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Article

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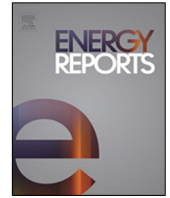
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Research paper

Does oil price volatility influence real sector growth? Empirical evidence from Pakistan

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ABSTRACT

The study investigates the short-run and long-run relationship between oil price fluctuation and real sector growth in Pakistan. Four major sectors of the economy (Manufacturing, electricity, transport and communication, and livestock) were analyzed to find any relation. Similar studies can be found in the existing literature, however, the distinguish feature of present study is that it investigates each individual sector's linkage to oil price changes. Annual time series data of selected sectors ranging from 1976 to 2017 is selected for the study. Classical normal linear regression models under auto regressive distributed lag (ARDL) were employed to study the relationship between economic sectors and oil price fluctuation. Empirical results indicate that changes in oil price adversely affect manufacturing, livestock and electricity sectors in short-run and long-run, while significant positive impact was found on transportation and communication. Consequently, the sectors prone to oil price changes require special attention of policy makers. An expansionary monetary policy can be a short-run solution to reduce the impact of increasing oil price, whereas the government can introduce a policy framework to counter this effect in long-run.

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1. Introduction

Oil is one of the major energy sources for both the developed and the developing economies of the world. It serves as a backbone for economic development, as it satisfies the industrial and domestic energy requirements of any country. The data of June 2017 indicate that United States along with China, Japan, India and Russia are the five major oil consuming countries in the world. Collectively, these five countries consume 40 million barrels per day. However, consumption is expected to further aggravate in future due to rising demand for energy in these countries. The rise in demand is expected to occur because the rapid economic development of export oriented China and India, it has challenged the global trade dominance of the United States, Japan and the European Union. While, these global players compete, a sudden oil price shock can have a detrimental impact on their economic growth which can consequently cause a global economic recession. As such, oil prices can influence the performance of numerous macroeconomic factors. For example, oil price fluctuations influence economic policy uncertainty (Ahmed et al., 2018; Kang et al., 2017; Kang and Ratti, 2015; Wesseh Jr and Lin, 2018), human development (Marza et al., 2018), movements

in stock and bond prices (Bastianin et al., 2016; Waheed et al., 2018), inflation (Naser, 2019), interest rates (Nazlioglu et al., 2019), portfolio optimization (Sarwar et al., 2019) and business cycle (Pönkä and Zheng, 2019).

The scientific literature from the past support the argument that upward oil price shock has a negative influence on economic growth of both developed and the developing economies (Kilian, 2008; Kilian and Vigfusson, 2011; Narayan et al., 2014). The study of Hamilton (2009) highlights that the oil price shock of 2007–2008 were due to high global demand for oil while the preceding oil shocks are attributed to the supply disruptions; but, the consequence of both types have been the same which results in causing economic recessions. According to Lescaroux and Mignon (2008) rising oil prices have an adverse effect on the economic growth of net oil importing countries because both consumer and producers of goods and services suffer. The producers have to suffer because the marginal cost of production undergoes an increment resulting into a decline in profitability; whereas, the consumer has to cut down their consumption of goods other than necessary if disposable income lags behind inflation. All this adds up to having an adverse impact on economic output that consequently results into an adverse impact on real wages, employment, profitability, investment and price level. It was generally perceived that developed economies were the only who were drastically affected by the oil price surge. But, in reality, the developing countries are more affected by these oil price shocks because of inefficient energy utilization and wastage. The price surge in the

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2000's have been a matter of great distress for the economists of developing countries because the oil price increments had interrupted the economic growth by creating an inflationary pressure in the economy, large government budget deficits and problems in balance of payments. Moreover, the recent fall in oil prices has opened a new paradigm of discussion in contrast to the general view which indicates that downward fall in oil price is better for economic activity worldwide. It has been stated that in industrialized economies, the near zero interest rate has changed the traditional channels through which benefits of lower oil prices get transferred to real economic output (Obstfeld et al., 2016). Additionally, the positive association among oil price fluctuations and equity markets has also provided the evidence of a slowdown of global economic activity, as a relaxing of aggregate demand has condensed profitability of firms and the overall demand for oil (Bernanke, 2016).

Previous research reveals that energy plays an important role in improving economic productivity (Shahbaz et al., 2017). Further, the economic progress in any country stimulates the demand of energy due to the demand in consumption patterns (Sadorsky, 2013). The study of Komal and Abbas (2015) highlighted that EIA estimates have shown 56% increase in energy consumption in 2010–2040 worldwide. Mostly, the increase in energy consumption will occur in non-OECD countries, where energy consumption is encouraged by strong economic growth (Islam et al., 2013; Khan and Ahmad, 2008). Population growth and industrial sector expansion has increased the use of energy consumption in Asian countries, specifically in Pakistan (Zaman et al., 2017, 2012); and the country belongs to the group of low middle income countries. Pakistan is facing severe energy crises from last two decades (Zameer and Wang, 2018). The country has 6.5% long-run growth potential, while energy crises have reduced this potential to 2% (Komal and Abbas, 2015). It indicates that the economic growth of the country is largely suppressed by the energy crises. The electricity shortage in the country is creating negative effect on exports, international competitiveness, poverty alleviation and employment in Pakistan (Kessides, 2013). The overall evaluations of previous research indicates that mostly studies have emphasized on overall economic performance of the countries, but, studies that focus on the behavior of individual sectors in response to oil price fluctuations are scarce in literature.

Since Pakistan is a developing country and oil is considered as a major source for energy production and similarly it drives the economic growth. Further, country's most of the energy production system is dependent on thermal electricity (Solangi et al., 2018; Zameer and Wang, 2018). The country fulfills most of its energy requirement using imported furnace oil (Wakeel et al., 2016). The undiversified energy production mix and huge reliance on imported oil has made Pakistan more reactive to oil prices. Most of the oil consumption requirements of the country is based upon imported furnace oil from the Gulf countries. Therefore, an upward trend in oil price is expected to negatively affect the economic growth of Pakistan like other developing countries in the world. The rise in oil will result into a rise in the production cost, the balance of payment problems, exchange rate depreciation, government budget deficits, fall in aggregate demand, fall in real wages, unemployment, overly contractionary or expansionary monetary policy, and even an economic recession (Malik, 2008). Pakistan's energy mix is highly imported furnace oil dependent. The upward rise in oil prices can influence only oil dependent countries like Pakistan, while the global consumption may fall as the trading partners are also adversely affected by oil shocks. Therefore, it is highly significant to point out that oil prices will not only influence domestically but the affects becomes more severe when exports decline. The previous studies

in the context of Pakistan by (Khan and Ahmed, 2011b; Malik, 2010; Syed, 2010a) have revealed that oil price has a negative relationship with GDP growth; but so far we have not come across any work that could signify the relationship between oil prices and growth of individual economic sectors contributing to Pakistan's gross domestic production. As, the role of individual economic sectors is highly important for the overall economy. Accordingly, it is vital to signify the relation between oil prices and growth of individual economic sectors contributing to Pakistan's gross domestic production.

Therefore, the aim of this study is to explore the effects of oil price changes on the growth of the real sector in Pakistan. The real sector of Pakistan comprises of agricultural, industrial, and services sector. Within these sectors, the study highlighted over four sub-sectors (Manufacturing, electricity, transport and communication, and livestock) that are instrumental to Pakistan's gross domestic product. This study will put-forward how the growth of an individual sector responds to the fluctuations in oil price. The study fills the research gap by exploring the impact of oil price fluctuations on the growth of individual economic sectors. Similarly, the study put-forward the policy framework, so that the policy maker can avoid over or under-reacting to oil price shocks by developing a sound monetary policy that is neither over contractionary nor over expansionary. Further, it pitches the vulnerable sectors those are not immune to oil price shocks. It will help the policy makers in redirecting their attention to the vulnerable sectors and facilitate them according to their unique requirements. Similarly, the investment in such sectors is encouraged and they can withstand the detrimental impacts of oil price shocks.

2. Materials and methods

2.1. Data

Broadly, the study has three sectors under investigation that are the agricultural, industrial and the services sector. Within these sectors, the study selected four sub-sectors that are critically important to gross domestic production. Data of all variables is annual data and encompasses the period from fiscal year 1976 to 2017. All the economic data for Pakistan was obtained from "handbook of statistics on Pakistan economy 2015" that is available at the State Bank of Pakistan's website (Pakistan, 2017) and Pakistan Economic Survey 2016–17 available at the website of the ministry of finance (Finance, 2018), whereas UK Brent crude oil price data was obtained from commodity price data available at World Bank's website.

The real output in million rupees from all the selected sub-sectors has been transformed into growth by calculating a quantum index. The quantum index has been calculated at a constant factor cost of year 1980–81 by using the Laspeyres formula (1) following the study of Biggeri et al. (2017). The calculated growth or quantum indexes for the selected sub-sectors are the dependent variables. After initial transformation variables were converted into log form.

$$\text{Quantum Index} = \frac{Y(n)}{Y(0)} * 100 \quad (1)$$

Where, Y (n) = Real output in million Rupees in a year (n) at a constant factor cost of 1980–81 and Y (0) = Real output in million Rupees in base year 1980–81.

For oil prices, the study used UK Brent crude oil prices which were USD/BL. Following the study of Lee and Chiu (2011), authors has converted them into real oil prices in PKR by multiplying

Table 1
Acronym and complete names of variables.

