A study about Impact of Crude oil Price on GDP and Inflation

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Abstract

India is ranked as the fourth largest crude oil user in the world and imports 100 million tons of crude oil annually, or 37% of the total imports, which is essential to controlling inflation and sustaining rapid economic growth. Crude is a commodity whose price directly affects the prices of other commodities and society at large, making it a price determinant among many other commodities. Even a dollar drop in crude oil prices has a threefold effect on the economy, saving the nation roughly 40 billion rupees Since June 2014, oil prices have fallen approximately 55%, which confirms that OPEC and the US have oversupplied the market and that there is weak demand for the commodity globally. India has established a pricing system for petroleum products that takes global crude prices into account. With a 57 percent price drop as a result of India reflecting the worldwide trend in petroleum prices, the country was able to close its current account deficit and stable the currency rate.

This study examines the effects of crude oil prices on the GDP and Inflation in Indian economy by taking into account pertinent data from the GDP, CPI, and crude oil prices during the period - 1960-2021. The suggested approach to analyse the linkage among the key variables is done by using Regression model.

Keywords: *Crude prices, inflation, GDP*

Introduction

Crude oil is a vital natural substance and currently, the speed of worldwide utilization is around 90 million barrels each day. The oil price impacts the expenses of the country's other production and manufacturing sectors. India Imports 85% of its crude oil requirement, which makes the country more vulnerable to the prices of crude oil in the global market.

Crude oil has significant financial impact, such that an ascent in crude oil costs adds to expansion, which estimates the general pace of cost increments across the economy. The roundabout commitments of raw petroleum costs to expansion are reflected in the central CPI file, excluding energy or food costs since they will generally be more unstable. Oil costs essentially affect the purchaser's cost file. A supported 10% ascent in oil costs might cause the customer value file to rise 2.7%.

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Relation between Crude oil Price and GDP

Since petrol is a vital substance in world life and the economy, the connection between oil and macroeconomics is mainly researched through oil costs. A negative relationship between oil costs and macroeconomic movement has turned out to be generally acknowledged since Hamilton's (1983) work demonstrating that oil costs increment diminished US yield development between 1948-1980.

One customary clarification is that oil cost increments lower GDP development by raising creation costs. On the other hand, massive oil cost changes, either increment or decline, may influence total results antagonistically because they defer business ventures by raising vulnerability or expensive sectoral asset redistribution. This clarifies that unrefined costs increment influence adversely impacts business because the increment is a duty on utilization. In addition, firms confront more significant expenses and increment costs for their products, which implies inflation expansion.

Assuming that yield development eased back as a result of vulnerability postpones interest in capital products, this brings another outcome, since business development will generally be exceptionally reliant upon yield development, cost unpredictability diminishes work development and increments the unemployment rate.

This paper talks about India's increasing dependence on import of oil and how the increase in the crude oil prices is impacting the Gross Domestic Product and Inflation of the country.

Literature Review

1.An Analytical View of Crude Oil Prices and Its Impact on Indian Economy (K Soundarapandiyan, M Ganesh)

Oil imports into India are rising. Our reliance has grown to 80% and is expected to continue. 2008 also saw an unheard-of increase in the price of oil on the global market. The unpredictability of oil prices has also grown. Although it is difficult to anticipate the future of oil prices, an increase is widely predicted. India's reliance on oil imports increased from 78.5% to 81% in 2015–16. The objective that Primes Minister Narendra Modi set just a year ago was to reduce this to 67% by 2022. The government recently published new exploration laws for its oil and gas blocks, intending to close gaps in its earlier regulations that only promoted limited participation of resource-rich foreign oil corporations and were unable to significantly increase the country's economic output.

2. Determinants of inflation in India (P Dua, D Goel)

The article uses quarterly data from Q1: 1996-1997 to Q3: 2013-2014 in its multivariate econometric framework attempt to uncover the causes of inflation in India. A structural vector auto regression (SVAR) model is used to investigate the identified domestic inflationary factors, such as crude oil prices, the output gap, fiscal and monetary policy, and their relationship to inflation. Further, a time-varying parameter SVAR model with stochastic volatility is used to analyse the temporal changes in inflation dynamics. It was discovered that the dynamics of inflation in India have evolved over time, with a number of drivers exhibiting notable time variation in recent years, especially following the global financial crisis.

