



# On the predictive power of CAPE or Shiller's PE ratio: the case of the Greek stock market

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## Abstract

This paper examines the capability of the Cyclically Adjusted Price to Earnings (CAPE) or Shiller's P/E ratio, along with other relative valuation ratios such as the P/E and the P/BV, to predict future returns of the FTSE/ASE Large Cap Index, starting from the development of the index (1997) to December 2018. We have herein used several regression models in order to examine the relationship between the above ratios and the future returns of 1, 3, 5 and 10 years. We show that, while P/E and P/BV ratios are not correlated to future returns, the CAPE ratio and its variation CAPE 5, which uses real 5 year earnings, are efficient estimators of future returns. Our results imply the informational inefficiency of the Greek Stock Market.

**Keywords** Returns forecasting · FTSE/ASE large cap index · CAPE ratio · Efficient market hypothesis

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# 1 Introduction

Over the past decades extensive research has been carried out in order to predict future returns of the Greek Stock Exchange. The latter offers various financing tools and solutions to companies, expands local and foreign investor choice by providing a safe, stable and easy environment in full alignment with international practices and the European regulatory framework. The Greek stock market offers some profitable industry sectors as options to invest in, such as tourism, energy, food & beverage, the ICT sector, export-oriented manufacturing and logistics (Ghosh et al. 2021; Koutsokostas et al. 2019; Christopoulos et al. 2018). Through future valuation, investors attempt to determine the intrinsic value of each security in order to identify investment opportunities. If a market is efficient, the price of any security reflects all available company information and therefore its price should be equal to its intrinsic value. However, because markets are not always effective, the purpose of valuation is to identify overpriced and underpriced securities.

The aim of this study is to examine if the CAPE, the P/E and the P/BV ratios to forecast the future returns of the Greek Stock Market. We therefore investigate the role of the P/E and P/BV ratios in the Greek Stock Market, exploring whether the cyclical component of the price to book value and the price to earnings ratios contain a forecast power for stock returns. In addition, we inspect if Robert Shiller's cyclically adjusted price/earnings ratio (CAPE) is a powerful descriptor, as well as a useful predictor, of long-term equity returns in the Greek Stock Market. We have also tried to associate our CAPE ratio findings to the Efficient Market Hypothesis. There are many studies about other financial ratios for the Athens Stock Exchange (Drousia et al. 2019; Dokas et al. 2014; Papadaki and Siougles 2007; Christopoulos et al. 2019; Papathanasiou et al. 2019). To the best of our knowledge, a similar study concerning the CAPE ratio and the Greek Stock Market has not been conducted to this day, so this is the gap our study endeavors to fill.

For many decades, the CAPE ratio (Cyclically Adjusted Price to Earnings ratio) or Shiller's P/E ratio has been used by academics, researchers, investing firms and others in an attempt to evaluate the US Stock Market, especially the S&P Index and many other stock markets globally. The supporters of the ratio believe that it can predict future returns (Angelini et al. 2012; Lleo and Ziemba 2019; Dimitrov and Jain 2018; Rangvid 2017).

For the purpose of our research, we use the FTSE/ASE Large Cap Stock Index established in September 1997, which consists of the 25 largest and most liquid stocks that trade on the Athens Stock Exchange. The period of the present analysis spans from the date the Index was established up to December 2018. Though this specific time span may in fact seem sufficient, it actually is not, as the CAPE index requires decades of earnings data in order to be calculated. For this reason, we have also created a variant of the index, the CAPE 5, which uses five-year earnings.

We focus on the Greek stock market due to the transformation taking place in Greece's economy following the country's recent financial crisis, as it was

the weakest “peripheral” emerging market for a number of reasons (debt crisis, market capitalization slump, CDS spreads, the Brexit referendum, investor risk aversion, counterparty risk, market illiquidity, etc.). Today there seems to be a new focus on exports, innovation and more active trading in all ASE Stock Index Caps.

The research questions which this paper attempts to answer are the following: (a) Are Cyclically Adjusted Price to Earnings (CAPE) or Shiller's P/E ratio, along with P/E and P/BV capable of predicting future returns of the FTSE/ASE Large Cap Index? (b) Is the Greek Stock Market informationally efficient (EMH) for the time period examined? (c) Which ratio from the above mentioned has the most predictable power over the FTSE/ASE Large Cap Index for the period examined?

The predictive power of the CAPE ratio is tested by examining the relationship between the future returns of one, three, five and ten years of the FTSE/ASE Large Cap Index and CAPE, CAPE 5, P/E and P/BV (Wu 2014; Rahman and Shamsuddin 2019; Ramcharan 2002; Koutsokostas et al. 2017). To examine these relationships, we construct several regression models, while in an effort to increase their interpretive ability, we add to some of them two additional variables: The returns of short- and long-term interest rates.

The CAPE or Shiller's P/E is a valuation ratio that uses the average of real (inflation-adjusted) earnings over a period of ten years in order to smooth out the large fluctuations in earnings that arise during an economic cycle, causing the Price to Earnings ratio to instantly appear artificially inflated. Furthermore, the Price to Earnings ratio seems outrageously high for the time being, for the sole reason that SARS-CoV-2 (COVID-19) has temporarily shrunk earnings. Robert Shiller's ratio is arguably considered the gold standard for gauging if equities are undervalued or not. The name CAPE derives from the initials Cyclically Adjusted Price-to-Earnings ratio, and its second name from Robert J. Shiller, American Economist, Sterling Professor of Economics in Yale University and Nobel Laureate (2013). The biggest advantage of the CAPE ratio lies within its own calculation. Instead of using annual earnings (those that the P/E ratio uses), average ten-year earnings are used resulting in a more stable ratio. Annual earnings exhibit higher volatility, thus being “noisy”, more so in times of economical crises, hence the P/E ratio is “noisy” too. On the other hand, the CAPE ratio appears smoother. Additionally, the fact that the CAPE ratio has been able to predict two forthcoming crises, i.e. the dot-com bubble (2002) and the housing bubble (2007–2009), has made it very attractive (Philips and Kobor 2020; Radha 2018; McMillan 2019; Samitas, et al. 2020).