Acronym	Complete name
FDI	Foreign direct investment
WPI	Wholesale price index
ROP	Real oil prices
MC	Money in circulation
GOVEXP	Government expenditures
REXR	Real exchange rate
GDEXP	Government development expenditures
LVSTKG	Livestock sector growth
MANUFG	Manufacturing sector growth
ELEC	Electricity sector growth
TRC	Transportation and communication sector growth
ARDL	Autoregressive distributed lag
ADF	Augmented Dickey–Fuller
PP	Phillips–Perron
CUSUM	Cumulative Sum
CUSUMSQ	Cumulative Sum of Squares
AGDP	Agricultural gross domestic product
GDP	Gross domestic product

them with exchange rate and then deflating them by consumer price index based on the 1980–81 price level.

$$ROP = \frac{IOP * FEX}{CPI} \quad (2)$$

Where, ROP = Real oil price in PKR, IOP = international oil price in USD/BL, FEX = foreign exchange in PKR/USD, and CPI = consumer price index based on the 1980–81 price level.

The other variables used in the model as explanatory variables include wholesale price index, foreign direct investment, money in circulation, real foreign exchange rate and the government development expenditures. The data of these variables are also collected from “handbook of statistics on Pakistan economy 2015” that is available at the State Bank of Pakistan’s website and Pakistan Economic Survey 2016–17 available at the website of the ministry of finance. The detailed list of variables and their acronyms is given in Table 1.

2.2. Methods

To discover the relation between oil price fluctuations and growth of economic sectors, the multifactor classical normal linear regression models have been estimated that are based on the open economy IS function for output or production. As in the succeeding section we will observe that the estimated models incorporate independent variables that are actually proxies for consumption, investment, government spending and international trade. As the basic objective is to explore the effects of oil price changes on sectors growth; each model will necessarily contain oil price as an explanatory variable, whereas the rest of the independent variables are incorporated to improve the model fitting. These independent variables include foreign direct investment, money in circulation, government expenditures and wholesale price index. Initially, the data was transformed in log form as a logarithm format of data provide better results. The selection of the independent variables is supported by previous studies (Hunt et al., 2002; Jo, 2014; Khan and Ahmed, 2011b; Malik, 2008, 2010; Montgomery, 2017; Mussa, 2000; Syed, 2010a).

In preliminary models estimation by trial and error, we resolved the problem of multicollinearity without inducing specification bias by dropping out variables. The study employs ARDL model introduced by Pesaran et al. (2001a) to estimate the influence of oil price changes on sector growth. ARDL is an advanced approach and it has many advantages. Such as the technique of Engle and Granger (1987), this method is useful in estimating

the relation among two variables. Whereas, when more than two variables are in the model, Johansen Cointegration test (Johansen, 1988) is used. Therefore, it can be argued that Johansen Cointegration test has certain advantages over Engle–Granger technique. The study of Johansen and Juselius (1990) has extended the VAR (vector auto regression) model. But, this model is merely useful under specific conditions. First, it is merely used when large sample size data is under evaluation. Second, the precondition for co-integrated vector auto regression is that variables being estimated must have the same order integration. ARDL modeling technique not merely overcomes aforesaid problems but it also has numerous added benefits. ARDL approach is more appropriate as compare to other techniques in case of small size (Pesaran et al., 2001b). Further, ARDL technique can be applied even if variables are purely stationary at level I(0) or at first difference I(1) or the mixture of both I(0) and I(1) (Haseem and Pesaran, 1997). The study of Laurenceson and Chai (2003) indicate that in data generating process ARDL technique can capture proper number of lags. Based on bound testing, error correction model can be obtained through transforming OLS. Without even losing the long-run information ECM show the adjustment mechanism of the model both in short-run and long-run (Pesaran and Shin, 1999). ARDL technique makes the econometric model more dynamic. Ouattara (2004) argued that ARDL approach cannot be used if any variable being used in the model is stationary at second difference, as bound testing method is based on merely I(0), I(1) or mix of these. In this study, to ensure that all the variables under investigation in this study are stationary at I(0), I(1) or mix of these, we employed ADF (Dickey and Fuller, 1979) and PP (Phillips and Perron, 1988) unit root tests.

Even though, ADF and PP methods are widely used in academic literature to explore unit root in data. But, many researchers in economics criticize that these tests have low power and give ambiguous results for unit root testing. The critic also debate that these tests do not have capability to report the evidence regarding structural breaks in the time series data. Therefore, to determine the reasonable outcomes, we followed the previous studies (Balcilar et al., 2017; Smith et al., 2019), and complemented unit root evaluation with Bai and Perron (2003) multiple structural breaks test.

Basically, to analyze the long-run relation, one can use ARDL approach following two steps. These steps include, first, a researcher needs to analyze the presence of the long-run relation using F-statistic. If the value of F-statistics confirms the existence of cointegration, then researcher can move forward and check and interpret the estimated coefficients for short-run and long-run. This technique postulates null hypothesis that there is no cointegration among variables. According to Pesaran et al. (2001a), ARDL model reports the critical values for lower bounds and upper bounds. The variables are taken as I(0) and I(1) at lower and upper bound respectively. To conclude that cointegration exists among the variables, the value of computed F-statistic should be greater than upper bounds. In other words, null hypothesis is rejected and it can be inferred that long-run cointegration exists. In contrast, if the calculated F-statistic value is below the lower bounds, it means, we could not found enough evidence to reject the null hypothesis, and cannot proceed with ARDL model. In a situation when the estimated value of F-statistic is found between the I(0) and I(1), this situation is regarded as an inconclusive. The critical bounds introduced by Pesaran et al. (2001a) are useful in case of large sample size. Ahmad and Du (2017) argued that it can provide biased results in the context of small sample size. The mechanism introduced by Narayan (2005) is useful for small size i.e. 30–80 observations. As the sample size of this study is between 30–80 observations, therefore, the study

followed the mechanism introduced by Narayan (2005). In order to employ ARDL model for individual sectors, the following ECMs are being estimated. The mathematical representation of these ECMs is as follows.

$$\begin{aligned}\Delta LVSTKG_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} + \delta_1 \Delta FDI_{t-i} \\ & + \delta_2 \Delta WPI_{t-i} + \delta_3 \Delta ROP_{t-i} + \delta_4 \Delta MC_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (3)$$

$$\begin{aligned}\Delta FDI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta LVSTKG_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \delta_1 \Delta LVSTKG_{t-i} + \delta_2 \Delta WPI_{t-i} + \delta_3 \Delta ROP_{t-i} \\ & + \delta_4 \Delta MC_{t-i} + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (4)$$

$$\begin{aligned}\Delta WPI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta LVSTKG_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} + \delta_1 \Delta FDI_{t-i} \\ & + \delta_2 \Delta LVSTKG_{t-i} + \delta_3 \Delta ROP_{t-i} + \delta_4 \Delta MC_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (5)$$

$$\begin{aligned}\Delta ROP_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta LVSTKG_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \delta_1 \Delta FDI_{t-i} + \delta_2 \Delta WPI_{t-i} + \delta_3 \Delta LVSTKG_{t-i} \\ & + \delta_4 \Delta MC_{t-i} + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (6)$$

$$\begin{aligned}\Delta MC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta LVSTKG_{t-i} \\ & + \delta_1 \Delta FDI_{t-i} + \delta_2 \Delta WPI_{t-i} + \delta_3 \Delta ROP_{t-i} \\ & + \delta_4 \Delta LVSTKG_{t-i} + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (7)$$

$$\begin{aligned}\Delta MANUFG_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \beta_6 \Delta ROP_{t-i} + \beta_7 \Delta WPI_{t-i} \\ & + \beta_8 \Delta GDEXP_{t-i} + \beta_9 \Delta REXR_{t-i} + \beta_{10} \Delta MC_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (8)$$

$$\Delta ROP_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta MANUFG_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i}$$

$$\begin{aligned}& + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \beta_6 \Delta MANUFG_{t-i} + \beta_7 \Delta WPI_{t-i} \\ & + \beta_8 \Delta GDEXP_{t-i} + \beta_9 \Delta REXR_{t-i} + \beta_{10} \Delta MC_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (9)$$

$$\begin{aligned}\Delta WPI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta MANUFG_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \beta_6 \Delta ROP_{t-i} + \beta_7 \Delta MANUFG_{t-i} \\ & + \beta_8 \Delta GDEXP_{t-i} + \beta_9 \Delta REXR_{t-i} + \beta_{10} \Delta MC_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (10)$$

$$\begin{aligned}\Delta GDEXP_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta MANUFG_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \beta_6 \Delta ROP_{t-i} + \beta_7 \Delta WPI_{t-i} \\ & + \beta_8 \Delta MANUFG_{t-i} + \beta_9 \Delta REXR_{t-i} + \beta_{10} \Delta MC_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (11)$$

$$\begin{aligned}\Delta REXR_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MANUFG_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \beta_6 \Delta ROP_{t-i} + \beta_7 \Delta WPI_{t-i} \\ & + \beta_8 \Delta GDEXP_{t-i} + \beta_9 \Delta MANUFG_{t-i} + \beta_{10} \Delta MC_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (12)$$

$$\begin{aligned}\Delta MC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MANUFG_{t-i} + \beta_6 \Delta ROP_{t-i} + \beta_7 \Delta WPI_{t-i} \\ & + \beta_8 \Delta GDEXP_{t-i} + \beta_9 \Delta REXR_{t-i} + \beta_{10} \Delta MANUFG_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (13)$$

$$\begin{aligned}\Delta ELEC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta GOVEXP_{t-i} + \beta_6 \Delta ROP_{t-i} + \beta_7 \Delta WPI_{t-i} \\ & + \beta_8 \Delta FDI_{t-i} + \beta_9 \Delta MC_{t-i}\end{aligned}$$

