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The Effect of Basel Regulations on Market Efficiency: The case of Greece

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Dissertation

Professor Kostas Giannopoulos

Evaluation Committee

Abstract

The aim of this paper is to provide evidence on the impact of Basel Regulations on market efficiency. The objective is accomplished by examining the weak form of efficiency of the Greek stock market using autocorrelation tests and run tests. The daily stock prices and returns for the periods of 2003 to 2007, before Basel II, and 2008 to 2012, after Basel II, are examined for three Greek banks and the market index (ATHEX).

The study results reveal that the daily return series of the three Greek banks listed in Athens Stock exchange, and market return series did not follow any predictable pattern during or before the implementation of Basel II.

Also, that all information included in the stock price in the past, are held into the current price of the stock. Thus, the impact of Basel Regulations on the opportunity of making abnormal returns based on information on past stock price is ruled out. Based on this empirical finding, several practical recommendations that should improve the market's efficiency are recommended.

KEYWORDS: EFFICIENT MARKET HYPOTHESIS ,ABNORMAL RETURNS, BASEL REGULATIONS

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Secondly, I would like to thank my husband and my friends for their patience and support during the writing of my dissertation and I give them due recognition for that.

Acknowledgement is also given to Neapolis University Paphos for giving me the opportunity to study in the field of my interest.

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Abbreviations

ACF – Autocorrelation Function

ASE – Athens Stock Exchange

AMA – Advanced Measurement Approach

BCBS – Basel Committee on Banking Supervision

BIA – Basic Indicator Approach

BIS – Bank for International Settlements

CET 1 – Common Equity Tier 1

CRD - Capital Requirements Directive

CVA – Credit Valuation Adjustment

EMH – Efficient Market Hypothesis

EBA – European Banking Authority

ECB – European Central Bank

G-10 - Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom

HI – Halloween Indicator

ICAAP - Internal Capital Adequacy Assessment Process

IRB – Internal Rating-Based

LCR – Liquidity Coverage Ratio

NSFR – Net Stable Funding Ratio

OECD – Organization for Economic Cooperation and Development

RWA – Risk Weighted Assets

RWH – Random Walk Hypothesis

STA – Standardized Approach

1. Introduction

The behaviour of the financial markets is explained by the Efficient Market Hypothesis (EMH), suggested by Fama (1970). Modern finance theory and most practical methods also use EMH for stocks valuation.

Each country has a different level of market efficiency(Lo and Mackinlay (1988), Urrutia (1995), Huang, B. (1995), Borges (2008) and many others) and the ‘’efficient market hypothesis’’ is not confirmed all times (Jensen (1978) and Malkiel (2003)) No common methodology exists, and we obtain different results.

EMH has many challenges, some of which are the empirical tests for EMH and the mathematical and statistical models for EMH that are limited. Direct tests of EMH are non-parametric.

The direction of the future price changes is better estimated when we know the relationship between the current price and the recent price changes, i.e. the prediction of future prices can be made from historical price changes. Therefore, ‘’the market is predictable and inefficient.’’ (Keane (1983, p.31))

In this study, we will examine the market efficiency under the Basel Regulations by detecting serial dependence on banks’ daily returns. According to the EMH, prices include all information and rational investors receive the correct and relevant information. Prices would change only with new information. Then, the stock returns are unpredictable.

However, financial markets behaviour could not be explained by the EMH contradictions. Thus, other theories developed like ‘’behavioral finance’’ (Kahneman and Tversky, 1979). Many researchers tried to assess the market efficiency without a solution to the problem ‘’(Peters (1994), Daw et al. (2003), Grech and Mazur (2004), Bassler et al. (2006), McCauley et al. (2007) and many others).’’

"Efficient Market Hypothesis" states that investors are rational, and prices follow a normal distribution, thus abnormal returns are not possible. Therefore, an investor might be wrong about the market, but the market is always right. A lot has been written about EMH and international financial standards and their regulations.

However, the literature for the relationship between the standards and the regulations, and their impact, is limited. In this study, we outline Basel Regulations in the concept of EMH, as an important area of research.

An effort is made to investigate the impact of Basel Accords on market efficiency. We test the serial dependence of stock returns with the "run test" and the "autocorrelation function (ACF) test". Then abnormal returns are calculated for the periods before Basel II and after Basel II.

The study will not investigate whether the Basel Accords are a solution to current and future recessions, even if Basel Accords were created by the need to avoid the bad effects of the recessions in the international banking sector.

Furthermore, we need updated information to come to a safe conclusion, and not many studies have been written for the impact of Basel Regulations on market efficiency in Greece, so the material is limited.

The Basel Accords are trusted in many countries of which some are non-members of the Basel Committee, and all banks are expected to apply the Basel Accords standards. The standards that have been applied fully or partially to the countries helped them from the negative effects of a recession.

Therefore, in this study we agree with the dominance of the Accords in the banking law, without implying that they are perfect, especially with their full implementation. Furthermore, this observation triggers the need to discuss further the efficient market hypothesis associated with the implementation of Basel III and the upcoming Basel IV.

In the weak form efficient market hypothesis, past price changes are contained in current stock prices. For this reason, "an investment decision can be made according to past prices" (Tezcanlı, 1996, p.22). Furthermore, technical analysis is not helpful to predict

future prices and it does not help investors to obtain higher returns.[1] However, it can be examined by the random walk theory.

The regulation of a business is usually driven by inconsistencies in the market and/or market failures. However, the deregulation of financial markets happened in many countries in the eighties, because cost exceeded the gain. After that, they tried to increase the market efficiency by removing the regulatory restrictions.

The Basel Accords, the Basel I and II accords, later imposed capital adequacy requirements by new regulations. Especially, when the risk exposures of the banks are high, prudential regulation is needed to transform banks' assets through credit and liquidity and to protect the overall financial system stability that might threaten even by minor disturbances.

This paper is organized into six chapters. Following this introductory chapter, Chapter 1 – Introduction, is a small review of the literature that exists on the Efficient Market hypothesis and an explanation of the research question and the importance of the study. Chapter 2 – Efficient Market Hypothesis, lays the theory and forms of EMH and introduces the relationship between EMH, behavioural finance, and abnormal returns. Chapter 3 – Basel Regulations, provides a detailed analysis of Basel I, II, and III and their historical background, Chapter 4 – Methodology and Data, provides the methods followed in this paper and describes the data used, Chapter 5 – Results, shows the results and the important findings of the study. Last, Chapter 6 – Conclusions and Recommendations, is a summary of findings, conclusions, and recommendations.

[1] "Investopedia. (2019). The Weak, Strong and Semi-Strong Efficient Market Hypotheses. [online] Available at:" "https://www.investopedia.com/ask/answers/032615/what-are-differences-between-weak-strong-and-semistrong-versions-efficient-market-hypothesis.asp."

2. The Efficient Market Hypothesis

The Efficient Market Hypothesis is a theoretical concept of financial economics. It is important as many papers were written about it; however, it remains a topic of many discussions and disagreements until today.

2.1 The Theory of Efficient Market Hypothesis[2]

The *"Efficient Market Hypothesis (EMH)"* was first explained by Eugene Fama in 1965. The term *"efficient market"* means that the share price includes all existing available information. Therefore, there is no benefit of using fundamental and technical analysis or from taking into consideration new announcements.

Also, the stocks cannot be determined if they are underpriced or overpriced and for that, it is difficult to obtain higher returns than the market. The only way to outperform the market is when you buy investments with higher risk.

Furthermore, according to the EMH, market efficiency is justified when prices respond to new information fairly and unexpectedly. This information however, which is random, does not help ''beat'' the market.

2.2 Evidence of the Efficient Market Hypothesis Theory [3]

Evidence exist in the EMH Theory, such as that the stock prices follow random walks, stock returns have a low linear correlation and are hard to predict and market is not beaten on average and almost no one can regularly beat the market

2.3 Assumptions on Market Efficiency

- The efficient market hypothesis (EMH) assumptions are that information is available to everyone and stock prices follow a random walk. Also, past prices do not affect current prices and news release happens independently of each other.[4]

[2] "http://godfreychege.blogspot.com/2014/01/efficient-market-theory-and-tests.html#more"
[3] "http://godfreychege.blogspot.com/2014/01/efficient-market-theory-and-tests.html#more"
[4] "http://godfreychege.blogspot.com/2014/01/efficient-market-theory-and-tests.html#more"

- All investors want to maximize their profits, so they adjust their portfolios to reflect new information. Sometimes prices will be undervalued and other times overvalued, but the market cannot foresee when and for which stocks this will happen.[5]
- Shares reflect all information in their market price and their value adjusts according to the new information. Therefore, the risk is also reflected in current prices and investors return will be according to the risk taken.[6]

2.4 Forms of the efficient market

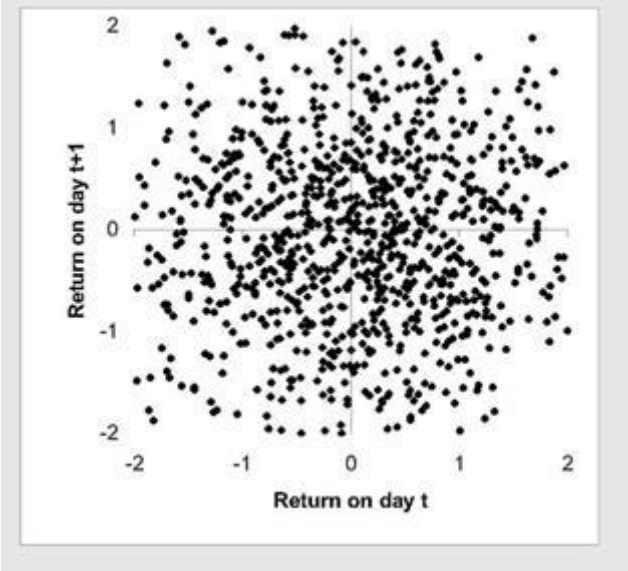
There are three forms of the efficient market hypothesis. The weak form, the semi-strong form, and the strong form which are described further below.

i. ***"Weak form of efficient market"*** [7]

In the weak form, all information in past prices is included in today's stock prices and returns and technical analysis is not helpful to investors for making trading decisions. However, the followers of the weak form efficiency suggest fundamental analysis and financial statement research can help trace underpriced and overpriced shares .

The weak form of market efficiency can be tested by checking the time series of stock returns for zero autocorrelation. This is shown in Figure 1, when the returns are not significantly related on two continuous days. The autocorrelation of the time series is then zero.

