Resource Curse Hypothesis and Role of Oil Prices in USA

Shahbaz, Muhammad and Ahmed, Khalid and Tiwari, Aviral Kumar and Jiao, Zhilun

Beijing Institute of Technology, Beijing, China, Institute of Business and Administration, Sukkur, Pakistan, Montpellier Business School, France, Nankai University, Tianjin, China

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Muhammad Shahbaz
School of Management and Economics,
Beijing Institute of Technology, Beijing, China.
Email: muhdshahbaz77@gmail.com

Khalid Ahmed
Institute of Business and Administration, Sukkur, Pakistan
Email: khalid.ahmed@iba-suk.edu.pk

Aviral Kumar Tiwari
Montpellier Business School, France
Email: aviral.eco@gmail.com

Zhilun Jiao
College of Economic and Social Development
Nankai University, Tianjin, China.
Email: zjiao@nankai.edu.cn

Abstract: This paper employs an augmented production function to examine resource curse hypothesis by incorporating oil prices as an additional determinant of economic growth. In doing so, the bounds testing approach to cointegration is applied in the presence of structural breaks in the series. The directional of causal association between the variables is examined by applying the VECM Granger causality approach. The empirical results show the existence of long run relationship between the variables. Moreover, natural resource abundance is negatively linked with economic growth confirms the validation of resource curse hypothesis. The nonlinear relationship between natural resource abundance and economic growth is inverted U-shaped. Oil prices add in economic growth. Capitalization increases economic growth. Labor boosts economic growth. The causality analysis reveals the unidirectional causal relationship running from natural resource abundance to economic growth. The feedback effect exists between oil prices and economic growth. Capitalization causes economic growth and in return, economic growth causes capitalization in Granger sense.
Keywords: Natural Resources, Economic Growth, Oil Prices, USA

* Corresponding author

1. Introduction

The pioneering study of Sachs and Warner (1995) identifies the resource abundance as a curse in most of the developing economies and argues that it limits the growth potential of the country[1]. Since then the debate on this front is ongoing and several resource abundant countries are tested for the so called 'resource curse hypothesis'. However, literature to date has found mixed and contradictory results, leading the research community to be more curious about the phenomenon and its theoretical connection (Collier and Goderis, 2008). For example; the notable studies (i.e., Rodriguez and Sachs 1999, Robinson et al. 2006, Karnik and Fernandes 2009, Dubé and Polèse 2015, Papyrakis 2016) explain that the too much dependence of a country on naturally endowed resource limit the growth potential in other sectors of the economy, turning the resource abundance a curse. Whereas, the study of Brunnschweiler and Bulte (2008) opine that the resource-curse-hypothesis is just a 'red herring' which only identifies the resource dependence but does not limit the growth potential of an economy. Similarly, Frankel (2010) finds that the economies with substantial commodity exports can overcome the crowding-out effect of natural resource abundance. The empirical evidence to date has yield mix results that vary country to country, depending on the economic structure. Thus, the literary discussion on this front is ongoing and requires further scholarship to advance the knowledge in the field. To address such gap, this study tests the resource curse hypothesis in case of U.S. The rationale behind choosing U.S as the case is based on two fundamental reasons. First, the origin of resource curse hypothesis is U.S and as the literature expands, the contradictory findings attract more attention of scientific community, requiring further empirical evidence to reach some consensus (see, Clay and Weckenman, 2014). Second, this study claims that the effect of resource curse in U.S is nested in resource price shocks rather than Dutch disease which is ignored in the existing literature (see, Kilian, 2016).

In the Global ranking for the countries with the most natural resources, U.S ranks second on the list with an estimated $45 trillion in natural resources. It is mainly comprising of crude oil, timber, coal and natural gas. In 2012, U.S Energy Information Agency (EIA) reveals that the country has 2 percent of world oil, consisting of 36.4 billion barrels proven oil reserves in addition to estimated 198 billion barrels. However, U.S maintains high trade deficit being a net importer of oil for decades. For long, it is debated that oil price shocks potentially explain U.S recessions and

[1] The **resource curse**, also known as the paradox of plenty, refers to the paradox that countries with an abundance of natural **resources** (like fossil fuels and certain minerals), tend to have less economic growth, less democracy, and worse development outcomes than countries with fewer natural **resources**.

as well as monetary policy or credit. Existing literature is divided on the notion that weather, it is sharp decline in oil prices cause recessions or sharp increase? Although evidence in both cases are available in favor and as well as against. For example; it is generally perceived that higher oil prices attract contractionary monetary policy which, subsequently lead to economic recession. Similarly, Baumeister and Kilian (2016) recently opine that the sharp decline in oil prices during 2014-2016 expected to boost the U.S economy but, it had no or little impact on capital reallocation, labor and credit availability. The potential cause of such unexpected behavior could be crowding-out effect of lower oil prices on non-oil-sectors of the U.S economy. Till now, the literature has investigated the financial and GDP related consequence of oil price shocks separately. However, this study considers that the both effects are not mutually exclusive but, coincide. Moreover, existing literature has also developed on the modeling side of this area where, the transmission of oil prices shocks has shifted from linear to non-linear models (Hamilton, 2003). The phenomenon of oil-related investment and non-oil-related investment transformation during the period of recessions in U.S has only seen with the lens of financial frictions or higher oil prices. However, the possibility of resource curse hypothesis has significantly ignored during the course. This study undertakes the task of filling the gap by taking a fresh look at the question using appropriate econometric model.

There is general agreement among the researchers who studied the U.S case for resource curse hypothesis that the price volatility of resource is the key determinant that causes fluctuations in U.S economic growth (Kilian 2016, Feyrer et al. 2017). Therefore, this paper considers two interdependent transmission channels through which resource curse might affect economic growth. The first channel is market capitalization (Kiyotaki and Moore 1997, Bernanke et al. 1999). Most of the recessions with oil-prices shocks are followed by unexpected reduction in credit availability (Romer and Romer 1989, Hall 2011, Gilchrist and Zakrajsek 2012). The most recent example is the recession of 2008. Lately, Hamilton (2009) and, Ramey and Vine (2011) conclude that the increasing oil-prices resulted in economic slowdown along-with deterioration of U.S. credit conditions. Likewise, Christiano et al. (2014) found the similar trend during the Great Recession. The second channel is labor market. The relationship between oil-prices shocks and labor market is extensively discussed in resource curse existing literature. Owing to oil-prices shocks, the labor cannot move freely across the other sectors (Jacks et al. 2011, Allcott and Keniston 2013). It limits the ability of economic growth indicators to boost economic activities

(Jacobsen and Parker 2014). The reallocation of both capital and labor depends on the general (Caballero and Hammour, 1996). Increase in resources during low economic growth attracts unused and underutilized labor but, in the period of high growth they compete for these assets (Karen and Weckenmen, 2014). Thus, labor market dynamics in resource rich economies are severely affected by the use of minerals in the period of recessions and booms. This notion sounds adverse implications for non-resource sectors in the economy.