3. Impact of Increase in Oil Prices on Inflation and Output in India (K Bhattacharya, I Bhattacharyya)

This paper makes an attempt to investigate how rising oil prices affect other commodity prices and Indian production. In addition, the research investigates the type and degree of "feedback" in such a transmission mechanism and gathers proof of a causal relationship between oil and non-oil inflation in India. The goal of the article was to investigate the effects of rising oil prices on other commodity prices and Indian

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output. It sought to determine the lag structure in which an increase in the price of mineral oil begins to affect the prices of other commodities and output by using a four equation VAR model on oil and non-oil inflation, growth in broad money, and output.

The paper also examined the nature and the extent of 'feedback' in such a transmission mechanism and obtained evidence in favour of bi-directional causality between oil and non-oil inflation in India. A 20-percentage point shock to oil prices resulted in a 1.3 percentage point increase in inflation in other commodities at its peak, which typically occurred five to seven months following the shock, according to the impulse response functions from the VAR model. The effect on pricing lasts for roughly two years, although during that time, its amplitude significantly decreases. A similar-sized shock causes output growth to slow down by about 2.1 percentage points before beginning to rebound roughly a year later.

4. Is the oil price pass-through in India any different? (K Mandal, I Bhattacharyya, BB Bhoi)

We assess the pass-through effect of international oil prices on the Indian economy in the wake of the deregulation of prices for some petroleum products. We find evidence of a stronger pass through to local inflation and industrial output compared to global trends, notably since 2002 when domestic prices began to react to worldwide oil prices more often. Additionally, we run simulations to determine the potential full pass-through effect if prices were entirely deregulated. We discover that such a pricing strategy might cause a considerable increase in inflation with a concomitant impact on output. On the other hand, gradual changes would hurt the state's finances. While analysing the effect of oil prices on inflation and output in the Indian context, this study delineates two distinct periods.

This shows that since 2002, when the prices of some petroleum products started to fluctuate more often in line with variations in global crude prices, there has been a greater pass-through effect of foreign prices on domestic inflation in India. Once the government agrees to deregulate the prices of all petroleum goods, the pass-through is anticipated to gradually rise in the future. The change in the economy's structure and the relaxation of the balance of payments constraint are both responsible for the very limited extent of the impact on industrial output. In spite of the expanding output gap that increased oil prices were accompanied by from 1994 to 2002, the gap has closed since 2002. While the counterintuitive outcome prior to 1994 is evidence that the government increased oil prices, only when the overall macroeconomic conditions were favourable, the results in the post-2002 period is in accordance with international experience .The simulation reveals that the impact on inflation and output in India would have been significantly worse, as was the experience of certain EMEs, if prices of the remaining administered petroleum products had followed the pattern of those freely priced items resulting in full pass-through. The Government and the OMCs have carried the responsibility, with associated financial expenses, in the absence of complete pass-through.

5.A Study on Impact of Crude Oil Price Fluctuation on Indian Economy (KC Modak, P Mukherjee)

Crude oil prices are a major factor in every nation's economic development. More than 70% of India's crude oil needs are met by imports. In this study, we considered a number of factors, including the gross domestic product (GDP), the price of crude oil (COP), and the wholesale price index (WPI). This study uses time series data from 2000 to 2014 to evaluate how changes in oil prices affect the expansion of the Indian economy. To analyze the data, multiple linear regression models are employed. Since the Indian economy is expanding quickly, India's reliance on imported crude oil is growing every day. Crude oil prices experienced a sharp increase, reaching a high of $148 per barrel. In July in the worldwide market in July 2008.In 2014 crude oil price was at low level as $ 84/bbl. Import of crude oil with higher price is increasing the balance of trade deficit in India. The purpose of this paper is to investigate the impact of crude oil price changes on economic growth in India. This paper examined the effects of oil price on Indian economy using time series data from 2000-2001 to 2012-13. Oil imports into India are growing. Our reliance on

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imports has increased to 80% and is expected to continue. At the same time, the price of oil on the world market increased by a record amount in 2008. The uncertainty of oil prices has also increased. Although it is difficult to anticipate the future of oil prices, an increase is widely predicted. Given the impact on the Indian economy of our growing reliance on imports. Because of the rise in the price of crude oil, the government must spend more on subsidies, inflation rises, our exports deteriorate, investment falls, and GDP is also impacted.

Relevance of the Study

Crude oil Price is a key measure in the economic growth of a country. With the onset of Russia- Ukraine war there has been continuous fluctuations in the price of Crude oil. This study focuses on the impact of fluctuations of prices of crude oil on GDP and Inflation of the country.

Objectives of the Study

- To analyze the trend in Crude oil price.
- To study the impact of Crude oil prices on GDP and Inflation.
- To analyze the factors that affect the crude oil prices.
- To study the impact of higher oil prices on the Indian economy.

