Evidence of Adaptive Market Hypothesis in International Financial Markets

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Abstract

Objective: Traditional finance emphasises the concept of market efficiency while behavioural finance suggests anomalies in investors. However, the emergence of the adaptive market hypothesis tends to suggest otherwise. The adaptive market hypothesis challenges market efficiency and behavioural finance by contesting that investors and market participants adapt to the changing market environment. In essence, investors learn from their mistakes. The purpose of this study was to explore the concept of an adaptive market hypothesis in five international markets, namely, the JSE, CAC 40, NASDAQ, JPX-NIKKEI and DAX.

Method: This study used a variance ratio test to explore the adaptive market hypothesis from January 2017 to April 2022.

Results: the findings revealed the existence of adaptive markets in the CAC 40 and NASDAQ during the period under review. Conversely, there was no statistical evidence to support the adaptive concept in the JSE, JPX-NIKKEI, and the DAX.

Originality/relevance: The findings imply that investors in the CAC 40 and NASDAQ should consider active volatility scaling because of multiple betas, hence fundamental analysis is worth the time. This study adds to the literature on adaptive market hypothesis as well as market efficiency and behavioural finance.

Keywords: Adaptive markets; market efficiency; behavioural finance; financial markets; variance ratio

Preuve de l'hypothèse d'un marché adaptatif sur les marchés financiers internationaux

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Résumé

Objectif : La finance traditionnelle met l'accent sur le concept d'efficacité du marché tandis que la finance comportementale suggère des anomalies chez les investisseurs. Cependant, l'émergence de l'hypothèse du marché adaptatif tend à suggérer le contraire. L'hypothèse du marché adaptatif remet en question l'efficacité du marché et la finance comportementale en contestant que les investisseurs et les acteurs du marché s'adaptent à l'évolution de l'environnement du marché. Essentiellement, les investisseurs apprennent de leurs erreurs. Le but de cette étude était d'explorer le concept d'une hypothèse de marché adaptatif dans cinq marchés internationaux, à savoir, le JSE, le CAC 40, le NASDAQ, le JPX-NIKKEI et le DAX.

Méthode : Cette étude a utilisé un test de ratio de variance pour explorer l'hypothèse de marché adaptatif de janvier 2017 à avril 2022.

Résultats : les conclusions ont révélé l'existence de marchés adaptatifs au sein du CAC 40 et du NASDAQ au cours de la période sous revue. À l'inverse, il n'y avait aucune preuve statistique pour soutenir le concept adaptatif dans le JSE, le JPX-NIKKEI et le DAX.

Originalité/pertinence : Les implications de ces résultats sont que les investisseurs du CAC 40 et du NASDAQ devraient envisager une mise à l'échelle active de la volatilité en raison des bêtas multiples, d'où l'analyse fondamentale vaut le temps. Cette étude s'ajoute à la littérature sur l'hypothèse des marchés adaptatifs ainsi que sur l'efficacité du marché et la finance comportementale.

Mots-clés : Marchés adaptatifs ; efficacité du marché; finance comportementale ; Marchés financiers; rapport de variance

Introduction

Financial markets have enormous influence on the day-to-day activities of almost every human living on earth either directly or indirectly. Financial markets provide several benefits such as price setting, asset valuations, commercial transactions and raising capital. However, estimating the behaviour of stock markets has been a source of continuous contention among academics and investment practitioners. This continuous controversy stems from the simple question; are financial markets efficient? The market efficiency hypothesis proposes that investors cannot consistently outperform financial markets because security prices quickly reflect new information (Enow, 2021). This makes it impossible to purchase undervalued stocks and sell them above the market price. In a stable environment, stable economic behaviours and relationships will emerge which is a fundamental aspect of market efficiency. This implies that, share prices follow a random pattern and it is impossible to outperform the market without assuming additional risk.