The existing literature is still in developmental phase and requires further scholarship to establish a well-grounded theoretical base coupled with empirical evidence. This study aims to explore the resource curse hypothesis in case of U.S and contributes to existing literature by six folds: (i), There are evidences that developed countries may also be resource cursed in different economic sectors. This study is good effort to examine whether resource curse hypothesis exists in USA or not. (ii), Oil prices is considered as additional determinant of economic growth in augmented production function. (iii), Non-linear relationship between natural resources and economic growth is investigated by incorporating squared term of natural resources in augmented production function. (iv), The empirical model of augmented production function accommodates potential structural breaks arise in the series due to resource price volatility. (v), The bounds testing approach to cointegration approach is applied to examine cointegration between the variables in the presence of structural breaks. (vi), The VECM Granger causality is applied for investigating the direction of causal relationship between the variables by accommodating structural breaks. The results confirm that resource curse hypothesis is present in USA. The inverted U-shaped association between natural resources and economic growth is also validated. Oil prices and capital contribute to economic growth. The bidirectional causality exists between oil prices and economic growth while natural resources Granger cause economic growth.

2. Literature Review

Numerous studies in existing literature investigated the association between natural resources and economic growth using data for developed and developing countries but came up mixed and contradictory results. For example, Sachs and Warner (1995) investigate the relationship between economic growth and resource abundance for 97 developing economies and found surprising results. They concluded that the economies with fewer natural resources outperformed resource rich economies in terms of GDP growth. Later, this phenomenon is referred as the resource curse hypothesis. Similar studies were conducted by Sachs and Warner (2001), Papyrakis and Gerlagh (2004) and Humphreys et al. (2007) found strong negative correlation between natural resource abundance and economic growth. Whereas, Mikesell (1997), Stevens (2003), Lederman and Maloney (2007) found weak empirical evidence of a negative correlation between natural resource abundance and economic growth. Following Sachs and Warner (1995), Mikesell (1997) extended the debate and revealed an indirect link between natural resource abundance and economic growth. He further explains that the large part of income in resource rich countries comes from their mineral exports and that income negatively influences trade and non-trade sectors of the economy, followed by short-run growth boom and stagnation in the long-run. Similarly, Ross (1999) extends the literature further and concludes that the rapid development in resource abundant (mineral resources) sector limit the development of other sectors of the economy due to appreciation in domestic currency and crowd-out investment in non-resource sectors. He referred this phenomenon as 'Dutch disease'. The ongoing discourse possesses consensus over the relationship between natural resource abundance and economic growth but, divided over the multiple factors that drive this phenomenon (Doucouliagos and Paldam 2009, Haber and Menaldo 2011, Weber 2012, Cavalcanti et al. 2014). However, in terms of methodology, all these preliminary yet prominent studies are focused on cross-country analysis while testing the resource curse hypothesis (Frankel, 2010, 2012). It is now generally believed that conducting the country specific study is a good strategy since it reveals the true picture of an economy that which phenomenon it is suffering from and possess meaningful policy implications suitable for the under observation economy. The current thesis on the topic explains different channels through which natural resource abundance hinders growth potential of a country. The empirical findings to date are mix and urges further scholarship on this front.

Nonetheless, Van der Ploeg (2011) recently explored a comprehensive literature survey on the resource-curse hypothesis and summarized that natural resource abundance hampers economic growth via crowding-out and weak-institutions effect. Here crowding-out refers to the additional wealth generated by abundant resources and currency appreciation, ultimately resulting in crowding-out of country's exports potential in other goods (see, Corden and Neary 1982, Corden 1984). Moreover, Larsen (2006) explains that how Norway escaped the resource curse phenomenon and sustained economic growth since 1976 when huge oil resources were discovered. He explains that strong institutions and mindful macroeconomic policy implementation helped

Norway to handle Dutch Disease. Therefore, the weak institutions and inappropriate policy regime are also key reasons behind the slow and even negative economic growth in a resource rich country. Here, weak institutions refer to the institutional quality in a resource abundant country that plays vital role in exploiting natural resources. For example; the country with higher institutional quality has ability to benefit more from the resources than the countries with weak institutions. Even, the resources rich countries with already weak institutions tend to have more negative impact of resource abundance on their institutional quality.

Two transmission channels (i.e. labor and capitalization) may be considered to examine whether the US is a resource curse country. Although, the past literature is filled with empirical evidence showing strong negative correlation between labor market shocks and resources measure. However, some recent studies i.e., Allcott and Keniston (2013), and Jacobsen and Parker (2014), who examine labor shocks due to large scale resources extraction projects in US, found no evidence of negative impact on manufacturing sector. Thus, making the literature ambiguous and leading the policy makers indecisive. Now as far as capitalization is concerned, Barsky and Kilian (2002) conclude that the credit contraction in the wake of oil price shocks marginalizes the overall capital formation in the US. Their results support the argument of Hoover and Perez (1994). We therefore, consider market capitalization as a potential variable which may be negatively influenced by oil price shocks.

Plenty of literature has discussed the resource curse hypothesis in U.S both in cross-sectional and time series analysis. For example; Goldberg et al. (2008a, b) conducted two studies in the same year, one using cross-sectional analysis and other using time series analysis. Their results reported that US is a resource curse country. The cross-sectional analysis of James and Aadland (2011) also found US a resource curse country despite using data for extended time periods and improved modeling technique. However, the results are conflicting for time series analysis. For example; the results of Boyce and emery (2011), and Keniston (2013) concluded that resources are blessings and positively linked to income. It means there is still a gap in existing literature on the side of time series analysis in a country specific case for seeking the general agreement to help policy makers whether the resources are curse or blessing in US. Similarly, Karen and Weckenmen, (2014) used state-level data to examine the association between different natural resources “oil and gas, mineral and agriculture” and economic growth for the period of 1880-2012. Their empirical findings are sensitive with natural resource indicators, but in overall, natural resource abundance hinders economic growth. The ambiguity in empirical results for US economy investigating the association between natural resources and economic growth encourages researchers for further research. This inconsistency in empirical results may be due to ignoring the important role of oil prices in augment production function. The USA is a major oil exporting country and any change in oil price may affect economic activity.

3. Empirical Modelling and Data

Numerous studies have been investigated the relationship between natural resources and economic growth not only in developed countries but also in resources abundant countries (Satti et al. 2014, Ahmed et al. 2016, Badeeb et al. 2017). These empirical studies provided inconclusive empirical findings due to the omission of relevant variables in production function. In doing so, existing studies in literature incorporated role of institutions (Mehlum et al. 2006, Sarmidi et al. 2014), oil wealth (Basedau and Lay 2009), governance (Busse and Gröning 2013), trade openness and financial development (Satti et al. 2014), capitalization (Ahmed et al. 2016) and domestic investment (Araji 2017) in augmented production and reported the ambiguous empirical results. Oil prices can be potential factor which affects domestic production and hence economic growth. The relationship of oil prices with economic activity matters if economy is oil exporting or oil importing. Existing studies in literature indicates that oil prices have effect on economic activity via supply and demand channels (Morey 1993, Tang et al. 2010). A rise in oil prices leads to rise in cost of production as oil is prime factor in production function is revealed by supply-side channel. Investment and consumption activities are affected by oil prices shocks entailed by demand-side channel. A rise in oil prices lower domestic output by lowering real wages and low demand for labor due to slowdown in economic activity/economic growth (Maeda 2008, Ftiti et al. 2016, Shahbaz et al. 2017). Furthermore, oil prices rise affects economic activity/economic growth via exchange rate and inflation channels. By keeping direct and indirect effects of oil prices on economic growth, we have incorporated oil prices as additional determinants of natural resources and economic growth in augmented production function. The general form of production function is formulated as following:

$$Y_t = f(R_t, O_t, K_t, L_t) \tag{1}$$

The general form of augmented production function has transformed into log-linear specification by taking natural-log of all the variables following Shahbaz et al. (2017). Shahbaz et al. (2017) argued that log-linear specification provides empirically efficient and reliable results[2]. The log-linear specification of augmented production function is modelled as following:

$$\ln Y_t = \beta_1 + \beta_R \ln R_t + \beta_O \ln O_t + \beta_K \ln K_t + \beta_L \ln L_t + \mu_i \qquad (2)$$

where, $\ln$, Y_t, R_t, O_t, K_t and L_t indicate natural-log, economic growth, natural resources, oil prices, capitalization and labor. Y_t is measured by real GDP per capita (in US$ constant 2010), R_t is real natural resources per capita (in US$ constant 2010), oil prices is indicated by O_t (in US$ 2010 constant), capitalization i.e. K_t is measured by real capital use per capita (in US$ constant 2010) and L_t is labor force. μ_i is residual term assumed to has normal distribution.