This study contributes to the existing literature by investigating for the first time, to the best of our knowledge, Robert Shiller's Cyclically Adjusted Price/Earnings ratio (CAPE) as a useful predictor of equity returns in the Greek Stock Market. Furthermore, by adopting the CAPE ratio, the Greek Market will be in a position to forecast future returns. This study in particular is significant for three reasons: First of all, it focuses on a less developed and efficient stock market, given the existing paucity of research in such markets. Secondly, in contrast to prior relevant studies, it examines for the first time the CAPE ratio's predicting power in the Athens Stock Exchange. Finally, traders would benefit from this research, as they will find that this

financial ratio works in the Athens Stock Exchange and that it is definitely profitable, since it has been tested with more advanced statistical methods.

So in this paper there will be an investigation of the time period from 1997 to 2018. This specific period is very important for the Athens Stock Exchange, as there are no prior studies for the examined ratio for the above mentioned period during which the Athens Stock exchange became a more developed market, Greece adopted the Euro currency and a successful derivatives market was introduced. Moreover, during this said period a series of political and economic events took place in Greece, i.e. the covered period; the Greek debt crisis; nine electoral contests; three memorandums and one referendum.

The structure of this chapter is organized as follows: The second section encompasses the literature review. The third section presents the data and methodological issues. The fourth section analyzes the empirical findings of the research. The final section contains the concluding remarks.

## 2 Literature review

Weigand and Irons (2007) investigated the market P/E and its relation to future stock returns, aggregate earnings and interest rates in the U.S. They used both the P/E and the CAPE ratio. Their results indicated that the relation between the above two ratios and future earnings and returns seems similar except when the P/E ratio is very high. The results of Aras and Yilmaz (2008) revealed that investors in emerging markets could be able to forecast future market stock returns with a high probability for a one-year period using the Book to Market ratio and partially the Dividend Yield. On the other hand, the P/E ratio plays a minor role in predicting stock returns.

Davis et al. (2012) confirmed that valuation metrics such as Price to Earnings ratios have had an inverse or mean-reverting relationship with future stock market returns. They reached similar results having used either trailing twelve-month earnings or the cyclically adjusted earnings which are used in the calculation of the CAPE ratio. Klement (2012) examined if the CAPE ratio may be used as a forecasting and valuation tool for 35 countries, including emerging ones. His findings indicated that the CAPE is a reliable long-term valuation indicator for developed and emerging markets and so he used it to predict real future returns for each market over the following five years. Klement and Dettman (2014) examined the relationship between risk and return, concluding that on the basis of current valuation levels of the CAPE, the US market exhibits a high risk of significant future capital losses. Klement (2015) examined the relationship between returns of countries with different currencies and concluded that the difference among the CAPE values offer a sighting of the long run trends of exchange rates. Liem and Basana (2012) examined the relationship between the P/E ratio and the stock returns (increased liquidity) listed on the Indonesian Stock Exchange. They found that the six-month returns differ between low and high P/E stocks, while for longer periods there is no difference in portfolio returns with various P/E values.

Gray and Vogel (2013) tested the ability of various cyclically adjusted ratios to predict future returns, including a variation of the CAPE (10-year average of actual

earnings to market capitalization), on NYSE, AMEX and NASDAQ stocks. Their results concluded that the CAPE did not perform the best, but the CA-BM (10-year average of real book value to market capitalization) was marginally better. Bunn and Shiller (2014) tested the predictive capability of the CAPE ratio in the Industrials, Utilities and Railroads sectors from 1870 until early 2013. They showed that the CAPE is not only effective in predicting how each sector performs, but it also has the ability to evaluate the performance across sectors. Keimling (2016) examined the predicting ability of CAPE in 17 MSCI Indices from 1979. In addition, for the same Indices, he examined the predicting ability of the P/E, the P/BV, and the PC (Price-to cash flow) ratios, the dividend yield and an adjusted for changes in payout ratios CAPE. The results of his research indicate that only the P/BV and the CAPE provide reliable forecasts of future returns and that in countries with structural breaks, the P/BV is more reliable.

Philips and Ural (2016) tried to enhance the CAPE in order to confute the criticism it receives in being overly pessimistic, of lacking robustness to distortions in corporate earnings, and for overstating the long-term predictability of returns due to overlapping observations and endogeneity. They confirm that there are theoretical reasons which enable the CAPE to better predict future returns and that the use of historical earnings averages is shown to reduce their fluctuations, thus making the CAPE stronger than the P/E.

Jivraj and Shiller (2017) analyzed whether the CAPE is strong from three different aspects: They concluded that the CAPE and in particular the CAPE yield ( $1/\text{CAPE}$ ) is the most consistent estimator of future returns for both short and long term. Rangvid (2017) used the inverse ratio of the CAPE ( $1/\text{CAPE}$ ) in order to convert it to a yield and use it for predicting the returns of the S&P 500 for the next decade. He came to the conclusion that by using the combination of  $1/\text{CAPE}$  and the total sum of future returns, the returns of the S&P 500 for the next decade could be very well predicted. Dimitrov and Jain (2018) tested market efficiency using the CAPE index. They stated that stock returns are higher than US 10-year bond yields, so even at very high CAPE prices, the buy and hold strategy can work.

Leo and Ziemba (2019) showed that both the P/E and the CAPE performed much better than the BSEYD (Bond—Stock Earnings Differential) on the Shanghai Stock Exchange, while all three ratios performed very well on the Shenzhen Stock Exchange. Kim and Byun (2018) showed that the CAPE exhibits a predictive power over the performance of the Equally Weighted (EW) and the Value Weighted (VW) CRSP Indices—predicting the performance of the EW Index better, even for future one-year returns. Angelini et al. (2012) concluded that  $1/\text{CAPE}$  (the inverse ratio of the CAPE) remains a good benchmark for future long-term returns.

