THE IMPACT OF OIL PRICES ON INDUSTRIAL PRODUCTION IN DEVELOPING COUNTRIES

Suhair M. AL-Risheq

(8464397)

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Supervisor: Professor Gamal Atallah

ECO 6999

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ABSTRACT

This paper investigates the impact of oil prices and other key variables on industrial production by utilizing data from 52 developing countries for the period 1970 to2012. Using a fixed effects model with instrumental variables, the paper finds that an increase in oil prices has a negative and highly significant impact on industrial production. Among the other variables included in the model, the real exchange rate had the greatest impact on industrial production. Furthermore, the magnitude of the oil price coefficient, which is considerably large and second only in magnitude to that of the real exchange rate, indicates the importance of oil prices in determining industrial production in developing countries. Considering both oil prices and the real exchange rate, the study shows that industrial production and the overall economic growth in developing countries are prone to negative oil price shocks mainly because they rely heavily on oil imports.

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1. INTRODUCTION

Oil is an essential raw material for industrial production. The price of petroleum products, energy bills, and other production costs are directly affected by the price of oil (Loungani, 1986). There have been many global shocks in the price of oil in recent decades that have affected the economic growth of developing countries. Broadly speaking, fluctuations in the price of oil affect economic growth through several different transmission channels. On the supply side, oil price shocks lead to increases in production expenditures, resulting in lower output. In the demand channel, an increase in oil prices results in an increase in the price of goods. As a result, consumers lose purchasing power, which then negatively affects investment and consumption decisions by firms and households (Jiranyakul, 2006).

Several researchers argue that oil price shocks cause stagflation and reduce output markedly (Ojapinwa and Ejumedia, 2012). Oil price shocks are a deep concern for developing countries, which have greater financial restrictions than the world economy. These shocks have significant effects on oil-importing developing economies due to their high reliance on oil imports and inefficient consumption of oil.

Many empirical studies show the negative effect of oil shocks on output (see, for example, Hamilton, 1983, and Burbidge and Harrison, 1984). Some empirical studies have also shown that oil shocks affect countries that import oil differently from those that export oil. For instance Kumar (2009), Jiménez-Rodríguez and Sanchez (2012) and Wang and Zhang (2014) found that an increase in oil prices lowers the industrial production of oil-importing countries, and, through higher production costs, affects output and economic growth. On the other hand, Jiménez-Rodríguez and Sanchez (2004) have reported that the effect of oil shocks on GDP growth of oil exporting countries may vary depending on the increase in oil revenues or reduction in oil export owing to the oil price increase.

The effect of oil prices on industrial production works through a variety of channels. Bjornland (2009) affirmed that a boom in oil prices positively affects an oil exporting economy by improving oil revenues, leading to greater economic growth. He also stated that oil price hikes negatively affect oil exporting countries by reducing trade; as the oil prices increase, oil-

importing countries reduce their demand for oil and other goods and services from oil exporting countries.

This study examines the response of industrial production from changes in oil prices. The negative and significant relationship between oil prices and industrial production suggests that shocks in oil prices reduce the industrial production of developing countries. These shocks decrease industrial output by raising the cost of both imports and production, and through a decrease in consumption and investment demand.

There are many studies regarding the industrial impact of oil prices in the context of the OECD and developed economies. However, to my knowledge, there are no studies covering the period 1970 to 2012 that have been conducted for developing countries. Therefore, this is an important issue to examine, as oil serves as a basis for industrial activity of developing countries. This paper intends to investigate the effect of oil prices on industrial production in developing countries. It also analyzes other key variables that affect industrial output and provides policy recommendations.

Using panel data for the period 1970 to 2012, this study employs a fixed effects regression with instrumental variables to estimate the relationship between industrial production and oil prices. An instrumental variable (IV) regression is utilized to remove endogeneity in the independent variable included in the model.

The rest of the study is organized as follows. Section 2 provides a brief literature review, and a descriptive analysis of industrial production and oil prices is presented in Section 3. Section 4 presents the methodology and data, and a detailed discussion of the empirical results is provided in Section 5. In section 6, a conclusion and recommendations are presented.

2. LITERATURE REVIEW

Oil is one of the most important raw materials for industrial production, and changes in its price affect both prices for petroleum products and the overall production cost (Loungani,

1986). Increases in oil prices lead to a decline in oil purchases or an increase in production costs, resulting in reduction of output. Moreover, increases in oil prices exert upward pressure on the prices of goods and services, and ultimately reduces aggregate demand (Jiranyakul, 2006). Due to these reasons, oil price shocks are expected to slow down industrial output (Hamilton and Herrera, 2004). The relationship between oil prices and industrial production is a well-studied subject, both theoretically and empirically. In this section, a brief review of relevant studies is presented. Section 2.1 reviews the theoretical links between oil prices and industrial production, and empirical studies are presented in Section 2.2.

2.1 Theoretical framework

Oil prices affect industrial production through different channels. On the supply side, a rise in oil prices increases production costs and leads to a contraction in output. This contraction in output increases further due to a resulting reduction in investment (Brown and Yucel, 2002). Through the demand-side channel, an increase in the costs of production, owing to an increase in oil prices, translates into higher product prices. Thus, aggregate productivity falls (Hunt et al., 2001).

Another important transmission channel of oil price shocks is the *wealth effect* that affects demand by transferring income from oil-importing to oil-exporting countries. As a result, purchasing power shifts from oil-importing to oil-exporting countries. The wealth transfer reduces aggregate demand in oil-importing countries, while the opposite occurs in oil exporting countries.

Another channel is the *real balance* transmission channel. An increase in oil prices leads to an increase in demand for money. When monetary authorities, for whatever reason, are not able to meet the money demand, the resulting increase in the interest rate causes a reduction in economic growth (Brown and Yucel, 2002). As a result of this increase in the interest rate, investment falls due to the reduction in producers' profits. Bernanke *et al*. (1997) acknowledged that the combination of tightening of monetary policy and oil price shocks depressed the real economy by discouraging investment.

There are other variables that are important determinants of industrial production such as the exchange rate, trade openness, foreign direct investment (FDI), the interest rate, gross capital formation (GCF), and the labor force. The relationship between trade openness and industrial production has been a topic of great debate. According to growth models, trade liberalization affects economic growth by opening import and export channels. Export liberalization enhances economic growth through an increase in competition and returns to scale, while import liberalization promotes economic growth by allowing economies to import advanced technologies (Krueger, 1978).

Exchange rate fluctuations also affect the level of output. Increases in the exchange rate (a depreciation of domestic currency against foreign currency) boost the price of foreign goods relative to domestic goods. This change increases the international competitiveness of domestic products and increases output (Dornbusch, 1988). On the other hand, the expansionary effects of currency depreciation have been questioned by some empirical studies. The main argument of these studies is that exchange rate depreciation reduces the output level in a developing country by increasing the prices of imported inputs, consequently increasing production costs (Hirschman, 1949; and Krugman, 1999).

Theoretical growth models suggest that FDI enhances productivity by enhancing technology (Grossman and Helpman, 1991). According to Frederic (2006), the traditional Keynesian model describes the monetary transmission mechanism through the channels of interest rate effects; the increase in the money supply (expansionary monetary policy) leads to a decline in the interest rate, which lowers the cost of capital. The lower cost causes a rise in investment spending, thereby leading to an increase in aggregate demand and output.

