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Multivariate Granger causality between macro variables and KSE 100 index: evidence from Johansen cointegration and Toda & Yamamoto causality

Rizwan Raheem Ahmed[a], Jolita Vveinhardt[b], Dalia Streimikiene[b] and Majid Fayyaz[a]

[a]Faculty of Management Sciences, Indus University, Karachi, Pakistan; [b]Institute of Sport Science and Innovations, Lithuanian Sports University, Kaunas, Lithuania

ABSTRACT

The pursue of this article is to scrutinise the long-haul relationship between stock returns of the KSE 100 index and monetary indicators such as rate of exchange, inflation, and interest rates. Month-to-month data from the KSE 100 index and monetary variables were extracted for the period January 1992 to November 2015. We transformed the data series into a stationary form by employing the augmented Dickey–Fuller method. The Johansen cointegration approach reinforces the long-haul association between equity prices and monetary indicators, for instance the rate of exchange, inflation, and interest rates. Results of the Granger and Toda and Yamamoto causalities demonstrate the unidirectional causal relationship between interest rate and KSE 100 index; the one-way causation existed from interest rate to equity returns for the KSE100 index. The analysis of the impulse response function concludes that the changes in the KSE 100 index happened due to its own shocks. However, changes in exchange and inflation rates were experienced because of the interest rate. The outcome of variance decomposition demonstrated that most of the changes in the KSE 100 index are because of its own shocks. Thus, it is concluded that the predictability of the equity prices for the KSE 100 heavily relied on exchange rate, inflation, and interest rate variations.

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KSE 100 index; macroeconomic variables; variance decomposition; Granger causality; Johansen cointegration; Toda and Yamamoto causality

JEL CLASSIFICATIONS
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1. Introduction

In recent decades the role of macroeconomic monetary variables in interaction with the share prices of stocks has been a crucial and interesting topic for academics and practitioners of financial economics. Normally, it is assumed that the changes in monetary indicators, for instance the rate of exchange, inflation, and interest rates, are the reasons for the variation in equity prices. The financial literature also demonstrated that investors usually relied on monetary policy and monetary variables, and it is assumed that the monetary indicators moderate a cogent effect on the stocks' volatility. Thus, the monetary variables affect the investment decisions of an investor. Hence, this postulate persuades researchers and

CONTACT Dalia Streimikiene Dalia.Streimikiene@lei.lt

financial experts to examine the affiliation between monetary variables and equity prices (Gan, Lee, Yong, & Zhang, 2006).

The financial market of any country is to be considered as a benchmark of its economic strength. According to the literature there are several factors, including social, economic, and political factors, that can influence the working performance of the equity market. These factors are interrelated with each other in a very complex manner; therefore, it requires great vigour to elaborate the interrelationship between these influential factors. According to Ahmed, Vveinhardt, and Meenai (2015), equity returns have relied heavily on economic variables, for instance foreign direct investment, the inflation rate, consumption, the rate of exchange, manufacturing production, money supply, and interest rate, etc. The literature has substantial data establishing the association between equity prices and macroeconomic indicators; it is also observed that equity returns tend to oscillate with the movement of macroeconomic variables and economic rumours. This opinion is supported by empirical confirmation, which shows that, essentially, macroeconomic indicators clarify the reasons for deviations in stock prices (Chaudhuri & Smiles, 2004). Monetary indicators, including the rate of exchange, inflation, and interest rates, are the fundamental macroeconomic indicators, which normally explicate the movements of stock returns. This is supported by numerous research studies that were carried out in different time horizons across the globe. Chen, Roll, and Ross (1986), and Ross (1976) used the arbitrage postulate to ascertain the effect of the inflation rate on equity markets in the United States. They concluded that both expected and unexpected inflation rates are inversely related to estimated stock returns.

Rahman, Coggin, and Lee (1998), Chen and Jordan (1993), Chen et al. (1986), Burmeister and McElroy (1988), and Fama and Schwert (1977) investigated the cause-and-effect phenomenon for different macroeconomic monetary indicators and stock returns. The literature shows an association between equity prices and inflation rate (Burmeister & Wall, 1986; Chan, 1985; Chang & Pinegar, 1990; DeFina, 1991; Gjerde & Sættem, 1999; Jaffe & Mandelker, 1976; Kryzanowski & Zhang, 1992; Nelson, 1976). Mukherjee and Naka (1995) and Kryzanowski and Zhang (1992) established the link between equity returns and exchange rate. Other characteristics of this problem were addressed by other researchers (Abounoori, Elmi, & Nademi, 2016; Anagnostidis, Varsakelis, & Emmanouilides, 2016; Charles, Darne, Kim, & Redor, 2016; Kandir, Erismis, & Ozturk, 2015; Lizarzaburu, Edmundo, Burneo, Galindo, & Berggrun, 2015; Tiwari, Dar, Bhanja, Arouri, & Teulon, 2015). In recent decades it has been one of the most important topics among financial experts and researchers to determine the role of economic variables on equity prices of emerging and developed markets. Currently, the investor considers monetary indicators a vital factor when making any investment in equity prices. There are several monetary variables that affect the equity markets, but the rate of exchange, interest, and inflation rates are regarded as extremely important elements, which exert a cogent effect upon stock returns. Therefore, we have investigated the influence of these monetary variables on equity prices from the KSE 100 index.

1.1. Pakistan stock market (PSX)

On 18 September 1947 the Karachi stock exchange came into existence. Pakistan had only one stock market during that period, and the market was recognised to be amongst the best-performing financial markets in 2002. In particular, in July 2016 the stock market

was given the status of emerging market. Bloomberg ranked the Karachi stock exchange third among the top 10 stock markets during 2014. On 11 January 2016 the Karachi stock exchange was renamed the Pakistan stock exchange. The PSX is a blend of Pakistan's three financial markets: the Islamabad stock index, the Karachi stock market, and the Lahore equity market. The PSX is one of the biggest stock markets in South Asia. A total of 654 companies were listed in December 2009, with a total market capitalization of US$120.5 billion; the Karachi stock exchange reached US$35 billion on 30 July 2011 and, as of 10 July 2015 it reached a market capitalization of US$72 billion. The volatility of the market has been an issue of recent years, due to the poor state of law and order, and the political and economic instability of the country (Ahmed, Meenai, & Hussain, 2013).

1.2. Interest rate

The interest rate is defined as 'a premium payment on borrowing by the debtor to the creditor in a form of cash liquidity'. The federal reserve board regularly monitors and changes the interest rate due to the repercussions of inflation in the country. Thus, the interest rate is linked to the exchange rate and equity returns. Financial experts are interested here because of the interrelationship between interest rates and equity markets' capitalization (Aydemir & Demirhan, 2009). According to these experts, if the interest rate rises then equity returns diminish, and any negative news linked to interest rates badly affects the exchange rate and stock markets (Lobo, 2000).

1.3. Inflation rate

The inflation rate is a phenomenon in which the prices of services and goods rises and, subsequently, the value of money decreases. An abrupt increase in inflation also affects the stock markets' performance in a negative manner. An increase in inflation affects equity market investors, because inflation depicts an unpleasant situation of the economy, thus investors feel insecure towards investing in share trading in a turbulent economic situation. Investors and financial experts anticipate that there will be inflexible economic strategies for the control of inflation by the government. On the other hand, a decrease in the rate of inflation exerts a positive effect on the equity markets and investors' confidence is reinstated, and they are keen to invest in financial markets (Omran & Pointon, 2001).