### 3 Data and methodology

#### 3.1 Data

The period covered by this study is from the establishment of the FTSE/ASE Large cap, from September 1997 to December 2018. Data used for empirical analysis was

collected from the Thompson Reuters Datastream database (closing prices of the Index as well as closing prices; EPS, BVS and Capitalization of each stock that comprised it); the Athens Stock Exchange Statistical Service (composition of the Index and investability weights of each stock) and the OECD database (prices of the 10-year Greek Government Bonds and the 3-month Treasury Bills).

Given that the EPS and BVS values are for each stock separately, the above data are calculated by comparing the percentages of each company in the Index per month in order to correctly calculate the total EPS and the BVS of the Index with the historical weighting. The Index's monthly closing prices and its monthly EPS are adjusted for inflation by base year 2018. Upon calculating the total EPS and the BVS of the Index, the following problem emerged: both the EPS and the BVS of the shares that participated in it over time exhibited negative values, which resulted in the Index itself exhibiting negative EPS and BVS, specifically in 2011, 2012, 2013, 2015 and 2016. Given these negative values, both the P/E and the P/BV of the Index could not be calculated since they do not exist as negative values. For this reason, all negative EPS and P/BV observations were excluded.

### 3.2 Methodology

The adjusted values of the Index are calculated by its logarithmic monthly real returns (adjusted for inflation) by formula (1), which are aggregated over time periods of one (1), three (3), five (5) and ten (10) years, creating the variables 1YR, 3YR, 5YR and 10YR, respectively.

$$r_t = \ln \frac{P_t}{P_{t-1}} \quad (1)$$

The P/E ratio of the FTSE/ASE Large Cap Index is then calculated by using Trailing 12 Months EPS (TTM). Finally, the CAPE ratio is calculated based on the Robert Shiller calculation and then the CAPE 5 ratio which is a variant of the CAPE ratio using five (5) years of EPS. For the calculations of the CAPE 5 and the CAPE indices, the following formulas 2 and 3 are used respectively:

$$CAPE5_t = \ln \frac{P_t}{\frac{1}{5}(EPS_{t-1} + EPS_{t-2} + \dots + EPS_{t-5})} \quad (2)$$

$$CAPE_t = \ln \frac{P_t}{\frac{1}{10}(EPS_{t-1} + EPS_{t-2} + \dots + EPS_{t-10})} \quad (3)$$

To examine the relationship between the performance of the FTSE/ASE Index Large Cap and the various factors, we defined as dependent the variables  $1YR_t + k$  (1-year returns),  $3YR_t + k$  (3-year returns),  $5YR_t + k$  (5-year returns) and  $10YR_t + k$  (10-year returns) and as independent the variables  $P/E_t$  (price to TTM earnings ratio),  $CAPE5_t$  (5-year average price to earnings ratio),  $CAPE_t$  (10-year average price to earnings ratio—CAPE or Shiller's P/E),  $P/BV_t$  (price to the book

value ratio),  $RLR_t$  (returns of the 10-year Greek Government Bonds) and  $RSR_t$  (returns of the 3-month Greek Treasury Bills).

We first examine the descriptive statistics of the variables. Then, we proceed to normality (using the Jarque—Bera statistic and the Shapiro—Wilk test), stationarity (using the Augmented Dickey—Fuller) and correlation (through Pearson correlation coefficient). We then construct several regression models in order to examine whether a relationship between our dependent and independent variables exists, but also to compare which relationships will emerge, also examining which factor proves to be the best estimator of future returns. Our regression models for each dependent variable are seven in number (28 in total) and their equations for  $n = 1, 3, 5$  and  $10$  and for  $k = 1, 3, 5, 10$  are the following:

$$nYR_{t+k} = a + \beta PE_t + \varepsilon_{t+k} \quad (4)$$

$$nYR_{t+k} = a + \beta CAPE5_t + \varepsilon_{t+k} \quad (5)$$

$$nYR_{t+k} = a + \beta CAPE_t + \varepsilon_{t+k} \quad (6)$$

$$nYR_{t+k} = a + \beta PBV_t + \varepsilon_{t+k} \quad (7)$$

$$nYR_{t+k} = a + \beta_1 PE_t + \beta_2 RLR_t + \beta_3 RSR_t + \beta_4 PBV_t + \varepsilon_{t+k} \quad (8)$$

$$nYR_{t+k} = a + \beta_1 CAPE5_t + \beta_2 RLR_t + \beta_3 RSR_t + \beta_4 PBV_t + \varepsilon_{t+k} \quad (9)$$

$$nYR_{t+k} = a + \beta_1 CAPE_t + \beta_2 RLR_t + \beta_3 RSR_t + \beta_4 PBV_t + \varepsilon_{t+k} \quad (10)$$

After completing the regression process, we perform residual tests (normality, autocorrelation, heteroskedasticity and multicollinearity). In order to evaluate the results of the regressions, we set a threshold of 95% confidence interval ( $p$ -value  $< 0.05$ ).

## 4 Empirical results

### 4.1 Preliminary analysis

Table 1 summarizes the descriptive statistics of the variables. We observe that most variables do not follow the normal distribution. Among the calculated ratios (P/E, CAPE5, CAPE and P/BV), P/E and P/BV ratios exhibit a high standard deviation, whilst the CAPE exhibits the lowest one. The high volatility of the P/E and P/BV indices is expected based on the literature (Davis et al. 2012), since the annual EPS used to calculate them is more volatile than the 5-year and 10-year normalized EPS of the CAPE 5 and CAPE, respectively.