The 40 years data over the period of 1976-2016 is used for empirical analysis[3]. The data on natural resources is collected from World Development Indicators (CD-ROM, 2017). Natural resources' data is measured by total natural resources rents composite of coal rents, oil rents, forest rents, mineral rents and natural gas rents. The data on real capital (constant LCU 2010), real GDP (constant LCU 2010) and labor is also collected from World Development Indicators (CD-ROM, 2017)[4]. We have combed US Energy Information Administration (https://www.eia.gov/) to collect data on crude oil prices data. The data has transformed into per capita by dividing all the series on total population except oil prices.

4. Methodological Framework

4.1 The ARDL Bounds Testing Approach to Cointegration

There are several econometric methods to examine the cointegration relationship among the variables however, we prefer to use bounds testing approach to cointegration based on the autoregressive distributed lag (ARDL) model developed by Pesaran et al. (2001). This approach

[2] The log-linear specification provides direct elasticity which helps policy makers in designing economic policy.
[3] The period is restricted due to availability of data.
[4] Real gross fixed capital formation is used proxy for capital.

has several advantages over traditional cointegration approaches. Though advantages of ARDL methods are well documented in the literature, we describe them very briefly here as (following Pesaran and Shin 1999): 1) this approach is suitable for small sample size of the time series data; 2) mixed order of variables (up to maximum order of one) is allowed; 3) both short-run and long-run models can be estimated simultaneously without losing information of long-run relationship. In brief, the ARDL bounds testing enables us to estimate the dynamic unrestricted error-correction model (UECM) which presents the short-run dynamics and long-run equilibrium path without affecting the long-run information. In ARDL bounds testing approach, it is easy to incorporate dummy variable capturing information of unknown single structural break in the series indicted by structural break unit test[5].

The ARDL bounds testing approach under the UECM framework may be presented as follows. Step 1- for our purpose, first estimate equation-1 as defined below:

$$\begin{aligned}\Delta\ln Y_t &= \alpha_1 + \alpha_T T + \alpha_Y \ln Y_{t-1} + \alpha_R \ln R_{t-1} + \alpha_O \ln O_{t-1} + \alpha_K \ln K_{t-1} + \alpha_L \ln L_{t-1} + \sum_{i=1}^{p}\alpha_i \Delta\ln Y_{t-i} \\ &+ \sum_{j=0}^{q}\alpha_j \Delta\ln R_{t-j} \sum_{l=0}^{s}\alpha_l \Delta\ln O_{t-l} + \sum_{j=0}^{s}\alpha_j \Delta\ln K_{t-j} + \sum_{l=0}^{s}\alpha_l \Delta\ln L_{t-l} + \mu_t\end{aligned} \tag{3}$$

$$\begin{aligned}\Delta\ln R_t &= \alpha_1 + \alpha_T T + \alpha_Y \ln R_{t-1} + \alpha_R \ln Y_{t-1} + \alpha_O \ln O_{t-1} + \alpha_K \ln K_{t-1} + \alpha_L \ln L_{t-1} + \sum_{i=1}^{p}\alpha_i \Delta\ln R_{t-i} \\ &+ \sum_{j=0}^{q}\alpha_j \Delta\ln Y_{t-j} \sum_{l=0}^{s}\alpha_l \Delta\ln O_{t-l} + \sum_{j=0}^{s}\alpha_j \Delta\ln K_{t-j} + \sum_{l=0}^{s}\alpha_l \Delta\ln L_{t-l} + \mu_t\end{aligned} \tag{4}$$

$$\begin{aligned}\Delta\ln O_t &= \alpha_1 + \alpha_T T + \alpha_Y \ln Y_{t-1} + \alpha_R \ln R_{t-1} + \alpha_O \ln O_{t-1} + \alpha_K \ln K_{t-1} + \alpha_L \ln L_{t-1} + \sum_{i=1}^{p}\alpha_i \Delta\ln O_{t-i} \\ &+ \sum_{j=0}^{q}\alpha_j \Delta\ln Y_{t-j} \sum_{l=0}^{s}\alpha_l \Delta\ln R_{t-l} + \sum_{j=0}^{s}\alpha_j \Delta\ln K_{t-j} + \sum_{l=0}^{s}\alpha_l \Delta\ln L_{t-l} + \mu_t\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta\ln K_t &= \alpha_1 + \alpha_T T + \alpha_Y \ln Y_{t-1} + \alpha_R \ln R_{t-1} + \alpha_O \ln O_{t-1} + \alpha_K \ln K_{t-1} + \alpha_L \ln L_{t-1} + \sum_{i=1}^{p}\alpha_i \Delta\ln K_{t-i} \\ &+ \sum_{j=0}^{q}\alpha_j \Delta\ln Y_{t-j} \sum_{l=0}^{s}\alpha_l \Delta\ln R_{t-l} + \sum_{j=0}^{s}\alpha_j \Delta\ln O_{t-j} + \sum_{l=0}^{s}\alpha_l \Delta\ln L_{t-l} + \mu_t\end{aligned} \tag{6}$$

[5] We have also incorporated dummy variable to accommodate structural breaks in the series while investigating cointegration between the variables. The break dates are based on results of Kim-Parron (2009) structural break unit root test.

$$\Delta \ln L_t = \alpha_1 + \alpha_T T + \alpha_Y \ln Y_{t-1} + \alpha_R \ln R_{t-1} + \alpha_O \ln O_{t-1} + \alpha_K \ln K_{t-1} + \alpha_L \ln L_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta \ln L_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta \ln Y_{t-j} \sum_{l=0}^{s} \alpha_l \Delta \ln R_{t-l} + \sum_{j=0}^{s} \alpha_j \Delta \ln O_{t-j} + \sum_{l=0}^{s} \alpha_l \Delta \ln L_{t-l} + \mu_t \quad (7)$$

The step-2 finds the appropriate choice of the lag length as empirical results are sensitive to the choice of lags. In doing so, we have used the Akaike Information Criterion (AIC) due to its superior power properties. The step-3 computes F-statistic (for the best model identified by AIC) and compares the values of computed F-statistics with the critical bounds generated by Pesaran et al. (2001) in order to make decisions on the existence of cointegration. In brief, the null hypothesis i.e. $H_0 : \alpha_Y = \alpha_R = \alpha_O = \alpha_K = \alpha_L = 0$ of no cointegration for equation-4 is tested against the alternative hypothesis $H_0 : \alpha_Y \neq \alpha_R \neq \alpha_O \neq \alpha_K \neq \alpha_L \neq 0$).

