaka, Ramasoot, and Kluaymai-Ngarm (2017) to use Johansen's (1991, 1995) cointegration test. The cointegration test identifies long-term correlation between time series. Engle and Granger (1987) recommend that the cointegration test be superior to the regression approach since the regression estimation can be spurious and detrending does not solve spurious regression. The Johansen Cointegration Test generally reports two statistics, the Trace and the Maximum Eigen values. The hypotheses of the Trace and Maximum Eigen tests are as follows:

Trace statistics	H_0: There are R cointegrating relations H_1: There are more than R cointegration relations
Maximum eigenvalue statistics	H_0: There are R cointegrating relations H_1: There are $R + 1$ cointegration relations

where r is the number of cointegrating relation

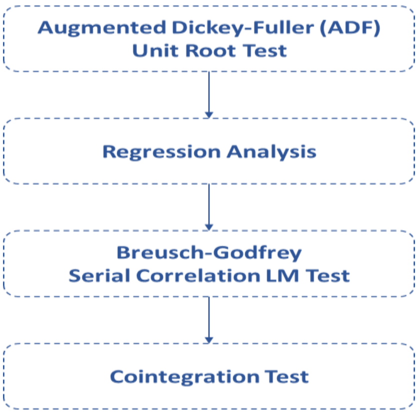

Figure 1: Research Flow (created by the authors for this study)

4. Results and Discussion

This part of the analysis covers the validity of all the variables before they are used in the regression equations. Table 2 summarizes the descriptive statistics of all the variables and Table 3 reports all the correlation among variables. It is shown that there is a small negative correlation between real returns on SET Index and each predictor.

Table 2: Descriptive Statistics

Data series	r_{t+k}	$CAPE_t$	PE_t	PBV_t
Mean	0.003217	15.20240	24.84492	4.191618
Median	0.007734	12.11509	20.36786	2.501179
Maximum	0.310420	46.60477	69.56396	17.40214
Minimum	-0.346793	3.175464	5.342926	0.892040
S.D.	0.074421	9.443350	13.27630	3.358343

Table 3: Correlation Matrix

	r_{t+k}	$CAPE_t$	PE_t	PBV_t
r_{t+k}	1.000000	-0.024045	-0.070759	-0.059348
$CAPE_t$	-0.024045	1.000000	0.909403	0.842489
PE_t	-0.070759	0.909403	1.000000	0.918957
PBV_t	-0.059348	0.842489	0.918957	1.000000

All the data series were examined for stationarity using an Augmented Dickey-Fuller (ADF) unit root test to ensure data qualification (Dickey & Fuller, 1979). Tables 4A and 4B show the results of the Augmented Dickey-Fuller unit root test on the level and the first difference, respectively.

Table 4A: Augmented Dickey-Fuller Unit Root Test at Levels

Augmented Dickey-Fuller Unit Root Test at Levels							
		Critical Value					
	ADF	**1% level**	**5%level**	**10% level**	**P-value**	**Null Hypothesis**	**Stationarity**
r_t	-17.28971	-3.449857	-2.870031	-2.571363	0.0000	Rejected	Stationary
$CAPE_t$	-2.132090	-3.449917	-2.870057	-2.571377	0.2323	Accepted	Non-stationary
PE_t	-2.630189	-3.449917	-2.870057	-2.571377	0.0879	Accepted	Non-stationary
PBV_t	-2.197732	-3.452442	-2.871161	-2.571968	0.2078	Accepted	Non-stationary

Table 4B: Augmented Dickey-Fuller Unit Root Test at First Difference

Augmented Dickey-Fuller Unit Root Test at First Differences							
		Critical Value					
	ADF	**1% level**	**5%level**	**10% level**	**P-value**	**Null Hypothesis**	**Stationarity**
$DCAPE_t$	-14.53203	-3.449917	-2.870057	-2.571377	0.0000	Rejected	Stationary
DPE_t	-13.68071	-3.452442	-2.871161	-2.571968	0.0000	Rejected	Stationary
$DPBV_t$	-13.53035	-3.452442	-2.871161	-2.571968	0.0000	Rejected	Stationary

As can be seen in these two tables, there is no unit root in real returns data series. The CAPE, P/E, and P/BV ratio data series contain unit root implying non-stationarity. The three data variables were, therefore, transformed into the first difference. The unit root test at the first difference confirms the stationarity of these three data series. All variables are now qualified for regression estimation. In this study, three regression equations were estimated. Each model has a stock returns predictor as an independent variable. These estimations reveal the relationship between each predictor and the real returns on the SET Index. The estimations were compared to find superior predictors among the CAPE, P/E, and P/BV ratios. Table 5 outlines the predictability of each independent variable to the dependable variable. It is found that the CAPE ratio and the P/BV ratio do not have a significant relationship with real returns on the SET index. Their correlation coefficients are close to zero and the null hypothesis of zero coefficient cannot be rejected. On the other hand, the P/E ratio is significantly related to the real returns of the SET Index although the correlation coefficient is very small. The small values of the coefficient of determination in the three estimations imply that the P/E ratio explains only in a small part the variation in returns of the SET Index. The main implication is that variations in the SET Index returns can possibly be explained by other variables.