**Table 1** Descriptive statistics

	1YR	3YR	5YR	10YR	P/E	CAPE5	CAPE	P/BV	RLR	RSR
Mean	-0.045356	-0.187728	-0.316490	-0.695104	2.025699	1.284149	0.741035	1.219546	-8.04E-05	-0.018136
Median	-0.020102	-0.212776	-0.285637	-0.659536	1.559801	1.318577	0.666668	0.845695	0.000000	-0.000894
Maximum	0.413475	0.464552	0.431397	0.366717	3.924973	2.119390	1.558500	3.247938	0.254808	0.827095
Minimum	-0.514896	-0.890959	-1.237801	-1.265994	0.705585	0.231864	0.278979	0.112742	-0.348153	-3.212766
Std. Dev	0.184982	0.306181	0.367700	0.387213	0.985519	0.489367	0.313585	0.892589	0.077061	0.244489
Skewness	-0.240876	0.086440	-0.230253	0.830007	0.771265	-0.149036	0.882357	0.695343	-0.040587	-8.651849
Kurtosis	2.531234	2.172949	2.699544	3.614106	1.922703	2.162110	3.111369	2.031331	5.552587	116.8534
Jarque-Bera	4.593569	6.544084	2.469102	17.75238	35.98966	6.459068	17.71752	30.51847	69.29934	140.908.9
Probability	0.100582	0.037929	0.290965	0.000140	0.000000	0.039576	0.000142	0.000000	0.000000	0.000000
Sum	-11.06695	-41.30019	-62.03204	-94.53421	494.2704	251.6931	100.7807	310.9843	-0.020511	-4.624775
Sum Sq. Dev	8.315033	20.53049	26.36471	20.24113	236.0132	46.69859	13.27530	202.3656	1.508360	15.18276
Observations	244	220	196	136	244	196	136	255	255	255

This table summarizes the descriptive statistics of the variables



**Table 2** Pearson's correlation

	$1Y_{t+k}$	$3Y_{t+k}$	$5Y_{t+k}$	$10Y_{t+k}$	$P/E_t$	$P/E5_t$	$P/E10_t$	$P/BV_t$	$R/LR_t$	$RSR_t$
$1Y_{t+k}$	1.000000									
	—									
	(244)									
$3Y_{t+k}$	0.546302	1.000000								
	0.0000***	—								
	(220)	(220)								
$5Y_{t+k}$	0.415372	0.715448	1.000000							
	0.0000***	0.0000***	—							
	(196)	(196)	(196)							
$10Y_{t+k}$	0.478473	0.493656	0.533170	1.000000						
	0.0000***	0.0000***	0.0000***	—						
	(136)	(136)	(136)	(136)						
$P/E_t$	0.311528	0.0242543	0.289637	0.649218	1.000000					
	0.0000***	0.0004***	0.0001***	0.0000***	—					
	(232)	(208)	(184)	(124)	(244)					
$P/E5_t$	0.132183	0.026801	—0.324713	—0.759762	0.171716	1.000000				
	0.0737	0.7366	0.0001***	0.0000***	0.0161*	—				
	(184)	(160)	(136)	(76)	(196)	(196)				
$P/E10_t$	—0.619261	—0.846669	—0.943791	—0.974213	—0.741928	—0.018591	1.000000			
	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.8299	—			
	(124)	(100)	(76)	(16)	(136)	(136)	(136)			
$P/BV_t$	—0.040921	0.252525	—0.161240	0.806990	0.789416	0.088929	—0.663889	1.000000		
	0.5255	0.0002***	0.0243*	0.0000***	0.0000***	0.2152	0.0000***	—		
	(243)	(219)	(195)	(135)	(244)	(196)	(136)	(255)		

**Table 2** (continued)

	$1Y_{t+k}$	$3Y_{t+k}$	$5Y_{t+k}$	$10Y_{t+k}$	$P/E_t$	$P/E5_t$	$P/E10_t$	$P/BV_t$	$RLR_t$	$RSR_t$
$RLR_t$	-0.177454 0.0055** (243)	-0.088198 0.1935 (219)	-0.162335 0.0234* (195)	-0.146614 0.0897 (135)	-0.154282 0.0159* (244)	-0.1111339 0.1203 (196)	0.102326 0.2359 (136)	-0.068086 0.2787 (255)	1.000000 – (255)	
$RSR_t$	0.078288 0.2240 (243)	0.005160 0.9395 (219)	-0.155732 0.0297* (195)	-0.040158 0.6438 (135)	-0.045683 0.4775 (244)	0.050289 0.4839 (196)	0.016953 0.8447 (136)	-0.012905 0.8375 (255)	0.074089 0.2384 (255)	1.000000 – (255)

The correlations between the variables are presented in above Table. With \*, \*\* and \*\*\* statistically significant observations are noted for significance level  $\alpha=0.05$ ,  $\alpha=0.01$  and  $\alpha=0.001$ , respectively

**Table 3** Unit root test at levels (Augmented Dickey Fuller Test)

Series	Prob	Lag	MaxLag	Obs
1YR	0.0095**	13	14	230
3YR	0.3286	0	14	219
5YR	0.6061	0	14	195
10YR	0.0835	0	12	135
P/E	0.5703	0	14	243
CAPE5	0.9421	1	14	194
CAPE	0.0856	0	12	135
P/BV	0.3162	0	15	254
RLR	0.0000***	0	15	254
RSR	0.0000***	0	15	254

ADF test in order to examine the stability of our variables is presented in above Table. With \*, \*\* and \*\*\* statistically significant observations are noted for significance level  $\alpha=0.05$ ,  $\alpha=0.01$  and  $\alpha=0.001$ , respectively. The lag order for each variable is selected according to the Schwarz Info Criterion

**Table 4** Unit root test at first differences (Augmented Dickey Fuller Test)

Series	Prob	Lag	MaxLag	Obs
D(1YR)	0.0000***	12	14	230
D(3YR)	0.0000***	0	14	218
D(5YR)	0.0000***	0	14	194
D(10YR)	0.0000***	0	12	134
D(P/E)	0.0000***	0	14	242
D(CAPE5)	0.0000***	0	14	194
D(CAPE)	0.0000***	0	12	134
D(PBV)	0.0000***	0	15	253
D(RLR)	0.0000***	3	15	250
D(RSR)	0.0000***	6	15	247

ADF test in first differences in order to examine the stability of our variables is presented in above Table. With \*, \*\* and \*\*\* statistically significant observations are noted for significance level  $\alpha=0.05$ ,  $\alpha=0.01$  and  $\alpha=0.001$ , respectively. The lag order for each variable is selected according to the Schwarz Info Criterion

The correlations between the variables are presented in Table 2. The P/E and P/BV ratios are highly positive correlated (0.65 and 0.81 respectively), while the CAPE 5 and CAPE ratios exhibit a highly negative correlation ( $-0.76$  and  $-0.97$ ) with the 10-year yields. The CAPE ratio also exhibits a high negative correlation with the 3-year and 5-year yields ( $-0.85$  and  $-0.94$  respectively). Long-term and short-term rate returns (RSR and RLR) exhibit a lower correlation with all the dependent variables.