In step-4, we decide the whether there is cointegration or not. For example, if the computed ARDL-F statistic is more than the upper critical bound value, we conclude that there is evidence of cointegration and if the ARDL-F statistic is less than the lower critical bound value, we conclude that there is no evidence of cointegration. Further, if ARDL F-statistic is between the upper and lower critical bound values, we conclude that the decisions about the cointegration is inconclusive. It is important to mention that Narayan (2005) has provided the critical values for small sample size (i.e. 54 observations), therefore, we have used critical values provided by Narayan (2005) as our sample size is small and the critical values provided by Pesaran et al. (2001) are not suitable to our sample size. Finally, we examine the stability of the bounds testing approach is tested by applying CUSUM and CUSUMsq tests suggested by Brown et al. (1975). We also used several diagnostic tests to see if the models hold good and has no problem of auto-correlation, ARCH-effect and miss-specification.

Once, the cointegration via the ARDL bounds testing approach is confirmed and models fits well to the assumptions of regression, we estimation the long-run model for the variables under consideration as follows:

we then estimate the long-run impact of natural resources (R_t), oil prices (O_t), capital (K_t), labor (L_t) on economic growth (Y_t), by following equation-8:

$$\ln Y_t = \theta_0 + \theta_1 \ln R_t + \theta_2 \ln O_t + \theta_3 \ln K_t + \theta_4 \ln L_t + \mu_i \quad (8)$$

where $\theta_0 = -\alpha_1 / \alpha_Y$, $\theta_1 = -\alpha_R / \alpha_1$, $\theta_2 = -\alpha_O / \alpha_1$, $\theta_3 = -\alpha_K / \alpha_1$, $\theta_4 = -\alpha_L / \alpha_1$ and μ_t is the white-noise term.

4.2 The VECM Granger Causality Approach

Last but not least, we also used the vector error correction model (VECM) version of Granger causality to test the direction of causal relationship after confirming the cointegration between economic growth and its determinants. The estimation of VECM based Granger-causality may be based on equations modelled as follows:

$$(1-L)\begin{bmatrix} \ln Y_t \\ \ln R_t \\ \ln O_t \\ \ln K_t \\ \ln L_t \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} b_{11i} b_{12i} b_{13i} b_{14i}\ b_{15i} \\ b_{21i} b_{22i} b_{23i} b_{24i}\ b_{25i} \\ b_{31i} b_{32i} b_{33i} b_{34i}\ b_{35i} \\ b_{41i} b_{42i} b_{43i} b_{44i}\ b_{45i} \\ b_{51i} b_{52i} b_{53i} b_{54i}\ b_{55i} \end{bmatrix} \times \begin{bmatrix} \ln Y_t \\ \ln R_t \\ \ln O_t \\ \ln K_t \\ \ln L_t \end{bmatrix} + \begin{bmatrix} \alpha \\ \beta \\ \delta \\ \Phi \\ \theta \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix} \quad (9)$$

where ECT_{t-1} is the lagged residual term derived from long-run equations as mentioned in equation-2, $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}$ and ε_{5t} are the white noise terms of equations entering into the system of VECM, and $(1-L)$ is the difference operator. The long-run causality is tested from the significance value of the coefficient for ECM_{t-1} through using the *t*-test statistic whereas the short-run causal relationship among the variables is tested through *F*-statistic or Wald test on the first differenced lagged independent variables. For example, $b_{12i} \neq 0 \forall_i$ reveals the causality running from natural resources to economic growth and $b_{21i} \neq 0 \forall_i$ indicates that economic growth causes natural resources in Granger sense.

5. Empirical Results and their Discussion

Table-1 reveals results descriptive statistics and pair-wise correlations. We noted that oil prices volatility high compared to natural resources. Capital is less volatile compared to economic growth and labor seems stable comparatively. The data for all the variables has normal distribution which leads us for linear empirical analysis between economic growth, natural resources, oil prices, capital and labor. The pair-wise correlation analysis indicates the presence of negative correlation between natural resources and economic growth. Oil prices are positively correlated with economic growth. A positive correlation is found of capital and labor with economic growth. The positive correlation exists between natural resources and oil prices. Capital and labor are inversely correlated with natural resources. Labor is positively (negatively) correlated with capital (oil prices). The positive correlation also exists between capital and oil prices.

Table-1: Descriptive Statistics and Correlation Matrix

Variables	$\ln Y_t$	$\ln R_t$	$\ln O_t$	$\ln K_t$	$\ln L_t$
Mean	10.5665	6.2259	3.9544	9.0267	4.1751
Median	10.5758	6.1493	3.9362	9.0162	4.1857
Maximum	10.8627	7.4109	4.7468	9.3350	4.2061
Minimum	10.1361	4.8973	2.8997	8.5562	4.1146
Std. Dev.	0.2235	0.5291	0.5341	0.1967	0.0258
Skewness	-0.3277	-0.0769	-0.0147	-0.3501	-0.6312
Kurtosis	1.7548	3.3792	1.6968	2.3480	2.2607
Jarque-Bera	3.4651	0.2932	2.9733	1.6022	3.7460
Probability	0.1768	0.8636	0.2261	0.4488	0.1536
Sum	443.7931	261.4909	166.0879	379.1250	175.3568
Sum Sq. Dev.	2.0495	11.4818	11.6984	1.5870	0.0272
$\ln Y_t$	1.0000				
$\ln R_t$	-0.5587	1.0000			
$\ln O_t$	0.1483	0.3940	1.0000		
$\ln K_t$	0.6395	-0.4537	0.0894	1.0000	
$\ln L_t$	0.3715	-0.2941	-0.3454	0.4713	1.0000

In order to examine the unit root properties of the variables, we apply ADF unit root test developed by Dickey and Fuller (1981) and results are reported in Table-2. It is noted that economic growth, natural resources, oil prices, capital and labor are nonstationary at level with constant and trend.

After 1st difference, we found all the variables are stationary confirmed by ADF unit root test. The ADF unit root test is unable to catch information of unknown structural break stemming in series which may be potential cause of unit root problem. This weakness of ADF unit root test misleads us and provides ambiguous empirical evidence. In doing so, we have applied structural break unit root test advanced by Kim and Perron (2009) that accommodates single unknown structural break in the series. The results of Kim and Perron (2009) are reported in Table-2 (lower segment). We note that all the variables are found non-stationary at level in the presence of structural breaks in the series. These breaks are 2007, 1999, 2003 and 2008 for economic growth, natural resources, oil prices, capital and labor. The structural break in economic growth indicates the presence of financial crisis which hit not only US real economic activity but also financial, oil, capital and labor markets. After first differencing, economic growth, natural resources, oil prices, capital and labor are found stationary in the presence of structural breaks in the series. This shows that all the variables are integrated at I(1) and unit root analysis is robust and reliable.

Table-2: Unit Root Analysis

Variable	ADF at Level		ADF at 1st Difference	
	T. Statistic	P. Value	T. Statistic	P. Value
$\ln Y_t$	-1.6546 (1)	0.7526	-4.5764 (2) *	0.0038
$\ln R_t$	-2.3128 (2)	0.4947	-7.1990 (1) *	0.0000
$\ln O_t$	-1.4238 (3)	0.8421	-6.5607 (2) *	0.0011
$\ln K_t$	-2.6768 (2)	0.2512	-4.5170 (3) *	0.0047
$\ln L_t$	-1.6428 (1)	0.7576	-3.6153 (2) **	0.0417
Variable	**ADF at Level with Break**		**ADF at 1st Diff. with Break**	
	T-statistic	**Break Year**	**T-statistic**	**Break Year**
$\ln Y_t$	-4.1215 (1)	2007	-5.1782 (2) *	2009
$\ln R_t$	-3.4758 (2)	1999	-7.7459 (3) *	2011
$\ln O_t$	-3.2178 (1)	2003	-7.2818 (2) *	1998

$\ln K_t$	-4.1018 (3)	2008	-4.9417 (1) **	2009
$\ln L_t$	-3.1416 (2)	2008	-5.9432 (3) *	2008
Note: * and ** show significance at 1% and 5% levels respectively. The optimal lag lengths used are shown in ().				

