Stock Market Calendar Anomalies in Sub-Saharan Africa Stock Markets

Dennis Murekachiro

Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development, Harare, Zimbabwe

ABSTRACT

With the use of appropriate tools and correct timing of the stock market, investors can predict the stock market and yield abnormal returns. One strategy can be based on the identification of calendar anomalies in a pursuit to increase returns and attain abnormal profits. The aim of this study was to find the presence of market inefficiency through identification of exploitable calendar anomalies (i.e. Day of the Week Effect, January Effect and Halloween Effect) in the S&P500 and ten African stock markets using a novel approach of generalized additive models (GAMs). The week effect and January effect were only prevalent in the S&P500 and new day of the week as well as month of the year effects were noticeable for the African stock markets through the April effect, May effect, August effect and October effect. No presence of the Halloween effect was identified for any of the eleven stock markets. African markets were found to be inefficient owing to calendar anomalies presence. The findings of this study affirm the Adaptive Markets hypothesis in that there are ever changing stock market ecologies resultantly giving rise to new calendar anomalies.

Keywords: African stock markets, inefficiency, calendar anomalies.

INTRODUCTION

Investors are continually in search for opportunities to increase returns and make use of varying trading strategies. The use of calendar anomalies, which are amongst the prominent reasons for the occurrences of abnormal returns is one strategy to attain abnormal profits (Norvaisiene, 2013; Zhang, 2017). The aims of this paper are to explore the existence of calendar anomalies that can be exploited for financial gain, add on to existing literature and introduce novel methodologies to detect stock market calendar anomalies.

Three key contributions arise from this paper. One, new empirical evidence exhibiting that stock markets are inefficient is reported as exemplified by the existence of calendar anomalies in African stock markets which can be exploited by investors for profitable gain as investors formulate trading strategies and portfolio allocations to maximize returns. Policy makers and regulators can make use of calendar results insights to enhance market stability and transparency, fostering investor confidence and participation.

Second, unlike most research studies that resorted to use of regression models with dummies to test for calendar anomalies or use of GARCH models to detect calendar anomalies, this current research assesses and finds usefulness of a machine learning technique, namely Generalized Additive Models (GAM) for calendar anomaly detection. To the best knowledge of the researcher, this is the first research to use GAM for stock market calendar anomaly detection.

Third, varying calendar anomalies were detected in the stock markets under consideration in this research revealing different stock market characteristics and calendar anomalies for developed and emerging economies. This amplifies on evidence that though stock markets are affected by global systemic effects, specific stock market characteristics, dynamic market forces and investor behavior give rise to varying stock market ecologies and resultantly different calendar anomalies. Unlike other researches that focus on developed

markets, this study focuses on emerging markets in Sub Saharan Africa in order to assess validity of the Efficient Market Hypothesis and existence of exploitable market inefficiencies by investors.

The remainder of the paper is outlined as follows; Literature review, Methodology, Data and data sources, Empirical results and Summary and conclusions in section 2,3,4,5and 6 respectively.

LITERATURE REVIEW

The study of calendar anomalies remains a source of empirical finance, tracing its geneses to observations of repeated patterns in stock returns that deviate from the Efficient Market Hypothesis (EMH). The EMH postulates that financial markets are informationally efficient, with asset prices reflecting all available information (Fama, 1970). However, increasing global evidence is showing that behavioral biases and institutional practices play a significant role in shaping market dynamics (Gibbons and Hess, 1981) and resultantly give rise to varying stock market calendar anomalies such as time of the day effects, day of the week effects, week of the month effects, month of the year effects, turn of the month effects, Halloween Effect and Mark Twain effect.

The Day of the Week Effect

The Day of the week effect results in a different return for each day of the week with the lowest and negative returns cited to occur on Mondays and highest returns attained on a Friday. Studies on the day of the week like any other calendar effect are continually producing varied results globally and in Africa. In a multi-country study by Zhang et al.,(2017), the presence of Monday Effects in USA, China, Argentina, Poland, Italy and Singapore stock markets were noted whilst Friday anomalies were identified for stock markets in Brazil, Chile, Russia, Turkey, India, Malaysia, Spain and Hong Kong. New day effects were also reported. Wednesday effects were found in stock markets in Mexico, Indonesia, Germany, Switzerland, Australia, Japan and New Zealand whilst Thursday anomalies were noticed in stock markets in Czech Republic and Philippines. A study by Diaconasu (2012) found Monday returns to be the lowest and negative for in nine out of the 18 countries studied, which was consistent with findings in the USA as in Zhang et al., (2017). In eight of the other countries, lowest returns were found on a Tuesday. Friday return is significantly positive in all the countries, except Luxembourg.