We then proceed with an ADF test to examine the stability of our variables (Table 3). The variables 1YR, RLR and RSR are stationary, while the other variables are non-stationary, so we repeat the ADF test on the first differences, where all variables are stationary (Table 4). We then proceeded to use the Engle-Granger Test, including the relation between the Durbin-Watson statistic and the  $R^2$ , thus examining if it would be possible to use our variables in levels. Unfortunately, in all our models the residuals were non-stationary, so we would be experiencing the phenomenon of a spurious regression. Had we been able to use our variables in levels, our results could have shown the long-term relationship between our dependent and independent variables. As Asteriou and Hall (2015) point out, by converting our variables into differences, our models will be incapable of producing a unique solution to the equation for their long-term relationship. Adjusting their example to our data, if our equation is  $1YR = 0.5 \text{ CAPE}$  and the CAPE has a value of 10 then the value of 1YR yields will be equal to 5. However, taking the first differences,  $1YR_t - 1YR_{t-1} = 0.5 (\text{CAPE}_t - \text{CAPE}_{t-1})$ , even if we know that  $\text{CAPE} = 10$ , we cannot solve the equation without knowing the past values of 1YR and the CAPE—and the solution for 1YR will not be unique.

## 4.2 Regression analysis

### 4.2.1 Results

Taking the literature (Jivraj and Shiller 2017) into consideration, we were aware that in our regression models we would face the following issues: (a) our variables are not all exogenous, considering that the price ( $P_t$ ) of the Index would appear on both sides of the equation violating the OLS assumptions and (b) the residuals would appear highly autocorrelated because of the presence of overlapping data.

The above could result in increased values of the  $R^2$  which could lead to an increased predictability than the actual one and biased t-statistic values, which in turn could lead us to reject the null hypothesis of the unpredictability of our regression models. For this reason, we used the Newey-West HAC (Heteroskedasticity and Autocorrelation Covariance) estimators, which are the ones most commonly used in empirical studies containing overlapping data (Harri and Brorsen 1998; Arnott et al. 2017) to estimate more accurately the errors in both autocorrelation and heteroskedasticity.

Before using the OLS method with the HAC estimators in our models, we examine if the residuals are autocorrelated (using Breusch—Godfrey LM test) and heteroscedastic (using a White test). Half of our models exhibited autocorrelation in their residuals, while only one exhibited heteroskedasticity.

Finally, we performed a Variance Inflation Factor (VIF) test to our multiple regression models for multicollinearity. Only one of them (model 4.3.b) had a  $VIF > 2.5$ , so we rejected the independent variable RSR (which had an increased VIF value and was also not statistically significant in our model) in order to address the multicollinearity.

**Table 5** Results from simple and multiple regressions for dependent variable  $1YR_{t+k}$ 

Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup> =R <sup>2</sup> <sub>adj</sub>	
<i>MODEL 1.1.a</i> $\Delta IYR_{t+k}=\beta\Delta PE_t+\varepsilon_{t+k}$						
DPE	0.024578	0.005527	4.447182	0.0000***	0.006966	
<i>MODEL 1.2.a</i> $\Delta IYR_{t+k}=\beta\Delta CAPE5_t+\varepsilon_{t+k}$						
DCAPE5	-0.783224	0.079198	-9.889437	0.0000***	0.389211	
<i>MODEL 1.3.a</i> $\Delta IYR_{t+k}=\beta\Delta CAPE_t+\varepsilon_{t+k}$						
DCAPE	-0.915042	0.094202	-9.713574	0.0000***	0.467015	
<i>MODEL 1.3.a</i> $\Delta IYR_{t+k}=\beta\Delta PBV_t+\varepsilon_{t+k}$						
DPBV	0.015999	0.010390	1.539827	0.1249	0.003829	
Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup>	R <sup>2</sup> <sub>adj</sub>
<i>MODEL 1.1.b</i> $\Delta IYR_{t+k}=\beta_1\Delta PE_t+\beta_2\Delta RLR_t+\beta_3\Delta RSR_t+\beta_4\Delta PBV_t+\varepsilon_{t+k}$						
DPE	0.020865	0.004217	4.947600	0.0000***	0.031830	0.019035
DRLR	0.001769	0.028884	0.061237	0.9512		
DRSR	0.030133	0.006513	4.626662	0.0000***		
DPBV	0.011293	0.009352	1.207604	0.2285		
<i>Chi-Square: 50.56182    Probability: 0.0000***</i>						
<i>MODEL 1.2.b</i> $\Delta IYR_{t+k}=\beta_1\Delta CAPE5_t+\beta_2\Delta RLR_t+\beta_3\Delta RSR_t+\beta_4\Delta PBV_t+\varepsilon_{t+k}$						
DCAPE5	-0.767508	0.083593	-9.181476	0.0000***	0.394937	0.384797
DRLR	0.010170	0.021606	0.470710	0.6384		
DRSR	0.012504	0.004023	3.107847	0.0022**		
DPBV	0.005092	0.005512	0.923704	0.3569		
<i>Chi-Square: 119.9517    Probability: 0.0000***</i>						
<i>MODEL 1.3.b</i> $\Delta IYR_{t+k}=\beta_1\Delta CAPE_t+\beta_2\Delta RLR_t+\beta_3\Delta RSR_t+\beta_4\Delta PBV_t+\varepsilon_{t+k}$						
DCAPE	-0.900003	0.096125	-9.362859	0.0000***	0.471664	0.458344
DRLR	0.012074	0.020325	0.594049	0.5536		
DRSR	0.010678	0.004299	2.483916	0.0144*		
DPBV	0.002471	0.002383	1.037114	0.3018		
<i>Chi-Square: 130.8825    Probability: 0.0000***</i>						

Results of our regression analysis for each dependent variable separately. With \*, \*\* and \*\*\* statistically significant observations are noted for significance level  $\alpha=0.05$ ,  $\alpha=0.01$  and  $\alpha=0.001$ , respectively

Tables 5, 6, 7, 8 report the detailed results of our regression analysis for each dependent variable separately.

