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# THE IMPACT OF COVID-19 ON MARKET EFFICIENCY: A COMPARATIVE MARKET ANALYSIS

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**Abstract**

Covid-19 has had severe consequences on the financial systems of many countries and has altered the manner in which most businesses operate. This adverse situation has a spill-over effect on financial markets where the market efficiency may have been altered, hence using pre-Covid-19 strategies for investment purposes may no longer be applicable. Market efficiency, which is closely linked to informational efficiency, depicts the extent to which financial markets adjust quickly and correctly to new information. It is instrumental for fundamental analysis. The aim of this study is to analyze the market efficiency during the pandemic in five major financial markets around the world. Using the runs tests, the results indicate that the market efficiency in the JSE and JPX-Nikkei 400 has been altered significantly, while the Nasdaq Index, DAX, and CAC 40 have not changed from what it used to be. This was evident in the significant difference between the expected number of runs and the total number of runs, as indicated by the runs test. The implication of this study is that investment professionals in the JSE and JPX-Nikkei 400 should alter their investment strategies, without which they may incur severe losses.

**Keywords**: Market Efficiency, Random Walk, Runs Test, Financial Markets

**JEL Classifications:** G11, G12, G15

## 1. Introduction

Market efficiency is an important but controversial topic in investment management and finance, as there are still contradictory opinions on this topic. Over the past 40 years, several researchers have investigated this concept in various ways, to have a common ground where their findings have had significant implications in the stock market and portfolio management. This concept of market efficiency is viz-a-viz the notion of random walk where prices follow an irregular pattern (Dupernex, 2007). Such implies that future stock prices are not related to today's price, which is a natural consequence of higher degrees of financial market efficiency (Fama, 1970). Capital markets are informationally efficient if stock prices adjust quickly and fully reflect all relevant information, which is implicit in many of the models used in financial decision-making (LeRoy, 1989). Markets with lower efficiency may have a spurious mechanism that indicates that prices will not be a good signal of the value of a firm. This may cause investors to withdraw from the equity market, resulting in a spill-over effect on the real productivity of the economy (Heymans amd Da Camara, 2013). The ripple effect will result in less funding for firms, thus a decline in gross domestic product (GDP) and employment. An important premise for efficient markets is a large number of profit-maximizing participants that are analyzing and valuing securities independently. The buy and sell decisions of these market participants will lead to security prices adjusting quickly to new information (Fama, 1970). Considering that new information regarding security prices arrives in a random fashion, the arrival of one announcement is independent of the other in an efficient market. Traditionally, capital markets are efficient when investors are rational (Daniel and Titman, 1999). This means that when new information is realized, investors will adjust their estimates of share prices in a rational manner, although some investors may still be guided by excessive optimism and, at other times, caught in extreme pessimism. However, the independent deviation from rationality will offset irrationality, and produce efficient markets. It is also worth noting that stock prices are difficult to predict with absolute certainty, despite regulated security markets (Cao, 2021). Taking the above mentioned in mind, stock prices in an efficient market should follow a random walk with a position drift (Dupernex, 2007). This means that the price of stock should be given as in Equation 1.

$$P_t = \psi + P_{t-1} + \Upsilon_t \quad (1)$$

, where $P_{t-1}$ is the past price, $\Upsilon_t$ is the error term, and ψ is the expected return. This suggests that price changes should be the expected return plus a random error term (Serin, 2017). Therefore, price changes cannot be forecast around their mean in an efficient market. In this case, there is no significant difference between the expected positive and negative runs to those of the observed positive and negative runs. Several researchers have investigated the market efficiency in several markets across the world prior to the Covid-19 pandemic (Bonga-Bonga, 2012; Guduza and Phiri, 2017; Gyamfi, 2017; Fusthane and Kapingura, 2017; Tsutsui and Hirayama, 2004; Noda, 2016; Patel *et al.* 2012) as well as during the pandemic (Dias and Santos, 2020; Ammy-Driss and Garcin, 2021; Tadoori, 2021). The emergence of the devastating effect of the pandemic has severely impacted stock markets. Markets across the globe are still bleeding following the continuous spread of the Covid-19.