$$\begin{aligned} & + \beta_{10} \Delta \text{GOVEXP}_{t-i} + \text{dummy}_{2012} + \mu_t \quad (14) \\ \Delta \text{ROP}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{ELEC}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{WPI}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta \text{GOVEXP}_{t-i} + \beta_6 \Delta \text{ELEC}_{t-i} + \beta_7 \Delta \text{WPI}_{t-i} \\ & + \beta_8 \Delta \text{FDI}_{t-i} + \beta_9 \Delta \text{MC}_{t-i} \\ & + \beta_{10} \Delta \text{GOVEXP}_{t-i} + \text{dummy}_{2012} + \mu_t \quad (15) \end{aligned}$$

$$\begin{aligned} \Delta \text{WPI}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{ROP}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{ELEC}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta \text{GOVEXP}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{ELEC}_{t-i} \\ & + \beta_8 \Delta \text{FDI}_{t-i} + \beta_9 \Delta \text{MC}_{t-i} \\ & + \beta_{10} \Delta \text{GOVEXP}_{t-i} + \text{dummy}_{2012} + \mu_t \quad (16) \end{aligned}$$

$$\begin{aligned} \Delta \text{FDI}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{ROP}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{WPI}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{ELEC}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta \text{GOVEXP}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{WPI}_{t-i} \\ & + \beta_8 \Delta \text{ELEC}_{t-i} + \beta_9 \Delta \text{MC}_{t-i} \\ & + \beta_{10} \Delta \text{GOVEXP}_{t-i} + \text{dummy}_{2012} + \mu_t \quad (17) \end{aligned}$$

$$\begin{aligned} \Delta \text{MC}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{ROP}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{WPI}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{ELEC}_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta \text{GOVEXP}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{WPI}_{t-i} \\ & + \beta_8 \Delta \text{FDI}_{t-i} + \beta_9 \Delta \text{ELEC}_{t-i} \\ & + \beta_{10} \Delta \text{GOVEXP}_{t-i} + \text{dummy}_{2012} + \mu_t \quad (18) \end{aligned}$$

$$\begin{aligned} \Delta \text{GOVEXP}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{ROP}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{WPI}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta \text{ELEC}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{WPI}_{t-i} \\ & + \beta_8 \Delta \text{FDI}_{t-i} + \beta_9 \Delta \text{MC}_{t-i} \\ & + \beta_{10} \Delta \text{ELEC}_{t-i} + \text{dummy}_{2012} + \mu_t \quad (19) \end{aligned}$$

$$\text{TRC}_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{WPI}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{ROP}_{t-i}$$

$$\begin{aligned} & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \beta_5 \Delta \text{WPI}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{FDI}_{t-i} \\ & + \beta_8 \Delta \text{MC}_{t-i} + \text{dummy}_{2005} + \mu_t \quad (20) \end{aligned}$$

$$\begin{aligned} \Delta \text{WPI}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{TRC}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{ROP}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \beta_5 \Delta \text{TRC}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{FDI}_{t-i} \\ & + \beta_8 \Delta \text{MC}_{t-i} + \text{dummy}_{2005} + \mu_t \quad (21) \end{aligned}$$

$$\begin{aligned} \text{ROP}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{WPI}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{TRC}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \beta_5 \Delta \text{WPI}_{t-i} + \beta_6 \Delta \text{TRC}_{t-i} + \beta_7 \Delta \text{FDI}_{t-i} \\ & + \beta_8 \Delta \text{MC}_{t-i} + \text{dummy}_{2005} + \mu_t \quad (22) \end{aligned}$$

$$\begin{aligned} \text{FDI}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{WPI}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{ROP}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{TRC}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \beta_5 \Delta \text{WPI}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{TRC}_{t-i} \\ & + \beta_8 \Delta \text{MC}_{t-i} + \text{dummy}_{2005} + \mu_t \quad (23) \end{aligned}$$

$$\begin{aligned} \text{MC}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{WPI}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{ROP}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{TRC}_{t-i} \\ & + \beta_5 \Delta \text{WPI}_{t-i} + \beta_6 \Delta \text{ROP}_{t-i} + \beta_7 \Delta \text{FDI}_{t-i} \\ & + \beta_8 \Delta \text{TRC}_{t-i} + \text{dummy}_{2005} + \mu_t \quad (24) \end{aligned}$$

In Eq. (3), the operator β_0 is constant, $\beta_1 - \beta_4$ are used as error correction dynamics in the model. Dummy variables are added into the model according to the structural breaks identified using [Bai and Perron \(2003\)](#) multiple structural break unit root test. The operator μ_t indicate white noise error-term in the model. In the second part of Eq. (3), the operator $\delta_1 - \delta_4$ represent the long-run association among variables. ARDL model is based on the value of Wald F-statistic which shows the long-run cointegration among variables with a null of no cointegration as $H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$. And, the alternative $H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0$. Following the same mechanism, the other Eqs. (4)–(24) can be explained.

After the evaluations on the long-run relation among variables (using F-statistic), application of model and finding the long-run coefficients (from bound testing), and the next step is to find short-run coefficients. Therefore, to find the short-run relations, the following short-run models are being estimated:

$$\begin{aligned} \Delta \text{LVSTKG}_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta \text{FDI}_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta \text{WPI}_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta \text{ROP}_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta \text{MC}_{t-i} \\ & + \eta_1 \text{ECT}_{t-i} + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t \quad (25) \end{aligned}$$

$$\begin{aligned}\Delta FDI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta LVSTKG_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} + \eta_1 ECT_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (26)$$

$$\begin{aligned}\Delta WPI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta LVSTKG_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} + \eta_1 ECT_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (27)$$

$$\begin{aligned}\Delta ROP_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta LVSTKG_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} + \eta_1 ECT_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (28)$$

$$\begin{aligned}\Delta MC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta LVSTKG_{t-i} + \eta_1 ECT_{t-i} \\ & + \text{dummy}_{1999} + \text{dummy}_{2005} + \mu_t\end{aligned}\quad (29)$$

$$\begin{aligned}\Delta MANUFG_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \eta_2 ECT_{t-i} + \text{dummy}_{1999} \\ & + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (30)$$

$$\begin{aligned}\Delta ROP_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta MANUFG_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \eta_2 ECT_{t-i} + \text{dummy}_{1999} \\ & + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (31)$$

$$\begin{aligned}\Delta WPI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta MANUFG_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \eta_2 ECT_{t-i} + \text{dummy}_{1999} \\ & + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (32)$$

$$\Delta GDEXP_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i}$$

$$\begin{aligned}& + \sum_{i=1}^n \beta_{3i} \Delta MANUFG_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \eta_2 ECT_{t-i} + \text{dummy}_{1999} \\ & + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (33)$$

$$\begin{aligned}\Delta REXR_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MANUFG_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MC_{t-i} + \eta_2 ECT_{t-i} + \text{dummy}_{1999} \\ & + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (34)$$

$$\begin{aligned}\Delta MC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta GDEXP_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta REXR_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta MANUFG_{t-i} + \eta_2 ECT_{t-i} + \text{dummy}_{1999} \\ & + \text{dummy}_{2008} + \mu_t\end{aligned}\quad (35)$$

$$\begin{aligned}\Delta ELEC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta GOVEXP_{t-i} + \eta_3 ECT_{t-i} \\ & + \text{dummy}_{2012} + \mu_t\end{aligned}\quad (36)$$

$$\begin{aligned}\Delta ROP_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEC_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta GOVEXP_{t-i} + \eta_3 ECT_{t-i} \\ & + \text{dummy}_{2012} + \mu_t\end{aligned}\quad (37)$$

$$\begin{aligned}\Delta WPI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta ELEC_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta GOVEXP_{t-i} + \eta_3 ECT_{t-i} \\ & + \text{dummy}_{2012} + \mu_t\end{aligned}\quad (38)$$

$$\begin{aligned}\Delta FDI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta ELEC_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i}\end{aligned}$$

$$+ \sum_{i=1}^n \beta_{5i} \Delta GOVEXP_{t-i} + \eta_3 ECT_{t-i} + \text{dummy}_{2012} + \mu_t \quad (39)$$

$$\begin{aligned} \Delta MC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta ELEC_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta GOVEXP_{t-i} + \eta_3 ECT_{t-i} \\ & + \text{dummy}_{2012} + \mu_t \end{aligned} \quad (40)$$

$$\begin{aligned} \Delta GOVEXP_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ROP_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta WPI_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \sum_{i=1}^n \beta_{5i} \Delta ELEC_{t-i} + \eta_3 ECT_{t-i} \\ & + \text{dummy}_{2012} + \mu_t \end{aligned} \quad (41)$$

$$\begin{aligned} \Delta TRC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta WPI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta ROP_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \eta_4 ECT_{t-i} + \text{dummy}_{2005} + \mu_t \end{aligned} \quad (42)$$

$$\begin{aligned} \Delta WPI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta TRC_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta ROP_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \eta_4 ECT_{t-i} + \text{dummy}_{2005} + \mu_t \end{aligned} \quad (43)$$

$$\begin{aligned} \Delta ROP_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta WPI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta TRC_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \eta_4 ECT_{t-i} + \text{dummy}_{2005} + \mu_t \end{aligned} \quad (44)$$

$$\begin{aligned} \Delta FDI_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta WPI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta ROP_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta TRC_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-i} \\ & + \eta_4 ECT_{t-i} + \text{dummy}_{2005} + \mu_t \end{aligned} \quad (45)$$

$$\begin{aligned} \Delta MC_t = & \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta WPI_{t-i} + \sum_{i=1}^n \beta_{2i} \Delta ROP_{t-i} \\ & + \sum_{i=1}^n \beta_{3i} \Delta FDI_{t-i} + \sum_{i=1}^n \beta_{4i} \Delta TRC_{t-i} \\ & + \eta_4 ECT_{t-i} + \text{dummy}_{2005} + \mu_t \end{aligned} \quad (46)$$

Here, in Eq. (25), the mathematical form of short-run model is presented for livestock sector. The ECT is used for error correction

term, which is basically used to explain if there is a disturbance in the model, how much time it will take to reach back to its equilibrium path in the long-run. Whereas, η_1 is used to represent the coefficient of error correction term. Dummy is used to incorporate structural breaks in the model. Lastly, the stability of the coefficients in the short-run and long-run is checked using CUSUM and CUSUMSQ introduced by Brown et al. (1975). Following the same mechanism, the other Eqs. (26)–(46) can be explained.