2.2 Empirical evidence

Most of the empirical studies support the argument that increases in oil prices affect the industrial production of developing countries. For example, Wang and Zhang (2014) investigated the impact of global oil price shocks on China's four fundamental industries, namely grains, metals, petrochemicals, and oil fats. They also examined the asymmetric effect of oil price shocks. The study applied both the autoregressive conditional jump intensity and

generalized conditional heteroscedasticity (GRACH) models on monthly data from October 8, 2001, to November 30, 2011. The results revealed that oil prices negatively affect industries, and asymmetric effects exist. The researchers suggested that the petrochemicals market suffered most from the oil price shocks, and the grains market was least responsive towards the shocks.

Similarly, Ojapinwa and Ejumedia (2012) explored the industrial impact of oil price shocks in Nigeria, an oil exporting country. The study employs the vector autoregressive (VAR) impulse response method. The data consisted of oil prices, exchange rate, inflation, unemployment, and money supply from the period of 1970 to 2010. The results of the impulse response function showed that the money supply did not significantly affect industrial output, and that oil price and inflation were negatively related to industrial production. The exchange rate had a positive effect on the industrial output of Nigeria.

Aye *et al.* (2014) examined the effect of oil price shocks on the manufacturing production of South Africa by utilizing monthly data on oil prices and manufacturing production over the period February 1974 to December 2012. For this purpose, a modified bivariate VAR, GARCH-in-Mean VAR, and maximum likelihood tests were applied. The results indicated that oil prices negatively affected South African manufacturing production and the response of manufacturing production towards the positive and negative oil price shocks were asymmetric.

Mehrara and Sarem (2009) investigated the effects of oil price shocks on industrial production in three oil-exporting countries, Iran, Saudi Arabia and Indonesia, using annual data from 1970 to 2005. The study employed the Gregory and Hansen co-integration and Granger causality techniques. Their findings revealed that Iranian and Saudi Arabian industrial production was strongly affected by oil price shocks. The authors argued that, in Indonesia, the role played by oil prices was limited, so the country was less sensitive to oil shocks.

Kumar (2009) empirically examined the macroeconomic impact of oil price shocks in India by focusing on industrial production growth. The author utilized quarterly data on oil prices, industrial production, inflation rate, real effective exchange rate, and interest rate from Q1 1975 to Q3 2014 and employed a multivariate VAR and Granger causality test. The results

revealed the asymmetric impact of oil price shocks on industrial growth. Furthermore, the study found that the inflation rate and short-term interest rate were positively affected by the increase in real oil prices.

Farzanegan and Markwardt (2008) analyzed the impact of oil price shocks on Iran's economy. The study estimated a VAR to analyze the dynamic relationship between oil price shocks and major macroeconomic variables. The study also pointed out the asymmetric effects of oil price shocks. The quarterly data included measures of industrial GDP per capita, government expenditures, inflation, imports, and exchange rate over the period Q2, 1975 to Q4, 2006. The results revealed that positive and negative oil price shocks significantly affect the inflation and the real exchange rate, but have a marginal impact on government expenditures. The results also suggested that positive oil price shocks increase industrial output by decreasing the price of imported inputs and negative oil price shocks reduce industrial output due to the higher price of imported inputs.

Researchers have also studied the relationship between oil prices and industrial production for developed countries. For example, (Ahmed et al., 2012) investigated the impact of oil price shocks on the industrial production of the US by decomposing oil price volatility into permanent and transitory components. By utilizing data from 1980 to 2010, the study employed the component-based autoregressive conditional heteroskedastic (CGARCH) model, VAR models, and an impulse response function. The findings revealed that there is a significant and long-run impact of increased transitory oil price volatility on industrial production.

Jiménez-Rodríguez and Sanchez (2012) utilized Japanese quarterly data on industrial production, oil price, consumer prices, real wage rate, real effective exchange rate, and interest rate from Q1 1976 to Q2 2008. The study employed the reduced form VAR and concluded that an increase in oil price leads to low industrial production and high inflation.

Within a new framework, Scholtens and Yurtsever (2012) conducted a study of 38 European industries to explore the impact of oil price shocks at the industry level for the period 1983 to 2007. The study also analyzed the asymmetric response of industries towards an increase and decrease in oil prices. This study applied the VAR and multivariate regression techniques. The

results found that the effect of an oil price shock differs among industries. It also found that there were asymmetric effects, but most of the time these asymmetries were not statistically significant.

Papapetrou (2009) conducted a study to investigate the asymmetry effect of oil price changes on industrial production of Greece over the period January 1982 to August 2008. A regime-switching model (RS-R) and a threshold model (TA-R) were employed to examine both the relationship and the presence of asymmetries between oil prices and industrial production. The RS-R model was applied with two regimes. The findings from both RS-R models suggested that oil price changes negatively and significantly affect industrial production when oil prices increased more than 3% monthly. Furthermore, empirical findings from the TA-R model suggested that oil price changes significantly and negatively affect industrial production only when oil price volatility is higher than 0.22% per month. The overall result revealed that the degree of negative correlation between oil prices and economic activity increases during periods of rapid oil price changes.

In addition, Jiménez-Rodríguez (2008) investigated the diverse effects of an oil price shock on the industrial output of four European Monetary Union (EMU) countries (France, Germany, Italy, and Spain), the UK, and the US. By utilizing annual data from 1975 to 1998, the study employed a VAR methodology and found that the impact of oil price shocks on industrial production was different across the four European Monetary Union (EMU) countries, and was found to be mostly similar in the UK and the US.

Jiranyakul (2006) analyzed the impact of international oil prices on the industrial production of Thailand using a Johansen cointegration technique. The results, based on monthly data from 1990 to 2004, indicated that oil prices significantly and positively affect industrial production. The authors argued that, in the long run, the manufacturing sector can adjust itself to higher costs of production. However, in the short run, the real money supply, real exchange rate, and international oil prices affect industrial production.

To find the effect of oil price on industrial production and on stock returns, Reyes and Quiros (2005) explored whether industrial production or stock returns react more rapidly to an increase

in oil prices. The study employed a Markov switching model and maximum likelihood test using data from January 1963 to May 2004. The results showed the existence of a negative and statistically significant effect of oil prices on both variables, but the effect of oil prices on stock returns was higher than on industrial production.

Jiménez-Rodríguez and Sanchez (2004) conducted another study to empirically test the relationship between oil price shocks and real economic activity in the case of industrialized OECD countries (France, US, UK, the Euro area, Norway, Japan, Germany, Italy, and Canada) by distinguishing between oil exporting and oil-importing countries. The quarterly data were taken from Q3 1972 to Q4 2001 and the study employed a VAR using linear and non-linear models. The results revealed that an increase in oil prices has a negative impact on the economic growth of oil-importing countries excluding Japan. While the effect of oil shocks on GDP growth differs between the two oil exporting countries in the sample, the increase in oil prices affects the output of UK negatively and Norway positively.

Within a new framework (Eksi et al., 2011) investigated the effects of crude oil prices on industrial production for developed and developing oil-exporting countries of the OECD, namely Turkey, the US, Germany, Spain, France, South Korea, and Japan. Monthly data were collected from January 1997 to December 2008 on industrial production and oil price. The study employed the Johansen cointegration technique and Granger causality test. Empirical findings revealed a short-term causality from crude oil price to industrial production in all countries except France. In France, causality was from industrial production to oil price in the short run. The author suggested that the causality from industrial production to oil prices could be associated with oil demand.

Lee and Ni (2002) used monthly data from January 1959 to September 1997 to analyze the effect of oil price shocks on demand and supply in different industries in the US. Using a reduced form of VAR and an impulse response function, they concluded that oil price shocks reduce the supply of oil-intensive industries and reduce the demand of many other industries, especially the automobile industry.