#### 4.2.2 Comparison of the models

Table 9 presents the models demonstrating statistical significance classified by  $R^2$ . The CAPE ratio appears to be a better estimator of future returns of the FTSE/ASE Large Cap, as the models in the first six places include it as an independent variable. We can also observe that its predictability increases when the dependent variables are long-term (10YR, 5YR), while it decreases when they are short-term (3YR, 1YR). The CAPE 5 ratio follows, showing the same characteristics: it can

**Table 6** Results from simple and multiple regressions for dependent variable  $3YR_{t+k}$ 

Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup> =R <sup>2</sup> <sub>adj</sub>	
<i>MODEL 2.1. <math>\alpha \Delta 3YR_{t+k} = \beta \Delta PE_t + \varepsilon_{t+k}</math></i>						
DPE	-0.008208	0.015859	-0.517549	0.6053	0.000767	
<i>MODEL 2.2. <math>\alpha \Delta 3YR_{t+k} = \beta \Delta CAPE5_t + \varepsilon_{t+k}</math></i>						
DCAPE5	-0.940039	0.100388	-9.364069	0.0000***	0.457788	
<i>MODEL 2.3. <math>\alpha \Delta 3YR_{t+k} = \beta \Delta CAPE10_t + \varepsilon_{t+k}</math></i>						
DCAPE	-1.056226	0.088820	-11.89170	0.0000***	0.593181	
<i>MODEL 2.4. <math>\alpha \Delta 3YR_{t+k} = \beta \Delta PBV_t + \varepsilon_{t+k}</math></i>						
DPBV	0.017815	0.015190	1.172840	0.2421	0.004182	
Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup>	R <sup>2</sup> <sub>adj</sub>
<i>MODEL 2.1. <math>\beta \Delta 3YR_{t+k} = \beta_1 \Delta PE_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}</math></i>						
DPE	-0.013493	0.012303	-1.095632	0.2745	0.046303	0.032209
DRLR	-0.069695	0.042681	-1.632947	0.1040		
DRSR	0.037840	0.005426	6.973995	0.0000***		
DPBV	0.015818	0.014888	1.062460	0.2893		
<i>Chi-Square: 52.91488    Probability: 0.0000***</i>						
<i>MODEL 2.2. <math>\beta \Delta 3YR_{t+k} = \beta_1 \Delta CAPE5_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}</math></i>						
DCAPE5	-0.919549	0.105015	-8.756326	0.0000***	0.472597	0.462389
DRLR	-0.064775	0.033623	-1.926501	0.0559		
DRSR	0.014847	0.002450	6.060406	0.0000***		
DPBV	0.000917	0.011428	0.080229	0.9362		
<i>Chi-Square: 320.4180    Probability: 0.0000***</i>						
<i>MODEL 2.3. <math>\beta \Delta 3YR_{t+k} = \beta_1 \Delta CAPE_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}</math></i>						
DCAPE	-1.035107	0.088279	-11.72537	0.0000***	0.607497	0.595103
DRLR	-0.056716	0.032839	-1.727081	0.0874		
DRSR	0.012657	0.001863	6.794665	0.0000***		
DPBV	-0.000969	0.005878	-0.164927	0.8694		
<i>F-Statistic 543.9501    Probability: 0.0000***</i>						

Results of our regression analysis for each dependent variable separately. With \*, \*\* and \*\*\* statistically significant observations are noted for significance level  $\alpha=0.05$ ,  $\alpha=0.01$  and  $\alpha=0.001$ , respectively

better explain long-term returns (10YR, 5YR) than short-term ones. In all the models however, the CAPE 5 and the CAPE ratio exhibit higher  $R^2$  than the P/E and P/BV ratios. From the above data we conclude that both Cyclically Adjusted ratios are better estimators of long- and short-term returns.

The P/E ratio appears to be important mainly in multiple regressions of short-term returns and in simple regressions of one-year returns, but with a very low  $R^2$ .

The P/BV index (as a standalone independent variable) does not appear at all in Table 9, since it was not statistically significant in any of the regression models and was not statistically significant in the multiple regression models either.

Short-term interest rate (RSR) returns are statistically significant in the one-, three-, and five-year models, appearing more significant in the 3YR models.