The unique order of integration of the variables i.e. I(1) intends us for investigating the cointegration between economic growth, natural resources, oil prices, capital and labor. For this empirical purpose, we employ bounds testing approach to cointegration by accommodating structural breaks in the series. Before proceeding to ARDL approach, it is necessary to select appropriate lag length of the variables by using vector autoregressive (VAR). The ARDL F-statistic is linked with the selection of lag length of the variables. The different leg lengths produce different ARDL F-statistic which makes empirical results ambiguous. This issue is solved by applying Akiake Information Criterion (AIC) which produces more accuracy in choosing appropriate leg length of the variables compared to Stewarts Bayesian Criterion (SBC). The results of AIC are shown in Table-3 (second column). Using augmented production function, we calculated ARDL-F statistic by using economic growth, natural resources, oil prices, capital and labor as dependent simultaneously. The results are reported in Table-3 and we find that computed ARDL-F statistic is greater than upper critical bound at 1% and 5% levels respectively as we used economic growth, oil prices and capital as response variables. The ARDL-F statistic is lower than lower critical bound as we used natural resources and labor as dependent variables which intends us to accept the null hypothesis of no cointegration. This implies the presence of three cointegrating vectors which rejects null hypothesis of no cointegration between the variables. We may conclude that there is a cointegration between economic growth, natural resources, oil prices, capital and labor for the period of 1976-2016 in case of USA. Further, all the estimated ARDL empirical show absence of serial correlation and autoregressive conditional heteroscedasticity. The functional form of all estimated models is well formulated and residual term of all models has normal distribution. The stability of CUSUM and CUSUMsq show the reliability of ARDL estimates[6].

[6] The similar outcome is found as we have included squared term of natural resources in augmented production function. We may conclude that there is also a cointegration relationship between economic growth and its determinants in US economy.

Table-3: The Results of ARDL Cointegration Test

Bounds Testing Approach to Cointegration				Diagnostic tests					
Estimated Models	Lag Length	Break Year	F-statistic	χ^2_{NORMAL}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{SERIAL}	CUSUM	CSUSUMsq
$Y_t = f(R_t, O_t, K_t, L_t)$	2, 2, 2, 2, 2	2007	9.0507*	0.7060	1.8085	2.6511	0.9006	Stable	Stable
$R_t = f(Y_t, O_t, K_t, L_t)$	2, 2, 2, 1, 2	1999	4.080	0.6212	2.1101	0.4019	1.1076	Stable	Stable
$O_t = f(Y_t, R_t, K_t, L_t)$	2, 2, 2, 2, 2	2003	8.806**	0.1593	1.6181	1.1806	2.1732	Stable	Stable
$K_t = f(Y_t, R_t, O_t, L_t)$	2, 2, 1, 2, 2	2008	8.505**	2.1536	2.1701	0.3461	0.1372	Stable	Stable
$L_t = f(Y_t, R_t, O_t, K_t)$	2, 2, 2, 1, 2	2008	3.909	1.3360	4.1227	2.1031	0.3143	Stable	Stable
$Y_t = f(R_t, R_t^2, O_t, K_t, L_t)$	2, 1, 2, 1, 2	2007	10.001*	1.2921	2.2102	2.1301	0.3114	Stable	Stable
$R_t = f(Y_t, R_t^2, O_t, K_t, L_t)$	2, 2, 2, 2, 2	1999	4.250	0.7565	1.8280	2.3212	0.9071	Stable	Stable
$R_t^2 = f(Y_t, R_t, O_t, K_t, L_t)$	2, 2, 2, 2, 2	1999	5.050	0.7761	2.0098	1.9807	1.8930	Stable	Stable
$O_t = f(Y_t, R_t, R_t^2, K_t, L_t)$	2, 2, 2, 2, 2	2003	8.818**	0.6070	2.3001	0.4330	1.1030	Stable	Stable
$K_t = f(Y_t, R_t, R_t^2, O_t, L_t)$	2, 2, 1, 2, 2	2008	7.846**	0.1551	1.7162	1.3038	2.1371	Stable	Stable
$L_t = f(Y_t, R_t, R_t^2, O_t, K_t)$	2, 2, 2, 1, 2	2008	2.120	2.1585	2.7213	0.3203	0.3533	Stable	Stable
Significance Level	Critical values (T = 42)								
	Lower bounds $I(0)$	Upper bounds $I(1)$							
1 percent Level	7.317	8.70							
5 percent Level	5.360	6.373							
10 percent Level	4.437	5.377							

Note: The asterisks * and ** denote the significant at 1 and 5 per cent levels, respectively. The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests.

After confirming the long run relationship between economic growth and natural resources along with oil prices, capital and labor force, we move for investigating the long-run impact of natural resources, oil prices, capital and labor force on economic growth. The results are reported in Table-4. We note that natural resources exert negative impact on economic growth at 1% significance level. It implies that a 1% increase in natural resources declines economic growth by 0.1449 by keeping other things constant. This confirms the presence of resource-curse hypothesis in USA. We find that this empirical evidence is consistent with existing studies in literature such as Paprak and Gerlagh (2007), James and Aadland (2011), Boyce and Emery (2011) and, Clay and Alex (2014) reported the validation of resource curse hypothesis in the US, US counties and US states respectively. Furthermore, Fan et al. (2012), Satti et al. (2014) and Ahmed et al. (2016) also noted that natural resources are negatively linked with economic growth in case of China, Venezuela and Iran respectively. The relationship between oil prices and economic growth is positive and significant at 1% level. This shows that a rise in oil prices is a stimulus to US economy. This empirical finding is consistent with Farhani (2012) who reported that oil price increases have positive effect on economic growth for US economy. The relationship between capitalization and economic growth is positive and statistical significant at 1% level of significance. This shows that a 0.7242% increase in domestic production by 1% increase in capitalization. This empirical evidence is similar with Uneze (2013) who noted that capital formation plays a significant role in stimulating economic activity and hence, economic growth. Labor has positive impact on economic growth and it is statistically significant at 1% level. Keeping other things constant, we note that a 1% increase in labor has positive contribution to economic growth by 0.2305%. This supports the view reported by Shahbaz and Lean that labor force is also a key factor like capitalization to speed up economic activity and hence economic growth. The dummy variable in included based on results of Kim and Perron (2009) unit test for capturing the effect of US financial crisis occurred in 2007 on economic growth. The results indicate that presence of US financial crisis declines domestic production and hence, economic growth.