3. Results and findings

This section provides the detailed estimation and discussion of results from unit root testing, structural breaks exploration and how selected exploratory variables influence the growth of four selected sector of the economy. The mathematical models designed in the previous part were applied to test unit root, structural breaks and to get short-run and long-run coefficients. In this part, we elaborated in detail about the unit root testing, structural breaks, model appropriateness, residuals normality and stability, heteroscedasticity and autocorrelation. Following this, we will discuss how oil price fluctuations influence the individual sector of the economy.

Initially, ADF and PP unit root test were employed to check the stationarity of data being used for the evaluation of the effects of oil price fluctuations on the real sector growth. The results from ADF and PP test are presented in Table 2.

The results from unit root testing from both tests (i.e.) confirms that all variable under evaluation are stationary at $I(0)$, $I(1)$ and none of the variable is stationary at $I(2)$. Hence, it confirms the precondition of ARDL approach that all the variable must be stationary at $I(0)$, $I(1)$ or mix of these.

As discussed in the previous part that the critics of ADF and PP test debate that these tests do not have capability to report structural breaks. Therefore, to determine the reasonable outcomes, we followed the studies of (Balcilar et al., 2017; Smith et al., 2019) and used Bai and Perron (2003) multiple structural breaks evaluation test. Using this test, we identified multiple structural breaks in the variables followed by the structural breaks in our models. Table 3 summarize the results from Bai and Perron (2003) multiple structural breaks test. It can be seen that all the independent variables contains structural breaks.

Following the exploration of structural breaks in the variables, we used the same mechanism of Bai and Perron (2003) to find structural breaks in the model. The results presented in Table 4 suggest that for every model we need to incorporate structural breaks. For livestock sector and manufacturing sector we need to incorporate two dummy variables. Whereas, for electricity and transportation & communication sector, the results from Bai and Perron (2003) multiple structural breaks exploration test indicate that we need to add one dummy variable in the model.

3.1. Oil price fluctuations and livestock sector growth

The livestock sector in Pakistan contributes about 56.3% of the total value of agriculture and almost 11% toward AGDP (agricultural gross domestic product) (Rehman et al., 2017). Milk is the single important commodity of Pakistan's livestock sector. Pakistan is 4th largest producer of milk worldwide after USA, China and India. Due to overall contribution of livestock sector toward agricultural GDP, it is considered as most significant sector of agriculture based economy like Pakistan. According to Betten-court et al. (2015) the livestock sector plays a significant role in wellbeing of rural households. This sector helps family nutrition, family income, food supply, soil productivity, asset savings and agricultural traction and diversification (Moyo and Swanepoel, 2010). It is widely acknowledged that energy and agricultural

Table 2

Summary of unit root testing.

Source: Authors' estimation using E-Views 10.

Variables	Augmented Dickey–Fuller				Phillips–Perron			
	I(0)		I(1)		I(0)		I(1)	
	C	C&T	C	C&T	C	C&T	C	C&T
FDI	−2.3098	−2.8005	−5.2304	−5.2620	−2.2709	−2.9507	−5.2257	−5.2628
WPI	−0.3653	−4.8847	−4.0626	−4.0130	−0.3711	−2.4540	−5.4953	−5.4381
ROP	−1.7946	−1.9252	−6.1472	−6.0918	−1.8319	−2.0090	−6.1449	−6.0857
MC	−1.9446	−3.7533	−7.4198	−7.8303	−2.1780	−4.1628	−7.4179	−7.8303
GOVEXP	−1.3075	−2.8391	−8.4684	−8.4244	−1.4178	−2.7438	−8.5268	−8.4934
REXR	−0.7418	−0.9864	−4.4984	−3.7117	−0.7015	−1.5421	−4.4953	−4.4481
GDEXP	0.8549	−0.9329	−5.1321	−5.2487	0.6069	−1.3066	−5.1795	−5.2801
LVSTKG	−3.6387	−6.1912	−6.4503	−6.5775	−3.5729	−6.1926	−24.917	−32.633
MANUFG	−4.4324	−4.9212	−9.2713	−9.1486	−4.4077	−4.8946	−29.010	−28.570
ELEC	−5.7727	0.9949	−7.0853	−7.6497	−5.9301	−5.8075	−24.565	−28.923
TRC	−3.7459	−5.6948	−6.7888	−6.7112	−3.7540	−5.6952	−19.040	−19.580
Test critical values								
1% level	−3.6009	−4.1985	−3.6267	−4.2349	−3.6009	−4.1985	−3.6055	−4.2050
5% level	−2.9350	−3.5236	−2.9458	−3.5403	−2.9350	−3.5236	−2.9369	−3.5266
10% level	−2.6058	−3.1929	−2.6115	−3.2024	−2.6058	−3.1929	−2.6068	−3.1946

Table 3

Summary of Bai–Perron structural breaks testing.

Source: Authors' estimation using E-Views 10.

Variables	F-statistic	Critical value**	Break dates
FDI	25.06278	11.14	1985, 1992, 2004
WPI	21.44766	11.83	1987, 1995, 2002, 2008
ROP	60.35027	8.58	2004
MC	33.12461	11.83	1984, 1995, 2001, 2007
GOVEXP	44.39183	11.14	1987, 1999, 2006
REXR	64.30310	11.14	1985, 1996, 2009
GDEXP	52.80955	11.14	1983, 1991, 2011
LVSTKG	36.72945	8.58	1999
MANUFG	13.77003	8.58	1999
ELEC	–	–	–
TRC	43.55637	8.58	1999

* Significant at the 0.05 level.

** Bai–Perron (Econometric Journal, 2003) critical values.

commodity markets are closely integrated due to the expansion of biofuel sector (Fabiosa, 2009). The major impact of said integration is on grains such as corn which is primary feedstock. So, the changes in feed cost will affect livestock sector. As 59% of total cost belongs to feed cost (Fabiosa, 2009). The study of Patton et al. (2012) also indicated the association of oil prices and livestock sector performance. Most of the previous studies in the context of oil price and livestock sector performance have been done in context of developed countries, but no study has been done in context of developing country like Pakistan. First time, this study is used to explore the impact of oil price fluctuations on the growth of livestock sector. The study has developed ARDL model to estimate the influence of oil price fluctuations on the livestock sector. The diagnostic test and estimated coefficients for short-run and long-run are given in the subsequent part.

Prior to the discussion of short-run and long-run coefficients, it is vital to explore the structural breaks in the data if any. Following this, one would be in a better position to elaborate

Table 5

Diagnostic test results for estimated model (1).

Source: Authors' estimation using E-Views 10.

Diagnostic test	Statistics
R ²	0.944517
F-statistic	22.34341 (0.000000)
Durbin–Watson'	1.277087
Serial Correlation	1.637345 (0.2108)
Normality	3.317675 (0.190360)
Heteroscedasticity	0.853680 (0.6217)

Note: The value in the parenthesis is *p*-value.

Jarque–Bera test null is normality, Breusch–Godfrey serial-correlation LM test null is no serial correlation, Breusch–Pagan–Godfrey heteroscedasticity null is no heteroscedasticity.

the results of model goodness of fit. Using the multiple structural breaks test of Bai and Perron (2003), we found that there are two structural breaks in the model. One structural break is found during year 1999 and other during year 2005. Results indicated that both structural breaks has significantly influenced our model. Therefore, to incorporate the influence of said structural breaks, we have added two dummy variables in the model. Table 5 provide summary of the results from model goodness of fit.

With reference to diagnostic test results, it can be seen from Table 5 that different stability and diagnostic test were performed to confirm the goodness of fit of the estimated model. These tests include overall functional form of the model, heteroscedasticity, normality, distribution of residuals and serial correlation. The stability coefficients were analyzed through CUSUM and CUSUMSQ introduced by Brown et al. (1975). The value of R² and Durbin–Watson test indicate the overall goodness of fit of the model. These values indicate that in overall evaluation, the model fitting is appropriate. The residuals follow a normal distribution, and the calculated Jarque–Bera test in insignificant which confirms the normality. The Breusch–Pagan–Godfrey test was used to check

Table 4

Identification of structural breaks in the models.

Source: Authors' estimation using E-Views 10.

Sector model	F-statistic	Critical value**	Break dates
Livestock Sector	13.59159	18.11	1999, 2005
Manufacturing Sector	10.67932	19.91	1999, 2008
Electricity Sector	4.383707	18.23	2012
Transportation and communication sector	4.190507	16.19	2005

* Significant at the 0.05 level.