However, the emergence of behavioural finance has proven otherwise (Enow, 2022). Behavioural finance examines observed behaviours in financial markets rather than normative assumptions about an investor's behaviour. This branch of finance proposes that investors do not always make optimal decisions due to cognitive biases such as loss aversion, overconfidence, information cascades and herding (Enow, 2022). Prior research (Kaluge & Kinesti, 2021; Scherf, Matschke, & Rieger, 2022; Jin, Lu & Zhang, 2022) has shown that investors behave in an irrational manner which makes financial markets inefficient. In the centre of market efficiency and behavioural finance is a fairly new concept known as adaptive market hypothesis (AMH) (Lo, 2004). AMH blends the efficient market hypothesis and behavioural finance through evolution (Lo, 2004). AMH proposes that investors are on average rational but there are situations where they display irrational behaviours through herding, fear, and greed leading to temporal inefficiencies (Lo, 2004). According to AMH, behavioural biases such as loss aversion and overconfidence are consistent with evolution, which helps investors adapt to the changing environment. In general, investors display four basic tendencies when adapting to a changing environment. These behaviours are;

- Investors generally act in their own interest.
- Investors tend to make mistakes.
- Investors learn from their mistakes
- Investors adapt their behaviour accordingly.

The basic principle behind the AMH is that market efficiency and behavioural finance are incomplete because they ignore the concept of investor adaptability which is an important component in finance. In the current dynamic environment, investors and market participants adapt to changing market conditions in order to enhance the performance of their portfolios. According to Lo (2004), the concept of AMH provides a framework for analysing the behaviour of stock markets and how investors adapt to changing market conditions which is necessary for decision making. Lo (2004), also contends that AMH is a framework that drives the current financial dynamics prevailing in many markets more than the market efficiency theory and behavioural finance concept. This is due to the fact that markets are driven by the environment and not by the economy (Lo, 2004). From the abovementioned, this study seeks to answer the following questions, Is there any evidence of AMH in financial markets during periods of financial distress and expansions? Do investors adapt to changing market conditions as stipulated by the AMH? Are there any suitable investment strategies that can be used to exploit the AMH? Investigating the AMH is of significant importance because financial markets are rapidly changing with the dynamic environment. Accordingly, investors and financial market participants should not hold onto prior theories when new concepts have emerged which may alter investments decisions.

Therefore, the aim of this study is to empirically investigate the concept of AMH in international financial markets so as to make important recommendations for investment practitioners,

academics, and other financial market participants. This study makes a significant contribution as the AMH concept is explored up to the Covid-19 pandemic era to rebuff or validate the concept. Hence, a noteworthy contribution to the literature on the behaviour of financial markets.

Literature

The nature and behaviour of financial markets are the basis of price formation which further affects the expected return. As documented by Fama (1965), efficient financial markets fully reflect all available information. The returns of an investment in an efficient market are appropriated for the level of risk assumed and investors should expect a normal rate of return. Also, firms should expect to sell their securities at fair values which is the present value of expected cash flows. In essence, the concept of market efficiency centres around two basic questions, which are:

- When new information enters the market, how well does the market respond to the information?
- Given the current information, is it possible to decide between profitable and unprofitable investments?

The availability of information is the crux of determining the price of a security which is the central aspect of market efficiency. However, there are exceptions that appear to contradict the concept of market efficiency such as earnings announcements, price clustering and herding behaviour (Schmitt & Westerhoff, 2017). Another contradiction to market efficiency is the value-ranking system where stocks are ranked based on fundamental analysis. According to this approach, stocks that are ranked in the top category tend to outperform other categories which is another evidence of market inefficiencies. In essence, markets are inefficient because investors are irrational due to systematic deviations from the norms. These distortions occur during the decision making process when making predictions and environmental analysis. However, behavioural finance is not a theory that explains a plausible principle, but evidence of imperfections in financial markets. Due to the fact that the environment changes constantly, investors and market participants need to adapt to this changing environment. According to Lo (2004), the adaptive market hypothesis is a reconciliation between the theory of market efficiency and behavioural finance. In reconciling market efficiency and behavioural finance, the AMH has several implications. Some of these implications are; unstable risk and reward premiums due to changing risk appetite and market size (Lo, 2004). Secondly, the presence of AMH may signal the existence of potential arbitrage opportunities because of slow price discovery mechanisms. Also, a one size fit all investment strategy will not be suitable due to pliable markets. It is therefore important to identify adaptive markets so as to have a suitable investment approach. Below are some of the studies that explored the concept of AMH.