Table-4: Long Run Analysis

Dependent Variable = $\ln Y_t$				
Variables	Coefficient	T. Statistic	Coefficient	T. Statistic
Constant	-5.2436***	1.8244	-6.0716**	-2.6880
$\ln R_t$	-0.1449*	-5.8905	0.6794*	3.56975

$\ln R_t^2$	....	....	-0.0673*	-4.2915
$\ln O_t$	0.1632*	4.5332	0.1745*	5.7875
$\ln K_t$	0.7242*	9.4473	0.7144*	9.5910
$\ln L_t$	0.2305*	2.9	0.1891*	2.6364
D_t	-0.1283*	5.5158	-0.0179*	4.1768
R^2	0.9429		0.9590	
Adj- R^2	0.9394		0.9531	
F-Statistic	15.6249*		16.3752	
Durbin Watson	1.7040		1.6967	
Stability Test				
Test	F. Statistic	Prob. Value	F. Statistic	Prob. Value
χ^2_{Normal}	1.7520	0.4164	0.8255	0.6617
χ^2_{serial}	1.7040	0.1432	1.0237	0.2212
χ^2_{ARCH}	1.0986	0.1231	1.1818	0.1123
χ^2_{Hetero}	1.6107	0.9405	1.8167	0.9123
χ^2_{Remsay}	0.9438	0.3517	1.0280	0.3409
CUSUM	Stable		Stable	
CUSUM	Stable		Stable	
Note: * and ** show significance at 1% and 5% levels respectively.				

The squared term of natural resources is added in augmented production function to examine whether relationship between natural resources and economic growth is U-shaped or inverted-U shaped. The U-shaped relationship between natural resources and economic growth reveals that initially natural resources affect economic growth negatively but after a threshold level, effect of natural resources on economic growth turns to be positive may be due to efficient allocation of natural resources in the economy and vice versa. The results of non-linear production function show the presence of inverted U-shaped relationship between natural resources and economic growth which further confirms the presence of resource curse hypothesis. The overall significance of model of linear and non-linear production functions is confirmed by the significance of F-statistic with no auto-correlation. The residual term of models is normally distributed with no serial correlation, auto-regressive heteroscedasticity and white heteroscedasticity. The functional form of models is well designed, is validated by Ramsey reset test.

Table-5: Short Run Analysis

Dependent Variable = $\Delta \ln Y_t$				
Variables	Coefficient	T. Statistic	Coefficient	T. Statistic
Constant	0.0129*	6.6847	0.0131*	6.7002
$\Delta \ln R_t$	-0.0031	-1.4057	0.0043	0.5854
$\Delta \ln R_t^2$	…	…	-0.0033	-0.4343
$\Delta \ln O_t$	0.0084***	1.8176	0.0082***	1.7381
$\Delta \ln K_t$	0.3506	5.8660	0.3502	5.8258
$\Delta \ln L_t$	-0.1033	-0.3176	-0.1077	-0.3371
D_t	-0.0048	1.5396	-0.0044	1.2201
ECM_{t-1}	-0.1001**	-2.4869	-0.1054**	-2.0082
R^2	0.8461		0.8672	
Adj-R^2	0.8318		0.8382	
F-Statistic	12.0046*		13.0601*	
Durbin Watson	1.9025		1.9093	
Stability Test				
Test	F. Statistic	Prob. Value	F. Statistic	Prob. Value
χ^2_{Normal}	1.3516	0.5205	1.2121	0.5309
χ^2_{serial}	0.0136	0.9864	0.0189	0.9789
χ^2_{ARCH}	0.0473	0.8290	0.1304	0.8098
χ^2_{Hetero}	1.3687	0.2814	1.4089	0.2659
χ^2_{Remsay}	0.8770	0.3870	1.1022	0.3789
CUSUM	Stable		Stable	
CUSUM	Stable		Stable	
Note: * and ** show significance at 1% and 5% levels respectively.				

Table-5 details short run results and we find that natural resources are inversely linked with economic growth but it is statistically insignificant. This shows the insignificant presence of resources curse hypothesis for USA in short run. The relationship between oil prices and economic growth is positive and statistically significant at 10% level of significance. Capital is positively but insignificantly related with economic growth. The relationship between labor and economic growth is negative but insignificant. The nonlinear relationship between natural resources and economic growth is inverted-U shaped and it is insignificant. The long run established relationship between the variables is also confirmed by statistical significance of

ECM_{t-1} estimate with negative sign. The negative sign of ECM_{t-1} also confirms the speed of adjustment from short run to long-run equilibrium path. The results reported in Table-5 reveal that the estimate of ECM_{t-1} is -0.1001 (-0.1054) for linear (nonlinear) augmented production function. This implies that short run deviations in production function are corrected with speed of 10.01% (10.54%) which takes 10 years (9 years and 6 months) to reach long run equilibrium path for linear (nonlinear) model. The empirical results reveal that overall model (linear and nonlinear) is good fit, confirms by highly significance of F-statistic with no auto-correlation. The diagnostic analysis indicates the absence of serial correlation. There is no empirical evidence for the presence of auto-conditional heteroscedasticity and white heteroscedasticity. Normal distribution of residual term is confirmed and specification of augmented production function (linear and nonlinear) is also validated by Ramsey rest test. The application of CUSUM and CUSUM of squares confirms the stability of long-run and short-run estimates as graphs of CUSUM and CUSUM of squares remain within critical bounds at 5% level of significance. The results of CUSUM and CUSUM of squares are reported in Figure-1, 2, 3 and 4 for linear and nonlinear augmented production functions in case of USA.