Szymanski and Wojtalik (2020) found presence of the day of the week in the Warsaw SWIG80 in Poland. In addition, Pandey (2022) also found presence of the day of the week effect in the Egyptian market where significant negative returns were observable on Sunday, since Sunday is the first trading day for the Egyptian stock market similar to Monday in other countries. Ferrouhi et al., (2021) also detect the presence of Monday effect for Cote d'Ivoire and Namibia. Mazouna and Ndlovu (2016) identified a significant Monday effect on the Zimbabwe Stock Exchange.

Evidence from emerging markets is pointing to new day of the week effects. Focusing on the Athens Stock Exchange in Greece using a stochastic dominance analysis, Khazali (2008) detected a strong day effect with the highest observed returns noted on Friday whilst the lowest returns were on Tuesday. The findings of the Tuesday anomaly are consistent with studies on non-Greek markets such as Singapore, France, Australia and Japan. The week effect is not so significant in the Athens stock exchange, even though the first week of the month yielded slightly higher returns than other weeks of the month. A Wednesday effect was noted in Egypt, Mauritius and Morocco and a Friday effect in Kenya and Namibia (Ferrouhi et al., 2021).

The Monday effect in which Monday returns are very low and Friday returns very high can be explained through various hypotheses. Most investors usually trade less on Mondays as compared to other week days which makes the returns lower (Plastun, 2019). In addition, mood also plays a key role in that investors who start the week on a low mood, will eventually trade less, hence dampening stock prices and returns. Different time zones also contribute to low Monday returns for other countries especially those affected by big stock market players (Seif, 2017).

The January Effect

The January effect is evidenced by higher stock returns in January as compared to the other months of the year. Khazali (2008) observed the January effect thought it was not statistically significant. Diaconasu (2012) provides evidence of higher returns in April and July and the absence of January effect in BET and BET-C indices through experiments which were done through a regression with dummies model. He also finds the presence of the January effect for Egypt, Nigeria and South Africa, a February effect for Morocco, Kenya and Nigeria with no monthly seasonality's identified for Tunisia. Ferrouhi et al., (2021) found presence of the January effect in Botswana and Zambia.

The January effect is mostly explained in terms of the tax-loss selling hypothesis. Most investors prefer to sell their securities prior to year-end in order to claim capital loss for tax purposes. In January, they reinvest their money causing security prices to rise. With such actions, security prices fall in December and rise in January with significant returns realizable in the month of January (Kumar, 2016).

The Halloween Effect

The Halloween effect indicates that returns between November and April are higher than in the other months of the year. Norvaisiene (2015) observes the Halloween effect in different stock markets such as in the Baltic stock exchanges and finds evidence of the presence of the Halloween effect in Estonia, in which Estonian investors may use the Halloween effect to earn a higher return during the 'winter' period as compared with the return on investment during the 'summer' period. Plastun (2019) examines the evolution of the Halloween effect in the developed stock markets of the US, UK, French, Canadian, German and Japanese. Key findings of this study were that the Halloween effect only became detectable in the middle of the 20th century and is still present in these developed markets. This provides investors an opportunity to develop trading strategy to beat the market. It is also noted that the Halloween effect in the US and the other developed markets is consistent with the Adaptive Market Hypothesis (AMH).

No explanations have been put forth for the Halloween effect, in which the month of May signals the start of a bear market where investors would rather sell off and hold cash. They wait till November when the market is bullish. Returns between November and April are the highest when compared to the other calendar months. Other hypotheses for calendar anomaly detection include the inventory adjustment hypothesis (public holiday effect), seasonal affective disorder (week 44 effect), tax-loss selling and window dressing for the month of the year effect (Seif, 2017).