Investigating market efficiency is not a punitive measure for any financial market, but rather, provides justification for the fees charged by most active managers. This is based on the premise that they can beat the market to some extent. Since market efficiency is not a static process (Noda, 2016), the pandemic may have significantly affected the efficiency of stock markets. In other words, markets that were efficient may no longer be applicable, and vice versa. The objective of the study is to empirically investigate the market efficiency of some major financial markets around the world. The results of this study advance the body of knowledge, because it can evaluate efficiency during the Covid-19 pandemic in countries, to make important recommendations for investment professionals and investors. This paper makes a significant contribution, as we empirically conduct a comparative analysis on market efficiency during the Covid-19 pandemic. The research question, ‘whether the market changed efficiently during the pandemic', yielded the need to alter the investment strategies to avoid losses.

## 2. Literature review

The concept of market efficiency was based on the principle of random walk, which contends that security prices have an irregular pattern (Fama, 1970). According to Fama (1970), market efficiency can be divided into three nested forms, namely weak-form efficiency, semi-strong form, and strong-form efficiency. In a weak-form efficiency market, current prices reflect all information embodied in past prices, meaning that it is impossible to forecast the future direction of price movement (Gilson and Kraakman, 1984). In a semi-strong form market, current prices fully reflect all publicly available information including fundamental analysis (Khan and Ikram, 2010). This means that share prices contain company reports and public information about the firm. Strong-form efficiency markets have stock prices that rapidly adjust to any information, including inside information (Lekovic, 2018). Therefore, no investor can earn excess returns using any information. Prior literature on market efficiency in several financial markets has published varying efficiencies. Tables 1 and 2 summarize the findings of market efficiency in the Nasdaq index, JSE, DAX, CAC 40, and JPX-Nikkei 400.

**Table 1. Review of the prior literature on the Nasdaq Index and JSE Index**

| NASDAQ Index (Panel A) | | | JSE Index (Panel B) | | |
|---|---|---|---|---|---|
| **Study** | **Model and Period** | **Findings** | **Study** | **Model and Period** | **Findings** |
| Busse and Green (2001) | Kolmogorov–Smirnov test (12/06/2020-27/10/2000) | The Nasdaq Index is very efficient and market participants cannot profit from widely distributed news unless they act instantly. | Bonga-Bonga (2012) | GARCH model (1995-2007) | The JSE can be classified as weak-form efficiency. |
| Huang et al. (2014) | GARCH models (N/A) | Nasdaq Index is market-inefficient, and investors can achieve abnormal returns. | Guduza and Phiri (2017) | Unit root testing procedures (2002-2016) | The JSE index displays weak-form efficiency. Analysts can take advantage of arbitrage opportunities. |
| Younas and Mehmood (2018) | Autocorrelation and runs test (12/2009-12/2017) | The Nasdaq Index has semi-strong efficiency, and market participants can still profit and achieve abnormal returns from widely distributed news. | Gyamfi (2017) | Semiparametric estimator and detrended fluctuation analysis (2000-2015) | Results support the evidence of weak-form efficiency. |
| Ammy-Driss and Garcin (2021) | Hurst exponent and Fractional Levy-stable motion method (2020) | The US stock markets lost their efficiency during the pandemic. | Fusthane and Kapingura (2017) | Unit root tests, autocorrelation test, and variance ratio (2005-2016) | The JSE Index displays weak-form efficiency, and investors can profit and achieve abnormal returns from fundamental analyses. |
| Tadoori (2021) | Hurst exponent (11/2019-01/2021) | The Nasdaq Index is efficient despite the Covid-19 pandemic. | Heymans and Santana (2018) | Automatic variance ratio test, the Chow–Denning joint variance ratio, and the joint sign test (01/03/2013-03/03/2015) | Active managers using active strategies can profit from inefficiencies in the JSE due to weak-form characteristics. |
| | | | Tadoori (2021) | Hurst exponent (11/2019-1/2021) | The JSE showed signs of market inefficiency during the Covid-19 pandemic. |
| | | | Dias and Santos (2020) | Unit root test and reason method of variance (09/2019-09/2019) | There is no empirical evidence to support the random walk theory, hence the lack of market efficiency during the pandemic. |