Linear Augmented Production Function

Figure-1: CUSUM

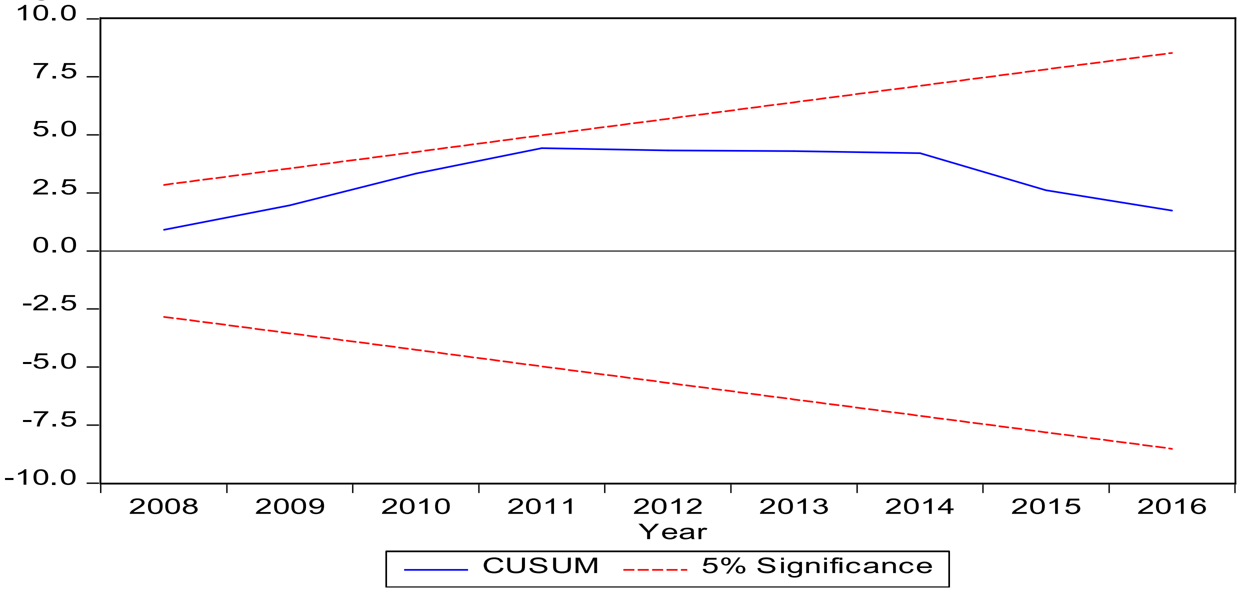
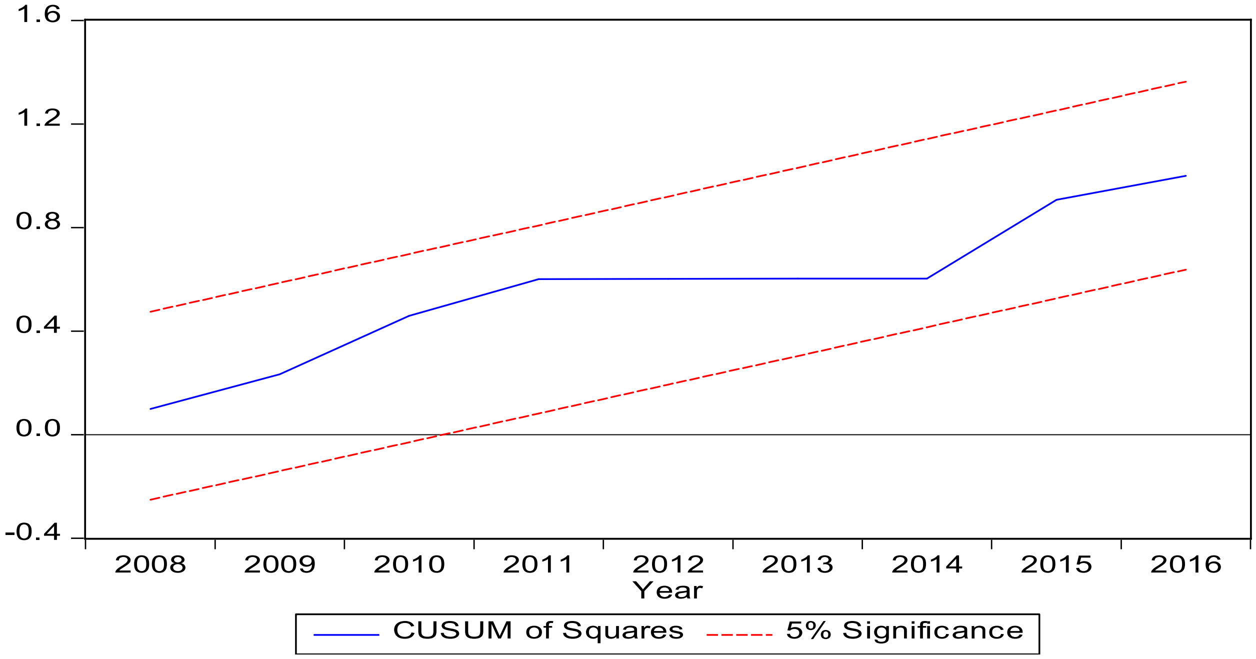


Figure-2: CUSUM of Squares



Quadratic Augmented Production Function

Figure-3: CUSUM

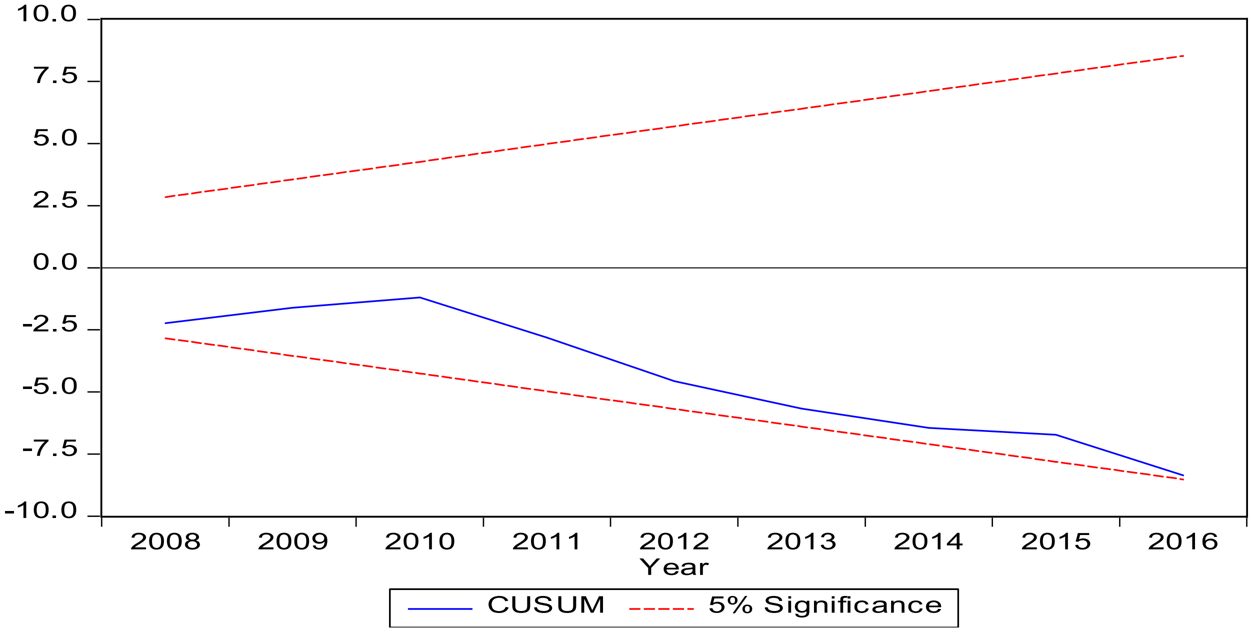
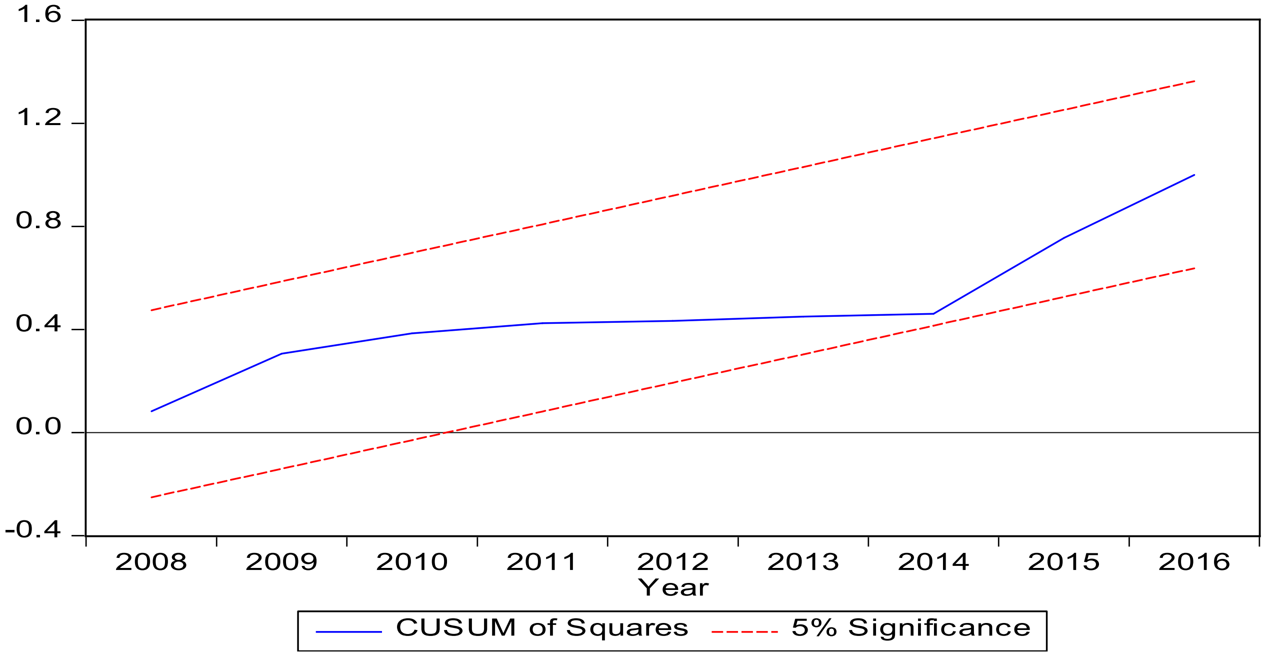