1.4. Exchange rate

The monetary worth of the currency vis-à-vis other currencies is known as the rate of exchange. Granger, Huangb, and Yang (2000) advocated a couple of established postulates that describe an association between equity returns and the rate of exchange. The first is called the traditional point of view (Aggarwal, 1981), whereas the second is known as the portfolio point of view (Tabak, 2006). The second theory deals with the indirect linkage between the exchange rate and equity prices. If equity returns decline, the investors' wealth also declines, which decreases the demand for money. Consequently, the interest rate will decline, which triggers capital outflows and, as a result, the currency will be devalued. Thus, it is established that variation in the rate of exchange causes variation in equity returns. If the rate of exchange escalates then the prices of equities diminish, and vice versa; equity

returns are lowered by an adverse change in the exchange rate (Krueger, 1983). Foreign investors also change their returns in their own country; if the local currency becomes stronger then foreign investors tend to invest in their local equities.

In an assessment of the discussion above, there is, therefore, an utmost need to study the long-haul association between stock returns and the monetary indicators comprising the rate of exchange, inflation, and interest rates. The literature has suggested that the rate of exchange, interest rate, and inflation rates have been the pivotal monetary variables, and have an established relationship with stock returns. This research study also examines how these macroeconomic indicators affect the Pakistan stock market. Therefore, we have conducted this research to check the relationship following a specific approach. The KSE 100 index is one of the top financial markets of Asia as well as of the rest of the world; hence, this is another reason to explore its relation to macroeconomic variables.

1.5. Objectives of the research

The purpose of the research is to scrutinise the long-haul relationship between equity returns of the KSE 100 and monetary variables such as the rate of exchange, interest rate, and inflation rates. The research also helps comprehension of the characteristics of equity market events with respect to the emerging equity market through ascertaining the macroeconomic variables, especially in the case of monetary indicators. This research also investigates the effect of variation in macroeconomic variables, i.e., the rate of exchange, interest rate, and inflation rates, on stock market activities. It also provides a basis for investors, financial firms, and government authorities to take rational decisions in the light of the research. This research paper provides a basis and guidelines to investors and financial experts for making investment decisions in the share market of Pakistan. This research may also be useful for the policy and decision makers of Pakistan.

1.6. Significance of the research

The significance of this research is manifold when compared to the previous research that has been conducted on the same topic. The KSE 100 is the leading stock market of Pakistan; in recent years it has shown tremendous growth and performance. This phenomenal growth distinguishes it from other regional stock markets; thus it has great relevance and is of interest for researchers. During recent periods significant variations have been detected in macroeconomic variables. Unparalleled changes have been witnessed in the rate of exchange, interest rates, and inflation rates due to a decrease in the price of oil; hence, this was the most vital instrument for the reduction of the rate of inflation. The interest rate is now at its lowest state as compared to the previous twenty years. Oil prices substantially affect other macroeconomic indicators in Pakistan. Hence, there is a desperate need to investigate again the association between Pakistan's stock returns and monetary indicators. These are the strongest reasons for replicating previous studies, possibly changing previous findings, and providing new dimensions in business, investment implications, and opportunities.

This article is in five parts. The second part reviews previous literature regarding the association between equity prices and macroeconomic variables. The third part contains an empirical framework and estimation techniques. The fourth part gives the empirical results and findings, and the fifth part contains conclusions and recommendations.

2. Theoretical substantiation

The role of macroeconomic monetary variables interacting with the prices of stocks has been a crucial and interesting topic for academics and practitioners of financial economics. The literature contains substantial data that demonstrate the associations between equity returns and different macroeconomic indicators. Macroeconomic indicators such as gross domestic product, inflation, oil prices, exchange rate, interest rate, gold prices, money supply, foreign direct investment, imports, exports, interest rates, and stock prices have been studied, and various outcomes have been inferred, but the debate continues regarding which indicator has a substantial effect on equity markets. There are three classifications of stock market, as shown in Figure 1.

2.1. Literature: developed markets

Gan et al. (2006) conducted a study on the equity market of New Zealand. They took monthly data, and considered the period from January 1990 to January 2003. Researchers have taken important monetary macroeconomic variables, and employed different econometric techniques to analyse the data, using multivariate cointegration, innovative accounting techniques, as well as the Granger tests. Results of the research study concluded that the CPI has an inverse affect on the NZSE40; however, the results of the Granger causality test demonstrated that equities of NZSE400 do not have direct relationship with consumer price index (CPI) since the NZSE40 has different dynamics when compared to other developed markets.

Maysami and Koh (2000) used domestic exports, money supply, industrial production, balanced foreign rate of exchange, and inflation and interest rates, and attempted to establish an association between economic indicators and the Straits Times Index, the Nikkei 225,

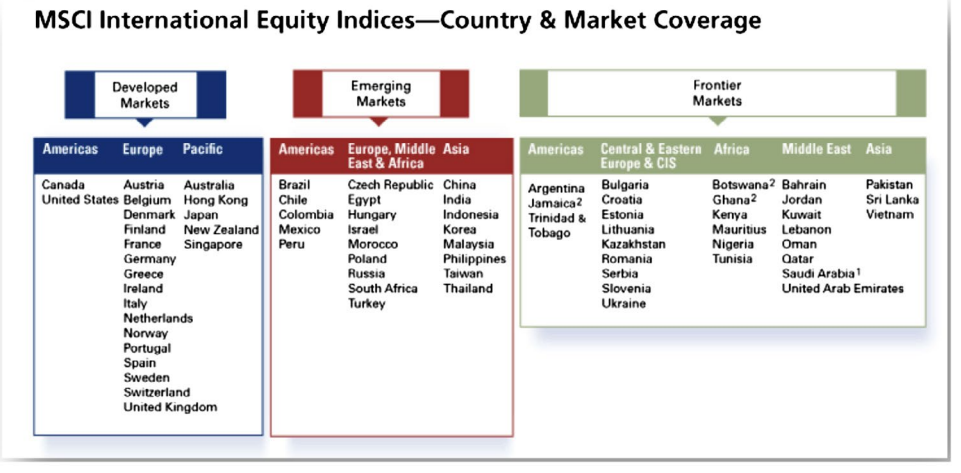

Figure 1. Classifications of stock markets. (a) Developed markets; (b) emerging markets; (c) frontier markets. Source: Morgan Stanley Capital International (2015).

[1]MSCI will monitor the effectiveness of the opening of the market and gather feedback from international investors before considering a proposal to include the MSCI Saudi Arabia Index in the MSCI Emerging Markets Index.

[2]The MSCI Standalone Market Indexes are not included in the MSCI Emerging Markets Index or MSCI Frontier Markets Index. However, these indexes use either the Emerging Markets or the Frontier Markets methodological criteria concerning size and liquidity.

and the S&P 500. They employed a vector error correction model econometric time series model; the outcomes of the research study demonstrated a long-haul association between the Straits Times Index and the exchange rate, growth, inflation, money supply, and rate of interest. The outcomes of the study further established a long-haul association between economic indicators and Straits Times Index stock prices, the S&P 500, and the Nikkei 225. They also concluded that there is a cointegration amongst the equity indices of the U.S.A., Singapore, and Japan.