Table 5: Regression Estimation

Regression Estimation Result					
Model	$r_{t+k} = \beta_0 + \beta_k DCAPE_t + \epsilon_{t+k,k}$				
Variables	Coefficient	Std. Error	t-Statistics	P-value	R^2
$DCAPE_t$	0.003029	0.002584	1.242057	0.2151	0.004653
Model	$r_{t+k} = \beta_0 + \beta_k DPE_t + \epsilon_{t+k,k}$				
Variables	Coefficient	Std. Error	t-Statistics	P-value	R^2
DPE_t	0.002945	0.001422	2.071345	0.0391*	0.012835
Model	$r_{t+k} = \beta_0 + \beta_k DPBV_t + \epsilon_{t+k,k}$				
Variables	Coefficient	Std. Error	t-Statistics	P-value	R^2
$DPBV_t$	0.005515	0.007447	0.740582	0.4595	0.001868

* Indicates a rejection of the null hypothesis at 5% significance leve

To ensure that the regressions are correctly specified, the three estimations were examined for serial correlation using Breusch-Godfrey Serial Correlation LM Test. Its purpose is to test whether the error terms in the time series are correlated. Table 6 presents the results of the Breusch-Godfrey Serial Correlation LM Test for the three regression models. As can be seen in this table, at a five percent significance level, the three regression estimations in this study have no serial correlation.

Table 6: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test			
Model	$r_{t+k} = \beta_0 + \beta_k DCAPE_t + \epsilon_{t+k,k}$		
F-statistics	Obs*R-squared	P-value	Prob. Chi-Square
0.169994	0.344259	0.8438	0.8419
Model	$r_{t+k} = \beta_0 + \beta_k DPE_t + \epsilon_{t+k,k}$		
F-statistics	Obs*R-squared	P-value	Prob. Chi-Square
0.116406	0.235823	0.8902	0.8888
Model	$r_{t+k} = \beta_0 + \beta_k DPBV_t + \epsilon_{t+k,k}$		
F-statistics	Obs*R-squared	P-value	Prob. Chi-Square
0.172197	0.348716	0.8419	0.8400

* Indicates a rejection of the null hypothesis at 5% significance level

Finally, a cointegration analysis was performed to confirm the predictability of the CAPE, P/E, and P/BV ratios. Table 7 shows the result of Johansen Cointegration Test. The result of Trace and Maximum Eigen hypothesis test are reported accordingly. The P-value of less than 0.05 leads to the rejection of the null hypothesis (H_0) and acceptance of the alternative hypothesis (H_1) as described in earlier sections.

Table 7: Johansen Cointegration Test

Cointegration Test - r_{t+k} and $CAPE_t$						
H_0	Eigenvalue	Trace Statistics	Critical Value	Max-Eigen Statistic	Critical Value	P-value
$R = 0$	0.200017	67.10994	15.49471	64.94091	14.26460	0.0000*
$R \leq 1$	0.007426	2.169034	3.841465	2.169034	3.841465	0.1408
Cointegration Test - r_{t+k} and PE_t						
H_0	Eigenvalue	Trace Statistics	Critical Value	Max-Eigen Statistic	Critical Value	P-value
$R = 0$	0.225727	78.76946	15.49471	74.44692	14.26460	0.0000*
$R \leq 1$	0.014744	4.322548	3.841465	4.322548	3.841465	0.0376*
Cointegration Test - r_{t+k} and PBV_t						
H_0	Eigenvalue	Trace Statistics	Critical Value	Max-Eigen Statistic	Critical Value	P-value
$R = 0$	0.204477	70.20216	15.49471	66.56782	14.26460	0.0000*
$R \leq 1$	0.012411	3.634337	3.841465	3.634337	3.841465	0.0566

As indicated in Table 7. Thus, there can be at most one cointegration relation between returns on the SET Index at time $t+k$ and the SET Index CAPE ratio. There are more than one cointegration relations between returns on the SET Index at time $t+k$ and the SET Index P/E ratio. Lastly, there is at most one cointegration relation between returns on the SET Index at time $t+k$ and the SET Index P/BV ratio. The cointegration results are derived at five percent significance level.