[5] "http://www.myinvestment101.com/efficient-market-assumption/"
[6] "http://www.myinvestment101.com/efficient-market-assumption/"
[7] "Haugen, R.A. (1990). Modern investment theory. [Hauptbd.]. Englewood Cliffs, Nj Prentice Hall"



''Figure 1 – Scatter diagram of the return on FTSE 100 Index on London Stock Exchange'' [8]

ii. "Semi-strong form of efficient market" [9]

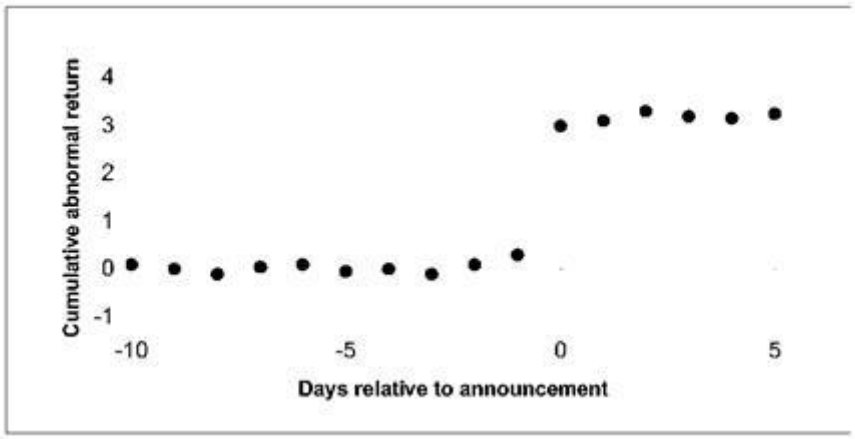
In the semi-strong form efficiency theory, the current price of a stock includes all public information, with past prices and past returns. Therefore, investors cannot obtain higher returns by using either technical or fundamental analysis and only the information that is not published may help them gain higher returns than the market.

Earnings announcements, takeover bids, etc. will affect stock prices as soon as the news is released and their impact can be seen on the abnormal returns,

"Abnormal stock return = Actual stock return – Expected stock return".

In Figure 2, the actual stock return is equal to the expected return, before the news announcement and that is why the abnormal return is 0. On day 0, the abnormal return becomes 3% on the announcement of the news. The following days, after the announcement of the news, the stock price does not have any movements.

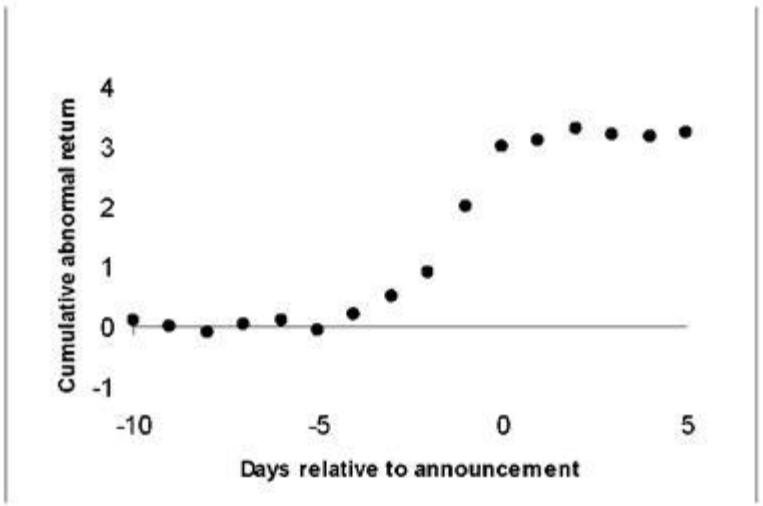
[8] "Haugen, R.A. (1990). Modern investment theory. [Hauptbd.]. Englewood Cliffs, Nj Prentice Hall"
[9] "Haugen, R.A. (1990). Modern investment theory. [Hauptbd.]. Englewood Cliffs, Nj Prentice Hall"



''**Figure 2** – Stock Price reaction to news announcement''[10]

iii. "Strong form of efficient market" [11]

"Jensen (1978)" best explained the strong form of efficient market where prices reflect all information, including ''inside information''. According to the strong form, stock prices do not change by the release of private information. In Figure 3 for example, the pattern concerns the trade on private information between two firms' merge. Before the announcement, the price increases because insiders use the private information for their benefit.



''**Figure 3** – Stock Price reaction to news announcement''[12]

[10] "Haugen, R.A. (1990). Modern investment theory. [Hauptbd.]. Englewood Cliffs, Nj Prentice Hall"
[11] "Haugen, R.A. (1990). Modern investment theory. [Hauptbd.]. Englewood Cliffs, Nj Prentice Hall"
[12] "Haugen, R.A. (1990). Modern investment theory. [Hauptbd.]. Englewood Cliffs, Nj Prentice Hall."

The efficient market hypothesis is supported by much empirical evidence; however, a lot of anomalies have been found that may question the validity of the efficient market hypothesis.

2.5 Stock Market Anomalies

Many stock market anomalies have been identified, some of which are the following:

i. "January effect"

The January-effect shows that historically, stock prices tend to go up in January, whereas in December tend to go down. This happens because investors sell their shares at the end of the year and buy new stocks in early January. Since 1982, the January effect became statistically insignificant because of the publicity it received in the financial press.[13]

ii. *"New issue puzzle"*

New stock issues are usually under-priced; however, the capital gain obtained initially often turns into losses in the long run of e.g. 5 years.

iii. "S&P Index effect"

There is a tendency for stocks to increase their share value exactly after their addition to an index (e.g. S&P500, where the index effect was first recognized)

iv. "Weekend effect"

The Weekend effect or Monday effect is a phenomenon in which stock returns are higher on Fridays and lower on Mondays. The reason for that might be that sellers buy back and reinvest as they do not want to keep their high-risk positions over the weekend.

v. "Halloween effect" [14]

The Halloween Indicator (HI) confirms May to be the signal of the beginning of a bear market. The Halloween effect is a "*stock market anomaly"* with a strategy that suggests closing your positions and walk away until October's "Halloween Effect". In theory,

[13] "Fama 1991"
[14] "Siriopoulos C., Giannopoulos P. (2006) , ''Market Efficiency in the Greek Stock Exchange: The Halloween Effect'', ''SPOUDAI'', Vol.56, No.2 (2006), University of Piraeus, pp.75-88."

from the end of October to the following May, stocks do better. (Siriopoulos C., Giannopoulos P. (2006)).

2.6 "Behavioural finance" and the EMH

According to the EMH, the market cannot be "beaten". However, Warren Buffett has outperformed the market many times. For example, if someone had invested $10k in shares of Berkshire Hathaway group in 1965, it would worth over $88m in 2017. Others too managed to outperform the market as Peter Lynch, Anthony Bolton, and others.[15]

Behavioural finance is a *"psychology-based approach"* that tries to explain the stock price changes from the investors' emotions and behaviour . Since the early 1980s, there has been an effort to add behavioural science to finance. Behavioural finance tries to explain the observed investor and market behaviour rather than mathematically correct them and to find solutions to how investors should behave.

"Behavioural finance" states that stock markets are not fully "*efficient"*. However, the efficient market hypothesis supports that people are rational investors, while behavioural finance accepts people as normal and irrational. [16]

"Cognitive psychology" describes how people think and cognitive bias is the incorrect reasoning and analysis that cause errors in decision making ,[17] even if investors want to act rationally.

"Emotional bias" happens when decisions are based on feelings and they can be irrational, and impulsive. But most important, behavioural biases are persistent and can lead to costly mistakes, as when you avoid a stock that has already outperformed or when estimates around a company are collected, "anchoring".

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[15] "Shah, A. (2017). How Behavioral Finance Can Help Investors In Today's Market. [online] ValueWalk. Available at:" "https://www.valuewalk.com/2017/06/how-behavioral-finance-can-help-investors-in-todays-market/"

[16] "Gupta, E., Preetibedi, P. and mlakra, P. (2014). Efficient Market Hypothesis V/S Behavioural Finance. IOSR Journal of Business and Management, [online] 16(4), pp.56–60. Available at:" "http://iosrjournals.org/iosr-jbm/papers/Vol16-issue4/Version-4/H016445660.pdf."

[17] "Durden, T. (n.d.). GOLDMAN: Behavioral Biases Are Found In Every Aspect Of The Investment Process. [online] Business Insider. Available at:" "https://www.businessinsider.com/goldman-sachs-behavioral-biases-2013-2"

People usually do not make the decisions that they are supposed to, and the market acts unpredictably at times. So, behavioural finance helps us to avoid the decisions that are driven by emotion and eventually lead to losses.

Some psychological and emotional biases are as below: [18]

1. *Herding*

Buying when everyone else buys (and/or when the share price is rising)

2. *Loss aversion*

Reluctance to sell losers but willingness to sell winners

3. *Mental accounts*

Unwillingness to invest in a good opportunity because you ‘’missed out already’’

4. *Status quo bias*

Reluctance to change a portfolio even if the evidence supports that change

5. *Overoptimism*

Underestimating the risks around a stock you own or recommend

6. *Recency bias*

Focusing on recent/upcoming catalysts rather than the long-run thesis

7. *Hindsight bias*

Assuming you always knew a certain outcome would happen

8. *Causal thinking*

Assuming a link between a news story and the share price performance that day

Investors’ beliefs and mindsets are created based on their emotions. Happy or sad feelings, optimistic or pessimistic mindsets, over or under-reactions encourage or discourage them from making investment decisions. Biases and emotions are crucial in influencing rational investment decisions. Behavioural Finance emphasizes that market

[18] “Montier, J.(2007), Behavioural investing: a practitioner’s guide to applying behavioural finance. Chichester, England; Hoboken,Nj: John Wiley & Sons”

outcomes are related to the investors' emotions; however, supporters of the EMH believe that emotions cannot coexist with rational decision-making. Nevertheless, emotions are the support of the behavioural finance theoretical framework.

2.7 EMH and Time Series Behaviour

A time series has properties such as the "white noise", the "random walk", the "martingale", and the "fair game", which support the EMH. If there are no arbitrage opportunities, *abnormal returns* may still exist when stock prices are wrong. But then, in an economy with rational investors, the wrongly priced shares are directly adjusted, and this is done each time there is an arbitrage opportunity. This prices property was developed by Samuelson (1965) as the random walk without drift:

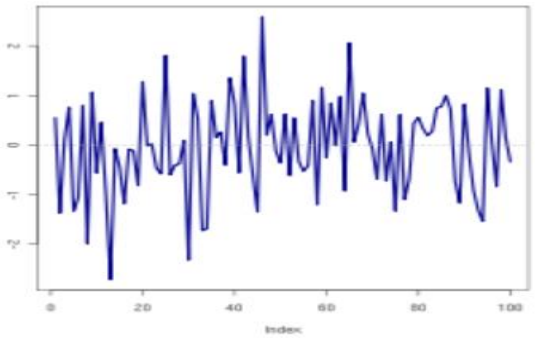
$$Y_t = Y_{t-1} + \varepsilon_t$$

and with drift (time trend):

$$Y_t = \mu + Y_{t-1} + \varepsilon_t$$

"Markov" and "martingale" properties can also be detected in random walks. Future values are independent of the past value. α is greater than zero when there is a positive drift in a random walk, and α is less than zero when there is a negative drift ,. We have a normal random walk when α is equal to zero. The "martingale property" is defined as:

$$Y_t = Y_{t-1} + \alpha + \varepsilon_t$$



''**Figure 4:** Martingale property (probability theory)''

Table 1 shows a summary of "random walk" and "martingale hypotheses" [19]

◢ **''Table 1**. Classification of Random Walk and Martingale Hypotheses''

$Cov[f(r_t), g(r_{t+k})] = 0$	$g(r_{t-k})$, $\forall g(.)$	$g(r_{t-k})$, $\forall g(.)$
$f(r_t)$, $\forall f(.)$	Linear Uncorrelated Increments Random Walk 3: $Pro_j[r_{t+k}\ r_t] = \mu$	
$f(r_t)$, $\forall f(.)$	Martingale/Fair Game: $E[r_{t+k}\ r_t] = \mu$	Independent Increments, Random Walks 1 and 2: $pd\,f[r_{t+k}\ I\ r_t] = pdf(r_{t+k})$

(Source: Campbell et al.1997, p.29)

When stock prices follow a random walk, we say that price changes are white noise. And it is the same as testing a random walk in stock prices.