2.3 Other variables and industrial production

Loto (2012) empirically investigates the determinants of output expansion in manufacturing industries in Nigeria. The study employed an ordinary least square methodology for the period of 1980 to 2010. The author argued that when the rate of inflation increases, it reduces both the purchasing power of consumers and the demand for manufactured goods. Consequently, shocks have a negative impact on capacity utilization, and domestic capital formation can also be damaged.

Nawaz (2012) conducted a study to examine the impact of the exchange rate on the output level in Pakistan by utilizing annual data from the period 1972 to 2010. The study employed the bound-testing approach to an auto-regressive distributive lag model (ARDL). The findings revealed that depreciation in the exchange rate leads to a reduction in output; however, the short run error correction model (ECM) results robustly support the traditional theories of open-economy macroeconomics in which currency depreciation increases the output level.

Trade liberalization is also considered to be an important determinant of industrial production. Dutta and Ahmed (2006) conducted a study to empirically estimate the impact of trade liberalization on industrial production in Pakistan. The study covers the period 1973 to 1995 and data was collected on Industrial Value Added (IVA), real capital stock, the labor force, real exports, the import tariff collection rate, and the secondary school enrolment ratio. The study employed the Johansen and Juselius cointegration technique and ECM, and the results suggested a significant relationship between trade and industrial production.

Existing empirical evidence mostly shows the asymmetric and significance impact of oil price shocks on industrial production in the context of both developed and emerging oil exporting and importing countries. The literature review shows that fluctuations in international oil prices affect industrial production. However, the extent of the impact differs. A large number of studies that capture the prolonged impact of oil prices on industrial production already exist, but not a single study examined developing countries using a panel-data approach. Therefore, this study covers the gap of previous literature by applying a panel-data approach for the case of developing economies.

3. DESCRIPTIVE ANALYSIS

This section describes the trend in industrial production and oil prices. The five-year averages and standard deviations are listed in Tables 1, 2 and 3. The data for this purpose have been accessed from the World Development Indicator (WDI) and the Energy Information Administration (EIA) for the period of 1970 to 2012. This section is divided into two sub-sections. The trends of IVA as percentage of GDP for developing countries are presented in Section 3.1, while Section 3.2 explains oil price trends.

3.1 Industrial value added (IVA)

Five-year averages of IVA as percentage of GDP are given in Table 1. The Albanian economic structure was strongly oriented towards industrialization. The share of the industrial sector in 1990 accounted for approximately 45% of net material product (NMP) and provided employment for about 23% of the working population (Muco, 1997). During the time periods of 1980-84 and 1985-89, the average IVA in Albania was 44% and 45%, respectively. However, after 1990 there was a decline in the IVA, and the real gross domestic product in Albania dropped in 1990-1992 by 39%. From 1990 onward, the share of the industry sector in Albania dropped from 39% to about 7.6% in 2009, and because of the financial crisis of 2008 to 2009, the industry share of the economy decreased by 2.5 percentage points as a ratio to GDP (Kota, 2005).[1]

Bangladesh's economic growth accelerated in the end of the 1980s. During 1985-89 and 1990-94, the average IVA was 21%. From 1995-99, there was little improvement in the average of IVA. During this period there was a decrease in the price of oil, and since Bangladesh is an oil-importing country this decrease benefited the Bangladeshi economy. The share of industry was 30% in 2009,[2] and the average industry value added was high in 2010-12, relative to previous years, at 28%.

[1] Economic Bulletin, 2005, Bank of Albania.
[2] Bangladesh Bureau of Statistics, World Bank.

Table 1: Average of Industrial Value Added (IVA) (% of GDP)

Country	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-12
Albania			44	45	32	19	20	20	
Armenia					41	32	39	43	34
Bangladesh				21	21	23	25	26	28
China	42	47	45	43	44	47	46	47	46
Colombia	30	31	32	37	35	30	35	34	36
Congo, Rep.	23	34	52	38	39	52	66	74	76
Costa Rica			33	32	30	30	30	29	26
Cote d'Ivoire	18	16	20	22	22	22	23	26	
Croatia					35	31	28	28	26
Dominican Republic	27	30	28	24	35	37	34	32	32
Ecuador	23	26	27	29	29	27	32	36	36
Egypt, Arab Rep.	27	29	33	28	32	31	35	37	38
Equatorial Guinea	-	-	-	9	19	58	89	95	
Fiji	22	21	21	21	25	24	23	18	19
Gabon	51	69	59	48	46	51	53	60	62
Georgia			36	28	25	22	24	24	23
Guatemala							29	30	29
Guyana	36	35	28	28	32	32	28	28	33
Hong Kong SAR							11	8	7
India	21	24	25	26	26	26	26	28	27
Indonesia	25	35	40	36	40	44	45	47	47
Jordan	20	23	27	25	27	27	29	31	30
Kenya	20	19	20	19	18	17	17	19	18
Korea, Rep.	27	33	38	41	42	41	37	37	39
Kuwait	73	74	63	51	44	54	53		
Lao PDR				13	17	21	19	27	34
Lesotho	12	22	27	30	39	43	33	36	33

Liberia	40	35	30	25	16	6	5	7	10
Malaysia	30	36	39	39	41	44	47	45	41
Mauritius		26	26	32	33	31	30	27	25
Mexico	32	33	34	34	30	35	35	36	35
Mongolia			26	30	37	28	27	38	36
Nigeria			34	34	44	42	40	40	44
Pakistan	22	23	23	24	25	24	23	24	23
Panama			19	18	17	19	17	17	17
Paraguay					37	35	37	32	28
Peru	33	36		33	29	30	31	36	36
Philippines	33	36	39	35	33	34	33	33	31
Singapore		33	36	34	33	33	32	29	27
South Africa	38	42	45	42	37	33	32	31	29
Sri Lanka	25	28	27	27	26	27	28	30	30
St. Lucia			21	18	20	19	17	19	16
Tajikistan				40	42	31	38	30	26
Tanzania					16	17	21	23	24
Thailand	27	29	30	34	39	40	43	44	44
Tonga	0	12	14	14	14	21	21	19	21
Uganda	12	6	9	10	13	17	23	25	24
Ukraine				48	46	38	35	33	30
Uruguay			33	35	32	27	25	26	25
Vietnam				26	26	32	36	38	38
Yemen, Rep.					29	37	44	41	29
Zambia	56	44	43	48	47	31	26	32	

Source: Data is taken from World development indicators (WDI) and averages are calculated by the author.

China's economic performance over the last few decades was phenomenal, which is why we observe sustained performance in IVA. From 1980 to 2000 China's economy expanded at an average annual rate of 7% to 8%, which was much higher than the world average at that time. The share of industry in GDP increased from 35% in 1965 to 46% in 2004 (World Bank, 2006). In 2005, manufacturing, metallurgical, machinery, and chemical industries contributed 46% to Chinese GDP. However, in China the impact of an increase in oil prices is relatively modest. The strong investment and the large flow of foreign capital in China were sufficient to offset the negative impact of higher oil prices (Zaouali, 2007).

In Colombia, the average IVA fluctuated between 30% and 37%. During the 1970s, the economic performance of Colombia was very impressive. GDP per capita was growing at 3% per year on average in the 1970s, and the manufacturing sector was growing at 6.8% per year (Meléndez and Harker, 2008). From 1985 to 1999, there was a decline in the average IVA. However, after 1999 Columbia's IVA figures improved, particularly between 2002 and 2005, mainly due to an increase in private sector investment.