According to Gjerde and Sættem (1999) real interest rates affected the equity returns of U.S. and Japanese financial markets and the inflation rate; moreover, changes in the price of crude oil exerted an affirmative impact on stock indices. They finally concluded that there was a positive effect of domestic real activity on the equity returns in all three markets. Another important study by Cheung and Ng (1998) demonstrated a long-haul association between economic indicators, for instance real consumption, oil prices, money supply, and equity returns for markets in the U.S.A., Canada, Japan, Germany, and Italy. They also concluded that the variation in equity prices is dependent on the changes in these macroeconomic variables. An important study by Leigh (1997) examined the equity returns of the Singapore stock market and macroeconomic variables, and concluded that money demand alone has a positive relationship with stocks, and that other basic macroeconomic indicators did not have any impact on stock prices. Fung and Lie (1990) studied the same relationship in Taiwan with the same results.

An important research study demonstrated a positive long-haul association between equity returns for Japanese indices and economic indicators such as real gross domestic product, money supply, bond rate, call money rate, exchange rate, and the rate of inflation. They used the vector error correction model econometric technique; they also confirmed the positive role of equity prices in this association (Mukherjee & Naka, 1995). Lee (1992) explored the post-war relationship between the equity prices of U.S. stock markets and macroeconomic variables, for instance the rate of inflation, real gross domestic product, and interest rate. It was concluded that equity returns influence the real activity and have a minor effect on inflation. The interest rate is a major factor for the variation in inflation and has a minor impact on real activity. Bulmash and Trivoli (1991) studied U.S. stock prices, money supply, treasury bill rate, recent federal debt, unemployment, and the federal rate. They concluded that there was a positive long-term relationship between stocks, unemployment, money supply, and recent federal debt; but a negative association between equity prices and treasury bills rate. According to Geske and Roll (1983) the relationships between equity returns of U.S. markets and macroeconomic variables, for instance the rate of inflation, gross domestic product, and real economic activity, are diverse. They concluded that there is an inverse relationship with inflation and a direct relationship with real economic activity. It is important to note that these outcomes are identical to the conclusions of Lee (1992) and Fama (1981).

Important research was conducted by Bahmani-Oskooee and Sohrabian (1992) to examine the association between equity returns of the S&P 500 and the rate of real exchange in the case of the U.S. economy. They employed multivariate cointegration and Granger causality econometrics techniques; they used monthly S&P 500 data for the index and real exchange rate. They concluded that there was a short-run association between equity returns and the effective exchange rate, and a one-way causation from the exchange rate to equity returns. However, they did not trace a long-haul association between the rate of exchange

and equity returns for the S&P 500 index. Chen et al. (1986) investigated the association between equity returns of U.S. markets and macroeconomic indicators such as oil prices, industrial production, low- and high-rank bonds, expected and unexpected inflation, and interest rates. They concluded that interrelated risks associated between variables could be measured in isolation. In research identical to the research study conducted by Chen et al. (1986), Hamao (1988) examined the equity returns of Japanese stock markets and macroeconomic variables. He added additional international trade variables, and came to the same results except that industrial production and stock prices appeared to be insignificant. Similarly, Poon and Taylor (1991) conducted a parallel study on equity prices from UK stock markets and macroeconomic variables. However, the results are dissimilar to Chen et al. (1986), concluding that macroeconomic indicators do not have significant effects on equity returns. They argued with Chen et al.'s (1986) findings and suggested either that different macroeconomic indicators have a significant positive effect on equity returns of U.S. markets or that the research methodology adopted by Chen et al. (1986) was not appropriate.

2.2. Literature: emerging markets

Dasgupta (2012), Naik and Padhi (2012), and Bhattacharya and Mukherjee (2006) investigated the association between equity returns of the Indian markets and macroeconomic indicators such as gross domestic product, foreign direct investment, rate of exchange, money supply, manufacturing production, interest rate, wholesale price index, and national income. They concluded that there was a positive and significant relationship between economic indicators and equity returns from Indian stock markets. Vuyyuri (2005) used monthly data for the real sectors of the Indian economy and different economic variables such as industrial production, the rate of exchange, inflation, and interest rates, and equity returns of the Indian stock markets. The outcomes of the study demonstrated a long-haul association between equity returns and the real sector and monetary variables; however, they further concluded that there was a one-way causation from monetary indicators towards the real sector.

Mishra (2004) examined an association between equity returns for the Indian markets and monetary indicators, including the demand for money, interest rates, and the exchange rate. However, he did not conclude that there was a long-haul association between equity returns and the rate of exchange; moreover, the study established a one-way causation from the rate of exchange to the interest rate and demand of money. Islam and Watanapalachaikul (2003) conducted research on equity returns from Thailand and macroeconomic variables including the rate of exchange, bond rates, earning price ratio, interest rate, market capitalization, and consumer price index. They considered the period 1992 to 2001; the outcomes of the study demonstrated a strong and cogent long-run association between equity prices and macroeconomic indicators. Islam (2003) analysed the association between equity returns from the Malaysian stock market and economic indicators, for instance the rate of exchange, manufacturing productivity, rate of interest, and inflation rate. The outcomes of the research study established a long-haul 'equilibrium', and short-term 'dynamic' association between economic indicators and equity prices of the Kuala Lumpur Stock Exchange index.

Hong and Stein (2003) conducted another relevant study in Malaysia. They explored the effect of the interest rate and the rate of exchange on equity prices of the Kuala Lumpur Stock Exchange. They employed Error Correction Model (ECM) modelling and a multivariate

cointegration technique. The results of the study demonstrated that the equity returns and interest rates have a strong negative onset than the positive association in the equilibrium state. The results further concluded that there was a neutral interaction between the exchange rate and its own shocks; however, the exchange rate has an equilibrium interaction with interest rates and equity returns. Important research was carried out to investigate a long-run association between stock prices of the nine Asian markets and exchange rates; the period considered was from January 1980 to June 1998. The outcomes of the research study demonstrated a significant long-haul association between the financial markets of Singapore and the Philippines and exchange rates. The researchers established the same result when one more variable such as interest rate was included in their study. A comparison was made through cointegration between equity returns of remaining markets and interest rates and exchange rates, and they came to the same results (Amare & Mohsin, 2000).

Zhou (1999) investigated the long-run association between equity returns of Chinese financial markets and different macroeconomic indicators, including inflation rate and industrial production. The outcomes of the research study revealed a cogent but inverse causal association between equity prices and the rate of inflation, whereas further results demonstrated a significant positive causal link between equity returns and industrial production. According to Kwon and Shin (1999), there was no evidence of the influence of economic indicators on equity prices of the Korean stock index. They investigated the association between macroeconomic indicators, for instance the rate of exchange, money supply, and trade balance index of production and stock prices. Gong and Mariano (1997) examined the Korean stock markets and macroeconomic variables like indices of manufacturing industry, money supply, and inflation rate. They concluded that the expected and unexpected stock returns fluctuated with the macroeconomic variables.