** Bai–Perron (Econometric Journal, 2003) critical values.

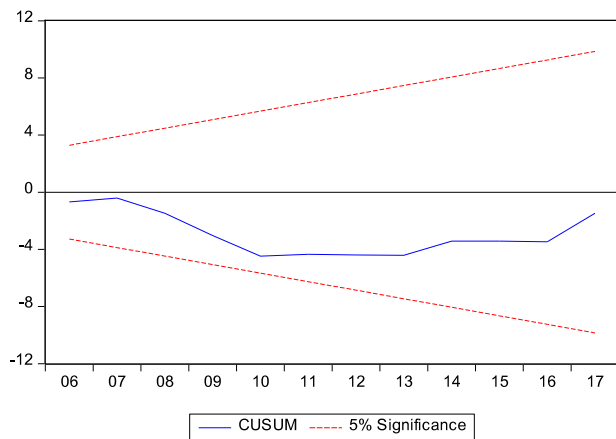


Fig. 1. CUSUM for Livestock Sector Model.

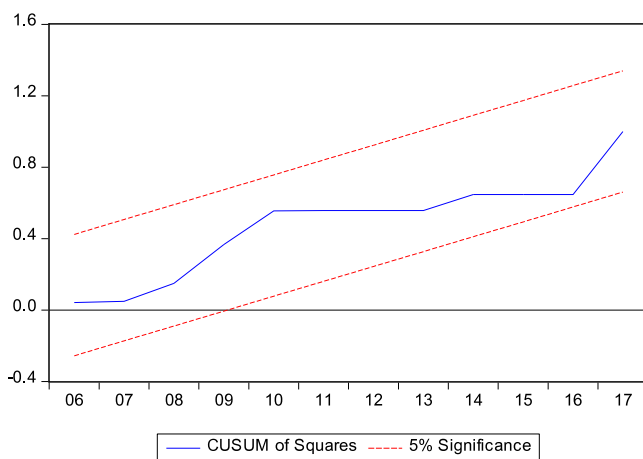


Fig. 2. CUSUMSQ for Livestock Sector Model.

Table 6

Estimated coefficients for livestock sector using ARDL model (1).

Source: Authors' estimation using E-Views 10.

Variable	Long-run coefficient (P-value)	Short-run coefficient (P-value)
LFDI	−0.061895 (0.3036)	−0.238984 (0.0398)
LWPI	1.218230 (0.0034)	2.723812 (0.0192)
LROP	−1.391670 (0.0000)	−0.680050 (0.0026)
LMC	−0.969323 (0.0019)	−1.319310 (0.2709)
ECT _{t−1}	–	−1.719691 (0.0000)

Note: Livestock sector growth is dependent variable.

the heteroscedasticity; the results are insignificant which nullify the null hypothesis. It means that the residuals are homoscedastic. Breauch–Godfrey serial-correlation LM test null which means no serial correlation. Further, the stability of coefficients was measured using CUSUM and CUSUMSQ. Figs. 1 and 2 present the CUSUM and CUSUMSQ which shows that statistics remains within the bounds at 5% level of significance, so it can be said that coefficients are stable. In summary, the aforesaid discussion indicates that econometric problems like non-normality of residuals, heteroscedasticity, autocorrelation, and model miss-specification errors are not present. And also, CUSUM and CUSUMSQ present that all the coefficients in the model are steady. So, we can safely move to interpret the results for livestock sector growth.

After having done with the appropriateness of model, the next step is to move toward the calculation of F-statistics from bound testing to check that is there long-run co-integration exist among variables or not. Putting livestock sector growth as dependent

variable and FDI, WPI, ROP and MC as independent variables, and two dummy variables were also included into the model to incorporate the two structural breaks identified in the previous section. The F-statistic from bound testing is 44.34931 that is higher than the upper-bounds at 1% significance level. Therefore, it can be concluded that there is a long-run relation between the variables. The detailed results are presented in Table 6. The results show that FDI has negative effect on the growth of livestock sector in the short-run. The results are significant at 5% level, whereas in the long-run results are insignificant. WPI has positive influence on livestock sector growth. The values are significant at 5% level in the short-run and 1% level in the long-run. ROP has a significant negative impact on livestock sector growth. The values are significant at 1% level both in long-run and short-run. However, MC does not influence livestock sector growth in the short-run. But, it adversely affects the sector growth in the long-run.

The significant negative impact of FDI on livestock sector growth in the short-run indicate that foreign direct investment is not a determinant of international integration of agricultural economies like Pakistan. Previously, most of scholars have emphasized on exploring the impact of FDI on economic growth (Ang, 2009; Azman-Saini et al., 2010; Chowdhury and Mavrotas, 2006; Iamsiraroj and Ulubaşoğlu, 2015; Pradhan et al., 2017; Regan and Brazys, 2018). But, first time this study has explored its impact on livestock sector growth that provides insights to policy makers. It highlights that FDI in Pakistan is mostly dedicated to other sectors which creates adverse effects on livestock sector in the short-run. These results offer policy insights to the government. Policy makers need to reconsider their policy for the livestock sector. The government can offer attractive packages to foreign investors to invest in the livestock sector. The effective utilization of FDI for positive improvement of livestock sector will not only improve the productivity of livestock sector but it will positively contribute toward GDP via a growth of livestock sector.

The livestock sector meets the food and raw material needs of households and industry. The positive impact of the whole sale price index on livestock sector's growth shows that there is highly inelastic demand locally and internationally which is absorbing the output of this sector. The positive impact suggests that supply lags behind demand that causes the price level to go up that consequently encourages the producer to produce more. The increase in demand is possibly due to increase in local and global population along with the increase in income levels. In addition, the positive impact of a whole sale price index indicates the immunity of this sector toward the shocks in input costs as they are readily transferred on to the wholesale buyer. Further, the significant negative impact of real oil prices on the livestock sector can be justified by the fact that even though petroleum oil is not a direct input in livestock output. But, as reflected in the positive relationship between wholesale price index and sector growth an increase in cost of production due to rise in fuel and electricity prices which create negative consequence for sector's growth, so if the crude oil price undergoes an increase the livestock sector output decreases due to high cost of input which results negative growth of the livestock sector. Further, it can be seen that money in circulation also hurts sector growth in the long-run.

3.2. Oil price fluctuations and manufacturing sector growth

Manufacturing sector is a core of industrial sector, and it is a very important sector of an economy. It generates economic productivity, work as source of exports, stimulate research and development and provide employment opportunities. In the context of Pakistan, this sector is 3rd biggest sector and contribute

Table 7

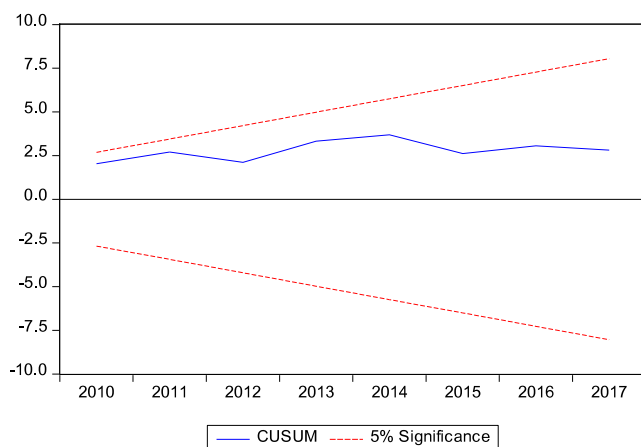
Diagnostic test results for estimated model (2).

Source: Authors' estimation using E-Views 10.

Diagnostic test	Statistics
R ²	0.845089
F-statistic	4.909772 (0.000653)
Durbin–Watson*	2.112472
Serial Correlation	0.291290 (0.7512)
Normality	0.487763 (0.783581)
Heteroscedasticity	0.825905 (0.6625)

Note: The value in the parenthesis is *p*-value.

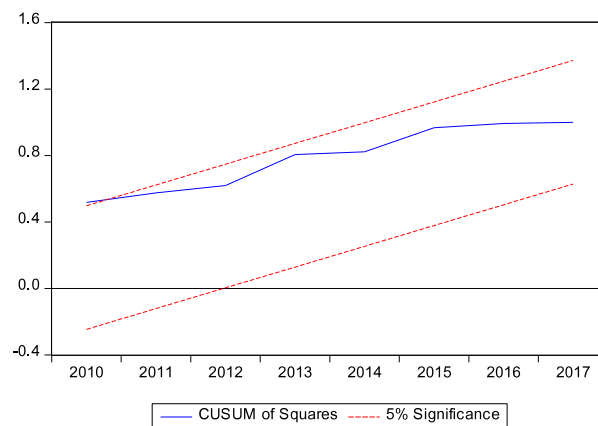
Jarque–Bera test null is normality, Breauch–Godfrey serial-correlation LM test null is no serial correlation, Breusch–Pagan–Godfrey heteroscedasticity null is no heteroscedasticity.

**Fig. 3.** CUSUM for Manufacturing Sector Model.

18.5% toward GDP and provides 13% of total employment. Manufacturing sector is highly dependent on electricity and oil is a major source of electricity production in Pakistan. Therefore, it is highly important to study how oil price fluctuations can influence the manufacturing sector of Pakistan. The study has developed ARDL model to estimate the influence of oil price fluctuations on the growth of manufacturing sector. The diagnostic test and coefficients for long-run and short-run are being presented.