From 1970 to 1984 there was a significant improvement in the IVA of the Congo Republic. From 1970-74 it was 23%, and from 1980-84 it increased to 52%. From 1970-84, per-capita real GDP doubled. The Congo Republic is an oil exporting country, so revenue generated from oil resulted in an increase in government investment by an annual average of 2 percentage points of GDP between 1970-74 and 1975-79 (Bhattacharya and Ghura, 2006). However, this improvement in IVA started to decline in the second half of the 1980s. From 1995 onward, recovery was seen in the IVA of the Congo's economy.

In the period 1970-74, the average IVA of Cote d'Ivoire was 18%, which dropped to 16% in 1975-79. In 1979, the growth of Cote d'Ivoire slowed due to the decrease of export prices for agricultural products and the increase in oil prices. This situation caused a deterioration in the terms of trade (Aka, 2006). However, after the 1980s the average IVA of Cote d'Ivoire improved and ranged between 22% to 26% from 1980 to 2012.

Egypt faced a drop in economic growth in the early 1970s as a result of their defeat in the 1967 war, resulting in loss of revenues from oil fields. However, after 1974 there was an increase in private investment and economic growth due to an increase in oil prices and revenues generated from the Suez Canal (Abu-Badar and Abu-Qaran, 2005). The average IVA was 23% during the period 1970-74 which improved to 29% during the period 1975-79. From 1980-84, the average IVA further improved to 33% because this period had many oil price booms. During the time periods of 1985-89, 1990-94, and 1995-99 the average of IVA fluctuated around 30%.

In Equatorial Guinea, the average IVA was quite low at 9% during 1985-89. However, in 1990-94 IVA jumped to 19%, and further to 95% in 2005-09. Equatorial Guinea is a significant oil and natural gas exporter and its oil sector has seen tremendous growth; it increased from 7% of GDP in 1992 to 83% by 2000. The average IVA was high from 2005-09 at 95%, as in 2004, when there was a decrease in oil production and demand for oil was high. Equatorial Guinea had raised their quotas of oil production four times during the same period (AFDB, 2007).[3]

In Gabon, the average IVA improved significantly in 1975-79 to 69%, compared to 51% in 1970-74. Gabon also is a major oil exporting country and oil is the key economic sector, accounting for half of GDP and more than two-thirds of revenue. In the 1980s and 1990s, there was a decline in the average IVA. The economy of Gabon suffered a stagnation in 1998 and 1999 that was due to swings in the prices of oil (Zafar, 2004).

In India, the average IVA was 21% during 1970-74. After that period little advancement was seen in the average IVA as there was no sizable change in the share of manufacturing. It was 16% in 2005 as compared to 14% in 1965. The share of industry remained at the same level around 25% from1987 to 1988 (Papola, 2012). The average IVA in India ranged from 21% to 28% between 1970-74 to 2010-12.

From 1970-74, the average IVA of Indonesia was 25%, which further increased in later years. In Indonesia, oil revenue occupied only 12% of total revenue in 1967, which expanded to around 60% by the middle of the 1970s. The increases in oil price together with the growth in

[3] African Development Bank Research Department documents (2007).

oil production resulted in an increase in petroleum exports. Petroleum accounted for 70% of export earnings, 22% of GDP and 55% of total government revenues (Woo et al., 1994). However, from 1985-89 there was a decline in the IVA to 36% as compared to 40% in 1980-84. Average oil prices during 1985-89 declined to 37.56$ per barrel in contrast to their former price of 80.56$ per barrel in 1980-84. After 1984, there was a significant improvement in the IVA, and the share of industrial sectors increased significantly from 11% in 1960 to 33% in 1995 (World Bank, World Data 1999).

In Jordan, from 1970-74, the average IVA was 20%. After that time, there was progress in the IVA, with the exception of the period 1985-89. During 1985-89, average IVA in Jordan decreased to 25% as compared to 27% in 1980-84. In the early 1980s, there was a boom in oil prices that ended in the second half of the 1980s. The subsequent decline in oil prices resulted in the curtailment of economic activity of the Gulf countries, leading to a drop in demand for Jordanian exports (Kanaan and Kardoosh, 2002).

During 1970-74, the average IVA in Kuwait was between 73% and 74% during 1975-79. Kuwait exports most of its oil production and uses the revenues generated from the oil to purchase expenditures and imports (Al-Yousif, 1997). It experienced high growth rates in oil exports for the period 1970-79 (Central Bank of Kuwait, 2005). [4] However, in the 1980s there was a decrease in the average IVA; Kuwait's economic growth declined, caused by the decrease in oil prices (Merza, 2007).

In Liberia, the average IVA was 40% during 1970-74, which decreases until 2000-04. After 2004, IVA improved somewhat. The period of 1980 to 2003 includes the years of political instability owing to the coup in 1980 and civil war, which ended in 2003. During this peaceful period, the Liberian economy declined dramatically, and the annual growth rate of GDP was -5.2% (World Development Indicators, 2008; and IMF, 2009). After the end of the conflict in 2003, growth significantly increased.

[4] Central Bank of Kuwait. 2005, "Annual Report," *Economic Research Department.*

In Malaysia, the average IVA was 30% during 1970-74. In the 1970s, manufactured exports accounted for a growing share of national output and employment (Ariff, 1998). From 1974 to 2004, continuous and significant progress was seen in the IVA. The manufacturing sector was growing rapidly from 13.9% to 35.5% between 1970 and 1997. From 2005 to 2012, a small drop was witnessed in the IVA due to the 2008-09 global economic crisis. At this time, the demand for Malaysian products in advanced economies dropped significantly, and the boom in oil prices in 2008 had no effect on the Malaysia economy as Malaysia is a net oil exporter (Shah and Wang, 2012).

In Mauritius, the IVA average ranged between 25% and 33%. There was an improvement in the average IVA. In 1975-79, it was 26% and improved further in the 1980s and 1990s. In the 1970s, Mauritius focused on industrialization and became one of the first tax-free zones in the world (Yin et al., 1992). This tax-free zone lead to its industrial development in the 1990s (Dimou, 2004).

In Nigeria, the average IVA fluctuated between 34% and 44% from 1980 to 2012. In 1990-94, there was an increase in the IVA that was 44% as compared to 34% in 1980-89. In 1988-97, as a result of the Structural Adjustment Program (SAP), GDP grew at a positive rate and the agriculture, industry and manufacturing, and oil and gas sectors had a greater contribution in GDP. In 2000-04, the average IVA was 40%. Nigeria benefitted greatly from the oil price boom during the second Gulf War (Aliyu, 2009).

In Pakistan, the average IVA ranged between 22% and 23% from 1970 to 2012. Pakistan imports $13 billion worth of oil every year, which is 70% of total imports (Ahmed, 2011). The increase in import price for petroleum, along with raw materials and other manufactured goods has reduced the country's growth during recent years (Ahmed and Donoghue, 2010). Similarly security issues, political instability, and floods also contributed to the downfall of Pakistan’s economy.

In the Philippines, during the 1970s, economic performance was better, and the GDP growth rate was 6.2%. Despite the oil shocks of 1973, economic performance was still good as

compared to the 1960s (Pante and Medalla, 1990). After the first half of the 1980s, there were fluctuations in the IVA.

In Singapore, from 1980-84, the IVA was 36% compared to 33% in 1975-79. By the end of the 1970s, as a result of industrial base policies and diversification, Singapore gained dominance in the South East Asian region. However, from 1985-89, the average IVA declined. In the 1980s, Singapore faced upward pressure wages driven by the labor markets. This pressure decreased the competitiveness of Singapore's products (Menon, 2007*)*. During the 1990s, IVA remained at an average of 33%.