Abdalla and Murinde (1997) explored a long-haul association between equity indices for India, the Philippines, Pakistan, and Korea, and covered the time period January 1985 to July 1994. The outcomes of the research study confirmed a long-haul relationship between the equity markets of India and the Philippines and exchange rates, but did not succeed in establishing a long-haul affiliation between the equity markets of Korea and Pakistan and exchange rates. The Granger causality results established the one-way causation from exchange rate to equity prices of Indian markets, and a one-way inverse causal relationship from stock returns to the rate of exchange in the case of the Philippines. However, in the case of Pakistan and Korea, there was no evidence of any causation either from equity returns to the exchange rate or exchange rate to equity prices. According to Rittenberg (1993), in the case of the Turkish stock market, the only one-way causation was recorded from equity returns to the exchange rate. Hendry (2009) examined the long-haul and short-term associations between stock prices of the six emerging Asian stock markets and selected macroeconomic indicators including real activity, inflation rate, money supply, the rate of exchange, and rate of interest. Results of the research study confirmed the positive effect of these macroeconomic indicators on equity returns for all six emerging markets; however, the kind and stretch of this affiliation was prominent, and reliant on individual countries' economic situations and monetary policy configurations.

2.3. Literature: frontier markets

Benaković and Posedel (2010) examined the impact of monetary variables and stock returns. For this reason they used a multifactor instrument developed by Ross (1976). The outcomes

of the research study confirmed the importance of market indices, and concluded that there was a positive association between equity returns and market indices. The study further confirmed the affirmative impact of oil prices, industrial production, and the interest rate on equity returns, except for the inflation rate. The study concluded that the CROBEX index was one of the most prominent financial markets in which equity returns were stimulated with a positive risk premium. Another important research study was carried out to investigate an association between stock prices of the Pakistani, Indian, and Bangladeshi stock markets and exchange rates. The outcome of the research study concluded that there was a neutral causal association among equity prices of the stock indices of India, Pakistan, and Bangladesh and the rate of exchange (Rahman & Uddin, 2009).

Adam and Tweneboah (2007) used quarterly observations from 1991 to 2004 and examined the influence of monetary indicators on the equity index for Ghana. They used the innovation accounting test and a multivariate cointegration technique to investigate the long-haul and short run association. The outcomes demonstrated an affirmative long-haul association between equity prices and the rate of inflation; however, the results of forecast error variance decomposition established that inflation has become an obstacle to gaining a positive effect for equity returns in comparison to the rate of interest, foreign direct investment, and the rate of exchange. Achsani and Strohe (2002) investigated the frontier regional stock market of Indonesia and concluded that there was an inverse causal association between inflation and interest rates on equity returns. They also established a positive and strong association between oil prices and equity returns. Similarly, Gunasekarage, Pisedtasalasai, and Power (2004) examined the long-haul and short run relationship of equity prices of the Colombo equity index, and selected macroeconomic indicators including money supply, consumer price index, and rates for treasury bills. They employed month-to-month data from January 1985 to December 2001. For the analysis they employed a vector error correction model and multivariate cointegration econometrics techniques, and concluded that the consumer price index, treasury bills, and money supply influenced equity returns. Maghyereh, Omet, and Kalaji (2002) used monthly data from January 1987 to December 2002 to analyse the long-haul affiliation between equity returns of the Jordan stock index and selected monetary indicators. They employed multivariate cointegration and concluded that there was a long-haul affiliation between stock returns and monetary indicators.

2.4. Literature: the KSE 100 index

Similarly, Ahmed and Mustafa (2012) examined the effect of the rate of inflation on equity returns of the KSE 100 index; they used annual data from 1972 to 2002. They employed Fama's (1981) method to ascertain the relationship between the variables; they incorporated two important macroeconomic indicators such as consumer price index as an inflation indicator, and real gross domestic product as the real growth rate. The results of the study demonstrated the causations between the economic variables and equity prices; they further demonstrated that the real gross domestic product has a dominant effect on equity prices. They also concluded that there was an inverse effect of the inflation rate on equity prices, which indirectly hampers the stock prices of the KSE 100. Akash, Hasan, Javid, Shah, and Khan (2011) investigated a long-haul and short-term association between equity returns of the KSE 100 and selected economic variables including foreign reserves, treasury bills' rate, exchange rate, consumer price index, industrial production, and money supply. The results of the study demonstrated a cogent positive long-haul association between equity

prices and consumer price index, industrial production, and money supply. They further concluded that there was an inverse but significant association between equity prices and the rate of inflation and interest rates; moreover, there was a positive association between equity prices and money supply.

Sohail and Hussain (2010) investigated a long-haul and short-term affiliation between equity returns of the KSE 100 and different economic variables, for instance the rate of treasury bills, gross domestic product growth, money supply, rate of inflation, and the rate of exchange. They used month-to-month data, and employed time series modelling like Johansen multivariate cointegration and a vector error correction model to analyse the data series. They concluded that there was an affirmative and cogent long-haul affiliation between equity returns, and the rate of exchange, gross domestic product growth, and inflation rate; though they confirmed an inverse association between equity returns and the rate for treasury bills and money supply. Important research was conducted to investigate the long-haul association between equity returns of the KSE 100 and selective economic indicators including interest rates, treasury bills' rate, consumer price index, the rate of the exchange, and money supply. The outcomes of the research study concluded that there was a cogent long-haul association between equity returns and money supply, consumer price index, and treasury bills' rate, but the rate of interest has an inverse influence on stock prices; however, the rate of exchange has a marginal effect on stock prices (Hassan & Javed, 2009).

Hasan, Saleem, and Abdullah (2008) also examined the relationships between KSE 100 stocks and different economic indicators including inflation, oil prices, money supply, rate of exchange, manufacturing productivity, and rate of interest. The outcomes of the study exhibited a cogent long-haul association between equity prices and money supply, the rate of exchange, and interest rate; however, they did not trace any affiliation between equity prices and oil prices, manufacturing productivity, and inflation rate. Akmal (2007) studied a long-haul association between equity returns and the rate of inflation; he has also concluded that the rate of inflation provided a hedging to the stock returns in a long-term relationship. Nishat and Shaheen (2005) examined a long-haul affiliation between equity returns of the KSE 100 index and economic indicators: for instance, manufacturing productivity, economic growth, and rate of inflation. They covered annual data from 1973 to 2004 and employed a vector error correction model, a variance decomposition method, and a multivariate cointegration econometrics model to examine the series. The outcome of the research study demonstrated a causal association between equity prices and annual gross domestic product growth; however, they confirmed an inverse association between equity prices and industrial production. They further concluded that there was an inverse cogent relationship between stock prices and the rate of inflation; the outcomes of variance decomposition analysis confirmed that one of the dynamics exerted a cogent variation on equity returns, not only in the medium run, but also in the short term as well.

Nishat and Rozina (2004) investigated a long-haul affiliation between stock returns of the KSE 100 index and selected economic indicators including industrial production, exchange rate, inflation rate, and narrow money. They used month-to-month data from January 1973 to December 2004; they employed time series models like the Johansen cointegration and a vector error correction model to analyse the data series. The outcomes of the research study demonstrated a positive long-haul association between equity returns and industrial

production, exchange rate, and narrow money; however, they established that the rate of exchange exerted an inverse effect on equity prices. They additionally confirmed that macroeconomic indicators have a one-way causation to equity returns.