Prior to the discussion of short-run and long-run coefficients, it is important to elaborate the model goodness of fit results. Using multiple structural breaks test of Bai and Perron (2003), we found that there are two structural breaks in the model. One structural break is found during year 1999 and other during year 2008. Results indicated that both structural breaks has significantly influenced the model. Therefore, to incorporate the structural breaks two dummy variables have been added in the model. Table 7 summarize the results from model goodness of fit.

Similar to the diagnostic test of model (1), the diagnostic test results for manufacturing sector model (2) are presented in Table 7, it can be seen that in overall evaluation, model fitting is appropriate. The residuals follow a normal distribution, and the calculated Jarque–Bera test is insignificant which confirms the normality. The Breusch–Pagan–Godfrey test was used to check the heteroscedasticity; the results are insignificant which nullify the null hypothesis. It means that the residuals are homoscedastic. Breauch–Godfrey serial-correlation LM test null is no serial correlation. Further, the stability of coefficients was measured using CUSUM and CUSUMSQ. Figs. 3 and 4 present the CUSUM and CUSUMSQ which shows that coefficients statistics remains within the bounds at 5% significance level, so it can be said that coefficients are stable. Hence, results from the model (2) can be used for interpretation.

**Fig. 4.** CUSUMSQ for Manufacturing Sector Model.**Table 8**

Estimated coefficients for manufacturing sector using ARDL model (2).

Source: Authors' estimation using E-Views 10.

Variable	Long-run coefficient (P-value)	Short-run coefficient (P-value)
LROP	−1.182869 (0.0041)	−0.702628 (0.0147)
LWPI	1.983227 (0.0302)	1.617094 (0.3123)
LGDEXP	−0.622392 (0.0568)	−1.287913 (0.0046)
LREXR	−3.029970 (0.0005)	1.300064 (0.2422)
LMC	0.609720 (0.0492)	3.861007 (0.0117)
ECT _{t−1}	–	−1.730406 (0.0000)

Note: Manufacturing sector growth is dependent variable.

Similar to the model in previous discussion, after having done with the appropriateness of model, the F-statistics was calculated from bound testing to check that is there long-run co-integration exist among variables or not. Putting manufacturing sector growth as dependent variable and ROP, WPI, GDEXP, REXR and MC as independent variables, and two dummy variables were also included into the model to incorporate the two structural breaks identified in the previous section, the F-statistic from bound testing is 10.57033 that is higher than the upper-bounds at 1% significance level. Therefore, it can be concluded that there is a long-run relation between the variables. Moreover, the detailed estimations are shown in Table 8. The results indicate that ROP has negative influence on the growth of manufacturing sector. The values are significant at 5% level in short-run and at 1% level in the long-run. WPI has positive impact on the growth of manufacturing sector in the long-run at 5% level of significance and the influence is insignificant in the short-run. GDEXP has negative impact on the growth of manufacturing sector. The values are significant at 5% level in short-run and at 10% in the long-run. RFEX has insignificant impact in the short-run. Whereas, in the long-run it has negative impact on the growth of manufacturing sector. Further, MC positively impacts the growth of manufacturing sector, both in the short-run and long-run. The values are significant at 5% level.

The negative impact of oil price shows that manufacturing sector is vulnerable to changes in oil price and sector's growth is being negatively affected. This negative impact has some serious implications. The supply side impact is observed; as when oil prices rise the prices of substitute energy sources such as natural gas also undergo an increment due to rise in demand. The fertilizer, cement and the textile industries are heavily dependent on gas and have to suffer due to increase in cost of production. Similarly, as more than 80% of the electricity is being produced through oil (Zameer and Wang, 2018), increase in the prices of crude oil result into an increase in electricity tariff. All such cost increment finally drives the production cost up that consequently

causes a decline in profitability and investment due to which sectors output or production suffers. Secondly, the demand side impact is understood by the fact that an ordinary household is also a victim to oil price hike because two of his major routine expenses; transport and electricity expense undergo an increment and we also know that oil creates an inflationary pressure in the economy due to which household have to cut down their consumption expenditures to withstand such price hike as they are left with little or no discretionary income if disposable income lags behind inflation. Decline in consumption expenditure means; households are reluctant to consume goods other than necessary; therefore a decline in consumption expenditure of the household will cause the aggregate demand for manufactured goods to fall and require a lower price level. Increased cost of production accompanied with a decline in demand for manufactured goods hampers the growth of manufacturing sector.

Furthermore, the manufacturing sector consumes the bulk of raw material and at the same time has a huge energy requirement. The manufacturing sector is vulnerable to both international and local competition and the price of raw material is determined on the basis of national and international demand. Results have shown that as the prices of the basic inputs rise they have a significant positive impact on the manufacturing sector growth. The positive impact of wholesale price index on the sector's growth also gives an insight that the production cost increments are completely transferred into the buyers of manufactured goods. So, it can be said that finally the consumer suffers. Money in circulation has a positive impact on the growth of this sector which shows that in a time when a general price level goes up an increment in money supply compensates for the price rise which results into a positive impact on the growth of the manufacturing sector in the short-run, as well as in the long-run. Finally, the negative impact of government development expenditures gives an alarming signal to the policy makers because all the development expenditures are being consumed on the projects those are not necessary for the growth of manufacturing sector. The government is putting a huge amount of money in building roads & bridges, irrigation and urban developments & transport. Even though these projects are important, but, these are not the necessity of manufacturing sector. So, the government needs to divert its attention and build projects like electricity generation from cheap energy sources that is the need of manufacturing sector and it will give some relief to this sector.

3.3. Oil price fluctuations and electricity generation & gas distribution sector growth

Electricity generation and gas distribution sector is one of the important sectors of an economy; this sector plays a key role in socio-economic development. In the context of Pakistan, this sector is highly dependent on imported furnace oil (Zameer and Wang, 2018). Previous studies have emphasized on how oil price fluctuations influence monetary policy (Malik, 2008), exchange rate sensitivity (Nandha and Hammoudeh, 2007), economic growth (Jawad, 2013) and stock returns (Waheed et al., 2018). Even though, electricity sector is highly dependent on furnace oil and suffering from severe crises since last two decades, but no study in the past has tried to explore the impact of oil price volatility on the growth of electricity generation and gas distribution sector of Pakistan. Therefore, it is highly significant to study the role of oil price fluctuations on the growth of electricity and gas sector of Pakistan. The studies that have focused on exploring the role of oil price volatility on individual economic sectors are scarce in literature. First time, this study is used to explore the impact of oil price fluctuations on the growth of electricity generation and gas distribution sector. The study has developed

Table 9

Diagnostic test results for estimated model (3).

Source: Authors' estimation using E-Views 10.

Diagnostic test	Statistics
R ²	0.959076
F-statistic	7.532869 (0.001681)
Durbin-Watson'	1.885164
Serial Correlation	1.024801 (0.4070)
Normality	1.853536 (0.395831)
Heteroscedasticity	1.207688 (0.4037)

Note: The value in the parenthesis is p-value.

Jarque-Bera test null is normality, Breauch-Godfrey serial-correlation LM test null is no serial correlation, Breusch-Pagan-Godfrey heteroscedasticity null is no heteroscedasticity.

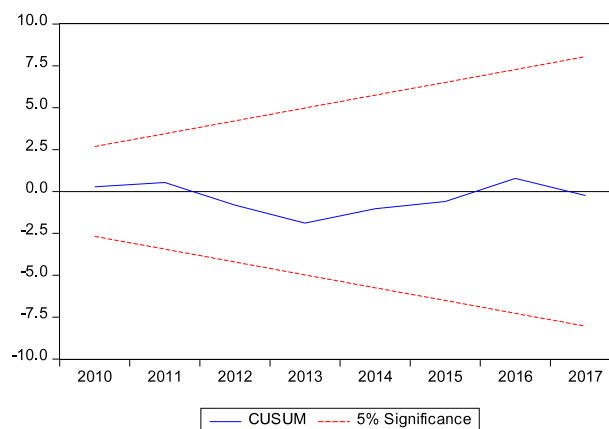


Fig. 5. CUSUM for Electricity and Gas Sector Model.

ARDL model to estimate the influence of oil price fluctuations on the growth of electricity generation and gas distribution sector. The diagnostic test and coefficients for long-run and short-run are given in the subsequent part.

Prior to the discussion of short-run and long-run coefficients, it is vital to explore the structural breaks in the data if any. Following this, one would be in a better position to elaborate the results of model goodness of fit. Using multiple structural breaks test of Bai and Perron (2003), we found one structural break in the model. Structural break is found during year 2012. Results indicated that structural break has significantly influenced our model. Therefore, to incorporate the influence of said structural break, we have added one dummy variables in the model. Table 9 provide a summary of the results from model goodness of fit.

Similar to the diagnostic test of models in preceding discussion, the diagnostic test results for electricity generation and gas distribution sector model (3) are presented in Table 8, it can be seen that in overall evaluation, model fitting is appropriate. The residuals follow a normal distribution, and the calculated Jarque-Bera test is insignificant which confirms the normality. The Breusch-Pagan-Godfrey test was used to check the heteroscedasticity; the results are insignificant which nullify the null hypothesis. It means that the residuals are homoscedastic. Breauch-Godfrey serial-correlation LM test null is no serial correlation. Further, the stability of coefficients was measured using CUSUM and CUSUMSQ. Figs. 5 and 6 present the CUSUM and CUSUMSQ which shows that statistics remains within the bounds at 5% level of significance, so it can be said that coefficients are stable. Therefore, results from the model (3) can be used for interpretation.