If r_t is the percentage change in Y_t, then the null hypothesis, H_0 of market efficiency is formed as testing for the standard statistical properties of homoscedastic white noise process as below:[19]

$$H_0: E(rt) = 0$$
$$E(r_t r_i) = \sigma^2_r$$
$$E(r_t r_s) = 0, \forall_{t \neq s}$$

Also, when stock prices and returns cannot be predicted, the time series come up with properties implying the validity of EMH. Since the existing empirical tests show that stock prices and returns can be predicted, it can be argued that the stock prices and returns in Greece showed those properties of time series.[20]

[19] "Campbell et al. (1997, p.29)"

[20] **"**Sardar M.N. Islam, Sethapong Watanapalachaikul, Colin Clark, May 2005, ''Are Emerging Markets Efficient?'', Financial Modelling Program Centre for Strategic Economic Studies, Victoria University."

2.8 EMH and Abnormal returns

"Abnormal returns" can be earned by looking for wrongly priced stocks. The efficient market hypothesis (EMH) however, states that all stocks are correctly priced and that abnormal returns are not possible. Furthermore, future stock prices follow a random walk pattern, so they cannot be predicted.

The Small Firm effect has shown that given the higher risks, the small firms can acquire higher returns than the average for long periods of time.[21]

According to some researchers, the stock returns averages reverse. If today's stock return is low, it is expected that it will increase in the future and if today's stock return is high it is expected that it will decrease in the future.[22] This is known as the Mean Reversion effect.

These are only some examples of the market anomalies that exist. These and other inconsistencies may be reflected within the short and long term and are not investigated in this paper for the periods under examination, before and after Basel II.

[21] "Reinganum, 1983,Ritter, 1988, Roll, 1988."
[22] "Porteba and Summers, 1988, Fama and French, 1988, Kim, et. al. 1991,Engel and Morris, 1991."

3. Basel Regulations

The Beginning of Basel

Basel Committee was set up at the end of 1974, as the "Committee on Banking Regulations and Supervisory Practices", by the central-bank Governors of the Group of Ten countries during the disruption of the international currency and banking markets That was the "failure of Bankhaus Herstatt in West Germany".

The headquarters of the "Committee" are at the "Bank for International Settlements" in Basel, Switzerland and its goal is to improve the international financial stability through the supervision of the banks and to assist for the normal collaboration between its member countries on banking supervisory matters. [23]

The first meeting of the Committee was held in February 1975, and since then they meet regularly three or four times per year. The "Basel Committee on Bank Supervision" (BCBS) has established a series of international standards, Basel I, II, and III which provide recommendations on banking regulations regarding capital risk, market risk, and operational risk. Basel accords' purpose is to ensure that financial institutions have adequate capital on account to meet obligations and absorb unexpected losses. [24]

The Basel Accord was initially introduced by the "Bank for International Settlements (BIS)" to be implemented internationally. However, the BIS regulations can be modified by the United States, European Union, and countries within regions, to comply with their own regulator(s) individual requirements, given that these alterations are within the "BIS Accord". Furthermore, BCBS regulations do not have legal force. The implementation of the Accords is the responsibility of each country.

[23] "https://www.bis.org/bcbs/history.htm"
[24] "https://www.bis.org/bcbs/history.htm"

3.1 Basel I Accord

The first Basel accord was imposed to stabilize the regulation guidelines of international banks and to prevent the forceful competition between them from taking on risky assets without having the required capital base to absorb unexpected losses.

The capital under Basel I is defined based on two tiers (levels):

- *"Tier 1 (Core Capital)":* "Tier 1" capital includes issues of stocks (or shareholder equity) and reserves, such as loan loss reserves that have been put away to support future losses or for reducing income discrepancies.
- *"Tier 2 (Supplementary Capital)":* "Tier 2" capital includes of all other capital such as profits from investment assets, long-term debt with more than five years of maturity, and reserves such as additional reserves for losses on loans and leases. Short-term unsecured debts are not included in capital.

Credit risk is defined as the "risk-weighted assets", or RWA, of the bank, which are the bank's weighted assets with their relevant credit risk levels. According to Basel I, the total capital should represent at least 8% of the bank's credit risk (RWA). The three types of credit risk are:

a) The on-balance-sheet risk
b) Derivatives trading off-balance-sheet risk, such as interest rates, foreign exchange, equity derivatives, and commodities and
c) General guarantees non-trading off-balance-sheet risk, such as the assets forward purchase or transaction-related debt assets

The implementation of the capital adequacy framework was based on different risk-weights depending on asset type. However, the competition was more costly by this asset categorization as banks were required to be highly capitalized on the riskier assets in their balance sheets.

The bank asset classification system that was created was focused on credit risk and assets were classified according to the level of risk that was associated with their asset class. This classification system divided banks' assets into five risk categories of which

banks as mentioned above, had to maintain "Tier 1" and "Tier 2" capital equal to a minimum of 8% of their risk-weighted assets. [25] The risk categories are the following:

i. Cash, central bank and government debt and any OECD government debt - **0%**
ii. Public sector debt - **0%, 10%, 20% or 50%**
iii. Development bank debt, OECD bank debt, OECD securities firm debt, non-OECD bank debt, and non-OECD public sector debt, cash in the collection - **20%**
iv. Residential mortgages - **50%**
v. Private sector debt, non-OECD bank debt with a maturity over a year, real estate, plant and equipment, capital instruments issued at other banks - **100%**

To obtain the bank's total risk-weighted assets you multiply these risk weights by the asset value and then add everything together. Also, in this calculation, you need to include off-balance-sheet assets such as forwards and futures, options, and credit default swaps to prevent banks from acquiring tons of off-balance sheet assets claiming that there is no risk at all.

Another problem with the asset classification is that the risk included in the asset categories is rather random and does not automatically correspond to the actual default risk of these assets. Moreover, all banks were treated in the same manner without any consideration of their size and degree of complexity regarding asset and liability (risk) management.[26]

This ''economic'' and regulatory'' capital gap, as well as other loopholes, created an opportunity for ''regulatory arbitrage''. [27] It is not fully clear, though, whether a remaining gap between economic and regulatory capital really existed or it happened because of the banks' asymmetric information used.

3.2 Basel II Accord

Basel I criticisms led to the creation of a new Basel Capital Accord, known as Basel II, which added operational risk and defined credit risk with new calculations. Operational

[25] "Baselcompliance.net. (n.d.). Basel I Accord Requirements: Credit Risk. [online] Available at:'' ''https://baselcompliance.net/basel-i.htm"
[26] "Jones, 2000; Calem & LaCour-Little, 2004; Bergendahl & Lindblom, 2007"
[27] "Jones, 2000; Calem & LaCour-Little, 2004; Rowe, Jovic & Reeves, 2004"

risk is the risk caused by human error or management failure. The implementation of the Basel II Accord started during 2007.

The purpose of Basel II, which was initially published in June 2004 by the BCBS release of *"International Convergence of Capital Measurement and Capital Standards: A Revised Framework"*, was to create an international standard that banking regulators could use to protect banks against the risks that may face. Basel II included credit risk, market risk, and operational risk as well.

From an economic point of view, the risk assessment capability of the individual banks considered under Basel II and the reduction and closing of the gap between the capital required to manage a bank efficiently as well as the regulatory capital adequacy requirements were important reasons for developing and implementing this regulatory framework.

Basel II provided many advanced internal and external approaches for a bank to be able to assess its exposures to risk and to determine regulatory capital. However, banks and regulators faced a great challenge as to how to effectively manage the regulatory framework because of its increased flexibility. This, does not, in fact, prevent all banks from trying to gain from regulatory arbitrage.[28]

The Basel II accord had three pillars.

- ✓ *"Minimum Capital requirement"*. Credit, Market, and Operational risk are based on Risk-Weighted Assets (RWAs) and the capital that needs to be maintained is calculated through these areas for all risks.
- ✓ *"Supervisory review"* The bank's capital adequacy is monitored by the Central Bank who supervises the regulation and frameworks of managing minor bank risks.
- ✓ *"Establishing market discipline"* by the increase of the disclosures that banks must provide.

[28] "Blundell-Wignall and Atkinson, 2010"

3.2.1 Pillar 1 – Minimum Capital Requirements

The first pillar deals with the preservation of regulatory capital which is required to protect against the risks of a bank – Credit risk, Operational risk, and Market risk.

Minimum capital requirements are:

- "Tier 1 capital" ratio - 4%, consists of shareholders' equity and retained earnings
- "Core Tier 1 capital" ratio - 2%

The difference between the total capital requirement of 8% and the "Tier 1" requirement can be met with "Tier 2" capital that includes revaluation reserves, hybrid capital instruments and subordinated debt, general loan-loss reserves, and undisclosed reserves.

There are different approaches for meeting capital requirements for credit risk, market risk, and operational risk:

- "*Credit Risk"* can be calculated in three different methods as below:

a. *''Standardized Approach''* which allows a bank to use their own rating system, including their own calculations on the probability of bankruptcy, but the losses recorded are provided by the supervisory institution. The value of the firm's exposure is multiplied by an appropriate risk weight which is determined by its credit rating.
b. *''Foundation Internal Rating-Based (IRB) Approach'',* and
c. *''Advanced IRB Approach''* which banks can calculate their capital requirements based on their models, with the approval of the supervisory institution.

"Liquidity risk" is also important under this framework. It introduces the "liquidity coverage ratio (LCR)" and "net stability funding ratio (NSFR)". Many residual risks were also identified, like cybersecurity.

- "*Operational Risk"* has three different approaches:

a. *"Basic Indicator Approach (BIA)"*
b. *"Standardized Approach'' (STA)".* The "Standardized approach" uses different shares in relation to Basel I, and the financial instruments are used to limit credit risk.

c. *''Internal Measurement Approach''*, with the "Advanced Measurement Approach (AMA)" that includes:
    - Procedures for the assessment of the internal performance of its own equity
    - The responsibility for the evaluation method performed by the banks belongs to the supervisory authority
    - Improving the dialogue between bank-supervisor
    - Fast interference for the prevention of capital decrease

The regulatory capital for the *"Basic Indicator Approach"* and the *"Standardized Approach"*, is determined by the bank's average gross income multiplied by a given risk weighting.

The *"operational risk"* linked risk with the internal controls, the systems, and people, in the banking industry. It covered aspects as a fraud committed by internal or external stakeholder, failure of systems and financial losses due to a legal case or lost reputation.

However, its calculation was more difficult because of the banking assets risk. Many risk weights were identified for different categories of assets like lending portfolios and risk weights were assigned based on the asset type, ratings, and collaterals.

Further, with the ''*Internal rating-based model''*, risk weights were assigned based on the bank's evaluation on the loss given default, probability of default and recovery rates. The introduction of these methods made the risk evaluation process more precise and dynamic; however, it had a more complex calculation.