In South Africa, the average IVA increased from 38% in 1970-74 to 42% in 1975-79, and then to 45% in 1980-84. The first oil price shock in 1973 affected South Africa because it is a net importer of oil. However, despite these shocks, in the 1970s its economy grew at an average annual rate of 4%. After 1990, there was a decline in the IVA. There was also a decrease in the contribution of capital due to a decline in investment, which further slowed the growth of the manufacturing sector during the 1990s (Fedderke and Simkins, 2009).

In Thailand, there was consistent progress in the IVA in 1970-74. During those years, it was 27% and rose to 44% in 2010-12. From 1988-96, the country experienced its highest average growth rate of about 9% (Bank of Thailand). Thailand has an industrialized economy. As a result of industrial policies, there was a tremendous expansion in the industrial production. The financial crisis of the mid-1990s caused a substantial decrease in industrial production. However, industrial production recovered in 1999. Thailand's economy also experienced a boom in oil prices, which affected more the oil-importing economies than the industrialized economies (Jiranyakul, 2006).

In Uganda, the average IVA was low in the 1970s and 1980s. Between 1960-70 Uganda had a vibrant economy, and manufacturing played a key role in maintaining economic growth. In 1971, its industrial output accounted for 14% of GDP but after 1971 the situation changed drastically. Uganda's economy experienced domestic and external shocks (rising prices of petroleum products) which were worsened by improper macroeconomic policies. Thus, industrial production declined by 3.9% per annum between 1983-86 (Kuteesa et.al, 2006).

Ukraine went through an economic policies failure in the early 1990s, after which the average IVA began to decrease. In 1992 and 1994, output dropped, and there was hyperinflation (Hirschhausen, 1996). The value of industry GDP declined from 42.3% in 1991 to 28.4% in 1997, and then the Russian crisis of 1998 caused a decrease in the demand of Ukraine's exports (Dabrowski and Jakubiak, 2003). However, in the early 2000s the economy recovered, but the financial crisis of 2008-09 adversely affected Ukraine's economy.

Vietnam experienced an upward trend in IVA. During 1985-95, the average was 26% and reached 38% in 2010-12. In 2005, Vietnam achieved a GDP growth rate of 8.4%, and 49.71% of that growth was attributable to the industrial and construction sectors.[5]

In Yemen, average economic growth was 3.8% in 2000-2006, with service and industrial growth as the main contributors (Breisinger et al., 2010), the average IVA from 2000-04 was 41%. However from 2010-12 IVA dropped to 29%.

In the early 1970s, the industrial performance of Zambia was very impressive, with an average of 55% during 1970-74. After 1974, a decline in the trend of IVA was witnessed. The oil shocks of 1973-74 and 1978-79 severely affected the Zambian economy. The terms of trade of copper to petroleum declined. Furthermore, the political instability and economic environment of the late 1980s discouraged both private and public investment (Mwanawina and Mulungushi, 2002). The average value added of industrial production was 31% in 1995-99, which further decreased in the 2000s.

[5] General Statistics Office of Vietnam.

Table 2: Standard Deviation of IVA (% of GDP)

Country	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-12
Albania			0.76	1.20	12.65	2.61	1.20	1.35	0.23
Armenia					10.05	0.90	2.17	3.88	2.14
Bangladesh			0.47	0.30	1.26	0.46	0.51	0.58	0.14
China	1.08	1.03	1.95	0.46	2.52	0.81	.60	0.62	0.77
Colombia	1.29	0.63	0.98	1.12	2.52	1.42	1.35	1.00	1.58
Congo, Rep.	1.71	3.38	3.76	9.38	4.43	6.99	4.11	2.60	0.88
Costa Rica			1.05	0.70	0.49	2.60	1.34	0.79	0.55
Cote d'Ivoire	1.51	0.77	1.22	1.14	0.92	1.70	1.21	0.35	
Croatia					1.42	1.31	0.52	0.45	0.25
Dominican Republic	0.91	1.15	0.51	5.26	2.05	0.69	1.12	0.32	0.70
Ecuador	1.23	1.50	1.08	1.21	2.31	0.90	2.09	2.26	1.11
Egypt, Arab Rep.	1.68	3.94	3.85	0.88	1.99	0.59	1.38	0.99	0.95
Equatorial Guinea				0.84	7.45	20.62	1.93		
Fiji	0.75	1.18	1.09	1.78	0.83	1.10	0.63	0.66	0.07
Gabon	7.13	2.25	1.58	11.49	3.94	4.84	2.27	4.13	2.16
Georgia			1.02	1.05	10.55	3.35	1.96	2.12	0.54
Guatemala							0.32	0.46	0.24
Guyana	3.14	0.69	5.18	2.29	4.86	1.73	0.98	4.59	0.46
Hong Kong SAR,							1.17	0.71	0.07
India	0.57	1.07	0.47	0.32	0.50	0.83	1.03	0.52	0.90
Indonesia	6.05	1.69	1.54	1.72	0.61	1.27	1.11	0.63	0.08
Jordan	2.65	0.85	1.51	1.10	1.75	1.29	1.22	2.20	0.52
Kenya	0.36	0.99	0.75	0.44	1.17	0.89	0.48	0.53	0.63
Korea, Rep.	1.75	2.70	1.44	1.07	0.51	0.60	0.88	0.46	0.25
Kuwait	7.23	3.43	8.85	5.13	13.88	4.55	4.37		
Lao PDR				1.47	1.37	2.06	1.47	2.24	
Lesotho	1.40	5.72	3.25	2.09	2.86	3.48	1.29	2.39	1.86
Liberia	1.93	6.78	2.66	2.28	1.15	3.06	1.77	1.16	5.86
Malaysia	2.37	2.07	1.34	0.59	1.04	1.82	1.45	2.24	0.38
Mauritius		0.50	0.91	1.40	0.35	0.53	0.80	0.77	0.79

Mexico	0.56	0.51	0.93	3.29	2.29	0.91	0.97	0.91	0.54
Mongolia			0.85	4.79	3.96	4.60	2.99	4.50	2.36
Nigeria			5.13	6.35	7.27	6.15	7.95	3.59	2.79
Pakistan	0.58	0.60	1.15	0.83	0.45	0.23	1.46	2.76	0.72
Panama			0.71	1.80	1.02	1.00	1.23	0.57	0.59
Paraguay					1.95	0.82	2.28	1.87	1.34
Peru	1.32	4.31		3.68	1.69	0.61	1.34	1.41	1.03
Philippines	1.12	0.94	0.52	0.31	0.87	1.00	0.34	0.80	0.79
Singapore		0.77	0.76	0.58	0.72	0.42	1.32	2.25	0.44
South Africa	1.55	1.95	1.96	1.40	2.11	1.35	0.52	0.53	0.71
Sri Lanka	0.64	0.90	1.48	0.44	0.26	0.47	0.76	0.48	1.07
St. Lucia			2.38	1.30	1.09	0.78	0.79	1.99	0.33
Tajikistan				2.63	4.53	4.81	1.86	1.64	2.87
Tanzania					1.00	2.99	1.59	0.61	0.22
Thailand	0.77	1.82	1.23	1.67	1.48	0.54	0.74	0.51	0.85
Tonga		2.14	1.67	1.07	3.79	1.51	0.86	0.50	0.68
Uganda	1.54	1.68	2.92	0.30	1.07	2.04	1.04	1.24	0.03
Ukraine				0.64	5.41	2.91	0.83	2.89	0.82
Uruguay			0.89	1.15	3.22	1.40	0.77	0.73	1.12
Vietnam				2.62	2.90	2.28	1.23	0.67	0.36
Yemen, Rep.					3.88	5.31	1.88	7.21	
Zambia	4.54	1.71	3.10	2.77	5.35	4.36	1.14	2.00	0.91

Source: Data is taken from World development indicators (WDI) and standard deviations are calculated by the author.