3. Empirical framework

The research study investigated the long-run association between equity returns of the KSE 100 index and monetary indicators including the exchange rate, inflation, and interest rates. We took month-to-month data from January 1992 to November 2015. We also employed the KSE 100 monthly closing index, and the exchange rate was used in comparisons against the U.S. dollar. The setting of data series of the equity market index and month-to-month data for monetary indicators were consistent with previous studies that examined the same association in different market indices, and with diverse time horizons across the globe (Chan & Faff, 1998; Maghyereh et al., 2002; Nishat & Rozina, 2004).

3.1. Macroeconomic indicators

In this research we used four different economic variables such as: equity returns of the KSE 100 index, the rate of exchange, inflation rate, and rate of interest. We used the KSE 100 index as the dependent variable, while monetary indicators, for instance the rate of exchange, interest rate, and rate of inflation, have been taken as independent variables.

3.2. Sample period and sources

As discussed above, we used the month closing index of the KSE 100 index; 287 readings of the index were extracted from the KSE 100 website. The rest of the monetary indicators' data were taken from various issues of economic surveys released by the State Bank of Pakistan (2015). We synchronised the data series according to the research setting, and considered 287 observations for each variable from January 1992 to November 2015. We transformed monthly readings into a natural log so that the differences could be interpreted directly as the return. Table 1 shows the details of the macroeconomic indicators, sources, and frequency of the data series.

3.3. Estimation techniques

We calculated the returns of the macroeconomic indicators using the following methods and formulas.

Table 1. Data collection sources.

Variable	Frequency	Source
KSE 100 index	Monthly	Karachi stock exchange website (2016)
Interest rate	Monthly	State Bank of Pakistan (2015)
Inflation rate	Monthly	State Bank of Pakistan (2015)
Exchange rate	Monthly	State Bank of Pakistan (2015)

Source: Authors' calculations.

3.4. Change in KSE 100 index

The natural log difference approach is used to compute the stock returns. To substantiate the objective, the following equation for the KSE 100 index has been applied

$$KSE100_{(t)} = ln\left(C_t / C_{t-1}\right) \tag{1}$$

where stock $KSE100_t$ is regarded as the equity return of the KSE 100 at period of time t, and C_t and C_{t-1} are the current and previous day stock indices for the current day t and previous daytime period $t - 1$.

3.5. Change in interest rate

An interest rate is calculated by using the natural log difference. The following equation has been used for interest rate return

$$INT_{(t)} = ln\left(INT_t / INT_{t-1}\right) \tag{2}$$

where INT_t refers to the returns of the interest rate at period of time t, and INT_t and INT_{t-1} are the current and previous day interest rates for the current day t and previous daytime period $t - 1$.

3.6. Change in inflation rate

The inflation rate return can be calculated by applying the difference of the natural log. Equation (3) is the mathematical representation of the inflation rate return

$$INF_{(t)} = ln\left(INF_t / INF_{t-1}\right) \tag{3}$$

where INF_t is the returns of the inflation rate at period of time t, and INF_t and INF_{t-1} are the current and previous day inflation rates for the current day t and the previous daytime period $t - 1$.

3.7. Change in the exchange rate

Exchange rates returns can be calculated by applying the difference of the natural log. Equation (4) is the mathematical representation of the exchange rate return

$$EXC_{(t)} = ln\left(EXC_t / EXC_{t-1}\right) \tag{4}$$

where EXC_t refers to the returns of exchange rates for the period of time t, and EXC_t and EXC_{t-1} are the current and previous day rates of exchanges for the current day t and previous daytime period $t - 1$.

3.7.1. Long-run association

This research scrutinises the long-haul relationship between stock returns of the KSE 100 index and monetary indicators, for instance rate of exchange, interest rate, and the rate of inflation. We employed the Johansen cointegration approach for establishing a long-haul affiliation between the macroeconomic indicators. Moreover, we employed descriptive analysis, Granger causality, and Toda and Yamamoto Wald (1995) econometrics techniques to examine the causation and causality direction between a pair of economic indicators. Finally, we employed the variance decomposition method and impulse response function to carry out further analysis.

3.7.2. Unit root test (augmented Dickey–Fuller)

To run any appropriate econometrics techniques on the considered data series, we first have to check for the presence of a unit root in the data series. If we have deduced the presence of a unit root then the second objective is the transformation of the data series into a stationary data series. The data should be stationary; therefore, we used the augmented Dickey and Fuller method (1979, 1981), which is an extensively used method. The general equation of the augmented Dickey and Fuller test is

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^{n} \alpha \Delta y_t + e_t \tag{5}$$

where y represents the time series in the time period t, Δ is the first difference operator, α_0 represents the constant, n is the optimum number of lags, and e is the white-noise error.

3.8. The Johansen multivariate cointegration

If the relationship of variables is in a form of linear stationary combination then the two series of variables are known as the cointegrated to each other, and they must have a long-haul association. Though, an individual data series is not necessarily to be stationary. There might be a long-term equilibrium state for cointegrating association among the data series (Hall & Henry, 1989). However, in a short-term association, the variables are not dependent on each other (Dickey, Ghil, & Marcus, 1991). We used the Johansen (1988, 1991) cointegration technique. In the model below we used n non-stationary variables and engaged a variance decomposition analysis approach with p lags. The expression can be shown as

$$\Delta y_t = \mu + \Delta_1 y_{t-1} + \ldots + \Delta_p y_{t-p} + \varepsilon_t \tag{6}$$

where y_t is considered to be $(n \times 1)$ vectors, and ε_t is an error term. The variables are incorporated in order as

$$\Delta y_t = \mu + \eta y_{t-1} + \sum_{i=1}^{n-1} \tau_t \Delta y_{t-1} + \varepsilon_t \tag{7}$$

where $\eta = \sum_{i=1}^{p} A_{i-1}$ and $\tau_t = \sum_{j=i+1}^{p} A_j$

The value of cointegrating vectors could be singled out by applying Johansen and Juselius' (1990), and Johansen's (1988, 1991, 1995) techniques. The objective of these techniques is

to figure out the two-statistic examination. The first is called λ-trace, which tests the invalid speculations in the time series. It checks whether the number of the specific cointegrating vector is equal to probability p in an association of unrestricted selection p = r. An expression of the trace test can be written as

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} ln\left(1 - \overset{\Lambda}{\underset{r+1}{\lambda}}\right) \tag{8}$$

where T is the number of operational annotations and $\lambda r + 1$ is called the projected eigenvalue from the matrix. The second expression is known as the maximum eigenvalue or simply λ-max. The equation can be written as

$$\lambda_{max}(r, r+1) = -Tln\left(1 - \overset{\Lambda}{\underset{r+1}{\lambda}}\right) \tag{9}$$

where for the void assumptions we check whether there are r cointegrating vectors in association according to the option theory that represents $r + 1$ cointegrating vectors.