- "*Market Risk"* is allowed for

a. *''Standardized''* and b. *''Internal approaches''*.

The selected approach here is "Value at Risk (VaR)".

Each bank uses its own risk measurement system and can apply more improved and certain requirements for each asset category , obtaining lower risk capital requirements.

3.2.2 Pillar 2 – Supervisory Review Process [29]

Pillar 2 provided regulators with more improved "tools", with the power to supervise and audit the risk management system of the bank, and guidance for dealing with systemic risk. Pillar 2 requires that banks and supervisors consider the amount of additional capital that should be held against Pillar 1 risks as well as those risks not covered by Pillar 1, and act accordingly.

Risks like concentration risk, systemic risk, pension risk, strategic risk, reputational risk legal risk, and liquidity risk were merged under "residual risk". This way the banks were able to review their own risk management system. "Internal Capital Adequacy Assessment Process (ICAAP)"is the result of Pillar 2 of Basel II accords. [30]

Furthermore, regulators questioned banks for buffers ("additional capital") whenever they found the risk exposure of the bank was more than necessary. The "Supervisory Review process" stated that banks must make an assessment for their internal capital requirements and must have a strategy for maintaining capital levels.

This is known as an "Internal Capital Adequacy Assessment Process" or "ICAAP" and includes:

- Policies and procedures to identify, measure, and report on bank's risks
- Internal capital in relation to risks processes
- The bank's goals statement process in relation to capital adequacy
- Internal controls, review, and audit procedures

It is the bank's responsibility to design and develop its own plan for the ICCAP, according to its circumstances and needs, as only the principles are defined by the framework. The method must be risk-based and recognize that Pillar 1 covers to some extent the risks that put the bank in danger. A "Supervisory Review" and "Evaluation Process" is undertaken by the supervisory authority which considers the bank's ICAAP.

[29] "https://www.ibm.com/support/knowledgecenter/SSVUBL/com.ibm.ima.tut/tut/bas_imp/bas2_sum.html"
[30] "https://en.wikipedia.org/wiki/Basel_II#The_second_pillar:_Supervisory_review"

Following the review, the supervisor may issue an "Individual Capital Guidance" among other measures for the bank.

3.2.3 Pillar 3 – Disclosure & Market Discipline

The aim of Pillar 3 is to improve the market discipline by requiring from banks to disclose certain details of their risks, capital, and risk management practices like risk rating processes and risk assessment processes and therefore the *"capital adequacy"* of the institution.

Regulation is increased by "Market Discipline" since the information shared helps others like investors, customers, analysts, rating agencies and other banks to evaluate the bank. These information needs to be disclosed quarterly by internationally active banks and every six months by the national banks. Furthermore, the bank's risk exposure is known, and the risks comparability between the countries is improved.

Also, a summary of the "general risk" management objectives and policies is made annually and is disclosed within the qualitative disclosures. All disclosures need to be made under a precise policy with the bank's specific controls.

The Basel II Accord expands the risk weights and diversifies credit risk using derivative financial tools like credit default swaps, credit-linked notes, and total return swaps. The clients' expected value of loss is then measured with the use of internal models and ratings.

Therefore, not only credit risk is important. The interest rate, the volatility of the exchange rate, the capital adequacy and technical or human errors increase the risk of losses.

Basel II is a framework adopted by over 100 countries including the US. It is designed to keep the international financial infrastructure stable by the consistent application of certain standards and to ensure that all banks meet a minimum capital and risk management standards.

In early 2003, US banking regulators declared that most US banks do not have to comply with the Basel II rules, given the high cost related to the compliance and the strict

international regulation. Unfortunately, Basel II has been accepted as another regulatory burden that will create further inequities between large and ordinary banks.[31]

3.3 Basel III Accord

Basel III tries to strengthen the supervision, the risk management and the regulation of the finance and banking sector by introducing new liquidity and capital standards. It could be asserted as an expansion of the "Basel II Framework".

Basel III has more strict liquidity and capital requirements that affect banks. The costs are high, as banks are required to keep long-term funding or more liquid assets. The new regulatory framework for banks was published after the financial crisis on 12 September 2010.[32]

The members of the "Basel Committee" on "Banking Supervision" approved the Basel III Accords in 2010–2011 and were established in the period of 2013 – 2015. In April 2013, however, there were changes and the implementation was postponed by March 31, 2018. Then, the implementation date of the Basel III Accords, which were confirmed in December 2017, has been delayed until 1st January 2023. The revised market risk framework implementation was confirmed in January 2019 , but until 1st January 2023 it has also been delayed.

The Basel III Accord was developed in a response to the problems in financial regulation. It introduces new regulatory requirements on bank leverage and liquidity and reinforces the banks' capital conditions. It builds on Basel I and Basel II and seeks to improve the bank's ability to deal with economic and financial stress, to improve risk management and transparency.

It also strengthens the three pillars of Basel II , particularly Pillar 1 with higher minimum capital and improved liquidity requirements. Pillar 2 under Basel III demands a greater

[31] "www.anatbird.com.(n.d.). AnatBird.com. [online] Available at:" "http://www.anatbird.com/articles/detail.cfm?ArticleID=42"

[32] "https://hypo.org/ecbc/publication-news/basel-committee-proposes_changes-pillar 3-disclosure-rules/"

supervisory review process for risk management and capital planning. Pillar 3 under Basel III demands greater risk disclosure and market discipline.

3.3.1 The Three Pillars

Basel III continues with the "three-pillars" of Basel II and adjusts for the improvement of the banking sector. Additional capital, liquidity and leverage standards have been added to "Pillar I" for better risk management, supervision, and better regulation in the banking sector.

"Pillar II" is improved with some additional requirements for supervision and risk management.

"Pillar III" is established to make sure the minimum liquidity and capital requirements are met by the banks and has a revised set of disclosure requirements for the market discipline.

3.3.2 Pillar 1 – Minimum Capital Requirements

Basel III recommends changes to improve the banking sector in "Pillar I". Liquidity and capital requirements are included in "Pillar 1". In relation to the Basel II Accords, the capital constraints and the additional capital buffers require banks to keep extra qualitative capital.

The types of capital are:

- "Common Equity Tier (CET 1)", which is closely related to the book value of the common stock.
- "Tier I Capital", which includes options other than common equity for absorbing losses.
  i. "Tier 1 Capital Ratio" - 6%
  ii. "Core Tier 1 capital ratio" - 4.5%
- "Tier II Capital", which includes all resources like equity that are not reported elsewhere.

3.3.3 Capital Requirements

More capital buffers were added by the Basel III:

- *"Capital Conservation Buffer"*. To be able to absorb losses in future periods of stress, the financial institutions are required to have a capital conservation buffer of 2.5%, so the total common equity requirement becomes 7% (4.5% common equity and 2.5% capital conservation buffer). The capital conservation buffer must include only common equity. Restrictions are imposed to the financial institutions that do not maintain the capital conservation buffer.
- *"Countercyclical Capital Buffer"*. It is between 0% and 2.5% and includes "common equity" or other "full loss-absorbing capital". Banks with excess in credit supply must hold an additional capital buffer that serves as an extra to the "capital conservation buffer".
- *"Higher Common Equity Tier 1 (CET1)"* is 4.5% from 2% in 2010. However, from 2015, the bank must always keep a "minimum Common Equity Tier 1 (CET1)" ratio of 4.5%.
- *"Minimum Total Capital Ratio"* stays at 8%. However, the total amount of capital is increased to 10.5% of "risk-weighted assets", due to the "capital conservation buffer". 8.5% of these assets must be "Tier 1" capital. "Tier 2" capital mechanisms are harmonised, and "Tier 3" capital is removed.

No "Common Equity Tier 1" capital instruments and no "Tier 2" capital instruments are cut out over a 10 - year period since 1 January 2013. The minimum capital requirements, the higher minimums for "Common Equity" and "Tier 1" capital were passed in since 2013 but at the beginning of 2015 were taken into force.

An outline of the program is as follows:

- Beginning of 2013, the "minimum common equity" and "Tier 1" requirements increased from 2% and 4% to 3.5% and 4.5%, respectively.
- Beginning of 2014, the "minimum common equity" and "Tier 1" requirements increased to 4% and 5.5%, respectively.
- Beginning of 2015, the final requirements for "common equity" and "Tier 1" capital were placed at 4.5% and 6%, respectively.

The "minimum total capital ratio" is 12.5%, which means the "minimum Tier 2 capital" ratio is 2% and "Tier 1 capital" ratio is 10.5% in 2017. The capital requirements set by the Basel III, have been implemented by the "CRD IV package" which describes both the "EU Directive 2013/36/EU" and the "EU Regulation 575/2013".

This “Capital Requirements Regulation” for credit institutions and investment firms applies directly in Greece and the “Directive 2013/36/EU” or “Capital Requirements Directive IV”, has been implemented in Greece by statute.

3.3.4 ‘’Liquidity requirements’’ [33]

The liquidity ratios that were established by Basel III are:

- *“Liquidity Coverage Ratio (LCR)”* . It makes certain that there are enough levels of high-quality liquid assets to survive for one-month in a harsh stress scenario.
- *“Net Stable Funding Ratio (NSFR)”.* It supports financial institutions in the long-term, to finance their endeavours with more secure sources of funding.

3.3.5 Pillar 2 – Supervisory Review

After the recent financial crisis shortcomings in corporate governance activities in the financial sector were revealed. The extreme risk-taking showed that “Pillar II” was not sufficient, because there was not enough risk management.

In December 2010, with the finalization of Basel III, the supervisory review process becomes stronger with “Pillar II”. The enhanced process includes capital planning, risk management, risk appetite, corporate governance and stress testing.

The impact of Basel III internationally is monitored by the “Basel Committee” twice a year and at a European level, by the “European Banking Authority (EBA)”.

3.3.6 Pillar 3 – Market Discipline

“Pillar III” recommends disclosure requirements at a higher level, to enhance market discipline and to improve the transparency of regulatory capital. These were added to the revisions of the “Pillar 3” disclosure requirements, finalized in January 2015. Both, the revisions, and the disclosure requirements, form the enhanced and consolidated “Pillar 3” framework.[34]

[33] “https://www.bis.org/bcbs/publ/d356.htm”
[34] “https://www.bis.org/press/p160311.htm”

The suggestions include: [35]

- significant metrics addition,
- hypothetical risk-weighted assets disclosure, based on Basel's "standardized approaches", and
- better disclosure of the valuation variations.

3.3.7 Changes to Counterparty Credit Risk (CCR)

The *"counterparty default"* was covered in Basel I and Basel II. However, the Basel III accord introduced a new capital requirement for the "counterparty credit risk (CCR)" because of the deteriorated creditworthiness of the counterparty. For example, from a derivatives transaction. This mark-to-market loss is known as "CVA risk". It describes the changes in counterparty credit spreads and other market risk factors. Many unexpected bank losses occurred during the "Great Financial Crisis" due to the "CVA risk".