Given the dearth of empirical studies on calendar anomalies in emerging and frontier markets, results found for such markets would assist in the better understanding of stock returns across such markets and for trading strategy formulation. Investors can make use of calendar anomalies in developing asset pricing models that are powerful predictors in emerging and frontier markets, hence improving their investment decision making.

This paper is premised on the examination of the AMH through evidence of calendar anomalies and return predictability for African stock markets. Unlike most studies that have made use of regression models with dummy models, this study adopts the use of machine learning techniques to establish calendar effects and contribute to the long standing debate of validity or non-validity of the EMH. Financial intelligent computing decision making can enable African stock market investors to maximize on their returns.

METHODOLOGY

In order to examine predictability of stock indices and detect calendar anomalies, the generalized additive model (GAM) was implemented in this paper. GAM is a statistical approach for nonparametric or semi parametric modeling and it has demonstrated its ability to capture nonlinear relationships between explanatory variables and response variables [16]. The financial time series is decomposed into three components namely trend, seasonality, and holidays and expressed as follows;

$$y(t) = g(t) + s(t) + h(t) + \epsilon_t \qquad (1)$$

where g(t) is the trend function modeling non-periodic changes in the value of the time series, s(t) represents periodic changes (e.g., weekly, monthly or yearly seasonality), and h(t) represents the effects of holidays which occur on potentially irregular schedules over one or more days. The error term t represents any idiosyncratic changes which are not accommodated by the model. The forecasting problem is framed as a curve-fitting exercise, which is inherently different from time series models that explicitly account for the temporal dependence structure in the data. An important benefit of the decomposed model is that it allows us to look at each component of the forecast separately.

Data and data sources

For the purposes of this research, daily stock index data were considered for ten African countries[1] based on market capitalization. Given the dearth in empirical evidence from Sub-Saharan African countries with respect to stock calendar anomalies, the stock markets were selected for this study. In addition, stock market calendar anomaly predictions in these emerging and frontier African countries were bench-marked to a developed financial market, the SP 500 (USA). The SP 500 is believed to be representative of the United States top 500 firms. The Bloomberg database was used to collect the daily stock index data for the period 2012- 2024 in the form of open, high, low and closing price which was used to predict the index next time step closing stock prices. Time series index data was considered in this paper to examine calendar anomalies in the eleven stock market indices adopted for this paper.

Empirical results

The empirical results for calendar anomalies (day of the week, month of the year effects and Halloween Effect) detected for the eleven stock markets considered in this paper are summarized in Table 1 below.

Table 1: Summary of Weekly and Monthly Highs and Lows

Country	Weekly Lowest	Weekly Highest	Monthly Lowest	Monthly Highest
Botswana	Monday	Thursday	January	April
Egypt	Friday	Tuesday	January	October
Kenya	Monday	Wednesday	December	April
Mauritius	Wednesday	Tuesday	November	May
Morocco	Wednesday	Tuesday	October	February
Nigeria	Monday	Wednesday	February	October
South Africa	Wednesday	Tuesday	January	May
Tunisia	Thursday	Friday	January	August
Zambia	Thursday	Tuesday	February	August
Zimbabwe	Thursday	Friday	August	October
SP500	Monday	Tuesday	December	January

Calendar effects vary amongst countries owing to differing capital market characteristics (Diaconasu, 2012). This was noted in the research findings in this paper. To start with, evidence of the January effect was only found for the S&P500 where returns are generally higher in January and lower in December. This is in agreement with studies by Plastun (2020) who cited that the January effect still remains established in the US market. Unlike Plastun (2020), the research findings in this paper detected low returns in January and February for some of the markets.

A possible explanation of this January and December effects is either the tax loss selling hypothesis or window dressing hypothesis. Under tax loss selling hypothesis, investors sell of their stocks in December and buy them back in January causing an increased demand for stock, and in turn prices go up. The window dressing hypothesis is when investors dispose their stocks at year end in pursuit of presenting a more acceptable portfolio performance in year-end reports. Thus, in this research, January returns for the S& P500 are attainable and significantly higher than the other months of the year. The tax year for the US ends in December

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[1] Botswana, Egypt, Kenya, Mauritius, Morocco, Nigeria, South Africa, Tunisia, Zambia and Zimbabwe

and possibly could be a contributing factor to the low December returns and high January returns. In other words, the tax low hypothesis is most ideal to explain this study's findings on the S& P500.