3.9. Toda and Yamamoto Wald causality technique

The analysis of causality and its direction among economic indicators is a prime feature for examination while conducting a study of macroeconomic variables and stock prices. Besides the Granger causality, another important procedure was developed by Tada and Yamamoto (1995) to investigate causation and the direction of causality. This method has been applied by using the revised and improved Wald (MWALD) approach. This approach could be used regardless of the cointegration, whether the fundamental indicators are simply integrated of order zero I(0) and order one I(1), and discreetly cointegrated to each other. This is the unique feature of the Toda and Yamamoto modified Wald method. The equations can be shown in Eq. (10) and Eq. (11)

$$Y_t = \alpha_1 + \sum_{t=1}^{k+d} g_{1i} Y_{t-i} + \sum_{t=i}^{k+d} g_{2i} X_{t-i} + e_{yt} \tag{10}$$

$$X_t = \alpha_2 + \sum_{t=1}^{k+d} h_{1i} Y_{t-i} + \sum_{t=i}^{k+d} h_{2i} X_{t-i} + e_{xt} \tag{11}$$

where k represents for the lag orders, d denotes the optimal number of orders for integration, and e_{yt} and e_{xt} are the white-noise errors. When a typical Wald test has been employed, it is noted that the first k matrices of coefficients exhaust the normal Chi-squared statistics.

3.10. Variance decomposition analysis

Variance decomposition analysis checks all the failures in accordance with variations in the values of macroeconomic factors in a specified time frame. Variance decomposition analysis

shows that the considered variable might be elevated due to either its own shocks or the impact of other macroeconomic variables. Variance decomposition analysis is known to be the best methodology to forecast the cumulative effects of shocks and their significant changes.

4. Empirical results

4.1. Descriptive analysis

Table 2 shows the monthly returns of equity prices of the KSE 100, which shows that an average return is 1.1% with a volatility of 0.089; and maximum and minimum returns of 24.6% and −44.8%, respectively, were recorded in a certain month time period. The average interest rate was recorded to be around −3%; however, the maximum interest rate was documented as being up to 19.4%. The average inflation rate was 0.50% and the maximum went up to around 12%. The average reduction in Pakistani money is around 0.40% per month. Results of the kurtosis showed that time series data do not follow the normality patterns because the values are greater than 3, thus the series are ideal for the econometrics analysis. The values of skewness showed that the series are leptokurtic, and all the series are negatively skewed except for inflation rate.

4.2. Unit root test (augmented Dickey–Fuller)

The results of the augmented Dickey and Fuller test have been depicted in Table 3. The results showed that stock returns of the KSE 100, rate of exchange, inflation, and interest rate data series possessed a unit root at level. Therefore, the data series were transformed and checked on first difference where these data series have become stationary; consequently, the series

Table 2. Descriptive statistics.

Statistics	DLKSE	DLINT	DLINF	DLEXC
Mean	0.011	−0.003	0.005	−0.004
Median	0.020	0.000	0.001	−0.005
Maximum	0.246	0.194	0.120	0.528
Minimum	−0.448	−0.194	−0.066	−0.575
Skewness	−0.873	−0.095	2.817	−0.018
Kurtosis	5.321	8.793	6.120	4.986
Standard deviation	0.089	0.042	0.017	0.142

Source: Authors' calculations.

Table 3. Results of stationarity augmented Dickey–Fuller test.

	Augmented Dickey–Fuller test statistics at level and first difference			
Macroeconomic variables	Level	Probability*	1st difference	Probability*
LKSE 100	0.08	0.96	−16.27	0.00
LINT	−0.31	0.92	−10.05	0.00
LINF	−1.14	0.70	−7.42	0.00
LEXC	−1.74	0.41	−14.82	0.00
Test critical values				
At 1% level	−3.25			
At 5% level	−2.87			
At 10% level	−2.57			

*Denotes MacKinnon (1996) one-sided *p*-values.
Source: Authors' calculations.

have been integrated by an order of one, or simply I(1). Since the method of checking a unit root and transforming the data series into a stationary form is a precursor to any advanced econometrics analysis, and the data series have been converted into a stationary form, we can proceed to further analysis.

Figure 2 portrays the graphical depiction of stationary and non-stationary data series of macroeconomic indicators such as the equity index of the KSE 100, exchange rate, inflation rate, and rate of interest for the considered time horizon from January 1992 to November 2015. Figure 2(a) shows the non-stationary time series data for all variables and Figure 2(b) shows the stationary time series data for economic indicators including the KSE 100 index, interest rates, inflation rates, and exchange rates.

4.3. Selection of lag length criterion

Before employing cointegration analysis, it is mandatory to single out an appropriate lag length from the series. The stock returns, the rate of exchange, interest rate, and rate of inflation data series are stationary at the first difference. Therefore, a time series model like the Johansen multivariate cointegration technique has been suggested. In order to find out

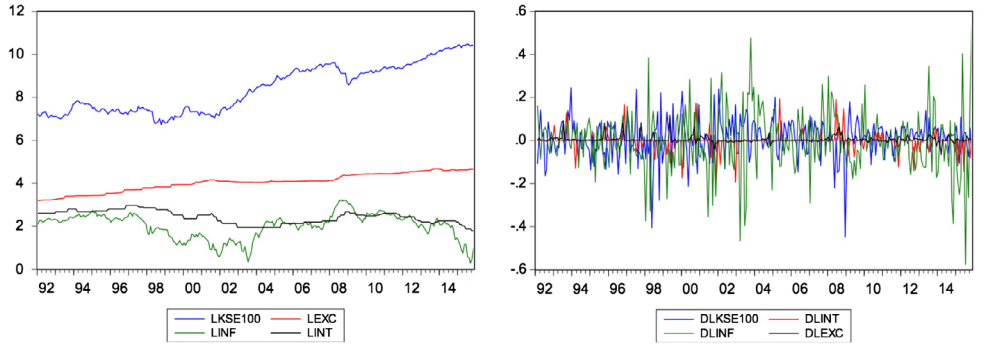

Figure 2. Time series data. (a) Non-stationary series data; (b) stationary series data. Source: Authors' calculations.
Note: X-axis represents for the numbers of observations and Y-axis represents the values of economic variables at natural log in left side and difference of natural log in right side of Figure 2.

Table 4. Optimum lag length – Akaike information criterion.

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	1629.04	N.A.	8.3×10^{-11}	−11.86	−11.81*	−11.84*
1	1650.00	41.00	8.0×10^{-11}	−11.90	−11.63	−11.79
2	1667.00	33.00	8.0×10^{-11}	−11.90	−11.43	−11.71
3	1684.00	33.00	7.9×10^{-11}*	−11.91*	−11.23	−11.64
4	1693.50	18.00	8.3×10^{-11}	−11.86	−10.97	−11.50
5	1703.44	18.40	8.7×10^{-11}	−11.82	−10.71	−11.38
6	17.06.10	5.00	9.5×10^{-11}	−11.72	−10.40	−11.19
7	1716.00	17.11	1.0×10^{-10}	−11.68	−10.15	−11.10
8	1729.20	24.00	1.0×10^{-10}	−11.66	−9.92	−11.00
9	1740.4	19.33	1.1×10^{-10}	−11.62	−9.67	−10.84
10	1758.00	30.00	1.1×10^{-10}	−11.63	−9.47	−10.80
11	1770.00	20.40	1.1×10^{-10}	−11.61	−9.23	−10.70
12	1821.11	84.00*	8.4×10^{-11}	−11.86	−9.28	−11.00

Note: *Denotes lag order selection criterion; test statistics of LR (tested at 5% level of significance).
Source: Authors' calculations.

the lag length, we followed a lag length selection criterion, following the Akaike (1969, 1973) information criterion (AIC), which suggests three lags for the time series data as the least value of AIC, i.e., −11.91 corresponds to three lags in the selected sample period as displayed in Table 4.