Research Design

- **Nature of study: -** Studies are conducted using analytical research.
- **Nature of data: -** A secondary data source was used in the current study. From different platforms to collect data.
- **Sources of data: -** The company's different sites like RBI statics money control are used for analysis.
- **Period of study: -** The present study examines the impact of Crude oil Prices in the long run between 1960-2021.
- **Scope of Data:** - Time Series Data
- **Tools Used:** - E views, Gretl

Hypothesis

H_0 - There is no impact of Crude oil Price on GDP and Inflation.

H_a - There is an impact of Crude oil Price on GDP and Inflation.

Research Methodology

To circumvent the issue, the traditional regression model demands that the dependent and independent variables in a regression be stationary. Different techniques and tests will be used to analyze the various variables. A correlation will be carried out to see if they are linked to the price of crude oil. The input variable are Crude Oil Price $ [Independent Variable], GDP $ [Dependent Variable], Inflation Rate (%) [Dependent Variable]

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Descriptive Statistics

Inflation Rate		*GDP*		*Crude oil Price*	
Mean	7.375879032	Mean	699.0357902	Mean	199.7218718
Standard Error	0.623403178	Standard Error	110.1380408	Standard Error	24.3042175
Median	6.64455	Median	292.1253927	Median	127.884932
Mode	#N/A	Mode	#N/A	Mode	11.3201997
Standard Deviation	4.908681531	Standard Deviation	867.2278008	Standard Deviation	191.3716
Sample Variance	24.09515437	Sample Variance	752084.0585	Sample Variance	36623.08929
Kurtosis	5.564352288	Kurtosis	0.921489246	Kurtosis	0.71583072
Skewness	0.987517187	Skewness	1.472290209	Skewness	1.223933223
Range	36.2326	Range	3136.367707	Range	690.9705475
Minimum	-7.6339	Minimum	37.02988388	Minimum	11.3201997
Maximum	28.5987	Maximum	3173.397591	Maximum	702.2907472
Sum	457.3045	Sum	43340.21899	Sum	12382.75605
Count	62	Count	62	Count	62

Augmented Dickey Fuller test has been used for checking the stationarity of the data. For the test we analyse the asymptomatic p-value, if the p-value is less than 0.05, the variable is stationary else it is non stationary data.

Inflation Rate

```
Augmented Dickey-Fuller test for InflationRate
testing down from 10 lags, criterion AIC
sample size 57
unit-root null hypothesis: a = 1

  with constant and trend
  including 4 lags of (1-L)InflationRate
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -1.26432
  test statistic: tau_ct(1) = -4.86394
  asymptotic p-value 0.0003287
  1st-order autocorrelation coeff. for e: 0.043
  lagged differences: F(4, 50) = 3.363 [0.0163]
```

Here, the p-value= 0.0003287, which is less than 0.05 at 95% confidence interval and hence the Inflation rate is a stationary variable.

Gross Domestic Product

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Augmented Dickey-Fuller test for GDP
testing down from 10 lags, criterion AIC
sample size 52
unit-root null hypothesis: a = 1

  with constant and trend
  including 9 lags of (1-L)GDP
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): 0.0463174
  test statistic: tau_ct(1) = 0.774316
  asymptotic p-value 0.9998
  1st-order autocorrelation coeff. for e: -0.041
  lagged differences: F(9, 40) = 3.239 [0.0048]
```

Here, the p-value= 0.9998, which is more than 0.05 at 95% confidence interval and hence the GDP is a non-stationary variable.

Crude Oil Price

```
Augmented Dickey-Fuller test for CrudeoilPrice
testing down from 10 lags, criterion AIC
sample size 61
unit-root null hypothesis: a = 1