Table I: Summary of previous studies

Study	Model	Period	Country	Findings
Urquhart &McGroarty (2016)	Autoregressive - GARCH model	January 1990 to May 2014	US, London, Japan	Evidence of AMH as excess returns turns out to be statistically significant in one period and insignificant in another period.
Mandacı, Taşkın, &Ergün (2019)	Variance Ratio and Brock, Dechert and Schieinkman Test	January 2002 to April 2017	Turkey	The findings revealed unpredictable returns from January 2002 to April 2017 indicating the absence of AMH.
Akhter & Yong	GARCH (1,1)	1993 to 2018	Bangladesh	Sufficient evidence to

(2020)	model			support the existence of AMH where there was seasonal abnormal return.
Kılıç (2020)	Automatic Portmanteau Box-Pierce Test, Generalized Spectral Test, and Wild-bootstrapped Automatic Variance Ratio Test.	January 02, 2013 - April 26, 2019	Turkey	There is no evidence of AMH as the Turkish stock market tends to display high levels of market efficiency.
Tripathi,Vipul, & Dixit (2020)	Quantile regression model	1998–2018	21 Major global market indices	Evidence in support of AMH.
Munir, Sukor,, &Shaharuddin (2022)	Cumulative average returns	1997 to 2018	Malaysia, Korea, China, Indonesia, Thailand & Philippines	The findings of this study reveal partial support for AMH as investors could not adapt to the changing market environment.
Aleknevičienė, Klasauskaitė& Aleknevičiūtė (2022)	GARCH (1,1) model	2000 to 2017	US	Investors realised abnormal returns before the financial crisis that disappeared during the financial crisis, which supports the existence of AMH.

The studies mentioned above, reveal evidence of AMH in some markets at different time frames. Despite the relevance of the above studies, the concept of AMH should be an ongoing process that is evident in multiple time frames. Exploring the concept at any given time and drawing conclusions does not paint a full picture of the AMH concept as investors and market participants are expected to continually adapt to the environment. Hence, this study fills in the gap by exploring the concept of AMH with more recent data which includes the novel Covid-19 pandemic. The next section highlights the methodology.

Methodology

This study used the variance ratio test to empirically investigate the concept of AMH. The Variance ratio test is typically used to ascertain whether stock returns follow a random walk and whether the returns normalise with the passage of time (Lo & Mackinlay, 1988). This test was developed by Lo & Mackinlay (1988) to investigate variance scaling under the assumption of market efficiency. When a random variable is independent and distributed in a similar way, the variance of period k should be equal to the sum of the individual variances for the same period. As proposed by Fama (1965), random walk in stock prices is evident when past price movements cannot be used to predict future price patterns due to the absence of autocorrelation. This is related to the AMH when the index returns display a significant autocorrelation one certain period and absent in the other (Lo & Mackinlay, 1988). The mathematical expression is given below. In so doing, the variance test ratio blends the market efficiency concept with the behavioural finance theory through its distinctive autocorrelation capabilities using multiple periods.

$$\text{Variance ratio} = \frac{K - day\ variance}{k \times daily\ varaince} + 1 \qquad (1)$$

$$\text{Variance ratio} \sim N(0, \sigma^2)$$

$$\sigma^2 = \frac{2(K-1)(2k-1)}{3kn}$$

Where k is the period, n is the number of observations and σ^2 the variance. The intervals of k were a multiple of 2 as commonly used in practice for up to 64 days. Five financial markets (NASDAQ index, French stock market index (CAC 40 index), Frankfurt stock exchange (DAX index), Japanese stock index (JPX-Nikkei 400) and Johannesburg stock exchange (JSE index)) were used as samples. These samples represent the largest financial markets in the world in each continent. The sample period was from January 1, 2017 to April 30, 2022 which was pre-Covid-19 (January 1, 2007 to December 15, 2019), during Covid-19 (December 15, 2019 to January 1, 2022) and post Covid-19 (January 2, 2022 to April 30, 2022). The Covid-19 era was also included in this study to provide a robust analysis. As already alluded in the introduction, AMH combines the market efficiency concept and behavioural finance where investors are expected to behave irrationally and rationally. When applied to this study, AMH is evident when the variance ratios are statistically significant in one period and insignificant in other periods, therefore the following hypotheses were examined;

H_0: There is no evidence of the AMH concept in the financial markets under consideration, and hence the theory should be considered when making investment decisions.