**Table 2. Review of the prior literature on the DAX Index, CAC 40 Index, and JPX-Nikkei 400 Index**

| DAX Index (Panel C) | | | CAC 40 Index (Panel D) | | |
|---|---|---|---|---|---|
| **Study** | **Model and Period** | **Findings** | **Study** | **Model and Period** | **Findings** |
| Starcevic and Rodgers (2011) | Runs tests and serial correlation tests (01/01/2005-0101/2007) | The DAX displays high levels of market efficiency. | Capelle-Blancard and Chaudhury (2001) | Spreads (02/01/1997-30/12/1999) | Lack of market efficiency and the existence of arbitrage opportunities. |
| Plihal (2016) | Granger causality (01/1999-09/2015) | High level of market efficiency in the DAX index. | El (2019) | Capital asset pricing model and arbitrage pricing theory. (31/07/2014-19/01/2015) | Semi-strong form efficiency. |
| Ammy-Driss and Garcin (2021) | Hurst exponent and Fractional Levy-stable motion method (2020) | DAX shows signs of inefficiencies during the Covid-19 pandemic. | Ammy-Driss and Garcin (2021) | Hurst exponent and Fractional Levy-stable motion method (2020) | Lack of market efficiency during the Covid-19 pandemic. |
| Tadoori (2021) | Hurst exponent (11/2019-01/2021) | The DAX index also shows signs of market inefficiency during the Covid-19 pandemic. | Tadoori (2021) | Hurst exponent (11/2019-01/2021) | The CAC 40 index shows informational inefficiency during the Covid-19 pandemic. |

| JPX-Nikkei 400 Index (Panel E) | | |
|---|---|---|
| **Study** | **Model and Period** | **Findings** |
| Tsutsui and Hirayama (2004) | Regression analysis (01/1988-10/2003) | The JPX-Nikkei 400 displays a symmetric return, implying high levels of efficiency. |
| Noda (2016) | Time-varying AR Model (10/1961-12/2015) | The level of market efficiency has evolved over time, and the JPX-Nikkei 400 is more efficient. |
| Patel et al. (2012) | Runs test (01/01/2000-31/03/2011) | The JPX-Nikkei 400 Index is weak-form inefficient, implying that investors cannot use past information to secure above average return. |
| Tadoori (2021) | Hurst exponent (11/2019-01/2021) | The JPX-Nikkei 400 Index portrays characteristics of market inefficiency during the Covid-19 pandemic. |

From the literature, there seems to be some evidence supporting the absence of market efficiency in the JSE, DAX, CAC 40, and the JPX-Nikkei 400 during the Covid-19 pandemic but conflicting findings in the Nasdaq index. Given the listed findings in tables 1 and 2, this paper aims to capture if these propositions have changed from the period of investigation. As noted by Noda (2016), market efficiency evolves and changes over time, and it is vital to be up to date, which this concept is, as it can have several implications for investors. Therefore, this study is significantly relevant to investment and finance professionals.

## 3. Methodology

This study uses a nonparametric runs test as introduced by Wald and Wolfowitz (1940) and an autocorrelation plot to investigate the randomness in a given sequence. According to Wald and Wolfowitz (1940), price changes are usually either in a positive, or negative direction. A series of consistent positive or negative changes can be described as a run (Reilly and Brown, 2003). However, when a positive price change is followed by a negative change, there is no run to be observed. In instances where a series of runs are observed, a test of independence is needed to determine whether there is a significant difference between the observed runs and expected runs. This is a simple but intuitive method for testing whether a set of returns follows a random walk, which is used as a proxy for market efficiency. When applying the Wald and Wolfowitz (1940) concept, the returns of a particular series should follow an expected number of runs in order to be considered random, implying that future returns are independent of past returns. The Wald and Wolfowitz (1940) run test is described as in equations 2, 3, and 4.

$$\text{Market run} \sim N(\mu, \Omega^2) \tag{2}$$

$$\mu = \frac{2N^+N^-}{N} + 1 \tag{3}$$

$$\Omega^2 = \frac{(\mu-1)(\mu-2)}{N-1} \tag{4}$$

, where $N^+$ is the number of positive runs, $N^-$ is the number of negative runs, N is the number of observations, and $\Omega^2$ and μ are the standard deviation and variance, respectively. The observed number of positive and negative runs is compared to a theoretical expected run to determine if there is a significant deviation, and the null is either accepted or rejected. The null- and alternate hypotheses are as follows.