  with constant and trend
  including 0 lags of (1-L)CrudeoilPrice
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + e
  estimated value of (a - 1): -0.210458
  test statistic: tau_ct(1) = -2.63249
  asymptotic p-value 0.2656
  1st-order autocorrelation coeff. for e: 0.102
```

Here, the p-value= 0.2656, which is more than 0.05 at 95% confidence interval and hence the Crude oil price is a non-stationary variable. Hence, because one variable is stationary and the other two are non-stationary this is a case wherein, we use Autoregressive Distributed Lag Model.

MODEL-1 Dependent Variable: GDP; Independent Variable: Crude oil price

The **ARDL** Test was conducted between the dependent variable, i.e., GDP and Independent Variable, i.e., Crude Oil Price.

H_0 - There is no impact of Crude oil Price on GDP.

H_a - There is an impact of Crude oil Price on GDP.

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Dependent Variable: GDP
Method: ARDL
Date: 10/10/22 Time: 18:31
Sample (adjusted): 1963 2021
Included observations: 59 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): CRUDE_OIL_PRICE
Fixed regressors: C
Number of models evaluated: 20
Selected Model: ARDL(2, 3)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.476655	0.137344	3.470514	0.0011
GDP(-2)	0.551307	0.138825	3.971221	0.0002
CRUDE_OIL_PRICE	0.650785	0.126960	5.125897	0.0000
CRUDE_OIL_PRICE(...	-0.704573	0.171727	-4.102858	0.0001
CRUDE_OIL_PRICE(...	-0.107705	0.197247	-0.546040	0.5874
CRUDE_OIL_PRICE(...	0.503540	0.144871	3.475767	0.0010
C	-10.19507	13.32558	-0.765075	0.4477

R-squared	0.994683	Mean dependent var	732.5728
Adjusted R-squared	0.994069	S.D. dependent var	875.9792
S.E. of regression	67.46093	Akaike info criterion	11.37197
Sum squared resid	236650.8	Schwarz criterion	11.61846
Log likelihood	-328.4731	Hannan-Quinn criter.	11.46819
F-statistic	1621.228	Durbin-Watson stat	1.951511
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Regression Equation

GDP$_{(T)}$= 0.476655*GDP$_{(T-1)}$ + 0.551307*GDP$_{(T-2)}$ + 0.650785* Crude oil price$_{(T)}$ -0.704573* Crude oil price$_{(T-1)}$ -0.107705* Crude oil price$_{(T-2)}$ + 0.503540* Crude oil price$_{(T-3)}$- 10.19507

Selected Model for ARDL is (2,3) which explains the level of difference at which the variables became stationary and hence the order of difference at which the GDP becomes stationary is Lag order 3 whereas the order of difference at which the Crude oil Price became stationary for this model is Lag order 2.

F- statistic- The p- value determines the significance of the test, if the p- value is less than 0.05 we reject Null Hypothesis (H_0). Here, the p- value is 0.0000 and hence we reject null hypothesis at 95% significance level.

Therefore, it can be determined from the model that GDP value is impacted by the value of Crude Oil Price.

Bounds Test for Co-integration

ARDL bounds testing approach is a cointegration method developed to test presence of the long run relationship between the variables. ARDL bounds testing approach is a cointegration method developed to test presence of the long run relationship between the variables. This model uses F and t-statistics to examine the relevance of the lagged levels of the variables in a univariate equilibrium correction system. The ARDL model is used in this situation to investigate the short- and long-term associations between variables. From the below table of ARDL bounds testing, F-Statistic of the F- bound test is being Interpreted to find the Co-integration between the two variables, i.e., GDP and Crude oil price.

Here, the value of F-Statistic is 26.442 which is greater than the I (1) of the 5% significance levels, i.e., 4.363 and hence GDP and Crude Oil Price are Co-integrated and the ARDL Test is significant.

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ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(2, 3)
Case 2: Restricted Constant and No Trend
Date: 10/10/22 Time: 18:32
Sample: 1960 2021
Included observations: 59

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-10.19507	13.32558	-0.765075	0.4477
GDP(-1)*	0.027961	0.020334	1.375107	0.1750
CRUDE OIL PRICE(-1)	0.342047	0.093870	3.643842	0.0006
D(GDP(-1))	-0.551307	0.138825	-3.971221	0.0002
D(CRUDE OIL PRICE)	0.650785	0.126960	5.125897	0.0000
D(CRUDE OIL PRIC...	-0.395835	0.137032	-2.888631	0.0056
D(CRUDE OIL PRIC...	-0.503540	0.144871	-3.475767	0.0010

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CRUDE OIL PRICE	-12.23285	11.65755	-1.049350	0.2989
C	364.6134	564.4540	0.645958	0.5211

EC = GDP - (-12.2329*CRUDE OIL PRICE + 364.6134)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	26.44241	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
Actual Sample Size	59		Finite Sample: n=60	
		10%	3.127	3.65
		5%	3.803	4.363
		1%	5.383	6.033
			Finite Sample: n=55	
		10%	3.143	3.67
		5%	3.79	4.393
		1%	5.377	6.047