**Table 7** Results from simple and multiple regressions for dependent variable  $5YR_{t+k}$ 

Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup> =R <sup>2</sup> <sub>adj</sub>	
<i>MODEL 3.1.a</i> $\Delta 5YR_{t+k} = \beta \Delta PE_t + \varepsilon_{t+k}$						
DPE	0.012142	0.008926	1.360333	0.1754	0.000421	
<i>MODEL 3.2.a</i> $\Delta 5YR_{t+k} = \beta \Delta CAPE5_t + \varepsilon_{t+k}$						
DCAPE5	-1.009635	0.077306	-13.06017	0.0000***	0.491647	
<i>MODEL 3.3.a</i> $\Delta 5YR_{t+k} = \beta \Delta CAPE_t + \varepsilon_{t+k}$						
DCAPE	-1.109681	0.054481	-20.36817	0.0000***	0.757263	
<i>MODEL 3.4.a</i> $\Delta 5YR_{t+k} = \beta \Delta PBV_t + \varepsilon_{t+k}$						
DPBV	0.005335	0.003570	1.494342	0.1367	0.000071	
Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup>	R <sup>2</sup> <sub>adj</sub>
<i>MODEL 3.1.b</i> $\Delta 5YR_{t+k} = \beta_1 \Delta PE_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}$						
DPE	0.011424	0.008382	1.344796	0.1804	0.025939	0.009614
DRLR	-0.037065	0.038368	-0.966037	0.3353		
DRSR	0.182797	0.072295	2.528504	0.0123*		
DPBV	-0.005400	0.005220	-1.034609	0.3022		
<i>Chi-Square: 11.44261    Probability:Q    0.0220*</i>						
<i>MODEL 3.2.b</i> $\Delta 5YR_{t+k} = \beta_1 \Delta CAPE5_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}$						
DCAPE5	-0.999695	0.071484	-13.94099	0.0000***	0.500213	0.488768
DRLR	-0.023475	0.032747	-0.716848	0.4747		
DRSR	0.107422	0.070286	1.528352	0.1288		
DPBV	-0.013107	0.009302	-1.409050	0.1612		
<i>Chi-Square: 324.7891    Probability:Q    0.0000***</i>						
<i>MODEL 3.3.b</i> $\Delta 5YR_{t+k} = \beta_1 \Delta CAPE_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}$						
DCAPE	-1.197407	0.053094	-20.66917	0.0000***	0.762166	0.752116
DRLR	0.002296	0.026429	0.086874	0.9310		
DRSR	0.070258	0.082405	0.852595	0.3968		
DPBV	-0.007705	0.005574	-1.383013	0.1710		
<i>Chi-Square: 848.6803    Probability:Q    0.0000***</i>						

Results of our regression analysis for each dependent variable separately. With \*, \*\* and \*\*\* statistically significant observations are noted for significance level  $\alpha=0.05$ ,  $\alpha=0.01$  and  $\alpha=0.001$ , respectively

Long-term interest rate returns (RLR) appear statistically significant only in the 10-year return model, which does include the independent variable CAPE.

Finally, Table 10 shows us the relationship between the CAPE and future 5 and 10 year returns. The results show that high ratio values are followed by low future returns and vice versa for the preceding five and ten years. Since our data start in 1997, we are unfortunately unable to compare the CAPE ratio values with its historical average before 2008 in order to predict the financial crisis in our country. However, its value in 2007 was very high (35.40), giving us some indication of its capability.

**Table 8** Results from simple and multiple regressions for dependent variable  $10YR_{t+k}$ 

Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup> =R <sup>2</sup> <sub>adj</sub>	
<i>MODEL 4.1.a</i> $\Delta 10YR_{t+k} = \beta \Delta PE_t + \varepsilon_{t+k}$						
DPE	0.003276	0.063841	0.051317	0.9592	-0.011106	
<i>MODEL 4.2.a</i> $\Delta 10YR_{t+k} = \beta \Delta CAPE5_t + \varepsilon_{t+k}$						
DCAPE5	-0.950251	0.148615	-6.394067	0.0000***	0.487162	
<i>MODEL 4.3.a</i> $\Delta 10YR_{t+k} = \beta \Delta CAPE_t + \varepsilon_{t+k}$						
DCAPE	-0.767214	0.037095	-20.68265	0.0000***	0.633051	
<i>MODEL 4.4.a</i> $\Delta 10YR_{t+k} = \beta \Delta PBV_t + \varepsilon_{t+k}$						
DPBV	0.080575	0.071992	1.119215	0.2651	-0.009824	
Variable	Coefficient	Std. Error	t-Statistic	Prob	R <sup>2</sup>	R <sup>2</sup> <sub>adj</sub>
<i>MODEL 4.1.b</i> $\Delta 10YR_{t+k} = \beta_1 \Delta PE_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}$						
DPE	-0.046505	0.685557	-0.678345	0.4989	0.008727	-0.016263
DRLR	0.024188	0.116236	0.208092	0.8355		
DRSR	-0.154896	0.255646	-0.605902	0.5457		
DPBV	0.122271	0.073155	1.671392	0.0973		
<i>Chi-Square: 3.559664    Probability: Q    0.4689</i>						
<i>MODEL 4.2.b</i> $\Delta 10YR_{t+k} = \beta_1 \Delta CAPE5_t + \beta_2 \Delta RLR_t + \beta_3 \Delta RSR_t + \beta_4 \Delta PBV_t + \varepsilon_{t+k}$						
DCAPE5	-0.949213	0.146790	-6.466449	0.0000***	0.493599	0.472201
DRLR	-0.070379	0.135900	-0.517871	0.6062		
DRSR	-0.046350	0.136139	-0.340459	0.7345		
DPBV	0.046688	0.124155	0.376046	0.7080		
<i>Chi-Square: 104.2760    Probability:    0.0000***</i>						
<i>MODEL 4.3.b</i> $\Delta 10YR_{t+k} = a + \beta_1 \Delta CAPE_t + \beta_2 \Delta RLR_t + \beta_3 \Delta PBV_t + \varepsilon_{t+k}$						
DCAPE	-0.793539	0.039976	-19.85047	0.0000***	0.739026	0.695531
DRLR	-0.341655	0.075362	-4.533518	0.0007***		
DPBV	0.126398	0.120874	1.045697	0.3163		
<i>Chi-Square: 494.1461    Probability:    0.0000***</i>						

Results of our regression analysis for each dependent variable separately. With \*, \*\* and \*\*\* statistically significant observations are noted for significance level  $\alpha=0.05$ ,  $\alpha=0.01$  and  $\alpha=0.001$ , respectively

## 5 Concluding remarks

Based on our empirical analysis, the CAPE ratio appears to be a good estimator of future returns of the FTSE/ASE Large Cap Index. This is consistent with the results of other relevant studies such as those by Campbell and Shiller (1988), Davis et al. (2012), Bunn and Shiller (2014), Philips and Ural (2016), Klement (2012), Keimling (2016), Arnott et al. (2018) in other stock markets. Although the time span of the data is short (the FTSE/ASE Large Cap Index was established in 1997) in comparison to the data span of similar surveys, especially those for the S&P 500 Index which dates back to 1900, our results seem encouraging.