4.4. Johansen multivariate cointegration analysis

Since the augmented Dickey and Fuller test demonstrated that the KSE 100 returns and monetary variables, for instance the rate of exchange, interest rate and rate of inflation series have been integrated to I(1), we can thus employ the Johansen multivariate cointegration technique. From the results shown in Table 5, it is clearly apparent that there is a trace of one cointegrating vector; therefore, a long-term association has been established between equity returns of the KSE 100 index, and the exchange rate, inflation and interest rates. It is further concluded that the trace approach has rejected the null hypothesis because the trace value is greater than the critical value, and the corresponding probability is less than 0.05 ($p < 0.05$).

However, the results of Table 6 showed that critical cointegrating vectors are not presented in the model because the maximum eigenvalue < critical value and the corresponding probability is also greater than 0.05 ($p > 0.05$). Hence, it is finally concluded that there is no evidence of a long-haul association between equity prices of the KSE 100 and the rate of exchange, inflation, and interest rates. According to Cheung and Lai (1993), if there are diverse results from the trace and max tests, then a preference will be given to the trace test. They further demonstrated that the trace approach signifies more rigidity to the residuals for skewness and extra value of kurtosis as compared to the maximum eigenvalue test.

Table 5. Johansen test results (trace test) – unrestricted cointegration rank test (trace values).

Hypothesised no. of CE(s)	Eigenvalues	Trace statistics	Critical values at 0.05 level	Probability**
None*	0.086	50.42	47.86	0.03
At most 1	0.057	25.08	29.80	0.16
At most 2	0.028	8.52	15.50	0.41
At most 3	0.002	0.47	3.84	0.49

Existence of one cointegrating vector at 5% significance level (trace value).
*Indicates the rejection of null hypothesis at 5% significance level.
**Indicates MacKinnon, Haug, and Michelis (1999) *p*-values.
Source: Authors' calculations.

Table 6. Johansen maximum eigenvalue test – unrestricted cointegration rank test (maximum eigenvalues).

Hypothesised no. of CE(s)	Eigenvalues	Maximum eigenvalue statistics	Critical values at 0.05 level	Probability**
None*	0.086	25.37	27.58	0.09
At most 1	0.057	16.56	21.13	0.19
At most 2	0.028	8.05	14.26	0.37
At most 3	0.002	0.47	3.84	0.49

Existence of no cointegrating vector at 5% significance level (maximum eigenvalue).
*Indicates the rejection of null hypothesis at 5% significance level.
**Indicates MacKinnon et al. (1999) *p*-values.; Source: Authors' calculations.

4.5. Impulse response function (IRF)

We have employed the impulse response function in a graphical form to investigate an occurrence of transmission from one variable to another. Figure 3 demonstrates the impulse response function analysis. Figure 3 shows the response of the series while having one standard deviation shock; activity and response can also be analysed from the figure. Impulse response function graphs are a snapshot of a single time period stun to one time period improvement on the prospective changes in values, and also the changes in a dependent or endogenous macroeconomic variable. Figure 3 depicts the impact and impulse response function of one macroeconomic variable on other variables. The impulse response graphs show that the KSE 100 behaves like an exogenous variable and the maximum part of the shocks is because of its own innovations. Observing the impact of other monetary indicators, they have also exerted a certain effect on equity returns of the KSE 100. Figure 3 characterises the shocks of the exchange rate, inflation, and interest rates over KSE 100 returns. Impulse response function analysis of KSE 100 stocks shows a one standard deviation innovation for the monetary indicators. From Figure 3, it is obvious that statistically around 93% of the impulse response function has been examined at cogent bounds. From Figure 3 the impulse response between equity returns and the interest rate shows that the rise in interest rate decreases stock returns because of the escalation in the rate of discount and, subsequently, a decrease in the current values of anticipated forthcoming liquidity

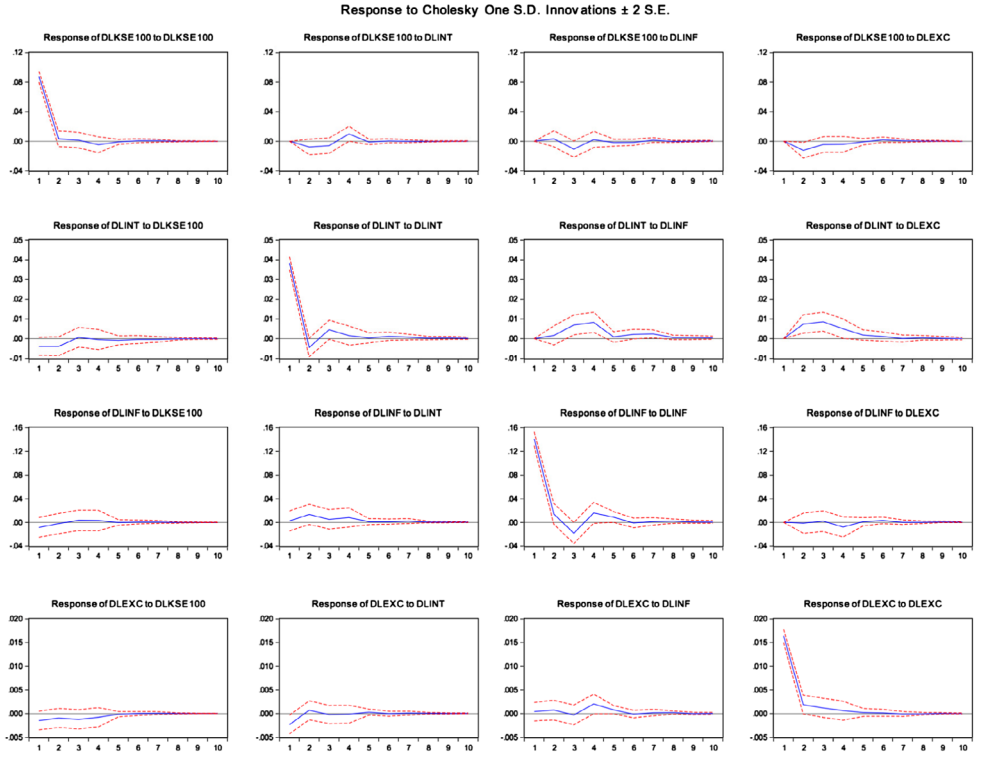

Figure 3. Impulse response analysis. Source: Authors' calculations.
Note: X-axis represents the period of 12 months, Y-axis represents the fluctuations of the variables in percent (%).

Table 7. Variance decomposition analysis.

Variance decomposition	No. of months	S.E.	DLKSE 100	DLINT	DLINF	DLEXC
DLKSE 100	1	0.09	100.00	0.00	0.00	0.00
	3	0.09	95.05	1.23	1.58	2.14
	12	0.09	93.47	2.43	1.72	2.39
DLINT	1	0.04	1.00	99.00	0.00	0.00
	3	0.04	1.74	87.70	3.00	7.56
	12	0.04	1.70	82.28	7.30	8.73
DLINF	1	0.14	0.37	0.03	99.60	0.00
	3	0.14	0.43	1.01	98.54	0.03
	12	0.15	0.47	1.33	97.83	0.37
DLEXC	1	0.02	0.77	1.94	0.06	97.23
	3	0.02	1.59	2.10	0.27	96.07
	12	0.02	1.78	2.10	1.93	94.23

Source: Authors' calculations.

flows. Finally, from Figure 3, it is concluded that the exchange rate and the inflation rate have an inverse relation to KSE 100 stocks, but this negative impact is not very significant.