Interestingly, results in this paper point to the fact of the non-existence of January effect in most African stock markets despite the fact that most of their tax years end in December. For Botswana, Egypt, South Africa and Tunisia, low returns are noted in January whilst evidence of low February returns is noted in for Nigeria and Zambia. This in contrast to the January effect were returns are expected to be significantly high in January. This research finding points to the fact that monthly effects are noticeable in other months other than January. This is in agreement with Girardin (2014) who identified that it was not possible to detect month-of-the-year effects in returns for Zimbabwe and other countries.

However, the best returns are noted in April, May, August and October[2] for most countries under consideration in this research. This suggests existence of April Effect, May effect, August effect and October effect. It can be suggested that since some of the African countries allow tax submission three months after year end, individuals and corporations can dispose their stocks in March, hence lowering the prices. However, in April, they buy back, causing an increased demand for shares and cause share price increases. Hence, the tax loss hypothesis can apply for submissions done in March. In addition, the research findings concur with Norvaiseine (2013) findings in developing or small markets. They found evidence of seasonality but the seasonal fluctuations of stock prices in these countries were evidenced not only in January, but in any other months of the year.

The research findings on the week effect reveal that the US returns are significantly negative on Mondays but significantly positive on Tuesday than on Friday as postulated by Khazali (2008) . A leading hypothesis for the weekend effect (Low Monday returns and High Friday returns) is the arrival of negative news at the beginning of the week [Caporale and Zakirova (2017); Agrawal (1994)]. These result findings also concur with French (1980) who also attained negative returns on Monday's for the S&P500. In addition, the low returns on Monday can also either be attributed to low trade transactions on a Monday dampening the share price or to the changing mood of investors who begin the week at a low mood and increase positive mood during the week (Plastun, 2019) .

Evidence of new day of the week effect was noted for the African markets under consideration in this paper. A Wednesday effect is noted for Mauritius, Morocco and South Africa with low returns on a Wednesday and high returns on a Tuesday. Similarly, Tunisia and Zimbabwe experience a Thursday effect with low returns on a Thursday and high returns on a Friday. Evidence of a Monday effect is noted for Botswana, Kenya, Nigeria and the S& P500. However, high returns in these markets are attainable on Thursday, Wednesday and Tuesday respectively. A plausible explanation for these results could be varying settlement periods in the respective countries as espoused in the settlement procedure hypothesis and in agreement with Ariss (2011).

For all the 11 countries (including the US) studied in this research, there is no evidence of the Halloween effect in 10 out of the 11 countries except for Mauritius. The Halloween effect indicates that returns between November and April are higher than in other months of the year (Plastun, 2019; Norvaisiene, 2013). This study finding are largely in agreement with Norvaisiene, (2013) finding that in small and emerging markets, there is no existence of the Halloween effect. However, a new 20th century phenomena is that shifts have been noted between the November to April months and the May to October months (Plastun, 2019). Mauritius is the only country that meets the May to October 20th century phenomena with best returns recorded between May and October. This study did not find a Halloween effect on the S&P 500. In addition, negative returns were recorded for all financial markets in this study during holidays. As in Wasiuzzaman (2013) study, holiday effects were found to have a negative impact on stock returns.

Evidence on the existence of calendar anomalies supports the view that stock markets are adaptive agents as postulated in the Adaptive market hypothesis. Owing to the fact that calendar anomalies are existent in the selected African countries, it can be concluded that these African stock markets are inefficient. Calendar

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[2] Botswana, Kenya (high in April); Mauritius and South Africa (high in May); Egypt, Tunisia and Zambia (high in August); Nigeria and Zimbabwe (high in October).

anomalies vary over time making them consistent with the adaptive market hypothesis. The researcher concurs with Zhang (2017) in that addition to other stock market analysis tools, investors can exploit calendar anomalies in order to maximize their investment returns. Additional empirical evidence to show that African stock markets are inefficient and calendar anomalies are inherent is shown in Table 2 which shows the prediction accuracies attained through GAM prediction.