- **$H_0$**: There is no significant difference between the total runs and expected run, hence the sample returns follow a random walk.
- **$H_1$**: There is a significant difference between the total runs and expected runs, hence the sample returns do not follow a random walk.

The sample period is from 02/01/2019 to 31/12/2021, and the returns are assigned a code of either 0 or 1 upon retrieving the data from Yahoo finance. If the return on a particular day is negative, its' caption is "0", and where it is positive, it is captioned as "1". The number of positive and negative runs are grouped accordingly. The number of days with positive and negative returns are also calculated, as well as runs deviation, the expected runs, and variance of runs as presented in the following section.

## 4. Findings and discussion

Autocorrelation outputs are shown in figures 1, 2, 3, 4, and 5 in appendices, whereas the findings of our runs test are reported in Table 3.

**Table 3. Run test results**

| Indicators | JSE | NASDAQ Index | DAX | CAC 40 | JPX-Nikke 400 |
|---|---|---|---|---|---|
| Positive runs | 182 | 192 | 196 | 189 | 199 |
| Negative runs | 183 | 192 | 196 | 187 | 199 |
| Total runs | 365 | 384 | 392 | 376 | 398 |
| Positive days | 384 | 441 | 407 | 423 | 395 |
| Negative Days | 366 | 309 | 343 | 325 | 355 |
| Total days | 750 | 750 | 750 | 748 | 750 |
| Expected runs | 375.78 | 364.38 | 373.27 | 368.58 | 374.93 |
| Runs Variance | 185.78 | 174.58 | 183.28 | 179.14 | 184.93 |
| Runs Stand. D. | 13.63 | 13.21 | 13.54 | 13.384 | 13.6 |
| Z-statistics | -0.79 | 1.49 | 1.38 | 0.554 | 1.696 |
| p-value | 0.786 | 0.07 | 0.08 | 0.289 | *0.045 |

According to the results presented in Table 3, the total number of positive and negative runs in the JSE for the period under consideration is 182 and 183, respectively totaling to 365, while the expected number of runs is approximately 375. However, the independence test indicates that there is no significant difference between the observed runs and the expected runs, indicating random walk or market efficiency. This finding contradicts the findings of Tadoori (2021) and Dias (2021), who found that the JSE showed signs of market inefficiency during the Covid-19 pandemic. The results of the runs test for the Nasdaq Index indicate an equal number of positive and negative runs, as well as no significant difference between the observed and expected runs, which supports the findings of Tadoori (2021), but contradicts the findings of Ammy-Driss and Garcin (2021). A similar finding is also observed in the DAX and CAC 40, where market efficiencies are also observed during the Covid-19 pandemic and is in sharp contrast with the study of Tadoori (2021) and Ammy-Driss and Garcin (2021). However, the results of the runs test for the JPX-Nikkei 400 index indicate inefficiencies in the market, meaning investors can outperform the market and achieve abnormal returns. This finding is in line with the results of Tadoori (2021), who also found that the JPX-Nikkei 400 is informationally inefficient during the pandemic. Looking at the autocorrelation outputs, the lag between the returns for JPX-Nikkei is significantly higher than the threshold line of other markets, indicating the absence of random walk. Based on the findings of this study, active managers can beat the JPX-Nikkei 400 market using fundamental analysis. However, this is not the case for the Nasdaq Index, JSE, DAX, and CAC 40.

## 5. Conclusion

The findings of this study indicate that the pandemic has affected the market efficiency in the JSE and JPX-Nikkei 400. Investors in the JSE and JPX-Nikkei 400 need to alter their investment strategies to avoid losses. This finding ties in with the proposition put forth by Noda (2016), which contends that market efficiency is not static, but dynamic and subject to change.