Figure-4: CUSUM of Squares



The direction of causal association between natural resources, oil prices, capital and labor is investigated by applying the VECM Granger causality. Granger (1969) argues that there must be causality at-least from one-side if the variables have cointegration with unique order of integration. The results are reported in Table-6. We find that in long-run, natural resources Granger cause economic growth but similar is not true from opposite side. This empirical evidence is contradictory with Satti et al. (2014) and Ahmed et al. (2016) who reported that natural resources is cause of economic growth and economic growth is cause of natural resources in Granger sense i.e. feedback effect. The unidirectional causality is also found running from natural resources to oil prices. On contrary, Kesikoğlu and Yıldırım, (2014) reported the absence of causal relationship between natural resources and oil prices. Capital and labor are Granger cause of natural resources. The feedback effect exists between oil prices and economic growth i.e. oil prices cause economic growth and similarly, economic growth causes oil prices. This empirical evidence is consistent with existing studies in literature such as Apergis et al. (2015) who reported that oil prices and economic growth are complementary in US states i.e. bidirectional causal association. Capital causes economic growth and economic growth causes capital in Granger sense i.e. feedback effect. This empirical evidence reveals that capital and economic growth are interdependent and similar with the empirical findings of Satti et al. (2014) and Ahmed et al. (2016). The unidirectional causality exists running from labor to economic growth. Labor Granger causes Oil prices. Capital is Granger cause of labor.

Table-6: VECM Granger Causality Analysis

Dependent Variable	Short Run						Long Run	CUSUM	CUSUMsq
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln R_{t-1}$	$\sum \Delta \ln O_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln L_{t-1}$	Break Year	ECM_{t-1}		
$\Delta \ln Y_t$	…	2.7225*** [0.0810]	2.5281*** [0.0979]	0.5905 [0.5608]	0.5287 [0.5951]	2007	-0.1071** [-2.3474]	Stable	Stable
$\Delta \ln R_t$	0.9238 [0.4087]	…	6.7048* [0.0056]	1.3911 [0.2655]	2.3133 [0.1175]	1999	…	Stable	Stable
$\Delta \ln O_t$	0.4094 [0.6679]	2.9205*** [0.0756]	…	0.6767 [0.5164]	0.9497 [0.3990]	2003	-0.3352** [-2.0908]	Stable	Stable
$\Delta \ln K_t$	5.5158** [0.0112]	3.1780*** [0.0570]	0.4117 [0.6664]	…	0.6780 [0.5158]	2008	-0.2761* [-6.4232]	Stable	Stable
$\Delta \ln L_t$	0.0893 [0.9147]	0.2772 [0.7599]	0.6946 [0.5076]	0.0015 [0.9984]	…	2008	…	Stable	Stable
	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln LR_{t-1}$	$\sum \Delta \ln O_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln L_{t-1}$	Break Year	ECM_{t-1}	CUSUM	CUSUMsq
$\Delta \ln Y_t$	…	3.6087** [0.0651]	2.8579*** [0.0712]	0.6027 [0.5600]	0.6570 [0.5789]	2007	-0.1470* [-2.8878]	Stable	Stable
$\Delta \ln R_t$	1.1028 [0.3302]	…	7.0040* [0.0044]	1.5602 [0.2431]	2.1212 [0.1312]	1999	…	Stable	Stable
$\Delta \ln O_t$	0.3838 [0.6701]	3.0337** [0.0711]	…	0.6074 [0.5201]	1.0910 [0.3867]	2003	0.2902** [-2.6529]	Stable	Stable
$\Delta \ln K_t$	5.0255** [0.0231]	4.2093** [0.0323]	0.3912 [0.6783]	…	0.7068 [0.5080]	2008	-0.2525* [-4.4409]	Stable	Stable

$\Delta \ln L_t$	0.1180 [0.8976]	0.3101 [0.7456]	0.7989 [0.4894]	0.0545 [0.9456]	…	2008	…	Stable	Stable
Note: *, ** and *** denote the significance at the 1, 5 and 10 per cent level, respectively.									

In short run, we find the unidirectional causality running from natural resources to economic growth. The feedback effect exists between natural resources and oil prices. Economic growth causes capital in Granger sense. The unidirectional causality also exists running from natural resources to capital[7].

[7] The causality results of quadratic augmented production function are similar to linear augmented production function. We have not interpreted the results of quadratic augmented production function just to save space in manuscript.

6. Conclusion and Policy Implications

This paper reinvestigates the validation of resources curse hypothesis by incorporating oil prices as additional determinant of economic growth in augmented production function. The empirical results confirm the presence of cointegration between economic growth and natural resources along-with oil prices, capital and labor. Furthermore, resources curse hypothesis is validated in USA economy in the presence of oil prices. Oil prices add to economic growth. Capital contributes to production function and hence positively affects economic growth. Labor has positive effect on economic growth. The causality analysis reveals the presence of unidirectional causal relationship running from natural resources to economic growth. The feedback effect exists between oil prices and natural resources. Economic growth causes oil prices and oil prices cause economic growth in Granger sense. The bidirectional causality is also found between capital and economic growth and similar outcome is noted between oil prices and capital. Labor causes economic growth, capital and oil prices.

The validation of resource curse even in the presence of several other explanatory variables implies that USA is going to have less economic growth, less democracy, and worse economic and social development outcomes. Given from the evidence that USA is facing the curse of resources abundance, policy makers have to be very careful in utilising the resources domestically and exporting them abroad. It would be good if USA economy is relatively de-linked with exploitation of these resources and relatively linked with some other sources of economic growth. It is important to note that oil price affects economics growth of USA positively while total natural resources rents which includes oil rents along with other rents such as coal rent, forest rents, mineral rents and natural gas rents affects economic growth negatively. Thus opening up of oil market for foreigners and its domestic consumption is likely to positive affect economic growth. Future research can focus on finding the transmission channel of resources curse. One can also use the time-varying regression models to understand the phenomenon and its dynamics over time. Further, it also would be good if all resources are analysed separately and then jointly as done in this study to have better understanding.

Based on the outcomes, this study suggest that the U.S need to focus on three core areas in order to dodge the Dutch Disease and escape resource curse phenomenon. First, the spending effect policy, which means the country has to pay back debts whenever it has an ability. Second, labour market policy, which means labour productivity, competitive wages and union effect should be monitored closely. Third, countercyclical policy, use of resource rent wisely. Further, we suggest to reinvestigate the resource curse hypothesis by applying asymmetric ARDL to examine the asymmetric effect of natural resources on economic growth by using high frequency data. This can help policy makers in designing comprehensive economic policy by utilizing resource abundance as an economic tool considering important role of economic shocks.

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