3.3.8 "Leverage ratio"

There is a minimum "leverage ratio" which can be derived by dividing "Tier 1 capital" with the bank's "average total consolidated assets". Under Basel II a leverage ratio of more than 3% is required by the banks. According to the US Federal Reserve Bank, however, the "minimum leverage ratio" would be 6% for 8 "SIFI banks" and 5% for their bank holding companies in July 2013. [36]

3.4 Basel III and Basel II

Figure 5 outlines the shortcomings of Basel II and the improvements made with Basel III.

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[35]"https://www.ibm.com/support/knowledgecenter/en/SSN364_8.8.0/com.ibm.ima.tut/tut/bas_imp/bas3_sum.html"

Shortcomings of Basel II	⇨	Components of Basel III
Unclear and inconsistent capital definition	⇨	Enhanced transparency, consistency and quality of capital base
Exposure to some risk not addressed (e.g. re-securitization etc.)	⇨	Risk coverage includes securitisations, off BS items and CCR
Inadequate treatment of Liquidity Risk	⇨	Enhanced liquidity standards including LCR & NSFR
Excessive BS growth despite relatively small levels of capital	⇨	Leverage ratio introduced as a risk-invariant measure of BS growth
Causes pro-cyclical amplification of shocks in financial sector	⇨	Adoption of measures to counteract pro-cyclicality

Source: (Edu-Pristine, 2011)

''Figure 5 – Basel III improvements over Basel II''[37]

3.5 EU Directives

Basel Committee has no legal authority even if it creates international supervisory standards and guidelines. However, most of Basel III is applied through direct regulation. The first "*Capital Requirements Directive (CRD)"* that implemented Basel II throughout the EU came into force in June 2006. Since then, the legal framework has been regularly updated to reflect revisions to Basel II with a series of changes, which are numbered for easy reference.

The second directive amendments, "*CRD II"***,** are effective from the end of 2010. The third directive amendments, "*CRD III",* for capital changes, are effective from the end of 2011, and for other aspects are effective from the start of 2011.

Finally, the fourth directive amendments, "*CRD IV"*, employ certain Basel III proposals, mostly those regarding the "capital conservation" and "counter-cyclical buffers". However, the most significant part of Basel III / *"CRD IV "*is applied by direct regulation, without the need to be written into national law.

[37] ''Edu-Pristine, 2011''

4. Data and Methodology

4.1. Data

In this paper, we have used daily stock prices retrieved from "Yahoo Finance" and returns, for the period of 2003 – 2012, for approximately 2550 observations for each bank. The data are separated into two Sub-Periods. Sub-Period I before Basel II, from 2003 – 2007, and Sub-Period II after Basel II, from 2008 – 2012. The data sets are consisting of a time series analysis of the closing daily returns of three representative Greek banks, the National Bank of Greece, Piraeus Bank, and Alpha Bank, listed on the Greek Stock Market and supervised by the Central Bank of Greece. The daily rate of return was derived by the formula:

$$RT_t = Ln\left(\frac{\Pr_t}{\Pr_{t-1}}\right) \quad (1)$$

Where:

$\Pr_t$ = closing price

$\Pr_{t-1}$ = previous day closing price

L_n = natural logarithm

4.2 Methodology

Our research problem is to investigate whether the stock prices of the three representative banks, the National Bank of Greece, Piraeus Bank, and Alpha Bank are predictable or not during the implementation of Basel Accords, and more specifically during Basel II. The *"serial dependence"* of these stocks is examined by different parametric and non-parametric methods as autocorrelation tests, run test and unit root tests. Then, the abnormal returns are calculated for the Total Period of 2003-2012, the Sub-Period I, 2003-2007, and the Sub-Period II, 2008-2012.

The investigation is performed for the three periods separately, to analyse the impact of Basel II on market efficiency. Many studies have used *"autocorrelation and run tests"*

to examine the randomness in asset prices. [38] Previous studies of the Athens Stock Exchange examined the weak form of efficient market hypothesis which implies that historical stock prices cannot be utilized to predict future prices, and stock price changes are random and serially independent.

4.2.1 The Autocorrelation test

"Autocorrelation" exists when the prices in time series can be predicted from their historical prices. In this case, there is a similarity between the observations and the time lag between them. "*Serial correlation"* and "*serial dependence"* are also referred to as autocorrelation. A model may be wrong when there is autocorrelation in the residuals. The subtracted standard errors, and therefore p-values, are misleading. Furthermore, "*autocorrelation"* can be detected by using a "*correlogram* (*ACF plot*)".

In this paper, the *"autocorrelation function test (ACF)"* is employed on the daily returns of the National Bank of Greece, Piraeus Bank, Alpha Bank, and the Market Index and is given by the formula:

$$\rho_k = \sum_{t=1}^{n-k} (RT_t - \overline{RT})(RT_{t+k} - \overline{RT}) / \sum_{t=1}^{n} (RT_t - \overline{RT})^2 \qquad (2)$$

Where:

k = lags number

r = actual rate of return

The actual rate of return is calculated as:

$$RT_t = \ln\left(\frac{\mathrm{Pr}_t}{\mathrm{Pr}_{t-1}}\right) \times 100 = \alpha + \mu \qquad (3)$$

[38] ''Harper and Jin, 2012; Harper and Jin, 2013''

The *"autocorrelation test"* investigates the *"serial correlation"* coefficients' significance. The null hypothesis is rejected when the stock returns are serially correlated. Furthermore, the "Ljung–Box (Q) statistic" is used to test the *"joint hypothesis"*[39] that all autocorrelations are significantly different from zero.

$$Q_{LB} = n(n+2)\sum_{t=1}^{k}(\rho_t^2 / n-t) \qquad (4)$$

k = lag length

n = sample size

4.2.2 Unit Root Tests

The stationarity of the stock returns is required for the random walk hypothesis and can be tested by the Unit Root tests. Therefore, we use the parametric test *"Augmented Dickey-Fuller"*, and the nonparametric test *"Phillips-Peron (PP)"* unit root test. The *"ADF test"* is computed by the following equation:

$$\Delta RT_t = \alpha_0 + \alpha_1 RT_{t-1} + \alpha_2 T + \sum_{T=1}^{n} \alpha_i \Delta RT_{t-i} + \varepsilon_t \qquad (5)$$

Where:

RT_t = time series

$\alpha_1 = 0$, the null hypothesis of the unit root test

t = time trend

Δ = first difference operator

t_ε = the error term with zero mean and constant variance.

The *"ADF t-statistic"* was amended by Z_t statistic which made a correction to the *"serial correlation"* and conditional heteroskedasticity in the errors $t_{\varepsilon.}$ [40] The *"Phillips and Perron"* test is estimated by the following equation. [41]

[39] "Fama, 1976"
[40] "Phillips and Perron,1987"
[41] "Campbell and MacKinlay,1997"

$$\Delta RT_t = \alpha + \beta(RT_{t-1}) + \varepsilon_t \qquad (6)$$

The critical values for the *"Phillips–Perron"* test remain the same as those for the *"Augmented Dickey–Fuller"* test. [42]

4.2.3 Run Test

The *"serial dependence"* in the stock returns is tested by the Run test which investigates the randomness of the data. It is non-parametric, and it is an alternative test for testing autocorrelation in time series. The null hypothesis states that our sample stock returns are *"serially independent"* and *"random"*. If the expected number of runs is different from the actual number of runs then the null hypothesis of randomness is rejected.

We can estimate the expected number of runs as follows:

$$\eta = N(N+1) - \sum_{i=1}^{3} n_i^2 \Big/ N \qquad (7)$$

Where:

N = the sample size

n_i = total number of price changes (returns)

The run test assumes that the mean and variance are constant, and the probability is independent. Also, when we have more than 30 observations the distribution of η becomes almost normal with standard deviation (σ_η) for runs:

$$\sigma_\eta = \left[\sum_{i=1}^{3} \left[\sum_{i=1}^{3} n_i^2 + N(N+1) \right] - 2N\left(\sum_{i=1}^{3} n_i^3 - N^3\right) \Big/ N^2 (N-1) \right]^{1/2} \qquad (8)$$

Then, we can apply the standard normal Z- statistics for a run test with this formula:

$$Z = (r \pm 0.05 - \eta) / \sigma_\eta \qquad (9)$$

[42] "Hamilton, 1994, chap. 17"

Where:

r = actual number of runs

η = expected number of runs

The consistency between the actual number of runs and the hypothesis of independence, H_0, can be examined by the standard normal Z-statistic, "$Z = (R-m)/ \sigma_m$". When the actual number of runs is more or is less than the expected number of runs, the Z value becomes positive or negative and implies respectively, a negative or positive *"serial correlation"* in the return series. [43] .

4.2.4 Abnormal Returns

Abnormal returns are calculated by deducting the returns that would have been realized from the actual returns of the stocks. Normal returns must be estimated, but actual returns can be empirically observed.

In this paper, we calculate abnormal returns given the assessment and supervision of the implementation of Basel II by the *"Basel Committee"*. We examine Sub-Period I, 2003-2007, before Basel II and Sub-Period II, after Basel II to extract possible abnormal returns.

Important issues, like which banks will be most affected, in which periods stock prices will change the most, as to their size and extent, have not had the necessary quantitative evidence.

The abnormal rate of return subtracts the market return from the return of the specific security as follows:

$$AR_{it} = R_{it} - R_{mt}$$

[43] "Abraham et al., 2002"

Where

AR_{it} = abnormal rate of return on security i during period t

R_{it} = rate of return on security i during period t

R_{mt} = rate of return on a market index during period t

It can be adjusted to show the expected rate of return for the stock, based on the market rate of return and the stock's relationship with the market. Then, instead of using the market rate of return, we use the expected rate of return on the stock . Then, the abnormal rate of return becomes: [44]

$$AR_{it} = R_{it} - E(R_{it})$$

Where

$E(R_{it})$ = the expected rate of return for stock i during period t based on the market rate of return and the stock's normal relationship with the market (its beta)

In other words, the

"Expected Return = Risk-free rate + beta x (Market Return – Risk-free rate)"

This is the formula to calculate the stock's expected return under the Capital Asset Pricing Model (CAPM).[45]

In this paper, for the purpose of obtaining the "*abnormal returns"* during Sub-Period I (2003- 2007) and Sub-Period II (2008-2012), we will use the first example by adjusting it for the average abnormal returns, average stock return, and average market return.

"Abnormal returns" can be positive or negative, and they define the performance for the risk taken. Also, certain improvements can be made as significance tests should be taken further.

[44] "Blajer-Gołębiewska, A. (2012). Stock Exchanges Indices and Abnormal Returns in the Crisis Condition. Journal of International Studies, 5(2), pp.9–17."

[45] **"**Staff, M.F. (2016). How to Calculate Abnormal Returns with Stock Prices and S&P 500 Data.The Motley Fool. Available at:" "https://www.fool.com/knowledge-center/how-to-calculate-abnormal-returns-with-stock-price.aspx"

5. Results

This chapter will present the findings and analyse the results from the tests employed following the methods mentioned in Chapter 4.

5.1 Descriptive Statistics

We have computed the descriptive statistics from the daily rate of returns of the National Bank of Greece, Piraeus Bank and Alpha Bank, as well as of the Market Index (ATHEX). The results are presented in Tables 2, 3, and 4 for Sub-Period I, before the Basel II implementation, for Sub-Period II, after the Basel II implementation, and for the total period of 2003 – 2012.