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MODEL-2 Dependent Variable: Inflation Rate; Independent Variable: Crude oil price

The **ARDL** Test was conducted between the dependent variable, i.e., Inflation Rate and Independent Variable, i.e., Crude Oil Price.

H_0 - There is no impact of Crude oil Price on Inflation Rate.

H_a - There is an impact of Crude oil Price on Inflation Rate.

Dependent Variable: INFLATION_RATE
Method: ARDL
Date: 10/10/22 Time: 18:34
Sample (adjusted): 1964 2021
Included observations: 58 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): CRUDE_OIL_PRICE
Fixed regressors: C
Number of models evaluated: 20
Selected Model: ARDL(4, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
INFLATION_RATE(-1)	0.437752	0.130115	3.364356	0.0014
INFLATION_RATE(-2)	-0.408585	0.140761	-2.902686	0.0054
INFLATION_RATE(-3)	0.196953	0.141157	1.395278	0.1689
INFLATION_RATE(-4)	-0.325503	0.128523	-2.532649	0.0144
CRUDE_OIL_PRICE	-0.001806	0.003062	-0.589990	0.5578
C	8.813754	1.875304	4.699906	0.0000

R-squared	0.267690	Mean dependent var	7.711224
Adjusted R-squared	0.197275	S.D. dependent var	4.895504
S.E. of regression	4.386123	Akaike info criterion	5.892466
Sum squared resid	1000.380	Schwarz criterion	6.105615
Log likelihood	-164.8815	Hannan-Quinn criter.	5.975492
F-statistic	3.801628	Durbin-Watson stat	2.039601
Prob(F-statistic)	0.005212		

*Note: p-values and any subsequent tests do not account for model selection.

Regression Equation

Inflation Rate$_{(T)}$= 0.437752*Inflation Rate$_{(T-1)}$ - 0.408585* Inflation Rate $_{(T-2)}$ + 0.196953* Inflation Rate $_{(T-3)}$ -0.325503* Inflation Rate $_{(T-4)}$ -0.001806* Crude oil price$_{(T)}$ + 8.813754

Selected Model for ARDL is (4,0) which explains the level of difference at which the variables became stationary and hence the order of difference at which the Inflation becomes stationary is at level whereas the order of difference at which the Crude oil Price became stationary for this model is Lag order 4. **F-statistic-** The p- value determines the significance of the test, if the p- value is less than 0.05 we reject Null Hypothesis (H_0).

Here, the p- value is 0.0052 and hence we reject null hypothesis at 95% significance level.

Therefore, it can be determined from the model that Inflation Rate value is impacted by the value of Crude Oil Price.

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Bounds Test for Co-integration

ARDL Long Run Form and Bounds Test
Dependent Variable: D(INFLATION RATE)
Selected Model: ARDL(4, 0)
Case 2: Restricted Constant and No Trend
Date: 10/10/22 Time: 18:34
Sample: 1960 2021
Included observations: 58

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.813754	1.875304	4.699906	0.0000
INFLATION RATE(-1)*	-1.099383	0.209279	-5.253199	0.0000
CRUDE OIL PRICE**	-0.001806	0.003062	-0.589990	0.5578
D(INFLATION RATE(-1))	0.537135	0.181995	2.951377	0.0047
D(INFLATION RATE(-2))	0.128550	0.147462	0.871749	0.3874
D(INFLATION RATE(-3))	0.325503	0.128523	2.532649	0.0144

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CRUDE OIL PRICE	-0.001643	0.002769	-0.593492	0.5554
C	8.017003	0.788030	10.17348	0.0000

EC = INFLATION RATE - (-0.0016*CRUDE OIL PRICE + 8.0170)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.202879	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
Actual Sample Size	58		Finite Sample: n=60	
		10%	3.127	3.65
		5%	3.803	4.363
		1%	5.383	6.033
			Finite Sample: n=55	
		10%	3.143	3.67
		5%	3.79	4.393
		1%	5.377	6.047

From the above table of ARDL bounds testing, F-Statistic of the F- bound test is being Interpreted to find the Co-integration between the two variables, i.e., GDP and Crude oil price. Here, the value of F-Statistic is 9.2028 which is greater than the I (1) of the 5% significance levels, i.e., 4.16 and hence GDP and Crude Oil Price are Co-integrated and the ARDL Test is significant.

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Crude Oil price Impacts the Gross Domestic Product of the country as well as the Inflation Rate.

Conclusion

Hence it can be determined that since the tests hold true that the Gross Domestic Product of the country as well as the Inflation Rate is impacted by the crude oil price. Increased interest rates, decreased tax revenues, inflation, and the budget deficit are all effects of high oil prices. All of these consequences have the potential to increase unemployment, at least temporarily. The rise in oil prices also violates the trade balance and exchange rate. Containing inflationary pressures through monetary and fiscal policy can worsen the recession and the impact of unemployment. On the other hand, expansionary monetary and fiscal policies postpone the reduction in national income and, over time, exacerbate the effects of rising oil prices. Unquestionably, the fall in GDP growth rates results from the rise in crude oil prices.

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