This study used a small sample (five markets), and further research should include other markets such as the S&P 500 and Shanghai stock exchange. This study used the runs test and autocorrelation plot to test for market efficiency. Further studies should complement these blueprints with other analyses such as simulation of specific trading rules. Considering that the pandemic is not yet over, the time frame can also be extended.

**References**

Ammy-Driss, A and Garcin, M., 2021. Efficiency of the financial markets during the COVID-19 crisis: time-varying parameters of fractional stable dynamics. *arXiv,* arXiv:2007.10727v3.

Bonga-Bonga, L., 2012. The evolving efficiency of the South African stock exchange. *International Business & Economics Research Journal*, 11(9), pp. 997-1002. https://doi.org/10.19030/iber.v11i9.7183

Busse, J. A. and Green, T. C., 2001. Market efficiency in real time. *Journal of Financial Economics,* 65(3), pp. 415-437. https://doi.org/10.1016/S0304-405X(02)00148-4

Cao, M., 2021. Predicting the link between stock prices and indices with machine learning in R programming language. *Journal of Mathematics*, 2021, pp. 1-10. https://doi.org/10.1155/2021/1275637

Capelle-Blancard, G. and Chaudhury, M., 2001. Efficiency tests of the French Index (CAC 40) options market. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.283695

Daniel, K. and Titman, S., 1999. Market efficiency in an irrational world. *Financial Analysts Journal*, 55(6), pp. 28-40. https://doi.org/10.2469/faj.v55.n6.2312

Dias, R. and Santos, H., 2020. *Stock market efficiency in Africa: evidence from random walk hypothesis*. LIMEN 2020, Leadership, Innovation, Management and Economics: Integrated Politics of Research, online, 26 November. https://doi.org/10.31410/LIMEN.2020.25

Dupernex, S., 2007. Why might share prices follow a random walk? *Student Economic Review*, 21, pp. 167-179.

El, K. R., 2019. The CAC 40 index's reaction to terrorist attacks: the case of Charlie Hebdo. *Studies in Business and Economics*, 14(2), pp. 55-72. https://doi.org/10.2478/sbe-2019-0025

Fama, E. F., 1970. Efficient capital markets: a review of theory and empirical work. *The Journal of Finance*, 25(2), pp. 383-417. https://doi.org/10.1111/j.1540-6261.1970.tb00518.x

Fusthane, O. and Kapingura, F. M., 2017. Weak form market efficiency of the Johannesburg stock exchange: pre, during and post the 2008 global financial crisis. *Journal of Economics and Behavioral Studies*, 9(5), pp. 29-42. https://doi.org/10.22610/jebs.v9i5(J).1907

Gilson, R. J. and Kraakman, R. H., 1984. The mechanisms of market efficiency. *Virginia Law Review*, 70(4), pp. 549-644. https://doi.org/10.2307/1073080

Guduza, S. and Phiri, A., 2017. *Efficient market hypothesis: evidence from the JSE equity and bond markets*. Paper No. 83487. Munich: MPRA. [online] Available at:< https://ideas.repec.org/p/pra/mprapa/83487.html > [Accessed on 11 December 2021].

Gyamfi, E. N., 2017. *Market efficiency of African stock markets.* Unpublished PhD dissertation. Limpopo: University of Venda. https://doi.org/10.1353/jda.2017.0088

Heymans, A. and Da Camara, R., 2013. Measuring spill-over effects of foreign markets on the JSE before, during and after international financial crises. *South African Journal of Economics and Management Sciences,* 16(4), pp. 418-434. https://doi.org/10.4102/sajems.v16i4.384

Huang, H., Su, Y., and Yang, M., 2013. The speed of convergence to market efficiency on NASDAQ hedging stocks. *Investment Management and Financial Innovations*, 10(2), pp. 84-92.

Khan, A. Q., and Ikram, S., 2010. Testing semi-strong form of efficient market hypothesis in relation to the impact of foreign institutional investors' (FII's) investments on Indian capital market. *International Journal of Trade, Economics and Finance*, (1)4, pp. 373-379. https://doi.org/10.7763/IJTEF.2010.V1.66

Lekovic, M., 2018. Evidence for and against the validity of efficient market hypothesis. *Economic Themes*, 56(3), pp. 369-387. https://doi.org/10.2478/ethemes-2018-0022

LeRoy, S. F., 1989. Efficient capital markets and martingales. *Journal of Economic Literature*, 27(4), pp. 1583-1621.