Table 2: Descriptive statistics for daily returns – Sub-Period I (2003 – 2007)

	National Bank of Greece	*Piraeus Bank*	*Alpha Bank*	*Index (ATHEX)*
Obs	1303	1302	1299	1287
Mean	0.0008797	0.0008359	0.0006174	0.0009148
Std. Dev	0.0626368	0.0172604	0.0220896	0.0110148
Min	-0.5229425	-0.1291487	-0.3450769	-0.0634561
Max	0.5257164	0.1157985	0.1475201	0.0535635

Table 3: Descriptive statistics for daily returns – Sub-Period II (2008 – 2012)

	National Bank of Greece	*Piraeus Bank*	*Alpha Bank*	*Index (ATHEX)*
Obs	1249	1249	1248	1247
Mean	-0.0027325	-0.0029397	-0.0021959	-0.0017112
Std. Dev	0.0483933	0.05153	0.0529673	0.0265819
Min	-0.2330939	-0.2503842	-0.2158911	-0.1020746
Max	0.2557013	0.2619169	0.2623628	0.1609659

Table 4: Descriptive statistics for daily returns – Total Period (2003 – 2012)

	National Bank of Greece	*Piraeus Bank*	*Alpha Bank*	*Index (ATHEX)*
Obs	2552	2551	2547	2534
Mean	-0.0007252	-0.0008359	-0.0007621	-0.00038
Std. Dev	0.055413	0.038155	0.0403206	0.0202848
Min	-0.5229425	-0.2503842	-0.3450769	-0.1020746
Max	0.5257164	0.2619169	0.2623628	0.1609659

5.2 ACF Results of Daily Returns

We use the *"serial autocorrelation (ACF)"* test, and *"Ljung-Box Q"* to investigate the randomness of the returns. The results are presented in Tables 5 – 13. We have included 6 lags for the autocorrelation tests, as per the *"Akaike criterion"* for *daily* returns.

The autocorrelation coefficient which is also presented in Tables 5 - 13 confirms the significance of the autocorrelation for the daily stock returns. The results of both *"Ljung -Box Q"* statistics and the non-zero autocorrelation for the returns series at a 99% confidence interval, are jointly significant at an 1% significance level. This also confirms that returns do not follow a random walk.

Table 5: Autocorrelation and Q-Statistics for daily returns for National Bank of Greece – Sub-Period I (2003 – 2007)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	-0.2022	-0.2493	53.415	0.0000		
2	-0.1436	-0.3304	80.358	0.0000		
3	-0.0344	-0.1808	81.905	0.0000		
4	-0.0090	0.0902	82.01	0.0000		
5	-0.0067	.	82.069	0.0000		
6	-0.0334	.	83.53	0.0000		

Table 6 : Autocorrelation and Q-Statistics for daily returns for National Bank of Greece – Sub-Period II (2008 – 2012)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0175	0.0216	.38275	0.5361		
2	-0.0592	-0.1072	4.7811	0.0916		
3	-0.0111	0.0183	4.9347	0.1766		
4	-0.0461	-0.1573	7.6038	0.1072		
5	0.0162	.	7.935	0.1599		
6	0.0228	.	8.5867	0.1982		

.

Table 7 : Autocorrelation and Q-Statistics for daily returns for National Bank of Greece – Total Period (2003 – 2012)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	-0.1624	-0.2061	67.337	0.0000		
2	-0.0402	-0.1031	71.457	0.0000		
3	-0.0529	-0.1063	78.604	0.0000		
4	-0.0962	-0.0512	102.25	0.0000		
5	0.0316	.	104.8	0.0000		
6	0.0165	.	105.49	0.0000		

Table 8 : Autocorrelation and Q-Statistics for daily returns for Piraeus Bank – Sub-Period I (2003 – 2007)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0372	0.0456	1.8048	0.1791		
2	-0.0233	-0.0346	2.5119	0.2848		
3	-0.0292	-0.0751	3.6295	0.3044		
4	0.0113	-0.0241	3.797	0.4342		
5	0.0379	.	5.6755	0.3391		
6	0.0045	.	5.7016	0.4574		

Table 9: Autocorrelation and Q-Statistics for daily returns for Piraeus Bank – Sub-Period II (2008 – 2012)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0463	0.0593	2.6867	0.1012		
2	-0.0460	-0.0820	5.3383	0.0693		
3	-0.0160	0.0147	5.6589	0.1294		
4	-0.0394	-0.1411	7.6106	0.1069		
5	0.0325	.	8.9344	0.1117		
6	0.0243	.	9.6786	0.1389		

Table 10: Autocorrelation and Q-Statistics for daily returns for Piraeus Bank – Total Period (2003 – 2012)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0478	0.0608	5.8342	0.0157		
2	-0.0385	-0.0696	9.6167	0.0082		
3	-0.0106	0.0177	9.9066	0.0194		
4	-0.0347	-0.1276	12.977	0.0114		
5	0.0306	.	15.367	0.0089		
6	0.0252	.	16.994	0.0093		

Table 11: Autocorrelation and Q-Statistics for daily returns for Alpha Bank – Sub-Period I (2003 – 2007)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0034	0.0052	.01475	0.9033		
2	-0.0209	-0.0515	.58395	0.7468		
3	0.0203	0.0221	1.1182	0.7727		
4	-0.0266	-0.0906	2.0398	0.7284		
5	0.0101	.	2.1719	0.8249		
6	-0.0322	.	3.527	0.7404		

Table 12: Autocorrelation and Q-Statistics for daily returns for Alpha Bank – Sub-Period II (2008 – 2012)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0572	0.0687	4.098	0.0429		
2	-0.0460	-0.0820	6.7477	0.0343		
3	-0.0224	-0.0025	7.3756	0.0608		
4	-0.0526	-0.1228	10.85	0.0283		
5	0.0492	.	13.886	0.0164		
6	0.0739	.	20.747	0.0020		

Table 13: Autocorrelation and Q-Statistics for daily returns for Alpha Bank – Total Period (2003 – 2012)

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.0532	0.0638	7.2228	0.0072		
2	-0.0397	-0.0696	11.24	0.0036		
3	-0.0186	-0.0033	12.127	0.0070		
4	-0.0514	-0.1092	18.88	0.0008		
5	0.0491	.	25.042	0.0001		
6	0.0574	.	33.446	0.0000		

Figures 5, 6, 7, 8, 9, and 10 show the correlograms of the autocorrelation and partial correlation function of the returns of National Bank of Greece, Piraeus Bank, and Alpha Bank during 2003 – 2007, before Basel II (Sub-Period I) and during 2008 – 2012, after Basel II (Sub-Period II).

A "*correlogram"* illustrates the correlation of a series of data with itself; it is also known as an "*autocorrelation plot"* and an "*ACF plot"*. The *lag* is the order of correlation. At lag 0, the correlation is 1, as the data is correlated with itself.

a) <u>National Bank of Greece</u>

At a lag of 1, during the Sub-Period I, before Basel II, the correlation is shown as being around -0.20. We can also see that we have negative correlations for the points apart. During the Sub-Period II, after Basel II, the correlation is positive at lag 1, around 0.02. Then, it is negative for the next 3 points and becomes again positive for the last 2 points.

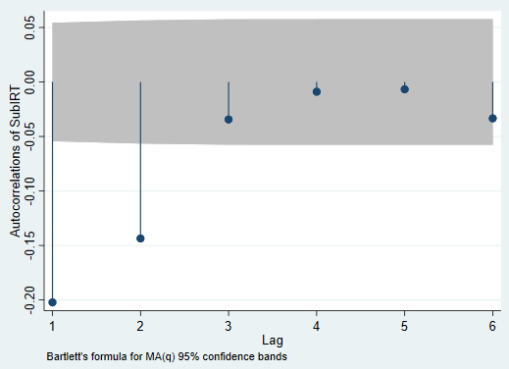

Figure 6: Correlogram NBG
Sub-Period I, 2003 – 2007

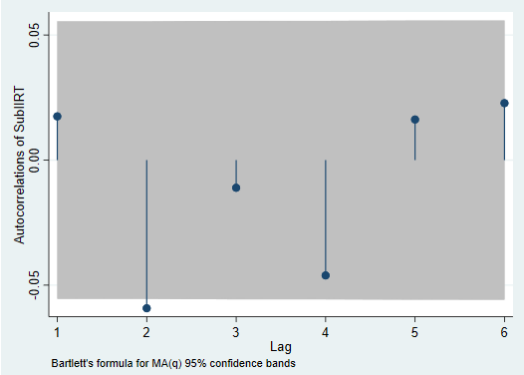

Figure 7: Correlogram NBG
Sub-Period II, 2008 – 2012

b) <u>Piraeus Bank</u>

At a lag of 1, during the Sub-Period I, before Basel II, the correlation is shown as being around 0.03. Then we have negative correlations for the next 2 points and becomes again positive for the last 3 points. During the Sub-Period II, after Basel II, the correlation is positive at lag 1, around 0.04. Then, it is negative for the next 3 points and becomes again positive for the last 2 points.

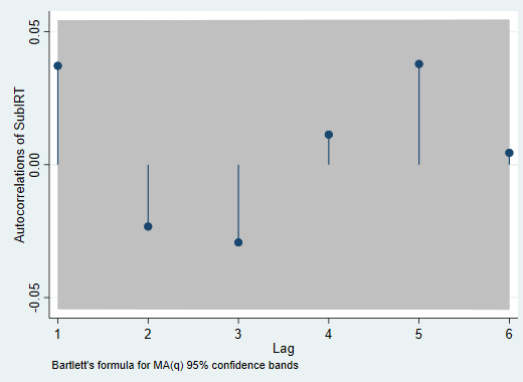

Figure 8: Correlogram Piraeus Bank Sub-Period I, 2003 – 2007

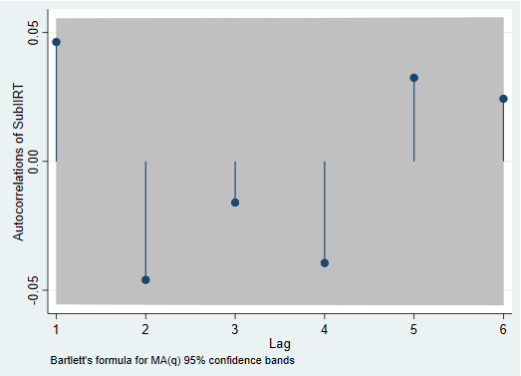

Figure 9: Correlogram Piraeus Bank Sub-Period II , 2008 – 2012

c) <u>Alpha Bank</u>

At a lag of 1, during the Sub-Period I, before Basel II, the correlation is shown as being around 0.01. At point 2 there is a negative correlation, then at point 3 is positive, at point 4 negative, at point 5 positive, and finally at point 6 again negative. During the Sub-Period II, after Basel II, the correlation is positive at lag 1, around 0.06. Then, it is negative for the next 3 points and becomes again positive for the last 2 points.