Table 2 shows the degree of variation in industrial production measured by standard deviation. During 1970-74, the standard deviation was highest in Kuwait amongst all other developing countries listed in the table. Kenya's industrial production experienced the lowest variation during this time period (0.36%). The standard deviation during 1975-79 was highest in Liberia (6.78%). In the 1970s, the economy of Liberia did not perform well due to the increase in international petroleum prices and a drop in export prices for major commodities (Radelet, 2007). The standard deviation for Mauritius was low at 0.50%. During this time period, the focus of the Mauritius government was on creating a tax-free zone and industrialization (Yin, et al., 1992).

In 1980-84 and 1990-94 the standard deviation was again highest in Kuwait at 8.85% and 13.88%, respectively. As in the 1980s, Kuwait's economic growth was declining due to the drop in oil prices caused by the fall in demand for oil (Merza, 2007). In 1990-94, the standard deviation was lowest in Sri Lanka at 0.26%.

In 2000-04 the standard deviation was highest in Nigeria at 7.95%. Nigeria benefitted greatly from the oil price boom as a result of second Gulf War (Aliyu, 2009). For the period 2010-12 in Indonesia, the standard deviation is highest relative to other countries (5.86%).

3.2 Trends in Oil Prices

Oil prices fluctuated between 1970 and 2012. The average oil price during 1970-74 was 24.92$. The period 1973-74 had several oil price shocks. Barsky and Kilian (2001) pointed out that these shocks were due to the unilateral termination of the rights of the US central bank to convert dollars to gold (i.e. end of the Bretton Woods system) 1971 and 1973-74, and OPEC's embargo in which Persian Gulf countries doubled the price of oil (Hamilton, 2011).

Table 3: Oil Price ($) Per Barrel

Year	Average oil Price	Standard deviation
1970-74	24.92	19.02
1975-79	58.00	6.58
1980-84	80.56	14.40
1985-89	37.45	11.93
1990-94	30.19	5.95
1995-99	24.86	4.88
2000-04	35.04	5.99
2005-09	72.76	16.01
2010-12	93.05	17.62

Source: US Energy Information Administration (EIA)

In 1978-79 there was an increase in oil prices due to the Iranian revolution. However, average oil prices during 1975-79 were 58.06$ per barrel. The period 1980-84 saw the Iran-Iraq war (1980-81) that resulted in the loss of production in both countries. This production loss led to the second oil shock and a quadrupling in crude prices (Stevens, 2010). The average price of oil during 1980-84 was 80.56$. The price increases of the 1970s caused a decline in petroleum demand in the early 1980s and led to the decline of crude oil prices in 1985-86. The average oil prices in 1985-89 decreased to 37.47$.

From 1990-94, the first Persian Gulf War resulted in low production of oil from Iraq and Kuwait. Consequently, the price of crude oil doubled within a few months. However, these increases in oil price were of short duration.[6] Prices then fell, the average oil price during 1990-94 was 30.19$ per barrel. From 1995-99, the average oil price was 24.86$. The East Asian crisis happened 1997-98 and led to decreases in the price of oil. However, the East Asian crisis ended in 1999-2000, leading to an increase in oil prices to early 1997 levels (Hamilton, 2011). In 2003, general strikes in Venezuela led to a decrease in oil production. The oil price increases between November 2002 and February 2003 were modest and short-lived.

Global economic growth in 2004 and 2005 was quite inspiring, and world oil consumption was growing. The growth in emerging markets, particularly in China, and strong demand pressures were the key reason for the steady increase in the price of oil in 2004. However, the production

[6] Between 1974 and 1978, Saudi Arabia played a key role by acting as a swing producer to balance the market.

of oil was decreasing due to hurricanes in the Gulf of Mexico and instability in Nigeria and Iraq (Hamilton, 2009). Analysts at that time thought that Saudi Arabia would increase oil production, but it did not. All these factors resulted in an increase in oil prices; the average oil price during 2005-09 was 72.76$.

During 2010, global demand grew, but OPEC did not increase output.[7] This failure to increase output by OPEC caused prices to rise in the second half of 2010. At the start of 2011, the events of the Egypt and Libya uprising and losses of supply from Yemen, Egypt, Syria, and Sudan led to an increase in prices. However, OPEC production began to increase in 2011 which first caused the ceiling of the oil price and then the decline. In the second half of 2011, the Euro Zone crisis caused prices to increase. Although the 2012 oil price increases caused demand to decline, OPEC increased production, which resulted in lower prices. Therefore, during 2010-12 there were fluctuations in oil prices, and the average oil price during this time was 93.05$.

4. METHODOLOGY AND DATA

This section is organized as follows: Section 4.1 presents the methodology; Section 4.2 presents the expected relationship of the explanatory variables with the dependent variable based on economic theory; Section 4.3 presents the data and transformation of variables. Section 4.4 presents the estimation technique.

4.1 Methodology

There is a huge amount of literature on the relationship between oil prices and other key economic variables (see, for example, Jiménez-Rodríguez, 2008; Eksi et al., 2011; and Scholtens and Yurtsever, 2012). According to these studies, oil price shocks affect industrial production significantly. For instance, Farzanegan and Markwardt (2008) have shown that positive oil price shocks increase industrial output because of a resulting decrease in the price

[7] The reason was that, during 2010 and for several quarters earlier, oil inventories had been at record five-year-high levels. OPEC's concern was that if this stock overhang came to market, then prices would fall dramatically, as had happened in 1998.

of imported inputs; furthermore, negative oil price shocks decrease industrial output due to the higher prices of imported inputs. Most of the literature is based on the OECD countries and other developed countries. The present study adds to the literature by investigating the impact of oil prices in the context developing countries. For the purpose of analyzing the effect of oil prices on industrial production in developing countries, this study specifies the following model:

$$IND_{it} = \beta_0 + \beta_1 RER_{it} + \beta_2 RR_{it} + \beta_3 TO_{it} + \beta_4 OIL_{it} + \beta_5 GCF_{it} + \beta_6 TOT_{it} + \beta_7 FDI_{it} + \mu_i \quad (1)$$

where,

IND = Industrial production
RER = Real exchange rate
RR = Real interest rate
TO = Trade openness
OIL = Oil price
GCF = Gross capital formation
TOT = Net barter term of trade
FDI = Foreign direct investment
μ_{it} = Error Term
i = 1, 2 …52
t = 1, 2……..42.

4.2 Theoretical justification for the variables

A detailed discussion of the expected relationship between the dependent and independent variables mentioned in the model is presented in this section.

Oil price shocks affect economic activities. Increases in oil prices affect output by reducing the demand of oil. Consequently, an increase in oil prices leads to a rise in production costs, inducing firms to lower output. Moreover, the high production cost leads to an increase in product prices, resulting in a fall in aggregate demand (Jiranyakul, 2006). Similarly, an increase in oil prices also negatively affects oil revenues of exporting countries by reducing the demand of oil and other goods and services from these countries (Bjornland, 2009).

The real exchange rate is another important determinant of industrial production. Increases in the exchange rate lead to an increase in prices of domestic products relative to foreign products,

which raises the international competitiveness of domestic industries and increases output Dornbusch, (1988). Hirschman (1949) and Krugman (1999) argued that exchange rate depreciation affects the level of output of developing countries by raising prices of imported inputs, causing an increase in production costs of domestic firms.

The terms of trade affect industrial production significantly. Expansion in terms of trade that increases exported commodity prices boosts both the value of output and the returns to investment in developing countries. For instance, Jawaid and Waheed (2011) showed that an increase in the terms of trade (the price of exports relative to the price of imports) led to the efficient allocation of resources and, eventually, to enhanced productivity and economic growth. For this reason, this study has incorporated terms of trade as a potential determinant of industrial production.