Noda, A., 2016. A test of the adaptive market hypothesis using a time-varying AR model in Japan. *Finance Research Letters*, 17, pp. 66-71. https://doi.org/10.1016/j.frl.2016.01.004

Patel, N. R., Radadia, N., and Dhawan, J., 2012. An empirical study on weak-form of market efficiency of selected Asian stock markets. *Journal of Applied Finance & Banking*, 2(2), pp. 99-148.

Plihal, T., 2016. Stock market informational efficiency in Germany: Granger causality between DAX and selected microeconomics indicators. *Procedia - Social and Behavioral Sciences*, 220, pp. 321-329. https://doi.org/10.1016/j.sbspro.2016.05.505

Reilly, F. K. and Brown, K. C., 2003. *Investment analysis and portfolio management*. 7th ed. Australia: Thomson South-Western.

Serin, P., 2017. Is random walk hypothesis a reasonable data generating process assumption for stock prices? Unpublished Master thesis. Bodo: Nord University. [online] Available at: <https://nordopen.nord.no/nord-xmlui/bitstream/handle/11250/2456268/serin.pdf?sequence=1> [Accessed on 16 December 2021].

Starcevic, A. and Rodgers, T., 2011. Market efficiency within the German stock market: a comparative study of the relative efficiencies of the DAX, MDAX, SDAX and ASE indices. *International Econometric Review*, 3(1), pp. 25-37.

Tadoori, G., 2021. *Testing market efficiency during Covid-19 pandemic - a study of select global Indices*. 15th International Conference on Business and Finance, ICFAI, Hyederabad, 16 August. https://doi.org/10.2139/ssrn.3905991

Tsutsui, Y. and Hirayama, K., 2004. *Market efficiency and international linkage of stock prices: an analysis with high-frequency data*. Discussion Paper No. 620. Osaka: ISER. http://dx.doi.org/10.2139/ssrn.604281

Wald, A. and Wolfowitz, J., 1940. On a test whether two samples are from the same population. *The Annals of Mathematical Statistics*, 11(2), pp. 147-162. https://doi.org/10.1214/aoms/1177731909

Younas, M. Z. and Mehmood, R., 2018. Examining the efficiency of American stock exchange NASDAQ: an empirical analysis of the market efficiency hypothesis. *Bulletin of Business and Economics*, 7(3), pp. 132-137.