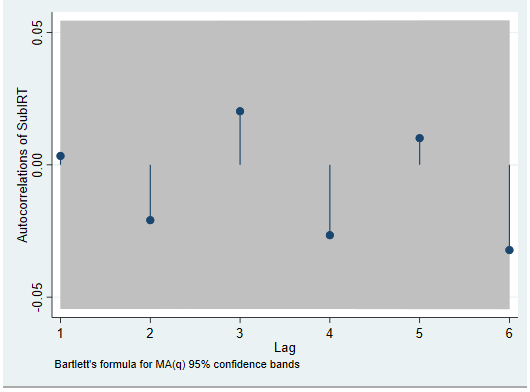

Figure 10: Correlogram Alpha Bank Sub-Period I, 2003 – 2007

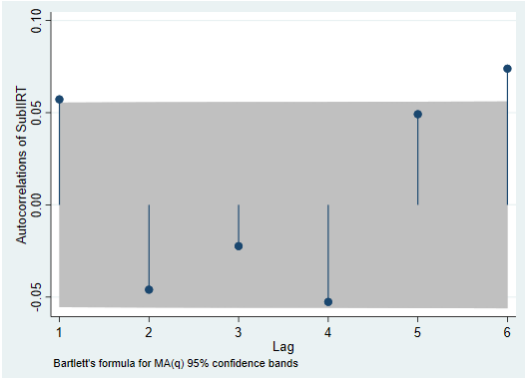

Figure 11: Correlogram Alpha Bank Sub-Period II , 2008 – 2012

According to the results and as seen from the diagrams above, there are movements of autocorrelation at various lags that drift around positive and negative numbers. Although some numbers are significant at conventional levels, they should not be over-interpreted. Correlations about 0.02 do not imply much predictive ability.

5.3 Run tests results of daily prices

The Run tests results are stated in Tables 14 to 16.

Table 14: Run tests for daily prices – Sub-Period I (2003 – 2007)

	National Bank of Greece	*Piraeus Bank*	*Alpha Bank*	*Index (ATHEX)*
Observed no. of runs	16	8	34	16
Expected no. of runs	651	651	623	386
Positive	625	679	515	236
Negative	678	624	784	1051
Test value (Z)	-35.2782	-35.7223	-34.1427	-34.5101

Table 15: Run tests for daily prices – Sub-Period II (2008 – 2012)

	National Bank of Greece	*Piraeus Bank*	*Alpha Bank*	*Index (ATHEX)*
Observed no. of runs	13	23	23	9
Expected no. of runs	599	576	576	331
Positive	754	801	799	196
Negative	495	448	449	1051
Test value (Z)	-34.6467	-34.0041	-33.9912	-34.4962

Table 16: Run tests for daily prices – Total Period (2003 - 2012)

	National Bank of Greece	*Piraeus Bank*	*Alpha Bank*	*Index (ATHEX)*
Observed no. of runs	28	14	14	16
Expected no. of runs	1266	1242	1268	1231
Positive	1397	1488	1181	1483
Negative	1155	1064	1366	1051
Test value (Z)	-49.4486	-49.9984	-49.9598	-49.7355

At the 0.05 significance level, the actual number of runs is considerably smaller than the expected number of runs during the reporting periods. Then, the coefficient (Z) becomes negative and implies a positive serial correlation.

The ACF and run tests are similar, as both tests produce positive autocorrelation. However, the run test produces much stronger positive autocorrelation evidence for the data.

Based on all results, all tests verify that the stock returns of the representative banks series are not random. Therefore, our data show a predictable (or non-random walk) behaviour, i.e. on a weak form efficiency level, therefore, we reject the null hypothesis, H_0.

5.4 Unit Root test Results

The *"Augmented Dickey-Fuller"* for unit root and the *"Phillips – Perron"* test for unit root have been contacted for the Unit Root tests for Sub-Period I 2003- 2007 and Sub-Period II 2008 – 2012, respectively, as follows:

5.4.1 Augmented Dickey-Fuller for unit root

a) *National Bank of Greece*

Dickey-Fuller test for unit root — Number of obs = 976

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-43.586	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

D.SubIRT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SubIRT L1.	-1.302999	.0298947	-43.59	0.000	-1.361665	-1.244334
_cons	.0022615	.0017621	1.28	0.200	-.0011965	.0057195

Dickey-Fuller test for unit root — Number of obs = 976

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-33.148	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

D.SubIIRT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SubIIRT L1.	-.9784116	.0295166	-33.15	0.000	-1.036335	-.9204881
_cons	-.0017854	.0014831	-1.20	0.229	-.0046958	.001125

In Sub-Period I, before the implementation of Basel II, we see a negative test statistic about -44, away beyond the 1% critical value. The null hypothesis $\alpha_1 = 0$ of stationary time series is rejected well beyond the 1% significance level for 99% confidence.

In Sub-Period II, after the implementation of Basel II, we see again a negative test statistic about -33, away beyond the 1% critical value. The null hypothesis is rejected again beyond the 1% significance level for 99% confidence.

b) Piraeus Bank

Dickey-Fuller test for unit root — Number of obs = 976

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-31.580	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

D.SubIRT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SubIRT L1.	-.9614145	.0304441	-31.58	0.000	-1.021158	-.9016708
_cons	.001443	.0005398	2.67	0.008	.0003837	.0025023

Dickey-Fuller test for unit root — Number of obs = 976

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-30.969	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

D.SubIIRT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SubIIRT L1.	-.9407207	.0303763	-30.97	0.000	-1.000331	-.8811102
_cons	-.0017509	.0015834	-1.11	0.269	-.0048581	.0013563

In Sub-Period I, before the implementation of Basel II, we see a negative test statistic about -32, away beyond the 1% critical value. The null hypothesis of the stationarity of the stock returns is rejected beyond the 1% significance level for 99% confidence.

In Sub-Period II, after the implementation of Basel II, we see again a negative test statistic about -31, away beyond the 1% critical value. The null hypothesis is rejected again beyond the 1% significance level for 99% confidence.

c) *Alpha Bank*

Dickey-Fuller test for unit root — Number of obs = 975

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-26.628	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

D.SubIRT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SubIRT L1.	-.9962805	.0374152	-26.63	0.000	-1.069704	-.9228566
_cons	.0010065	.0007226	1.39	0.164	-.0004116	.0024246

Dickey-Fuller test for unit root — Number of obs = 975

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-31.782	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

D.SubIIRT	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SubIIRT L1.	-.9313074	.0293033	-31.78	0.000	-.9888124	-.8738024
_cons	-.0014352	.0016086	-0.89	0.373	-.004592	.0017216

In Sub-Period I, before the implementation of Basel II, there is a negative test statistic about -27, away beyond the 1% critical value. The null hypothesis of the stationarity of the stock returns is rejected beyond the 1% significance level for 99% confidence.

In Sub-Period II, after the implementation of Basel II, we see again a negative test statistic about -32, away beyond the 1% critical value. The null hypothesis is rejected again at 1% significance level for 99% confidence.

5.4.2 Phillips – Perron test for unit root

The results contacted for the Phillips - Perron tests for Sub-Period I 2003- 2007 and Sub-Period II 2008 – 2012, respectively, are as follows:

a) *National Bank of Greece*

Phillips-Perron test for unit root — Number of obs = 1018, Newey-West lags = 6

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(rho)	-1120.351	-20.700	-14.100	-11.300
Z(t)	-48.472	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

Phillips-Perron test for unit root — Number of obs = 976, Newey-West lags = 6

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(rho)	-955.838	-20.700	-14.100	-11.300
Z(t)	-33.143	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

b) *Piraeus Bank*

Phillips-Perron test for unit root — Number of obs = 1017, Newey-West lags = 6

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(rho)	-971.717	-20.700	-14.100	-11.300
Z(t)	-31.914	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

Phillips-Perron test for unit root — Number of obs = 976; Newey-West lags = 6

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(rho)	-898.162	-20.700	-14.100	-11.300
Z(t)	-31.009	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

c) *Alpha Bank*

Phillips-Perron test for unit root — Number of obs = 1013; Newey-West lags = 6

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(rho)	-952.709	-20.700	-14.100	-11.300
Z(t)	-26.835	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

Phillips-Perron test for unit root — Number of obs = 975; Newey-West lags = 6

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(rho)	-880.843	-20.700	-14.100	-11.300
Z(t)	-31.913	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

Just as in *"Augmented Dickey-Fuller"* for unit root test, in *"Phillips-Perron"* test we reject the null hypothesis of a unit root at all common significance levels. The interpolated critical values for Z_t differ slightly from those shown in the *"Augmented Dickey-Fuller"* for unit root test, because the sample sizes are different. Some observations are missing with the *"Augmented Dickey–Fuller"* regression, because of the difference inclusion (Δ) of lagged terms as regressors.

5.5 Abnormal Returns results

Before deriving the abnormal returns for the selected periods it seems important to overview the average returns for Sub-Period I, before Basel II from 2003 – 2007, Sub-Period II, after Basel II from 2008 – 2012, and for the Total Period of 2003 – 2012. That is the average returns of five, five and ten years respectively as shown in Figure 12.

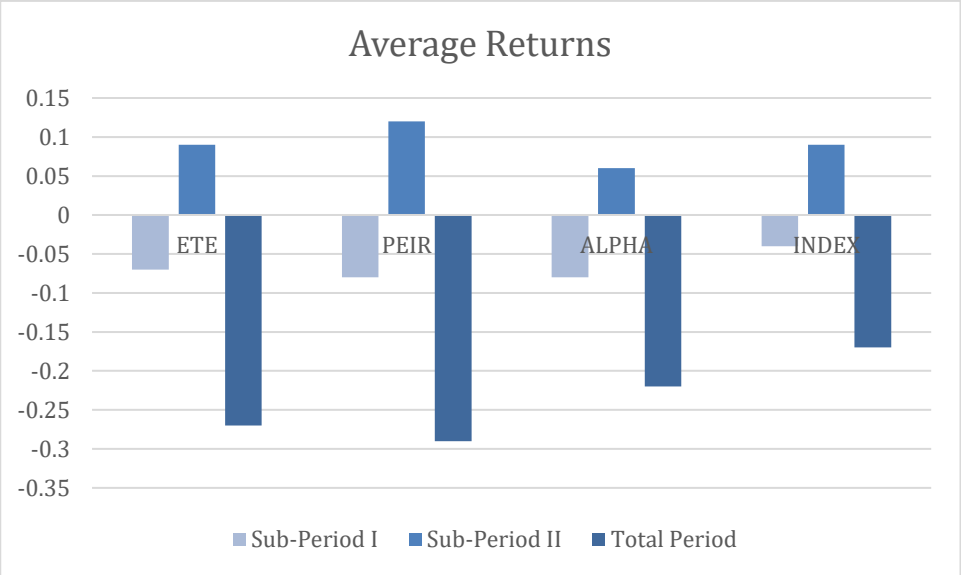

Figure 12: Average Returns

Sub-Period I which concerns the years 2003 – 2007 resulted in average *losses* for the three banks under study and the Market Index. During this period, the Basel II Accord was not yet implemented.

Sub-Period II which concerns the years 2008 – 2012 resulted in average *profits* for the three banks under study and the Market Index. During this period, the Basel II Accord was implemented.