Table 2: Sample of Empirical Results for GAM Predictions

Country	Date	Actual price	Forecast price	Accuracy
Botswana	0	6.832369	6.863061	99.76
-	1	6.829388	6.862539	
-	2	6.829917	6.855821	
Egypt	0	4.871717	5.135923	97.55
-	1	4.862623	5.148055	
-	2	4.862889	5.144487	
Kenya	0	-0.251736	-0.275153	100.00
-	1	-0.241855	-0.238294	
-	2	-0.239006	-0.173804	
Mauritius	0	4.163405	4.115217	99.21
-	1	4.167569	4.123147	
-	2	4.158637	4.112701	
Morocco	0	7.166496	7.203672	99.50
-	1	7.151629	7.161336	
-	2	7.14211	7.134551	
Nigeria	0	4.860511	4.878546	99.32
-	1	4.861386	4.882607	
-	2	4.851206	4.89401	
South Africa	0	8.30551	8.40951	99.58
-	1	8.291276	8.40003	
-	2	8.297291	8.38744	
Tunisia	0	8.059879	8.047616	99.88
-	1	8.049797	8.080291	
-	2	8.04301	8.033548	
Zambia	0	6.651844	6.574812	99.59
-	1	6.640492	6.583186	
-	2	6.641643	6.600482	
Zimbabwe	0	4.963404	4.937888	99.52
-	1	4.941928	4.922055	
-	2	4.940928	4.986051	
S&P500	0	7.194512	7.152316	99.57
-	1	7.213467	7.152504	
-	2	7.237342	7.15443	

SUMMARY AND CONCLUSIONS

This paper examined the presence of stock market calendar anomalies through GAM for eleven stock market indices. The study tested for three anomalies namely day of the week effect, month of the year effect and Halloween effect. Notably, evidence of stock price predictability and existence of calendar anomalies was evident in all eleven indices. Therefore, the studies revealed useful applicability of GAM as a method to assess calendar anomalies. Though investors can quickly take advantage of these anomalies for profitability, human judgement and trading skills remain key components for investor decision making. Instead of just reliance on technical analysis, investors or traders must also factor in other investment skills to manage risk.

Second, this study's findings show evidence of evolving stock markets, which can be predicted using past prices and volumes. This is in contrast to the Efficient Market Hypotheis. If market players are to rely on technical analysis, they may be a need to establish edge computing technologies for continuous updates of the machine learning algorithm.

Varying results were attained for each effect in the eleven indices suggesting that stock markets are distinct as evidenced by different trends and seasonality's exhibited in the results. Except for South Africa, Mauritius and Morocco, all the other countries exhibit different weekly trends. As for year trends, all countries displayed different trends and seasonality's.

Owing to the findings of this study, which aimed at assessing the applicability of machine learning models, GAMs in particular for this research to forecast stock market calendar anomalies, notable recommendations and future research gaps were identified. One, with use of the varying week and monthly effects for each country, regulatory agencies can formulate policies to control markets to avoid either excessive buying or selling through use of stock market circuit breakers for example. Investors can make use of the calendar anomaly results for arbitraging purposes and formulate optimal and profitable trading strategies. However, other nontechnical analysis skills by traders are required to manage risks, lower transaction costs and increase profitability.

Findings in this research are in contrast to the Efficient Markets Hypothesis as stock markets are predictable with high accuracy. Arbitraging opportunities are existent in African stock markets. Such high prediction accuracies can be capitalized on by investment professionals as they can use the prediction models to arbitrage in the stock markets. Hence, this cements on the key concept of Adaptive Markets Hypothesis and enhance the chances to attain great financial gain for investors and traders. In a nutshell, the presence of calendar anomalies in the stock markets under consideration supports the notion that African stock markets are inefficient and with the correct tools, they can be predicted and calendar anomalies be detected.

Since applicability of machine learning tools for stock market calendar detection proved useful, future research can look at a comparative approach of juxtaposing machine learning tools to other stock market calendar detection methods. In addition, applicability of the machine learning model must also be examined beyond the African capital markets to Asian, European and other stock markets. Due to limited availability of data for such markets to the researcher now, this work will be extended in future.

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