**Table 9** Regression models—ranked by  $R^2$ 

	Regression model	$R^2$ ( $R^2_{adj}$ )
(3.3.b)	$\Delta 5YR_{t+k} = \Delta CAPE_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.762166 (0.752116)
(3.3.a)	$\Delta 5YR_{t+k} = \Delta CAPE_t + \varepsilon_{t+k}$	0.757263
(4.3.b)	$\Delta 10YR_{t+k} = \Delta CAPE_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.739026 (0.695531)
(4.3.a)	$\Delta 10YR_{t+k} = \Delta CAPE_t + \varepsilon_{t+k}$	0.633051
(2.3.b)	$\Delta 3YR_{t+k} = \Delta CAPE_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.607497 (0.595103)
(2.3.a)	$\Delta 3YR_{t+k} = \Delta CAPE_t + \varepsilon_{t+k}$	0.593181
(3.2.b)	$\Delta 5YR_{t+k} = \Delta CAPE5_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.500213 (0.488768)
(4.2.b)	$\Delta 10YR_{t+k} = \Delta CAPE5_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.493599 (0.472201)
(3.2.a)	$\Delta 5YR_{t+k} = \Delta CAPE5_t + \varepsilon_{t+k}$	0.491647
(4.2.a)	$\Delta 10YR_{t+k} = \Delta CAPE5_t + \varepsilon_{t+k}$	0.487162
(2.2.b)	$\Delta 3YR_{t+k} = \Delta CAPE5_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.472597 (0.462389)
(1.3.b)	$\Delta 1YR_{t+k} = \Delta CAPE_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.471664 (0.458344)
(1.3.a)	$\Delta 1YR_{t+k} = \Delta CAPE_t + \varepsilon_{t+k}$	0.467015
(2.2.a)	$\Delta 3YR_{t+k} = \Delta CAPE5_t + \varepsilon_{t+k}$	0.457788
(1.2.b)	$\Delta 1YR_{t+k} = \Delta CAPE5_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.394937 (0.384797)
(1.2.a)	$\Delta 1YR_{t+k} = \Delta CAPE5_t + \varepsilon_{t+k}$	0.389211
(2.1.b)	$\Delta 3YR_{t+k} = \Delta P/E_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.046303 (0.032209)
(1.1.b)	$\Delta 1YR_{t+k} = \Delta P/E_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.031830 (0.019035)
(3.1.b)	$\Delta 5YR_{t+k} = \Delta P/E_t + \Delta RLR_t + \Delta RSR_t + \Delta PBV_t + \varepsilon_{t+k}$	0.025939 (0.009614)
(1.1.a)	$\Delta 1YR_{t+k} = \Delta P/E_t + \varepsilon_{t+k}$	0.006966

**Table 10** The CAPE and future 5 and 10 year returns

	CAPE <sub>t</sub>	5YR <sub>t+k</sub>	10YR <sub>t+k</sub>
2007	35.40	− 1.06	− 1.17
2008	21.26	− 0.79	− 1.00
2009	10.97	− 0.50	
2010	8.09	− 0.58	
2011	5.43	− 0.49	
2012	2.79	− 0.11	
2013	3.70	− 0.21	

The relationship between the CAPE and future 5 and 10 year returns

The relationship between the CAPE and future returns appears inversely proportional, that is, the higher the ratio, the lower the expected future returns. This inverse relationship is confirmed by the existing literature.

The biggest problem we faced in our econometric analysis, apart from the short time span of the data, was the non-stationarity of some variables. If all variables were stationary, we would have been in a position to evaluate the long-term relationship between them, but unfortunately this cannot be done, hence our conclusions apply only in the short term. Therefore, if we want to analyze the equation

of model 3.3.b which is the most statistically important one, we can predict that a 10% increase in the FTSE/ASE CAPE ratio will cause a decrease in the future 5-year returns about 11%.

P/E ratio does not appear to have a predicting ability since it was statistically significant only in future one-year returns with a very low  $R^2$ , confirming the previous studies of Aras & Yilmaz (2008), and Liem & Basana (2012). The P/BV ratio did not appear in a position to predict future returns, as it was not statistically significant in any of the models, which is opposing to the literature, since in many empirical studies the P/BV ratio appears to be a better estimator of future returns than the CAPE ratio (Keimling 2016).

Short-term interest rate returns (RSR) are statistically significant in the one-, three-, and five-year models. Based on the t-stat their ability of predicting future returns appears better in three-year returns and it remains the same if the model includes the P/E, the CAPE 5 or the CAPE. Increasing short-term returns leads to higher returns in the future. Long-term interest rate returns (RLR) are statistically significant only in model 4.3.b, in which they appear to be inversely related to future ten-year returns, but cannot predict future returns sufficiently since their t-stat value is very low. This probably happened because the Athens Stock Exchange seems to exhibit different characteristics from those observed in very developed capital markets, such as low market capitalization, market thinness, non-synchronous trading, tend to react slowly and gradually to new information and low substantial fundraising.

In conclusion, the FTSE/ASE Large CAPE ratio and its variation the CAPE 5, which use five-year real earnings, are efficient estimators of future returns. Our findings are in line with Lleo & Ziemba (2019) and Angelini et al., (2012). In addition, our empirical findings are compatible with the findings of Dimitrov & Jain (2018) and Rangvid (2017).

The limitation of the research is that the CAPE ratio is inherently backward-looking, rather than forward-looking. Another issue is that the ratio relies on GAAP earnings, which have undergone marked changes in recent years.

Our findings are inconsistent with the Efficient Market Hypothesis (EMH). When a market is efficient, both the variables we examined in our research and any other variables cannot predict future returns. As Robert Shiller (1996) himself points out about the relationship between the CAPE index and future returns "...but the strength of the association seems so strong as to suggest that this relation is not consistent with the efficient markets or random walk model".

The present study may have important implications for various market participants. Investors and portfolio managers make the most of the inferences regarding the usage of the P/E, the P/BV, the CAPE and the CAPE 5 ratios. At the same time, investors are urged to use the CAPE and the CAPE 5 ratios in order to maximize their forecasting ability. Finally, future research might have to consider whether an investor using this information, the CAPE ratio predicting capability, could achieve returns above average over time, given that the Greek stock market is not an efficient market.

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