According to the findings, the regression estimation does not support efficiency of the CAPE ratio to predict the real returns on the SET Index. This study, however, follows the original model of CAPE ratio estimation as proposed by Campbell and Shiller (2001). Until recently, there are a number of research on the variations of the CAPE ratio such as the Fair-Value CAPE (Klement, 2015; Waser 2021) and the Total Return CAPE (Bunn & Shiller, 2014; Jivraj & Shiller, 2017). In addition, Philips and Ural (2017) have provided evidence that the CAPE ratio offers better predictions of nominal returns than real returns. These various studies demonstrate that the CAPE ratio is sensitive to several factors (Klement, 2015). An application of CAPE should therefore take into account economic variables so as to provide robust predictions. The findings in this current research, however, are in line with Waser (2020) where the mean-reversion condition of CAPE is not met due to economic variables. Thus, there are possibilities that the prediction of real returns on the SET Index requires variant CAPE ratios to reflect volatility of economic indicators.

While the earlier regressions of the SET Index returns on the CAPE ratio do not support predictability of the CAPE, the cointegration test reveals that the real returns on the Set Index are integrated with the CAPE ratio in long-term. The cointegrating relation, however, may not be sufficient to reflect the finding in regression analysis. Among the three return predictors examined in the regression estimation, the P/E ratio is the only predictor that has a significant relationship with the real returns in the SET Index. While the P/E ratio is short-term based as opposed to long-term mean-reversion assumption of the CAPE ratio in forecasting stock returns, they are widely accepted among analysts due to simplicity and compromising data requirement

(Aras & Yilmaz, 2008; Keimling 2016; Kenourgios et al., 2021). The P/E ratio exhibits a cointegration relation with the SET Index returns. There is no significant relationship between the book-to-value ratio and the SET Index returns in the regression estimation. This finding contradicts Keimling's (2016) suggestion that the price-to-book ratio provides robust predictions. Like the other two predictor peers, the price-to-book value ratio is integrated to the SET Index returns in the long term.

5. Conclusion

The objective of this study is to investigate the predictability of the CAPE ratio in the Stock Exchange of Thailand. As noted earlier, the CAPE ratio has been hailed by many economists as offering a superior forecast relative to other measurements such as the P/E and price-to-book value ratios. This is because the CAPE ratio requires an average of 10-year earnings. This long-term average concept is believed to withstand short-term economic volatility. While the
re is a large body of literature on the predictability of the CAPE ratio in the U.S. stock markets, the study of CAPE in the context of Thailand and the Thai stock market is rather limited. Thailand is a small open economy vulnerable to cyclical shocks that has been through several crises caused by domestic and global factors such as the above-mentioned 1997 ASIAN Financial crisis and the 2007 US subprime crisis. This makes Thailand a good candidate for a study of the CAPE ratio. Specifically, this research examined the efficiency of the CAPE ratio to predict returns on the SET Index compared to the P/E and price-to-book value ratios, using a regression model.

The findings in this study do not support a superior prediction of the CAPE ratio. The estimation suggests that only the P/E ratio has a significant relationship with real returns on the SET Index. The cointegration test was included in this analysis to confirm the forecast ability of these predictors. It is found that returns on the SET Index have significant long-term cointegration with all three predictors. These inconclusive evidence leads to further research opportunities since there are CAPE ratio variants recommended in the relevant vast body of literature. The possibility that the predictability of the CAPE ratio in this study may be affected by external factors, i.e., economic variables and accounting practices, cannot be discarded. Finally, the results in this study are in keeping with prior research that suggest variation in CAPE calculation for a more efficient prediction.

- *Limitations of this Study and Future Research*

This study has limitations. The first limitation concerns the historical data. While the SET Index returns are available from the time the exchange was founded, in 1975, data on predictor ratios are only available from 1988 onward. Since CAPE predictions assume a 10-year average in earnings, earnings information over the past ten years is used to predict current returns on the SET Index. Therefore, a larger data sample might allow us to achieve more efficient predictions. Another limitation is that, as mentioned earlier, there are variations in the CAPE ratio calculations, which consider economic variables such as interest rates and inflation. Since CAPE ratios taking into account these variables are viewed by some academics (Davis et al., 2018; Klement, 2015; Lechner, 2021; Waser, 2021) as superior to the classic CAPE, there is an opportunity for future studies to empirically examine the efficiency of the CAPE ratio in its variation. Moreover, to date, there is no definite proof that the use of CAPE as market predictor is precise and perfectly accurate in every situation. As prior studies and this present article have demonstrated, while the CAPE ratio has proved to be an effective predicting tool in many markets, it has been less effective in others. It would therefore be useful to monitor CAPE movements as an indicator to assess the market situation together with other financial factors to assist the investors in making the right investment decision.

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