4.6. Variance decompositions analysis

The results of variance decomposition analysis have been described in Table 7; variance decomposition analysis is an additional validation for the investigation of these macroeconomic variables' association with each other. Variance decomposition analysis determines the spread of the prediction error of one factor because of other factors; thus, in this manner, variance decomposition analysis constructs the viability of selecting the comparative connotation of each variable for making fluctuations in diverse variables (Ratanapakorn & Sharma, 2007). The results in Table 7 confirm that the first difference of natural log of KSE100 (DLKSE 100) are discreetly lesser exogenous as compared to other variables due to its own oscillations, where approximately 93.47% fluctuations were explained by its own precise shocks in the succeeding 12 months. However, the rest of the forecast variation is explained by other monetary variables. First difference of natural log value of interest rate (DLINT) explained 2.43%, first difference of natural log value of inflation (DLINF) explained 1.72%, and first difference of natural log value of exchange rate (DLEXC) explained 2.39% exclusively for the DLKSE 100. Similarly, other variables can be interpreted in a similar manner from Table 7.

4.7. Granger causality results

For the identification of the direction of causal association among the variables, and to find out directional causality between the two variables, we used the pairwise Granger (1969) causality test. Table 8 shows the unidirectional causal relation between the KSE 100 and the interest rate. The one-way causation was established from the interest rate to the KSE 100 at 5% significance level ($p < 0.05$) at three lags. Table 8 further demonstrates that other pairs of variables do not have any causation in either direction. It is important to comprehend that a variation in one variable does not mean that change is carried in other variables. Basically, in time series, causality is unavoidable, acting upon variables (Awe, 2012).

Table 8. Results of pairwise Granger causality at three lags.

Direction of causality	No. of obs.	F-statistics	Probability
Interest rate → KSE 100	284	2.73	0.04
KSE → Interest rate	284	1.96	0.12
Inflation rate → KSE 100	284	1.73	0.16
KSE 100 → Inflation rate	284	0.21	0.90
Exchange rate → KSE 100	284	2.61	0.05
KSE 100 → Exchange rate	284	0.73	0.54

Note: The rejection of null hypotheses at 5% ($p < 0.05$).
Source: Authors' calculations.

Table 9. Wald test causality analysis.

		Modified Wald – statistics			
Dependent variable	Test results	KSE 100 index	INTR	INFR	EXCR
KSE 100 index	χ^2	–	4.587	6.661	5.456
	P-value		0.059	0.018	0.218
INFR	χ^2	7.987	3.765	–	0.564
	P-value	0.069	0.653		0.784
INTR	χ^2	3.334	–	0.478	2.13
	P-value	0.047		0.698	0.541
EXCR	χ^2	4.331	2.456	0.879	–
	P-value	0.519	0.212	0.121	

Note: The rejection of null hypothesis at 5% ($p < 0.05$).
Source: Authors' calculations.

4.8. Validation of causation from the Toda–Yamamoto Wald test

We validated the results of causality from another robust method, which was developed by Toda and Yamamoto (1995). Table 9, which was extracted by the Toda and Yamamoto Wald method, further substantiated the outcomes of the Granger causality approach, and also indicated a unidirectional causal association between the KSE 100 and an interest rate at the 5% level ($p < 0.05$), and the direction of causality was confirmed from the interest rate to the KSE 100. The results of the Toda and Yamamoto Wald test further demonstrated that any other monetary indicator such as inflation rate and exchange rate do not have any causation to the KSE 100.

5. Conclusions and recommendations

The purpose of the initiated research was to scrutinise the long-haul relationship between stock returns of the KSE 100 index and monetary indicators such as rate of exchange, inflation, and interest rates. Month-to-month data for the KSE 100 index and monetary variables were extracted for the time period January 1992 to November 2015. We transformed data series into a stationary form by employing the augmented Dickey–Fuller method. The Johansen multivariate cointegration approach reinforces the long-haul association between equity prices and monetary indicators, for instance rate of exchange, inflation, and interest rates. For the identification of a causal association and the direction of causation, we used Granger causality and Toda and Yamamoto techniques.

The descriptive analysis revealed that the monthly average returns of equity prices of the KSE 100 has an average return of 1.1% with a volatility of 0.089, while maximum and minimum returns were recorded at 24.6% and –44.8% in a month time period, respectively.

The average interest rate was recorded to be around −3%; however, the maximum interest rate was recorded at up to 19.4%. The average inflation rate is 0.50% and the maximum went up to around 12%. The average reduction in Pakistani money is around 0.40% per month. Results of the kurtosis showed that time series data do not follow the normality patterns. The values of skewness were exhibited, the series are leptokurtic, and all of the series are negatively skewed except for the inflation rate.

The outcome of the augmented Dickey and Fuller test concluded that the KSE 100 stock returns, the rate of exchange, interest rate, and the rate of inflation data series showed a level unit root. Therefore, data series are transformed and checked at the first difference where these data series have become stationary; consequently, data series are integrated of an order of 1. For the identification of an appropriate lag length, we followed a lag length selection criterion, following the Akaike information criterion, which suggests three lags for time series data in a selected sample period. We have employed an econometrics time series model like the Johansen multivariate cointegration approach to examine the long-haul association. The outcomes of the trace test suggested one cointegrating vector; therefore, a long-term association has been confirmed between equity returns of the KSE 100 index and monetary indicators including the rate of exchange, rate of inflation, and rate of interest.

Results of the Granger causality and Toda and Yamamoto Wald tests have demonstrated the unidirectional causation from the interest rate to the KSE 100 index. Analysis of the impulse response function concluded that the changes in the KSE 100 index happened due to its own shocks. However, changes in exchange and inflation rates were experienced because of the interest rate. The outcomes of variance decomposition demonstrated that most of the changes in variables are experienced because of its own shocks. Therefore, it is finally concluded that the KSE 100 index is more volatile as compared to the developed equity markets, and has not been associated with long-term integration, financial development, and influential efficiencies. Thus, it is concluded that the predictability of KSE 100 equity prices relies heavily on the variations of monetary variables including rate of exchange, interest rates, and inflation rate.

On the basis of the results and conclusions we have made the following suggestions and recommendations.

- Institutional and individual investors, portfolio and stock managers, and financial experts are advised to use selected monetary indicators including the rate of exchange, inflation rate, and rate of interest while making investment decisions on the equity prices of the KSE 100 index.
- It is important to make an efficient equity portfolio in order to create hedging for the best resource utilisation.
- Since equity markets are highly sensitive, reacting to any exogenous information, it is therefore extremely important to be well proficient in, and able to visualise, the responses of the equity markets.
- Since monetary variables are very sensitive to equity returns, policy makers and regulatory bodies should therefore take special care of monetary indicators such as exchange rate, inflation, and interest rates while making any future policies and regulations regarding the equity market.

- Similarly, the central bank, such as the State Bank of Pakistan, should play its due role in order to strengthen the equity markets by designing and employing good monetary policies.

Disclosure statement

No potential conflict of interest was reported by the authors.

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