Similar to the models in previous discussion, after having done with the appropriateness of model, the F-statistics was calculated from bound testing to check that is there any long-run

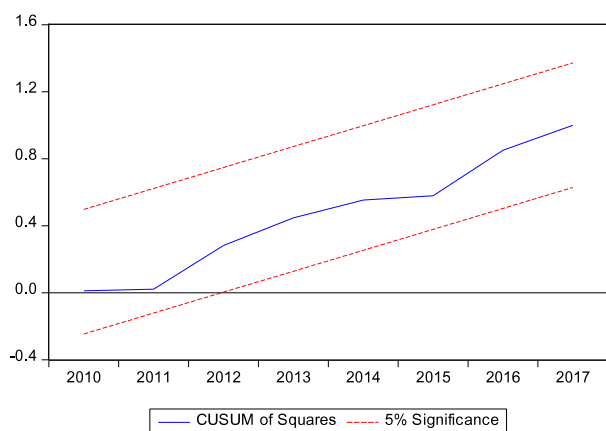


Fig. 6. CUSUMS of Squares for Electricity and Gas Sector Model.

Table 10

Estimated coefficients for electricity and gas sector using ARDL model (3).
Source: Authors' estimation using E-Views 10.

Variable	Long-run coefficient (P-value)	Short-run coefficient (P-value)
LROP	−1.607746 (0.0058)	−2.864945 (0.0010)
LWPI	−3.138399 (0.0267)	−3.489719 (0.3508)
LFDI	1.100356 (0.0033)	1.662567 (0.0106)
LMC	2.468284 (0.0948)	−7.501708 (0.0970)
LGOVEXP	−4.775262 (0.0055)	−10.73053 (0.0019)
ECT _{t-1}	−	−3.023719 (0.0000)

Note: Electricity generation and gas distribution sector growth is dependent variable.

co-integration among variables or not. Putting electricity generation and gas distribution sector growth as dependent variable and ROP, WPI, FDI, MC and GOVEXP as independent variables, and a dummy variable was also included into the model to incorporate the structural break identified in the previous section, the F-statistic from bound testing is 13.46160 that is higher than the upper-bounds at 1% level. Therefore, it can be concluded that there is a long-run relationship among the variables. Moreover, the detailed results are presented in Table 10. The results present that ROP has a significant negative impact on electricity generation and gas distribution sector growth. The values are significant at 1% level in both short-run and long-run. WPI has insignificant association with electricity generation and gas distribution sector growth in the short-run. Whereas, in the long-run it negatively influence the sector growth. FDI has significant positive impact on the growth of electricity generation and gas distribution sector. The values are significant at 5% level in short-run and in long-run values are significant at 1% level. MC has significant positive impact on the electricity generation and gas distribution sector growth in the long-run at 10% level of significance. Whereas, it negatively influence sector growth in short-run. GOVEXP have significant negative impact on electricity generation and gas distribution sector growth. The values are significant at 1% level both in short-run and long-run.

The negative impact of real oil price fluctuation is explainable by the fact that more than 80% of the electricity generation is carried out through non-renewable energy sources such as, natural gas, furnace oil, and coal, whereas furnace oil and natural gas having a greater part in electricity generation (Zameer and Wang, 2018). Secondly, natural gas is not only used for electricity generation, rather it has huge domestic and industrial consumption as well. The government owned electricity and gas distribution companies have to buy electricity and gas from government and private sector producers. When the producers cost of production rises, these distribution companies have to

buy energy at higher cost that consequently undermines their earnings if they are unable to shift the cost increment on to the industrial, agricultural and domestic users. In Pakistan, the electricity and gas distribution companies are under government and due to political interests of the government, these companies are unable to topple the cost increment onto the consumers. All this contributes to decline in their earnings and hampers the growth of the electricity and gas distribution sector. Moreover, results pretends some serious implications as the sector is directly being impacted by rise in oil prices. The power sector in 2017 consumed nearly 33% of oil out of total oil consumption in the country. Secondly, we should remember that when oil prices undergo an increment, the price of substitute energy source like natural gas also undergo an increment, therefore increase in the prices of inputs result into increase in production cost for electricity. Further, an increase in oil price cause a circular debt problem (Komal and Abbas, 2015) which makes the refineries to abandon the supply of furnace oil to the power producers, which consequently causes a significant decline in the supply of electricity. Increase in cost of buying electricity from the producers along with decline in supply results into the decline of earnings for the energy distributors which consequently results into a slowdown in sector growth.

We were quite amazed to find a significant and negative relationship between the government expenditure with the sector growth. But, our closer introspection gives us reasons for this negative relationship. Firstly, Pakistan's electricity generation capacity has stagnated since 1990's as no major electricity generation installation has been established despite of high demand. Secondly, due to continuous decline in earnings and losses faced by the distribution companies it has become a least prospective sector for government and private investment. Thirdly, even when government bales out these distribution companies and spends in installing distribution infrastructure like new transmission lines and pipelines; the recovery of sales from the final consumers made by these companies is very poor. Fourthly, since energy distribution companies are government owned and the mounting circular debt has to be settled by the government in the end. In order to pay such circular debts, the government has to cut upon its developmental expenditures and if it does not, then increase in the developmental expenditure means non-settlement of these debts which will consequently hinder the operations of these distribution companies. Finally, rather than developing new infrastructure the old one also requires attention and maintenance otherwise considerable land losses will keep on occurring that will undermine the earnings of these companies. The sector is a victim to internal corruption, politicized electricity and gas tariffs, theft by the consumers, and land line losses due to obsolete infrastructure. Until these problems are not eliminated, whatever the government allocates in terms of developmental expenditure and other expenditures it would result into a negative impact on the sector's growth because government spending is aggravating aggregate demand and consumption for energy, but is unable to positively influence the supply side of energy.

3.4. Oil price fluctuations and transportation & communication sector growth

Transportation and communication sector also plays a key role in socio economic development. From the economic perspective, this sector can help an economy to maximum utilize natural resources; promote trade, increase production and mobility of labor to cope with challenges of unemployment. From the political perspective, this sector can help to create political awareness among people. This sector is also important from social perspective; it is a key sector to stimulate the economic activity in the country. In the past, mostly studies have focused on how overall economy

Table 11

Diagnostic test results for estimated model (4).

Source: Authors' estimation using E-Views 10.

Diagnostic test	Statistics
R^2	0.826666
F-statistic	5.610827 (0.000201)
Durbin–Watson'	2.228974
Serial Correlation	0.512459 (0.6075)
Normality	4.237947 (0.20155)
Heteroscedasticity	1.374028 (0.2463)

Note: The value in the parenthesis is p-value.

Jarque–Bera test null is normality, Breuch–Godfrey serial-correlation LM test null is no serial correlation, Breusch–Pagan–Godfrey heteroscedasticity null is no heteroscedasticity.

Table 12

Estimated coefficients for transportation & communication sector using ARDL.

Source: Authors' estimation using E-Views 10.

Variable	Long-run coefficient (P-value)	Short-run coefficient (P-value)
LWPI	0.805321 (0.0625)	3.281248 (0.0964)
LROP	0.407046 (0.0001)	1.163946 (0.0011)
LFDI	0.408704 (0.0003)	0.695190 (0.0049)
LMC	−0.734412 (0.0325)	−4.708481 (0.0122)
ECT _{t−1}	−	−2.859493 (0.0000)

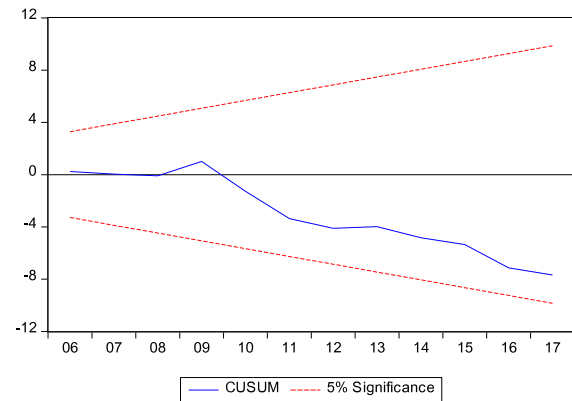
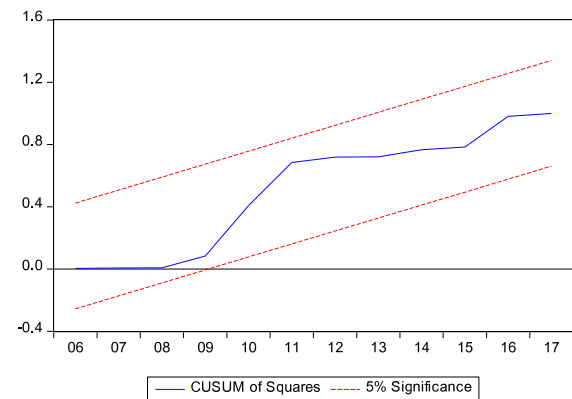
Note: Transportation and communication sector growth is dependent variable.

responds to oil price fluctuation. But, no study in the past has tried to explore how individual sector of an economy responds to oil price fluctuation. Specifically, how oil price fluctuation influence transportation and communication sector is scant in academic research. Therefore, to address these shortcomings, this study has developed ARDL model to estimate the influence of oil price fluctuations on the growth of transportation and communication sector. The diagnostic test and coefficients for long-run and short-run are given in the subsequent part.

Prior to the discussion of short-run and long-run coefficients, it is vital to explore the structural breaks in the data if any. Following this, one would be in a better position to elaborate the results of model goodness of fit. Using multiple structural breaks test of Bai and Perron (2003), we found one structural breaks in the model. Structural break is found during year 2005. Results indicated that said structural break has significantly influenced our model. Therefore, to incorporate the influence of structural break, one dummy variable has been added into the model. Table 11 provide a summary of the results from model goodness of fit.