H_1: There is evidence of the AMH concept in the financial markets under consideration; hence, the theory should be considered when making investment decisions.

Results and Findings
The variance ratio and the p-values of the data analysis are presented below; only the variance ratio values and the level significance are presented.

Table II: Summary of findings

	Max |z| (at period 2)*	k=2	k=4	k=8	k=16	k=32	k=64
VR - CAC 40 p-value	8.12 (0.0000)*	0.51 (0.0000)*	0.24 (0.0000)*	0.18 (0.0000)*	0.19 (0.0000)*	0.29 (0.0002)*	0.61 (0.1321)
VR - JSE p-value	9.38 (0.000)*	0.47 (0.0000)*	0.26 (0.0000)*	0.14 (0.0000)*	0.09 (0.0000)*	0.07 (0.0000)*	0.09 (0.0005)*
VR - DAX p-value	7.79 (0.000)*	0.45 (0.0000)*	0.25 (0.0000)*	0.13 (0.0000)*	0.06 (0.0002)*	0.03 (0.0038)*	0.02 (0.0201)*
VR -NASDAQ p-value	7.21 (0.0000)*	0.33 (0.0000)*	0.21 (0.0035)*	0.13 (0.0243)*	0.04 (0.0616)	0.02 (0.1245)	0.01 (0.1796)
VR- JPX NIKKEI p-value	7.12 (0.000)*	0.43 (0.0000)*	0.23 (0.0000)*	0.13 (0.0000)*	0.06 (0.0006)*	0.03 (0.0057)*	0.02 (0.0219)*

K=periods
*significant at 5% confidence level
VR= Variance ratio

From the above findings, the p-values for the variance ratio test in the JSE, DAX, and JPX-Nikkei are significant at 5% for all periods under consideration (k=2 to k=64). Also, the variance test ratio

coefficients are all positively correlated implying that past price movements may move in the same direction has future price movement although not significant in some cases. More specifically, the findings revealed that there is no significant difference for k=64 in the CAC 40 and Nasdaq. Furthermore, the p-values for the variance ratio test for k=16, k=32 and k=64 are insignificant for the Nasdaq. These findings indicate the presence of AMH in Nasdaq and CAC 40 but there is no evidence in JSE, DAX, and JPX-Nikkei. Evidence of AMH in the Nasdaq and CAC 40 emanates from the significant autocorrelation in certain periods (k=2 to k=8) and (k=2 to k=32) respectively and the absence of autocorrelation (k=16 to k=64) and (k=64) in the Nasdaq and CAC 40 respectively.   The above findings are consistent with the findings of Tripathi, Vipul & Dixit (2020); Aleknevičienė, Klasauskaitė & Aleknevičiūtė (2022), but contradict the findings of Urquhart & McGroarty (2016) who found evidence of AMH in the JPX-Nikkei. Therefore, the null hypothesis is accepted for the JSE, DAX, and JPX-Nikkei while the alternate is accepted for the CAC 40 and NASDAQ.

Conclusion and implications
The purpose of this study was to explore the AMH concept in different financial markets around the world. As with other hypotheses put forth, the concept needs to be thoroughly examined in order to make informed financial decisions. As opposed to the market efficiency hypothesis and behavioural finance, AMH contends that investors tend to adapt to the environment hence positive and negative returns turn to normalised with time. Accordingly, investors are affected by a combination of ecological and environmental factors which results in rationality and irrationality. In this way market participants tend to adapt and compete for survival. The findings of this study reveals adaptive markets in the Nasdaq and CAC 40 where market participants can improve their portfolio performance by employing adaptive investment approaches and should expect a non-stable risk reward trade-off. Also, market participants in the Nasdaq and CAC 40 tends to adapt to the environment, apply and modify heuristics in their decision marking processes. So investors and market participants investing in markets where the AMH is evident may carefully study past price patterns in order to shape their future investments strategies. In essence, fundamental analysis is of significant importance in markets where AMH is evident.

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