The interest rate is one of the main factors affecting economic growth. A decline in the interest rate lowers the cost of capital, causing a boost in investment spending and an increase in aggregate demand and output. Therefore, the expected sign of the coefficient for the interest rate is negative.

The degree of trade openness also has a positive effect on the industrial production of developing countries. Trade openness leads to innovations and efficient allocation of resources. It also enables developing countries to gain an advantage from technological advancements and research & development (Coe et al., 1995).

FDI is expected to be positively associated with industrial production. It increases the volume of investment and productivity, leading to higher levels of growth. FDI can also result in positive spillovers to the local economy through linkages with local suppliers, competition, imitation, and training. Moreover, FDI increases the growth rate in the host country through the transfer of advanced technologies. On the other hand, according to Aitken and Harrison (1999), FDI can also negatively affect domestic production. They argued that foreign firms reduce domestic firm productivity through competition effects. Since multinational companies have low marginal costs, they draw demand away from domestic firms, forcing them to reduce their production.

Labor force participation is an important determinant of industrial growth. An efficient workforce along with productive factors enhances output (Spencer, 1971). GCF is also considered an important variable in determining industrial production. It positively affects industrial growth by increasing the physical capital stock in the domestic economy (Plossner, 1992).

4.3 Data and variable transformation

The study employs annual data for 52 developing countries on real interest rate, terms of trade, oil prices, IVA, FDI, the real exchange rate, money supply, GCF, and trade. The countries considered in the study are listed in Table 2.

The data on GCF is in current US dollars and oil price is measured per barrel in constant 2011 dollars. The terms of trade, real exchange rate, labor force, and GCF are in log form, while IVA, trade, and FDI are expressed as a percentage of GDP. The exchange rate is made real by multiplying the official exchange rate with the US consumer price index (2005=100) and then dividing it by the consumer price index of each country. The data on IVA as a percentage of GDP is used as a proxy for industrial production. The study covers the period 1970 to 2012. The data on oil prices is taken from the US Energy Information Administration (EIA) and data for the other variables are extracted from World Development Indicators (WDI).

4.4 Estimation technique

4.4.1 Panel data

The model is estimated by using panel data for developing countries. Since panel data cover cross-section units over time, heterogeneity exists in these units. To solve this problem, a fixed effects model and random effect model are used (Gujarati, 2002).

4.4.1.1 Fixed effects model

As each cross section has some specific characteristics, the fixed effects model is used to account for the individuality (heterogeneity) of each cross-section. We present the following model:

$$Y_{it}=\alpha_{\circ}+ \alpha_1 X_{it}+ \alpha_2 X_{it}+ u_{it} \quad (2)$$

where $i = 1, 2 \ldots N$ and $t = 1, 2 \ldots T$.

The subscript *i* on the intercept term shows that the intercept of each cross section is different. In other words, each cross section has its own intercept term. The differences in intercept terms may be due to the different characteristics of the cross-sectional units. Model (2) is known as the fixed effects model, and the term "fixed effects" means that although each intercept of the cross-sections differs, it is time invariant. Moreover, the fixed effects model is appropriate to use when cross-section specific error terms and independent variables are correlated, that is:

$$E (u_{i,} X_i) \neq 0$$

4.4.1.2 Random effects model

The random effects model is also known as the error component model (ECM). It assumes that the intercept of each cross section is randomly drawn with a constant mean value. The random effect model is best suited when a cross-section specific error term is uncorrelated with the independent variables, that is:

$$E (u_{i,} X_i) = 0$$

4.4.1.3 Hausman test

The Hausman test is used to test whether a random or fixed effects model is suitable for the data. The null hypothesis is that the error term is uncorrelated with the regressors (i.e., the random effects model is preferred), and is tested against the alternative hypothesis that the error term and regressors are correlated.

H_o: $E(X, \mu) = 0$

H_1: $E(X, \mu) \neq 0$

4.4.2 Accounting for the endogeneity of FDI and trade openness

Trade liberalization enhances firm productivity and boosts export performance which, in turn, affect output growth through different channels like the reallocation of resources and the advancement of technology. There are also some opposing views regarding the direction of causality between trade liberalization and growth. Kaldor (1967) pointed out that causality runs from economic growth to exports, while Jung and Marshall (1985) suggested that growth of output leads to growth in exports.

Similarly, there are different views regarding the direction of causality between FDI and output growth. Profit maximization decisions made by foreign investors depend upon the country or sector having higher growth potential and higher technology levels (Hu and Jefferson, 2002; Hale and Long, 2011).

4.4.2.1 Test for exogeneity

To identify whether a regressor is endogenous or exogenous based on the theoretical background and available information, we use the Hausman test of exogeneity. The test consists of three steps. In the first step, the independent variables "trade openness" and "FDI" that are theoretically considered endogenous are treated as dependent variables and regressed on the rest of the independent variables included in the model. In the second step, fitted and residual values of the trade openness and FDI are predicted (this step is conducted individually for FDI and trade openness). Finally, the actual dependent variable (industrial production) is regressed on the fitted and residual values of both variables separately. The null hypothesis of the test is that the regressor is exogenous and the alternative hypothesis is that the regressor is not exogenous (rather, it is endogenous). The results of the test are given in Tables 4 and 5.

5. RESULTS AND DISCUSSION

Using a fixed effects IV regression, this section provides the empirical evidence regarding the effect of oil prices on industrial production of developing countries.

5.1 Hausman test results

The results of the Hausman test are given in Table 6. The p-values indicate the rejection of the null hypothesis of no correlation between the cross-sectional specific error term and the regressor at a 1% level of significance. Therefore, the fixed effects model is a valid model for this analysis.[8]

Table 4: Test of Exogeneity for Trade Openness

IND	Coefficient	Std. Errors	t-statistics	Probability
Fitted	0.097	0.015	6.38	0.000
Residual	0.061	0.009	6.39	0.000*
Cons	22.10	2.107	10.49	0.000

Note: ** shows the rejection of null hypothesis at 1% level of significance*

Table 5: Test of Exogeneity for FDI

IND	Coefficient	Std. Errors	t-statistics	Probability
Fitted	0.248	0.064	3.86	0.000
Residual	-0.025	0.029	-0.84	0.400
Cons	30.26	1.555	19.46	0.000

The probability value of the trade openness residual given in Table 4 shows the rejection of the null hypothesis. Therefore, the regressor suffers from an endogeneity problem. Conversely, the probability value of FDI residuals presented in Table 5 shows the acceptance of null hypothesis, which means FDI does not have a problem with endogeneity.

[8] The hypothesis tested is: H_0: $E(X, \mu) = 0$ and H_1: $E(X, \mu) \neq 0$.

5.2 Instrumental variable regression

In order to obtain a regression function in which the regressor (X_i) is not correlated with the error term (u_i), the (IV) technique is used. The instruments are the variables that are uncorrelated with the error term but correlated with the regressor (Stock and Watson, 2010), i.e.

$$\text{Corr}\ (Z_i, X_i) \neq 0$$

$$\text{Corr}\ (Z_i, u_i) = 0$$

So, in order to get around the endogeneity problem caused by trade openness, this study applies IV regression with a fixed effects approach using a one-time lagged variable of trade openness (T1) as an instrument for itself.