Similar to the diagnostic test of models in the preceding discussion, the diagnostic test results for transportation and communication sector model (4) are presented in Table 11, it can be seen that in overall evaluation, model fitting is appropriate. The residuals follow a normal distribution, and the calculated Jarque–Bera test is insignificant which confirms the normality. The Breusch–Pagan–Godfrey test was used to check the heteroscedasticity; the results are insignificant which nullify the null hypothesis. It means that the residuals are homoscedastic. Breuch–Godfrey serial-correlation LM test null is no serial correlation. Further, the stability of coefficients was measured using CUSUM and CUSUMSQ. Figs. 7 and 8 present the CUSUM and CUSUMSQ which shows that statistics remains within the bounds at 5% level of significance, so it can be said that coefficients are stable. Therefore, results from the model (4) can be used for interpretation.

Similar to the models in previous discussion, after having done with the appropriateness of model, the F-statistics was calculated from bound testing to check that is there long-run co-integration exist among variables or not. Putting transportation and communication sector growth as dependent variable and WPI, ROP,

**Fig. 7.** CUSUM for Transportation and Communication Sector Model.**Fig. 8.** CUSUMSQ for Transportation and Communication Sector Model.

FDI and MC as independent variables, and a dummy variable was also included into the model to incorporate the structural break identified in the previous section, the F-statistic from bound testing is 10.28748 that is higher than the upper-bounds at 1% level of significance. Therefore, it can be concluded that there is a long-run relationship among the variables. Moreover, the detailed results are presented in Table 12. The results show that WPI has a significant positive impact on the growth of transportation and communication sector. The values are significant at 10% level of significance both in short-run and long-run. ROP has significant positive impact on transportation and communication sector growth. The values are significant at 1% level in both short-run and long-run. FDI has significant positive impact on the growth of electricity generation and gas distribution sector. The values are significant at 1% level both in short-run and long-run. MC has significant negative impact on sector growth. The values are significant at 5% level of significance both in short-run and long-run.

The significant positive impact of wholesale price index on the growth of transportation and communication sector is explainable by the fact that when wholesale price index changes it significantly influences the economy. It trends to future inflation and discourage consumers from saving. In a result, the higher prices outcome in higher growth. On the one end, it is beneficial for the sector, but on the other hand, it is harmful for the general consumers. Therefore, the positive impact wholesale price index on the growth of transportation and communication sector is also providing a policy insight which indicates that prices are readily transformed in the context of this sector. Moreover, the oil price fluctuation has positive impact on the growth of transportation

and communication sector. Even though, transport sector consumes large quantity of oil, but, the positive impact of oil prices can be explained similar to wholesale price index. One can say that in the context of transportation and communication sector the changes in oil prices are readily transferred to end consumers. Again, it can be said that it positively contribute toward sector growth, whereas for the final consumer it is harmful.

The foreign direct investment (FDI) causes the sector's output to grow which shows that FDI in Pakistan is paying off in the form of increased output of transportation and communication sector. In past decade the most of FDI has been dedicated to the construction of roads and for the improvement of communication infrastructure. In a result, these initiatives has increased economic activity which drives positive growth of transportation and communication sector in Pakistan. Conversely, increasing the supply of money in the circulation stream increases the liquidity of goods and services and is catalytic for the exchange process therefore when sufficient money is circulating in the economy then buyers have little reliance on borrowed money. Secondly, an increase in money supply means that money demand is being met which brings down the interest rates and lending becomes less profitable, as result, the sector's growth is negatively affected by increasing quantity of money in the circulation stream. Moreover, the increased money supply also minimizes the options for firm saving and investment because the interest rates in the economy go down.

4. Conclusion and implications

4.1. Conclusion

This study has investigated the relationship between oil price fluctuations and growth of real sectors in the context of Pakistan. As the economy grows its complexities also grow and a single variable becomes insufficient to explain the variability in growth of domestic output. The study used the multifactor classical normal linear model using ARDL method to capture the long run relationship between oil prices and growth in various sub-sectors. The results have revealed that in the long-run and short-run three out of four selected economic sectors are negatively influenced by changes in oil prices. These three sectors are manufacturing sector, livestock and electricity sector. However, in the context of transportation and communication sector, oil price changes have positive influence. The oil price increments are affecting economic sectors through the supply and the demand channels, as the rise in oil prices cause an increase in the cost of production, and consumption of goods to decline.

The introspection into the sub-sectors of the economy reveals that transportation and communication sector is not vulnerable to oil price fluctuations. So, it can be concluded that the growth of transportation and communication sector is immune against fluctuations in oil prices in long-run and short-run. In contrast, the manufacturing sector growth is vulnerable to fluctuations in oil prices and increments in oil price have a negative impact on its growth. The manufacturing sector not only has direct consumption of crude oil and its derivatives, rather in addition to this, the cost of production for the sector rises when electricity tariffs increase due to rise in oil prices. Secondly, the decline in household consumption of goods other than necessity further aggravates that slowdown in growth of the manufacturing sector. The sector that is most hard hit by the rise in oil prices is the energy sector because it is highly oil intensive and is adversely influenced by oil price fluctuations in the long-run and short-run. The energy sector is the driver behind all other economic sectors, and if the output of this sector is hampered while demand being inelastic; it will result into a slowdown of a whole economy. The

conclusions from this study are consistent with the current status of Pakistan economy as energy shortage is attributed as the major factor in causing a decline in economic growth.

Furthermore, the study has observed that the macro economic variables inducted in the estimated models had a significant relationship with sectors growth and affected either negatively or positively. It can be concluded that oil prices have significant relation with these variables and variance in oil prices will affect the variance in the macroeconomic variables. In the same way, the investment and consumption by the private and public sector is affected by fluctuations in oil prices. In addition, the increase in oil prices cause inflationary pressure in the economy, and if household income lags behind inflation their savings will decline or even they become indebted due to reliance on borrowed money to supplement consumption. As a result capital formation and investment by the private sector declines and overall economic output declines. Correspondingly, the government has to suffer as its tax revenue falls. The fall in tax revenue either results into a decline in government spending or fiscal deficits, causing decline in consumption and investment by the government sector. In contrast, if the government increase tax rate to compensate its budget deficits, it will result rise in a tax default rate as business entities have to face decline in profitability and incur losses due to decline in aggregate demand and rise in cost of production when oil prices rise.

4.2. Policy implications

The study offer several policy suggestions for the government of Pakistan. As the results have revealed that oil price increments affect the growth of various economic sectors in the long-run through a variety of channels. These channels influence the supply and demand side of the economy. The precise results from the study offer framework to the policy makers, so that they can develop a sound monetary policy that is neither over expansionary (causing inflation in long-run), and overly contractionary (causing slowdown in growth) can be built to whip out the negative impact of oil prices. However, catering the slowdown in growth by increasing the monetary aggregate is a short lived solution if increment in oil price is persistent so in such a scenario government has to play a huge role. There are several steps that government can take to minimize the impact of increasing oil prices on the economy. Government should initiate energy saving programs that are aimed at educating the general public that how energy wastage can be stopped. Households those manage to reduce electricity consumption shall be given incentives. Use of bio fuels and renewable energy sources shall be encouraged by the government. Investment from the private sector shall be encouraged in developing renewable energy projects by offering tax holidays or lower tax rate. Minimum duties shall be imposed on the import of renewable energy infrastructure such as solar cells and wind mills. Obsolete electricity infrastructure shall be quickly replaced by with new transmission lines and grid stations to prevent line losses. Electricity theft shall be penalized by imposing monetary penalties. Import of electricity appliances shall be discouraged by imposing strict duties. Public transport shall be encouraged by providing transporters with fuel at a discount rather than subsidizing fuel for a whole public. Similarly, considerable loss of energy can be reduced by keeping traffic in flow because road jams result into considerable wastage of energy.

Government should encourage exports of goods to oil exporting country by easing up export licenses to these countries. Secondly, exporters to oil exporting countries shall be given rebates; by increasing the exports to oil exporters will prevent economy from the global slowdown because unlike the consumption of oil

importing nations; consumption of oil exporting countries goes unharmed during global recessions caused by oil prices. Further, the government shall take initiatives to diversify the country's energy mix with greater emphasis on renewable energy sources. It shall invest in exploring and utilizing in house energy resources like natural gas, coal and crude oil. All such government initiatives will help in reducing energy wastage and decrease reliance on imported fuel, which will consequently strengthen the sustainable supply of energy for industry, reduce the outflow of foreign exchange and will immune the real sector from the detrimental impact of oil price shocks.

Thirdly, the negative impact of government development expenditures gives an alarming signal to the policy makers because all the development expenditures are being consumed on the projects those are not necessary for the growth of manufacturing sector. The government is putting a huge amount of money in building roads & bridges, irrigation and urban development & transport. Even though these projects are important but, these are not the necessity of manufacturing sector. Thus, it is suggested that the policy makers needs to divert their attention and build projects like electricity generation from cheap energy sources that is the need of manufacturing and electricity sector, and it will give some relief to these sectors. Finally, the study also found that increase in money supply adversely affects most of the sectors. An increase in money supply means that money demand is being met which brings down the interest rates, and lending becomes less profitable, as a result, the sector's growth is negatively affected by increasing quantity of money in the circulation stream. Moreover, the increased money supply also minimizes the options for firm saving and investment because the interest rates in the economy go down. Thus, based upon the findings, the study provides policy suggestion to the government to control the money supply to improve the sectors growth.

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Declaration of competing interest

The authors declare no conflict of interest.

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