**Appendices**

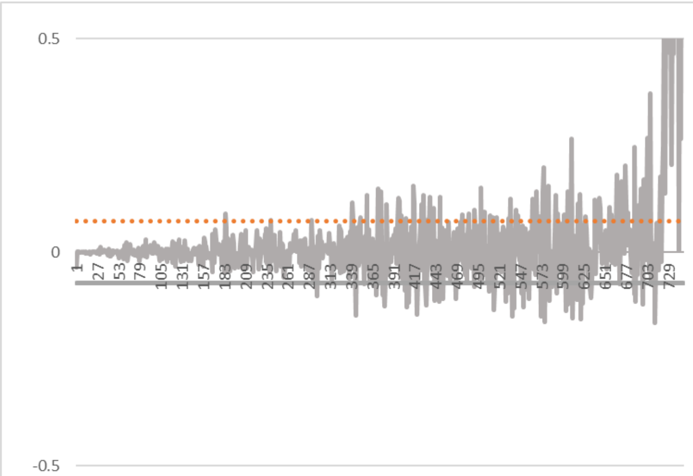


**Figure 1. Autocorrelation output for JSE**

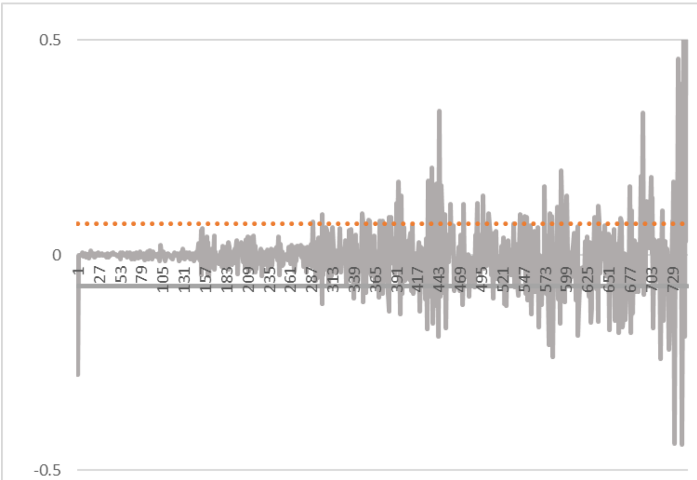


**Figure 2. Autocorrelation output for the Nasdaq Index**

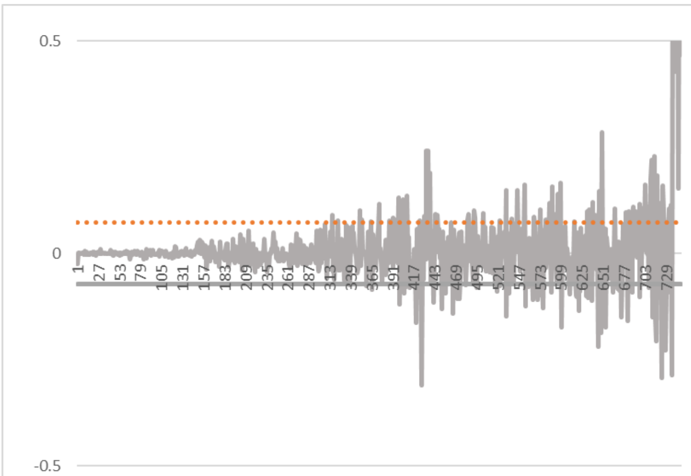


**Figure 3. Autocorrelation output for the DAX index**

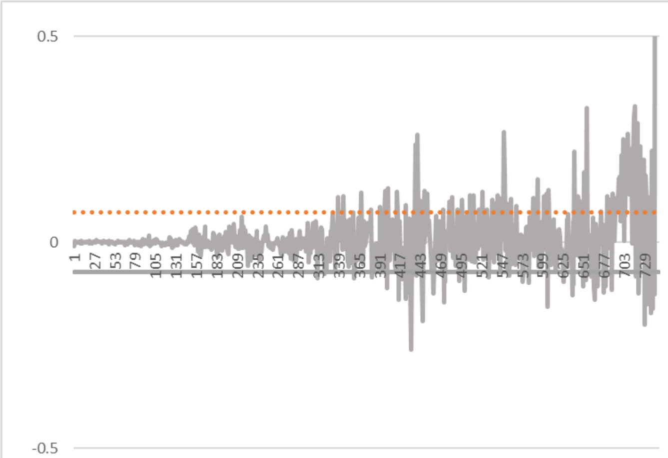


**Figure 4. Autocorrelation output for the CAC 40 Index**

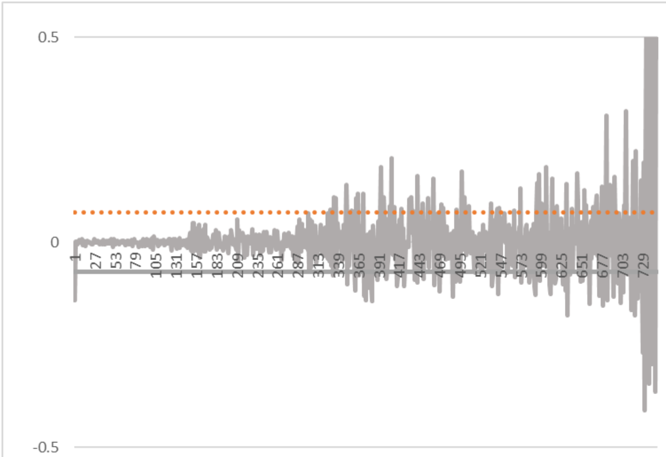


**Figure 5. Autocorrelation output for JPX-Nikkei 400**