Table 6: IV Regression, Fixed Effects

Model: Dependent variable: *IND*

Variables	Coefficients	Std. Errors	t-Statistics	Probability
TO	0.10	0.01	7.37*	0.00
FDI	-0.07	0.02	-2.87*	0.00
RR	0.06	0.01	-3.49*	0.00
LLB	2.37	0.91	2.60**	0.00
LOIL	-1.57	0.48	-3.22*	0.02
LRER	2.28	1.02	2.22**	0.00
LGCF	1.31	0.22	5.67*	0.00
TOT	0.10	0.009	10.95*	0.00
CONS	-56.50	14.23	-3.97	0.00
R-Squared	0.26	-	-	-
F-statistic	60.66	-	-	0.00
Hausman test	-	-	-	0.00*
Instrumented:	TO			
Instruments:	FDI, RR, LLB, LOIL, LRER, LGCF, TOT, T1,			

***Note**: **denotes significance at 1% level*
*** denotes significance at 5% level.*

The R-square is 0.26%, showing that a 26% variation in industrial production is explained by the independent variables. The F-statistic shows that the overall model is significant at the 1% level of significance.

The results of the fixed effects model indicate that trade openness has a positive and highly significant (at 1% confidence level) impact on industrial production. A one percent increase in trade openness leads to an increase of approximately 0.10% in industrial production. This result indicates that trade openness increases industrial production through export- and import-led growth channels. Export-led growth results in innovations and an efficient allocation of resources, and import-led growth accelerates domestic production and enables developing countries to gain an advantage from it. This result agrees with the findings of Halicioglu (2007) and Dutta & Ahmed (2004) that trade liberalization has a significant and positive impact on industrial production.

FDI has a negative impact on industrial production, which is also significant at the 1% level of significance. A one percent increase in FDI will bring about a 0.07% decrease in industrial production. This finding validates the theoretical argument given by Aitken and Harrison (1999) that FDI can also negatively influence domestic production because a multinational may cause a decrease in domestic production (see Section 4.2 for further discussion). Moreover, FDI likely does not encourage domestic production because raw materials and other inputs are obtained within the multinational enterprise and their foreign suppliers rather than domestic suppliers. This dynamic causes a decline in the production of domestic suppliers. The coefficient of FDI is significant at a 1% level.

GCF has a positive impact on industrial production, which is also significant at the 1% level. The magnitude of the coefficient shows that a one percent increase in GCF results in an increase in industrial production of approximately 1.31%. This finding highlights the important role of GCF in industrial output economic growth by boosting physical capital accumulation in the economy or by advancing technology. This result concurs with the findings of Anderson (1990) who concluded that investment is a key factor in increasing output growth if it is utilized proficiently.

The labor force also has a positive impact on industrial output and it is found to be significant at a level of 5%. The magnitude of the coefficient shows that a one percent increase in the labor force will bring about a 2.37% increase in industrial production. A resourceful labor force in combination with other productive components brings about significant improvement in output (Spencer, 1971).

The real interest rate has a negative and significant impact on industrial production, and a one percent increase in the real interest rate leads to a 0.06% decline in industrial production. As the interest rate increases demand for investment falls, which lowers industrial output. These results are in accordance with Bredin and O'reilly (2004) who examined the impact of interest rates on output and found that a temporary monetary contraction (increase in money supply or decline in the interest rate) leads to a decline in output.

The coefficient of terms of trade carries a positive sign, which shows that a one percent increase in the terms of trade will cause approximately a 0.10 % increase in industrial production. The improvement in commodity prices leads to an increase in returns to investment and value of output. Moreover, an increase in the terms of trade, which is defined as the price of an export relative to the price of imports, leads to the efficient allocation of the resource and eventually enhances productivity and economic growth. These results are in accordance with Jawaid and Waheed (2011) and Bleaney & Greenaway (2001). These studies suggested that an increase in price of exports boosts the rate of return on investment and improves economic growth. The coefficient for the terms of trade variable is significant at the 1% level.

The real exchange rate also has a positive impact on industrial production and is significant at the 1% level of significance. The magnitude of the coefficient indicates that a one percent increase in the real exchange rate will lead to approximately a 2.28% increase in industrial production. These results are the same as those reported by Choudhary and Chaudhry (2007) who suggest a positive relationship between the real exchange rate and output. Their study complements the findings of Dornbusch (1988) that an increase in the real exchange rate makes the price of domestic products relatively cheaper. Therefore, an increase in the international

competition of domestic industries increases the country's exports of domestically produced goods and improves output levels.

As expected, oil prices have a negative impact on industrial production and is found to be significant at the 1% level. The magnitude of the coefficient indicates that a one percent increase in oil prices leads to approximately a 1.57% decrease in industrial production, justifying the theoretical argument that an increase in oil prices adversely affects economic activity. In other words, an increase in oil prices leads to an increase in production costs and lowers output. Furthermore, an increase in oil prices through an increase in the price of products also results in a decline in aggregate demand for output. On the other hand, an increase in oil prices affects the economy of oil-exporting countries by reducing the demand of oil and other goods and services of oil-importing countries. These results are in accordance with the empirical studies of Wang and Zhang (2014) and Ojapinwa and Ejumedia (2012).

The results of the fixed effects model also show that the size of the impact of oil prices on industrial production is quite large relative to other variables included in the model. Its size is only second to the coefficient for the real exchange rate. The magnitude of the coefficient highlights the importance of oil prices in determining industrial production in developing countries. The coefficients of both the real exchange rate and the labor force also have a relatively high magnitude, which may be because many developing countries are labor abundant and labor costs are relatively low. Similarly, improvements in the real exchange rate create competition among foreign and domestic products by making the exports of the domestic country relatively cheaper relative to the exports of foreign nations.

6. CONCLUSION AND RECOMMENDATIONS

This study analyzes the impact of oil prices and other key variables on industrial production in the case of developing countries. We used the panel data of 52 developing countries covering the time span of 1970 to 2012. To remove the endogeneity problem caused by trade openness, a fixed effects IV regression technique is used. Oil prices have a negative and significant

impact on industrial production. Furthermore, the magnitude of the coefficient, which is considerably large, indicates the importance of oil prices in determining the industrial production of developing countries. Considering the importance of oil prices and the real exchange rate, this study indicates that both industrial production and overall economic growth in developing countries are susceptible to oil price shocks. They are affected by oil price shocks mainly because they rely heavily on oil, which makes a major part of their cost of imports.

Variables other than oil prices, such as the degree of trade openness, FDI, terms of trade, the real exchange rate, the labor force, GCF, and the real interest rate also have a significant relationship with industrial production. Trade openness through innovation and efficient allocation of resources enhances industrial production. Similarly, FDI negatively affects industrial production of the host countries by creating competition between the foreign companies as their marginal cost is low relative to their domestic peers. Improvements in the terms of trade lead to an increase in returns to investment, promoting industrial production. Moreover, an increase in the real exchange rate leads to a decrease in export prices; it creates competition and boosts the level of export and output. GCF encourages industrial production by increasing physical capital stocks in the domestic economy. While the increase in the real interest rate decreases, industrial production decreases through the increase in the cost of investment. A productive labor force significantly and positively affects the industrial production of developing countries.

This study has some important policy implications that may help lessen the effects of oil shocks on industrial production. Firstly, it is essential to improve the oil reserve system in developing countries to reduce vulnerability to oil shocks, as most developing economies are dependent on oil imports. Secondly, and most importantly, alternative sources of energy such as biofuels and solar power plants should be developed to reduce dependence on and consumption of oil. Thirdly, to boost investment for production purposes, the interest rate should be kept low, specifically for industry. Fourthly, the industrial base of developing economies is not strong when compared to that of industrialized countries. Measures should be taken to keep the real exchange rate at a level that benefits the domestic production and export activities of developing economies.

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