For the 10-year Total Period of 2003 – 2012 average *losses* were occurred.

a) *National Bank of Greece*

The stock of the National Bank of Greece experienced a -7% average negative return in Sub-Period I while Sub-Period II had a 9% average profit. The Market Index experienced -4% and 9% average returns respectively for the two periods.

b) Piraeus Bank

The stock of Piraeus Bank experienced a -8% average negative return in Sub-Period I, while Sub-Period II had a 12% average profit. The Market Index experienced -4% and 9% average returns respectively for the two periods.

c) Alpha Bank

The stock of Alpha Bank experienced a -8% average negative return in Sub-Period I, while in Sub-Period II had a 6% average profit. The Market Index experienced -4% and 9% average returns respectively for the two periods.

The Average Abnormal Return (AAR) was calculated by the formula AAR = Average Stock Return – Average Market Return for the Sub-Period I from 2003 – 2007, the Sub-Period II from 2008 – 2012, and the Total Period from 2003 – 2012. The results are presented in Figure 13.

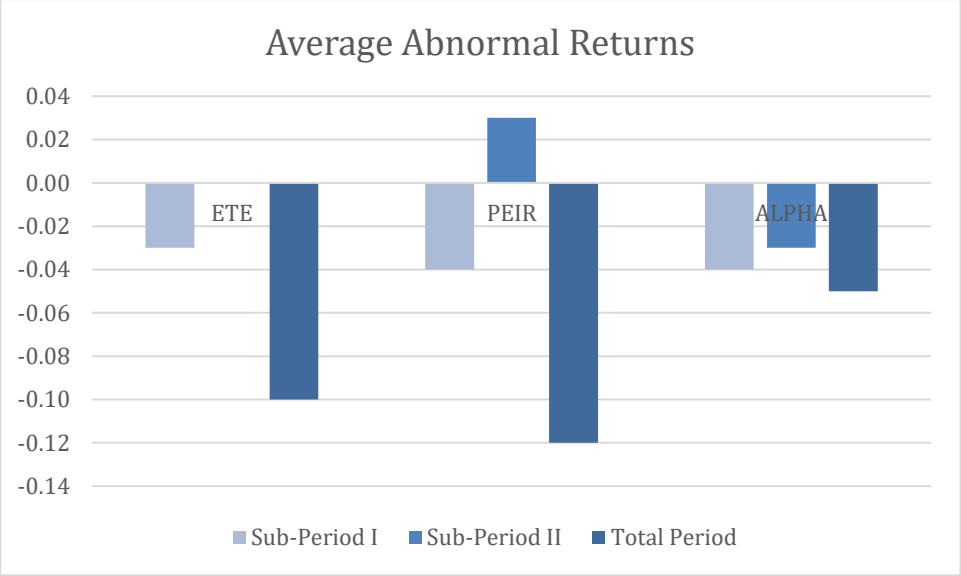

Figure 13: Average Abnormal Returns

In Sub-Period I, for the years 2003 – 2007 all three banks experienced negative abnormal returns on average. During this period, the Basel II Accord was not yet implemented.

In Sub-Period II, for the years 2008 – 2012 Piraeus Bank experienced a 3% average positive abnormal return, while the National Bank of Greece had zero average abnormal return and Alpha Bank a -3% average negative abnormal return. During this period, the Basel II Accord was implemented.

For the 10-year Total Period of 2003 – 2012 all three banks experienced average negative abnormal returns.

6. Conclusions and Recommendations

The aim of this paper is to examine the impact of the *"Basel Accords"* on market efficiency in Greece and more specifically the impact of Basel II. In analyzing the subject, the study established the theory of the efficient market hypothesis and its concepts and outlined the Basel Accords.

Autocorrelation tests and Run tests results were conducted from the daily returns series and prices of the National Bank of Greece, Piraeus Bank and Alpha Bank in Greece, for the Sub-Period I from 2003-2007, before the implementation of Basel II and for the Sub-Period II from 2008-2012, after the implementation of Basel II.

The theory of the *"Market Efficiency"* is hard to be tested empirically. Therefore, careful attention is needed when interpreting the empirical evidence that is presented as "testing" the EMH.[46] The understanding of the stock market is derived from the contribution of the theoretical and empirical studies of the efficient market hypothesis. However, the issue of how the stock market works, is still not assured.

The implementation of the Basel Accords in 2008 – 2012 did not affect the autocorrelation in our data. The autocorrelation existed in both periods before and after the Basel Accords, which means securities' prices are not random and are influenced by past events. An example is when prices rise day after day until some unexpected event occurs and then after some bad news, prices may continue to fall. This happens due to psychological reasons. Therefore, time series data usually exhibit autocorrelation.

There should be the necessary conditions for an efficient market to exist. The inefficiency of the Greek stock market implies financial and institutional imperfections. This leads to the conclusion that Greek financial policies and regulations such as those relating to liberalisation, privatisation and deregulation have created a tendency to produce instability and inconsistency. The implication is that the economy does not benefit from a well-operating stock market.

[46] "Alajbeg, D., Bubas, Z. and Sonje, V. (2012). The efficient market hypothesis: problems with interpretations of empirical tests. Financial Theory and Practice, 36(1), pp.53–72."

During Sub-Period II, after the implementation of Basel II, only Piraeus Bank experienced a 3% positive abnormal return. This alone does not justify the impact of the accords on market efficiency. Perhaps with more observations we would come to a better conclusion. An investment's abnormal return, positive or negative, measures the stock's performance over a given period of time. It is useful to investors for stock valuation and for comparing the performance of the stock returns to market performance.

A better assessment of the impact of the Basel Regulations on market efficiency can be made if we have more insights into the operation and characteristics of the Greek stock market in relation to its efficiency and valuation practices.

Furthermore, the *"Basel IV standards"* that were agreed in 2017, are due for implementation in January 2023. The international banking standards known as the Basel Accords will be amended. Regulators argue that these changes are just finalizing the *"Basel III"* reforms already agreed in theory in 2010 – 2011.

Market efficiency should be re-examined again then, after the full implementation of *"Basel III"* and implementation of *"Basel IV"*, to investigate further the impact of the new Basel Regulations on market efficiency.

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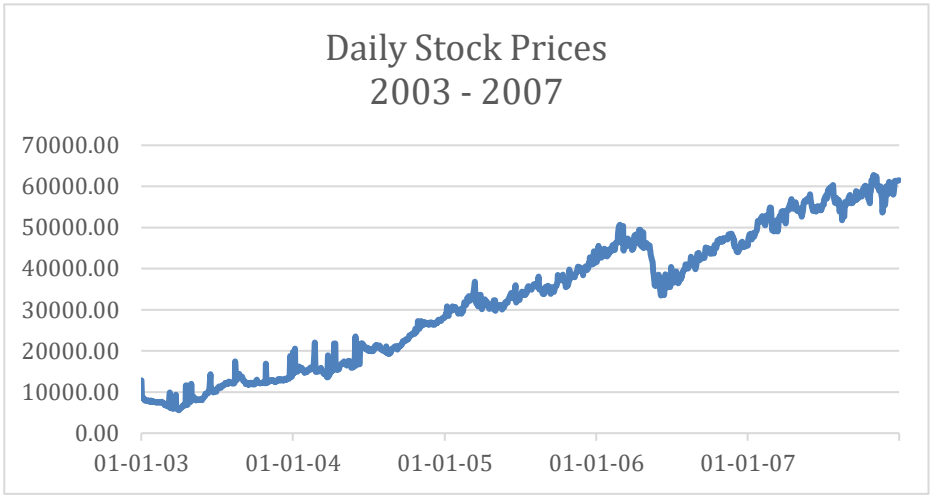
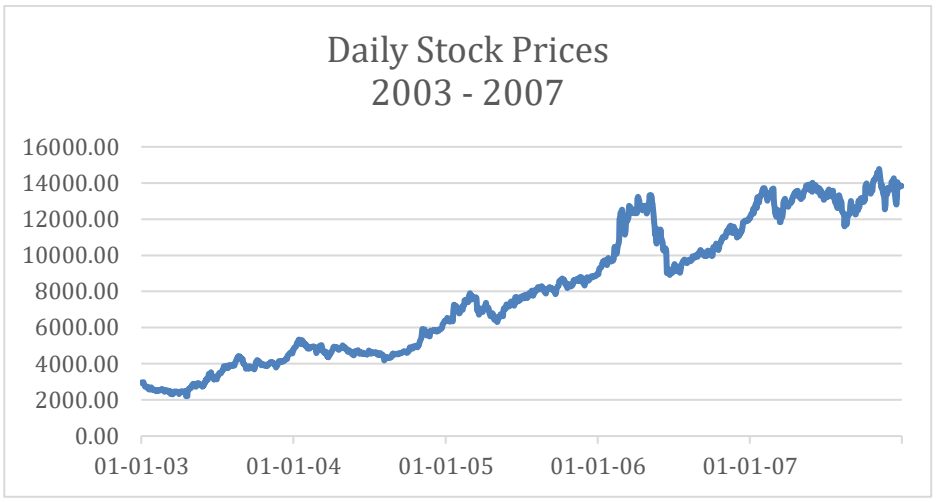
Appendices

Appendix A: Diagrams of Daily Stock Prices

National Bank of Greece



Piraeus Bank



Alpha Bank


Daily Stock Prices
2003 - 2012
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
07-01-03
07-01-04
07-01-05
07-01-06
07-01-07
07-01-08
07-01-09
07-01-10
07-01-11
07-01-12


Daily Stock Prices
2003 - 2007
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
07-01-03
07-01-04
07-01-05
07-01-06
07-01-07


Daily Stock Prices
2008 - 2012
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
02-01-08
02-01-09
02-01-10
02-01-11
02-01-12

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Appendix B*:* Key regulatory initiatives and assumptions of the Basel IV scenario analysed for European institutions

Exhibit 1: Key regulatory initiatives and assumptions of the Basel IV scenario analyzed for European institutions

Initiatives	Key scenario assumptions	Finalized Standard
Fundamental review of the trading book	▪ Assuming standardized approach market-risk RWA increase by 80% and internal model market-risk RWA increase by 40% for international banks and 25% for regional banks	✓
Revised credit risk standardized approach (SA)	▪ Regulatory rating-based risk weights for banks and corporates ▪ Assumption: 5% of exposures fail due diligence ▪ Corporate SME exposure receives 85% risk weight ▪ Mortgage risk weights based on loan to values (LTVs); assumption: 20% of exposures dependent on cash flows of property ▪ Qualifying revolving and other non-SME retail receive 75% risk weight ▪ Equity and subordinated exposures risk weights range 150-250%; assumption average risk weight of ~200%	✗
Removal IRB for low default portfolios (LDPs)	▪ Financial institutions into F-IRB ▪ Large corporates (turnover >€0.5bn) into F-IRB ▪ Specialized lending remains under A-IRB ▪ Equity exposure into standardized approach	✗
IRB RWA floor	▪ Aggregate IRB output floor of 75%	✗
Revised operational risk	▪ Removal of advanced measurement approach (AMA) ▪ Application of standardized measurement approach (SMA) for all banks	✗
IFRS 9	▪ Impact on CET1 capital through retained earnings driven by provisioning based on revised expected-loss model	✓
Risk weights for sovereigns	▪ Application of standardized approach risk weights for exposures to sovereigns based on current S&P sovereign ratings	✗

SOURCE: McKinsey; Basel Committee for Banking Supervision, www.bis.org/bcbs; International Accounting Standards Board (IASB), www.ifrs.org; Risk.Net

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